Fraunhofer
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FRAUNHOFER INSTITUTE FOR INTEGRATED CIRCUITS IIS

ANNUAL REPORT 2010

Annual Report 2010
Fraunhofer Institute for
Integrated Circuits IIS

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PREFACE

Fraunhofer IIS has survived the financial crisis well. The 25th anniversary of both Erlangen-based Fraunhofer Institutes IIS and IISB could therefore be made into a well-deserved highlight of summer 2010. The decision to celebrate this anniversary together was perceived, both by the outside world as well as amongst employees, as a clear indication of the positive cooperation developing between both institutes. Martin Zeil, Bavarian State Minister for Economic Affairs, Infrastructure, Transport and Technology, as well as more than 200 high-ranking representatives from politics, science and economy accepted our invitation. The many achievements were acknowledged in the official celebrations presented by Ursula Heller (Bavarian television). On behalf of the employees, both directors gratefully accepted the numerous commendatory speeches. Their own contributions particularly highlighted their outlooks for the future.

The good news arrived on January 26, 2010: "The application from the European Metropolitan Region Nuremberg is one of the winners of the BMBF Leading Edge Cluster Competition". Here, Fraunhofer IIS is represented by several projects. The decision was preceded by intensive conceptual preliminary work, difficult coordination processes and an elaborate application. In combination with the contributions of the industrial partners, the project has a total volume of over 80 million euros. The exceptional commitment of all participants, but particularly that of both speakers Prof. Reinhard and Prof. Schüttler, was a decisive factor in the success of the project. Thank you very much!

The appointment of two leading employees has taken the strategic cooperation with universities to a new level. Prof. Randolf Hanke was appointed to the Chair for Material Characterization at the Julius Maximilian University of Würzburg. In addition to being responsible for the location in Fuerth, he also manages the newly founded Fraunhofer Project Group "Nano X-ray Systems", which was also set up in Würzburg.

Prof. Jürgen Herre was appointed "Audio Coding" professor at the University of Erlangen-Nuremberg. The university has created six new chairs as part of the founding of the "International Audio Laboratories Erlangen (AudioLabs)", which established close cooperation between the University of Erlangen-Nürnberg and Fraunhofer IIS in the field of audio technologies. Two more colleagues were able to be appointed in addition to Prof. Herre: Prof. Edler of the TU Hannover and Prof. Habets from the Imperial College London. Herre also assumes an important bridging function in Fraunhofer IIS to coordinate the close cooperation between both institutions.

Two new departments have developed from the previous Electronic Imaging department. Dr. Siegfried Fößel manages the "Moving Picture Technologies" department and Dipl.-Ing. Stefan Gick took over the area of Camera Technologies and Image Evaluations. The previous term Electronic Imaging was adopted as the name for his department. Investigations in the field of optical image recording with CMOS image sensors led to new information relating to achievable resolution and speed. Experiments carried out so far have encouraged us to begin designing a new image sensor.

The work on mastering the design of highly complex and heterogeneous systems under boundary conditions represents an important activity in the Dresden branch. Of particular importance in this context was the decisive cooperation involved in the design standard SystemC AMS for the modeling and efficient simulation of analog and mixed-signal systems on various levels of abstraction, which was able to be approved this year.

The media has received the start of the test mode for "OPAL Health" in the University Hospital Erlangen with great interest. This project tests sensor networks under practice conditions. This allows cold chains in stored blood to be monitored and patients to be clearly identified.

Prof. Dr.-Ing. Heinz Gerhäuser and Prof. Dr.-Ing. Günter Elst (from left)

In countless elaborate coordination and preparatory meetings, representatives of the city of Nuremberg, the University of Erlangen-Nuremberg, the Georg Simon Ohm University of Applied Sciences, Fraunhofer IISB and Fraunhofer IIS have developed the large research project "Energiecampus Nürnberg". The project is sponsored by a special Bavarian program with a total of 50 million euros. The first grant approvals can be expected in 2010.

The continued development of Fraunhofer IIS is also reflected in construction plans and construction operations in Fuerth, Nuremberg, Erlangen, Würzburg and Waischenfeld.

In Fuerth, the new test hall at the Atzenhof location, which carries out X-ray examinations on large objects with a linear particle accelerator, is almost complete. A second construction stage in the next few years will see the erection of another institute building. Construction operations for a test hall for research into communication and localization systems which offers controlled test conditions for characterization and evaluation are beginning in Nuremberg. After its completion, a Fraunhofer institute building will also be constructed in immediate vicinity in Nuremberg.

In Würzburg, the university is providing rooms for the newly founded Fraunhofer Project Group "Nano X-ray Systems", which are being reconstructed as part of a small building operation. A test facility for field experiments has been created at the headquarters in Tennenlohe, whereby a few urgently needed visitor car park spaces were also constructed. The Fraunhofer research campus Waischenfeld is entering the planning stage. A particularly attractive architectural design was selected from several suggestions. The start of construction for this project is planned for mid 2011.

The IIS has been awarded the Fraunhofer PR prize for a third time. Representing the entire team, Patricia Petsch accepted the treasured trophy for the project "Students' Pages on the Internet" from the President Prof. Bullinger. Under the supervision of our PR experts, students developed a website, in which they used their own words to describe the research topics of Fraunhofer IIS and their significance for society from the students' point of view.

The tenth anniversary of the Chair for Information Technologies (LIKE) presented a good opportunity to point out the close cooperation between the university and Fraunhofer IIS. In the course of this, a new transmitter location was commissioned in the joint research project "DVB-H". The chimney of the thermal power plant of the Erlanger Stadtwerke (public utilities) proved to be an excellent location. At 140 m high, the antenna mounted there supplies the long-range Erlangen and its surroundings with digital wireless operation.

We would like to thank our employees for their excellent work during these difficult times. They have all significantly contributed to our economic and scientific success. We would like to thank our clients and public investors for trusting in our work and for the many challenging projects.

Executive Director
Prof. Dr.-Ing. Heinz Gerhäuser

Director
Prof. Dr.-Ing. Günter Elst

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PROFILE

Key Facts

Headed jointly by Prof. Dr.-Ing. Heinz Gerhäuser and Prof. Dr.-Ing. Günter Elst, the institute develops microelectronic systems and devices, including the associated circuits and software. Founded in 1985 and headquartered in Erlangen with branches in Nuremberg, Fuerth, Dresden and Ilmenau, the Fraunhofer Institute for Integrated Circuits IIS is the largest institute of the Fraunhofer-Gesellschaft.

amount of work goes into new audio and video coding schemes and establishing them as international standards. Fraunhofer IIS has gained worldwide recognition for the development of the MP3 and MPEG-AAC audio formats. Derived formats such as MP3 Surround or MPEG-Surround even provide surround sound through stereo headphones. In the video area, DVB-H (Digital Video Broadcasting Handheld) makes it possible to broadcast television content to mobile devices such as cell phones or PDAs. Another important strand of work is concerned with the digital

THE FRAUNHOFER INSTITUTE FOR INTEGRATED CIRCUITS IIS UNTERTAKES RESEARCH AND DEVELOPMENT WORK FOR BUSINESS AND PUBLIC INDUSTRY.

Scientists at Fraunhofer IIS do research in the fields of microelectronics, information technology, telecommunications, audio and multimedia technology, digital broadcasting, digital cinema, RF technology, positioning and route guidance, satellite navigation, medical engineering, automation in machine and plant construction as well as in the area of supply chain services.

The institute develops wireless communication systems, particularly digital broadcasting systems, which includes the implementation of pre-production prototypes. A significant

Fraunhofer IIS headquarters in Erlangen-Tennenlohe

future of cinema technology. Image acquisition and pattern recognition are key components of industrial quality control and automation as well as of many types of medical equipment.

For these purposes, intelligent image sensors, high-speed cameras and nanofocus X-ray systems are developed. Further research topics in medical engineering include health telematics as well as communication and sensor solutions for remote patient monitoring.

The institute co-founded the Fraunhofer "Personal Health" Innovation Cluster, which pools expertise and, through its Medical Technology Test and Demonstration Center, accelerates the conversion of new solutions into products and

applications. Fraunhofer IIS is also involved in the new leading edge cluster "Medical Valley European Metropolitan Region Nuremberg EMN". The departments Integrated Digital Terminals IDT and Communications NUE as well as the Project Group for Wireless Distribution Systems/Digital Broadcasting DVT are concerned with digital broadcasting systems and their applications. In the second half of 2010, the Fraunhofer X-ray Systems for Material Characterization Project Group was founded in close cooperation with the new chair for Material Characterization Using X-ray Microscopy, faculty of Physics and Astronomy at Julius Maximilians University of Würzburg.

The research unit on positioning and communication at the "Forschungsfabrik" laboratory in Nuremberg and the Development Center for X-ray Technology in Fuerth continue to reinforce their reputation as centers of excellence. Over the next few years, several modern centers dedicated to research into these areas will be built on newly purchased land. In addition, 2009 has seen the creation of the Department of Process-Integrated Inspection Systems, which is located in Fuerth and specializes in the inspection of components and castings at the production level. Combining the latest scientific work with field-tested engineering concepts generates innovative solutions for logistics and supply chain management. The Fraunhofer Working Group on Supply Chain Services in Nuremberg creates this synergetic connection for clients from industry, services and public bodies, while the Center for Intelligent Objects ZIO carries out interdisciplinary research into new identification, communication and positioning technologies and develops them for practical implementation.

Based in Dresden, the Design Automation Division EAS, with its Departments of Heterogeneous Systems, Mixed-Signal Systems and Digital Systems, carries out R&D work for computer-aided design of electronic and heterogeneous systems. It develops application-specific methods and tools for modeling, simulation, synthesis, optimization, verification and testing.

In the field of audio and multimedia technology, Fraunhofer IIS collaborates closely with the Fraunhofer Institute for Digital Media Technology IDMT in Ilmenau and with Fraunhofer USA's Digital Media Technologies Division, based in San José, CA.

Fraunhofer IIS is a member of the Fraunhofer Group for Microelectronics and a guest member of the Groups for Information and Communication Technology and for Defense and Security. In addition, it is a member of the Fraunhofer

WE HELP OUR DOMESTIC AND OVERSEAS CLIENTS BECOME GLOBALLY COMPETITIVE BY WORKING WITH THEM TO DEVELOP INNOVATIVE CONCEPTS, SOFTWARE, DEVICES AND SYSTEMS.

"Vision" and Digital Cinema Alliances, whose coordination and liaison offices are located at the institute's Erlangen headquarters, as well as the Alliances for Adaptronics, Ambient Assisted Living, Food Chain Management, Grid Computing, Energy, Numerical Simulation of Products and Processes, Wind Energy and Traffic and Transportation.

In a variety of areas, Fraunhofer IIS cooperates closely with Friedrich-Alexander University, Erlangen-Nürnberg, whose Department of Information Technology with a Focus on Communication Electronics is headed by Prof. Heinz Gerhäuser and also housed at headquarters. The collaboration involves a large number of departments, institutes and centers, including the Erlangen faculty of Humanities, not least in connection with the "Zukunftswerkstatt" interdisciplinary seminar on digital broadcasting.

Mission

We help our domestic and overseas clients become globally competitive by working with them to develop innovative concepts, software, devices and systems. Our approach is service-and client-oriented. We consistently develop our most valuable resource, providing specific additional training to our staff so as to improve their already high level of expertise.

We communicate our capabilities through scientific publications as well as presentations at conferences and trade shows. Our inventions are patented both nationally and internationally and are licensed non-exclusively whenever possible.

Research, development and services

We analyze our clients' problems and suggest possible courses of action. The services we offer range from technical consulting to the conduct of studies and the development of solutions. We always prepare a specific implementation plan, ideally in conjunction with future users. We carry out projects such as the development of a product prototype in accordance with the schedule and targets set by our clients. We liaise with semiconductor manufacturers and can broker partnerships. Using our own X-ray and other facilities, we also provide testing and measurement services. Our offer is broken down into separate services, which means that client requirements can be flexibly accommodated.

BUDGET AND FINANCE

Dr. rer. pol. Peter Dittrich | +49 9131 776-2000 | peter.dittrich@iis.fraunhofer.de

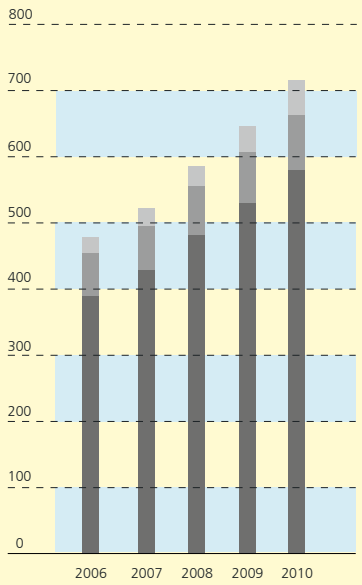
Human resources, operating and investment budget

The Halle Institute for Economic Research (IWH) considers the German economy to be in a surprisingly good condition after the global financial crisis. The trend which has been indicated in the last few months is becoming a certainty: the German economy is gradually recovering. In view of the upturn in many German businesses, the IWH has considerably increased its outlook for growth in Germany from 2.0 to 2.5 percent. This positive development also has an impact on the incoming orders at Fraunhofer IIS, even if this does come with a delay of approx. three to nine months.

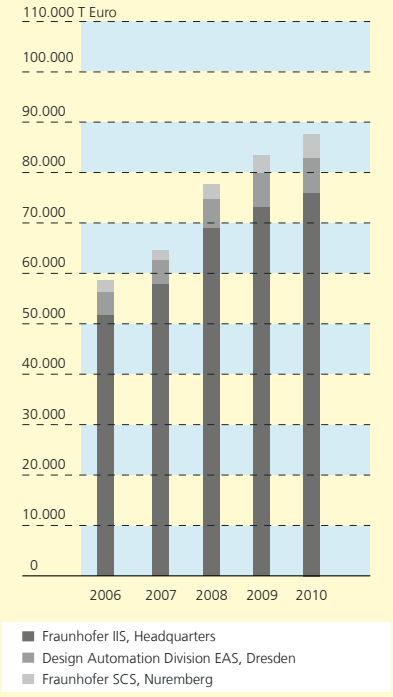
Human resources

Just as in previous years, the institute is continuously being developed at the locations of Erlangen, Nuremberg, Fuerth, Ilmenau and Dresden. The expectation that an increased number of qualified applicants would become available as a result of the economic situation in Germany has only been partially fulfilled. The research area of audio coding is registering the greatest growth, just as in previous years.

Staff Development



Operating Costs



Operating budget

At present, a series of new topics are being integrated into Fraunhofer IIS. These are actively supported by public sector funds, especially in the initial phase. This results in a shift in the earnings from industry and economy to public funds. This trend will reverse again the next few years.

24% of the institute's financing comes from basic funding through the Fraunhofer-Gesellschaft, 50% from funds from industry and economy and 26% from public and other revenues.

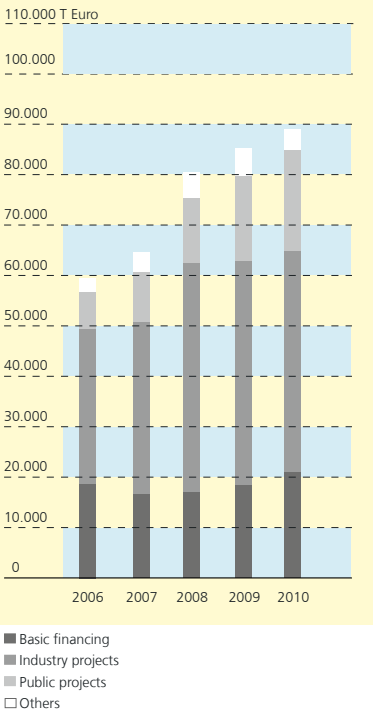
At least a balanced budget is expected at the end of 2010.

Investment budget

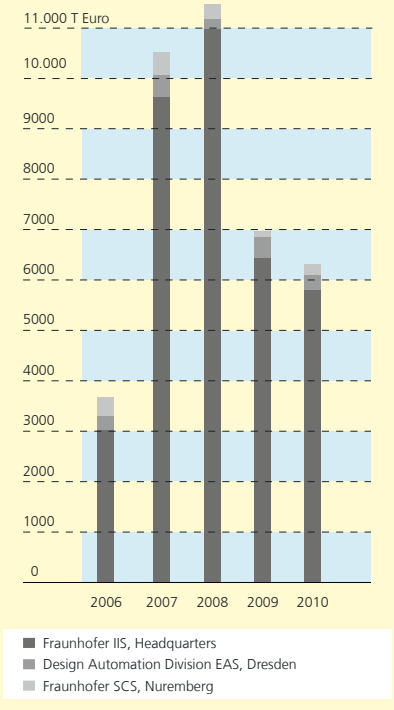
Both qualified staff and continuous investment are necessary in order to sustain one's position against the global competition. In accordance with the profile of the institute, the expenses for computers, software and high-quality design software, in connection with an efficient network, represent the main items of expenditure.

The investment budget is comprised of basic funding as well as revenue from projects and licensing. In 2007 and 2008, high initial funding was required as a result of moving into the new building. A considerably higher investment ratio is therefore to be registered during these years.

Budget Financing



Investment Budget



ORGANIZATION AND CONTACTS

Board of Directors
Prof. Dr.-Ing. Heinz Gerhäuser (Executive Director)
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Director Administration
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Departments

Audio
Dr.-Ing. Bernhard Grill

Contactless Test and Measuring Systems
Dr. rer. nat. Peter Schmitt

Moving Picture Technologies
Dr.-Ing. Siegfried Fößel

Imaging Systems
Dipl.-Ing. Stefan Gick

Image Processing and Medical Engineering
Dipl.-Inf. Christian Weigand

Development Center for X-ray Technology
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Dipl.-Ing. Josef Sauerer

IC-Design – Digital Systems
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Dipl.-Ing. Jürgen Hupp

Power Efficient Systems
Dr.-Ing. Günter Rohmer

Multimedia Realtime Systems
Dipl.-Ing. Harald Popp

Communications
Dipl.-Ing. Ernst Eberlein

Process Integrated Inspection Systems
Dr.-Ing. Thomas Wenzel

Project Groups

Adaptive System Software
Prof. Dr.-Ing. Wolfgang Schröder-Preikschat
(Universität Erlangen-Nürnberg)

Wireless Distribution Systems/ Digital Broadcasting DVT
Prof. Dr.-Ing. Albert Heuberger

Hardware-Software-Co-Design
Prof. Dr.-Ing. Jürgen Teich
(Universität Erlangen-Nürnberg)

Net Access Technology
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Dipl.-Ing. Peter Heusinger

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Dr.-Ing. Norbert Weber

X-ray Systems for Material Characterization
Prof. Dr.-Ing. Randolf Hanke

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Processes
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Technologies
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Center for Intelligent Objects
Dr. rer. pol. Alexander Pflaum

Division Design Automation Dresden EAS
Prof. Dr.-Ing. Günter Elst

Heterogeneous Systems
Dipl.-Ing. Peter Schneider

Mixed-Signal-Systems
Dr.-Ing. Manfred Dietrich

Digital Systems
Dr.-Ing. Steffen Rülke

Services

Administration
Dipl.-Kauffrau Sonja Ludwig

IT-Services
Dr.-Ing. Roland Plankenbühler

Press and Public Relations
Dipl.-Sozialwirt Marc Briele

Political Communication
Dipl.-Designerin Melanie Oßwald MdB a. D.

International Business Development
Dipl.-Ing. (FH) Martina Spengler MBA

Human Resource Training and Development
Dipl.-Germ. Katrin Schwendner

Change Management
Dipl.-Math. Christine Mertelmeier

Vision Alliance
Dipl.-Ing. Michael Sackewitz

Digital Cinema Alliance
Dr.-Ing. Siegfried Fößel

Knowledge Management
Ulrich Försterling, M. A.

ADVISORY COMMITTEE

The Advisory Committee supports the board of directors of the Fraunhofer-Gesellschaft as well as the institute's management concerning strategic developments. The Committee Members provide an interconnective network with industry and local organizations:

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Committee Chairman

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Vice President SES ASTRA S.A.

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Dean of the Technical Faculty
University of Erlangen-Nürnberg

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Federal Ministry of Economics and Technology

Ministerialdirigent Dr. Gerd-Achim Gruppe
Bavarian Ministry for Economic Affairs, Infrastructure, Transport and Technology

Dr. Klaus Heller
Federal Ministry of Education and Research

Markus Lötzsch
Managing Director
Nürnberg Chamber of Commerce and Industry

Dipl.-Ing. Gerhard Schaas
Chief Technology Officer and Member of Executive Board
Loewe AG

Dr. Ernst F. Schröder

Prof. Dr. Reinhard Schüttler
Dean of the Faculty of Medicine
University of Erlangen-Nürnberg

Ministerialrat Dr. Reinhard Zimmermann
Saxon Ministry of Science and the Fine Arts

State: October 2010

COMPETENCIES

Imaging Systems / Moving Picture Technologies

- Cameras and CMOS image sensors
- 3D camera technology
- Digital Cinema
- Postproduction tools
- Digital movie archives
- Data compression
- Mobile storage/fieldrecoding
- Embedded Imaging
- Cognitive systems
- Persona-, object recognition
- Scene analysis and detailed face analysis
- 3D modeling and reconstruction

Image Processing and Medical Engineering

- Real-time systems for pattern recognition and texture analysis
- Knowledge-based image processing
- Computer-assisted microscopy
- Computer-assisted diagnosis for mammography, endoscopy, dermatoscopy, colposcopy, sonography
- Evaluation of macro- and microscopic images from biological samples (cells, textiles) as basis for findings
- Processing and analysis of endoscopic and microscopic images
- Miniaturized sensor systems for vital parameters monitoring
- Signal processing algorithms for vital parameters
- Mobile, wearable systems for health
- Wireless communication and sensor networks
- Clinical trials, health services research
- Validation of medical devices and systems

IC-Design
Analog Systems

- High speed ASIC design
- RF-ASICs for communication technology
- ASIC prototypes and tested small batch series
- Analog-to-digital converters, complex mixed signal ASICs
- Sensor signal processing for measuring and control technology
- Sensor systems for standard processes (light, magnetic field, electricity)
- Intelligent sensor systems
- Development of magnetic position measuring systems
- Development of vertical Hall Sensors
- Design of optical systems
- Optoelectronic design

IC-Design
Digital Systems

- Mixed-signal and digital IC design, system on chip design with processors (Field Programmable Gate Array- and ASIC-Design)
- Specification and design of system on chip (SoC) and platform solutions based on microprocessors
- Energy supply and –management for electronic components with lowest power consumption
- Intelligent components for measurement and control (energy efficient integrated circuits)
- Energy efficient information- and communication technology:
  - Intelligent concepts for always-on devices
  - Green embedded systems and Energy efficiency management
  - Embedded systems based on Java

COMPETENCIES

Communications

- System design for communications: High level system simulation, system design and development of algorithms, simulation on hardware-level
- Implementation of communication systems in hard- and software
- Transmitters, receivers, test and measurement as well as fieldtesting for digital broadcasting systems
- Analysis and validation

Integrated Digitale Terminals

- System specification of digital transmission systems and their terminals (receiver or modem)
- Specification and development of hardware and/or software-based receiver and terminal architectures and their components
- Integration of hardware and software components into receiver and terminals
- Test and qualification of receivers and terminals within qualified test environments
- Development of receiver and terminal reference models for the efficient and smooth mass production
- Support for final product verification

Audio

- Coding of audio and video signals
- Mulitmedia applications, portable and mobile terminals
- Audio and video transmission via ISDN and IP networks, DVB-H
- Signal processing for multimedia applications
- MPEG-4 system solutions
- Surround audio solutions
- Sound quality assessment
- Identification of audio signals
- Intellectual property management and protection
- Broadcast server for digital broadcasting systems
- Modules for digital broadcasting systems, Internet radio
- Semantic audio processing
- Data service for digital broadcasting

Multimedia Realtime Systems

Real-time implementations of audio and video coding schemes (mp3, mp3 Surround, mp3D, MPEG-4 audio/video, high quality voice over IP, Acoustic Echo Control AAC, MPEG Surround, DAB+, DRM incl. DRM+) for:

- Personal computers
- PDAs
- Digital signal processors
- Embedded controllers
- Streaming of multimedia content

Wireless Distribution Systems / Digital Broadcasting

- Channel modeling for terrestrial and satellite based communication
- System design for mobile satellite communication
- Test systems for mobile satellite communication in Ku and Ka band

RF and Microwave Design

- Simulation and development of RF systems from prototype to product
- Design of miniaturized RF circuits
- Design and linearization of RF power amplifiers
- Simulation and design of antennas
- Simulation of electromagnetic fields
- Wireless positioning systems

- Wireless data transmission, Body Area Network, Sensor networks, RFID

Contactless Test and Measuring Systems

- X-ray detectors fully protected against radiation damage, dual energy technologies, contactless weighing, design of scanner systems
- Hardware: HW-based image processing, CCD cameras, low-noise electronics, embedded systems, turn-key industrial test and measuring systems, 3D CAD
- Sheet-of-light 3D imaging, optical design for laser scanners
- 3D Color scanning
- High-speed 3D measurement and classification of bulk foods
- Sensor fusion
- Simulation and design of optical systems
- Spectroscopic imaging
- Distributed software systems

Development Center for X-ray Technology and Process Integrated Inspection Systems

- X-ray image processing
- Embedded X-ray image processing
- X-ray detectors and sensor systems
- System integration for turn-key industrial systems
- Volume computed tomography
- Digital tomosynthesis
- Laminography
- Metrology using computed tomography
- Nanofocus X-ray systems
- Dual energy X-ray material characterization
- Refractive X-ray imaging
- X-ray microscopy
- Automatic X-ray inspection systems for solder inspection, aluminum wheels, welding inspection, food, plastics, ceramics, cast parts, fiber composites
- Optically or ultrasound excited lock-in thermography for inspection of light-metal cast parts and fiber composite materials
- Automatic ultrasound inspection of semi-finished steel parts, forged parts and fiber composite materials (by inverse phase adaption). Mechanized inspection of power plant components.
- X-ray simulation
- Industrial image processing systems for manufacturing
- Real-time systems for surface inspection, pattern recognition and texture analysis
- Inspection of bore holes, cavities and pipes
- Error localization in transparent pipes

Communication Networks

- Longstanding experience in the development of systems and protocols for wireless networks
- Software development for distributed cooperative systems
- Development of communication protocols and hardware for wireless communication networks in accordance with the DECT standard and its enhancements
- Software-based solutions for autarkic localization in cellular wireless networks
- Environment modelling for buildings
- Measurement and monitoring tools for communication networks
- Development of protocols for cooperative and interoperative systems
- Energy awareness
- Hard- and software development for self-organizing wireless sensor networks
- Type approval and preparation of series production of radio modules

COMPETENCIES

Power Efficient Systems

- Power/battery management
- Battery monitoring
- Power supplies
- Wireless energy transmission
- Energy Harvesting
- Voltage converters
- Low power circuit design
- System design and simulation
- Hardware and software components for satellite navigation receivers and localization systems
- High precision satellite navigation receiver
- Supporting systems for high precision applications (WITRACK-pseudolites)
- Solutions for indoor navigation systems with inertial sensors
- Seamless indoor and outdoor navigation systems based on inertial sensors
- Seamless navigation systems based on GPS, WLAN and inertial sensors
- Components for digital transceiver architectures
- Reconfigurable and multistandard systems
- Development of system software

Fraunhofer Working Group on Supply Chain Services SCS

Market and location research: Experts for the logistics market

- Market intelligence: Experience gained over decades as the basis for cutting-edge knowledge on the logistics market
- Market and competition analysis: Scientifically based analyses for customer-tailored strategic positioning
- Consultancy: Know-how on the market for sustainable market success

Decision support systems: Excellence in planning of logistics networks

- Network configuration: The combination of individualized tools and know-how on the market allows the identification of optimum network structures
- Decision support and algorithm engineering: Solutions for logistic problems elaborated with mathematical expertise
- Development and consultancy: Optimization of strategic decisions with model-based quantitative support

Process management in logistics and transport: Optimization of processes within the supply chain

- Benchmarking: Neutral assessment of logistic processes by means of science-based databases
- Streamlining: Industry and sector comparison to support the implementation of process improvements
- Organization development: Development of lean and efficiently structured organizational concepts

Center for Intelligent Objects (ZIO): Solutions for smart objects

- Market intelligence: The Technology Radar provides reports and forecasts on innovations regarding smart object technologies
- Technology coaching: Profound technology know-how as the basis for consultancy in the selection of the right smart object systems
- Development: Target-oriented further development of hardware and software as well as the development of specific smart object service concepts

Health Care & Life Science:

- Design of sustainable concepts: Development and implementation of new concepts to provide efficient and qualitative care services to patients
- Training and further education: Development of customized training and educational programs
- Thinking 2020: Development of scenarios and solutions to identify and tackle future challenges and problems before they arise

Service Factory Nuremberg: Development of new value-added Services

- Service portfolio analysis: SWOT analysis and identification of optimization potentials
- New service development: Generation and assessment of service ideas as well as development of promising models until market readiness
- Market entry consulting: Market simulation to support the decision-making about upon an innovation

EQUIPMENT

Imaging Systems

- 2D/3D digital movie theater
- Video and Audio Studio
- Post production studio and edit suites
- Camera test laboratory
- Professional cameras for TV, cinema and still image
- Smart cameras, cognitive cameras
- Studio for optical object scans
- Optical sensors for industrial image processing, texture analysis, color image processing
- 3D imaging sensor

Medical Engineering

- Medical Technology Test and Demonstration Center METEAN (Located at Erlangen University Hospital)
- Pulse oximeter evaluation system
- ESD evaluation system
- Spectrum analyzer, logic analyzer
- Optical sensors for image processing, texture analysis, color image processing
- Software libraries for image processing and analysis
- Microscopy laboratory with high-end microscopy systems
- Endoscopy laboratory with fiber-optic, rigid and video-endoscopic systems
- 3D ultrasonic system
- Laser laboratory
- Laboratory for imaging systems for minimally invasive surgery (MIS)

IC-Design
Analog/Digital Systems

- Software for IC Design:
  - Analog simulation: HSpice, Spectre, Spectre RF, HSIM, Ultrasim
  - Digital simulation: Mentor & Synopsys, System-Verilog, VHDL, System-C
  - Logic Synthesis and Test: Synopsys Design-, DfT-Compiler
  - IC layout analog: Cadence Analog Artist, Tanner
  - IC layout digital: Synopsys IC Compiler
  - High-level Synthesis: Mentor
  - IC extraction and STA: Synopsys StarRC, Primetime
  - IC layout verification: Mentor Calibre, Cadence Assura
  - Design of microwave circuits: ADS
- Emulation systems
- Waferprober Süss, Cascade
- Laser Cutter
- RF and microwave measurement equipment
- ADC characterization system
- IC Bonder
- IC & RF test equipment:
  - Climatic chamber
  - Bit error test equipment
  - Optical spectrum analyzer/optical test equipment
  - Fiber test equipment
- 7-axis method for the characterization of magnetic and positional measurement systems
- Gauss test equipment
- Bonder for Ball/Wedge and Wedge/Wedge
- Pull-Test
- Three-dimensional measurement microscope

Communications

- Arbitrary waveform generators
- Transient recorder
- Wideband recording and playback system (14 bit/200 MHz and 500 GByte memory)
- Vector signal analyzer and generators
- Fast time domain measurement equipment
- DVB-SH/DVB-H/ESDR/DRM network
- Van for coverage validation and field trials
- Radio channel simulators

- System simulation software (COSS-AP, SPW, Matlab, System Studio)
- Design systems for digital signal processors
- FPGA design software
- Hardware laboratory
- Thermal imaging camera

Integrated Digital Terminals

- Digital simulation: VHDL, System-C, System-Verilog
- Synthesis: Synopsys
- Emulation systems: CHIPit system of Synopsys
- Logic Analyzer: Agilent
- High-level Synthesis: Mentor
- Arbitrary waveform generators: Rohde & Schwarz

Audio

- Development and simulation systems for microprocessors and digital signalprocessors
- Systems for the design of complex logical devices
- Sound-proof audio laboratory with equipment for reference-quality playback and sound quality assessment and additional video projection possibility
- Sound studio with well-defined acoustical environment for 5.1-channel surround sound reproduction up to 96 kHz
- Studio equipment for multi-channel audio
- Loudspeaker-setups surround and 3D audio
- Multimedia systems
- Workstations for processing of audio and video signals
- Wavefield synthesis cinema
- AV-streaming test environment
- Analog/digital measurement equipment
- Development tools for microcontrollers
- Professional software development tools
- DRM (Digital Radio Mondiale) encoder and decoder chain
- Complete DAB transmission chain and diagnose tools
- GPS reference receiver
- Mobile DAB receiver
- DVB-H modulator
- Audio/video live encoder
- Server platform for own audio/video encoding and DVB-H transmission
- OMA DRM IOP Test Server
- OMA DRM CLIENT Conformance Test Tool
- Car for tests and demos of mobile broadcasting, audio and video applications

Multimedia Realtime Systems

- Simulation and development systems for microprocessors and digital signal processors (ARM, MIPS, Texas Instruments C6xxx, Motorola 563xx, Analog Devices 21xxx)
- Analog audio/video player/recorder (SVHS, BetacamSP, Laserdisc)
- Digital audio/video player/recorder (hard disk image sequence processor, DV recorder)
- Digital audio/video crossbar with control unit (32 x 32)
- TV reference monitors
- Video measuring instruments (digital component analyzer, analog analyzer, analog/digital signal generator)
- HDTV reference monitor
- HDTV disk recorder
- Prototype HD-radio receiver with MPEG Surround

Wireless Distribution Systems / Digital Broadcasting

- Data stream modulators for digital broadcasting systems (100 kHz to 6 GHz)
- Mobile receivers for frequencies from 30 MHz to 3 GHz, above all for GPS signals
- Broadband signal players (up to 3 GHz)
- Simulators for channel characteristics and signal dispersion (30 MHz to 3 GHz)

EQUIPMENT

- Magnetic antennas for 3D H-field characterization (9 kHz to 30 MHz)
- Signal analyzers (DC to 8 GHz)
- Equipment for Quality-of-service evaluation for terrestrial and satellite broadcasting
- Arbitrary waveform generator for UWB-applications (20 GS/s)
- 50 meter antenna tower

RF and Microwave Design

- Simulation software:
  - Microwave circuit simulation: ADS
  - System simulation: ADS, Matlab
  - Electromagnetic field simulation: HFSS, Momentum, CST Microwave Studio, Sonnet, Designer
- Electrodynamic shock tester (500 N)
- Network and spectrum analyzers up to 60 GHz
- Vector signal analyzer (12 Bit/95 MHz, 1.2 GByte)
- Noise and phase-noise measurement unit
- EMC measurements in screened cabin and GTEM cell
- Antenna measurement in a shielded anechoic chamber: farfield/nearfield measurements from 800 MHz up to 40 GHz
- Van with receiving equipment up to 2.7 GHz
- Climatic chamber
- Logic Analyzer up to 800 MHz
- Real Time Locating Systems (RTLS) Mesurement Lab
- RFID Mesurement Lab

Contactless Test and Measuring Systems

- CT capable Minifocus X-ray system, 225 kV/1.6 kW, focal spot size 0.4 and 1 mm manipulator system with 9 axis
- X-ray cabin 160 kV/1,6 kW, focal spot size 0,4 or 1 mm
- µ-focus X-ray system 225 kV, 64/320 W, focal spot size 2 or 6 µm
- X-ray scanner 100 kV, 1.6 kW, focal spot size 3 mm
- Flat panel X-ray detectors, resolution down to 0.03 mm
- TDI X-ray cameras, resolution down to 0.03 mm
- Line lasers
- Specialized cameras for sheet-of-light imaging, 3D imaging
- Spectroscopic imaging
- Industrial digital color cameras
- Optical simulation tool Zemax
- CAD work station
- Laboratory for electronic engineering

Development Center for X-ray Technology and Process Integrated Inspection Systems

- Minifocus 3D CT, 225 kV, voxel size down to 150 µm
- with KUKA KR 30-3 industrial robot
- Normal focus 3D CT, 450 kV, voxel size down to 300 µm
- µ-3D Visualiser: Tomosynthesis system for planar computed tomography, 160 kV, 10 µm spatial resolution within the represented planes
- Sub-µ 3D CT system, focus less than 1 µm, 160 kV, max. 15 W
- Fast CT, 160 kV and 225 kV, voxel size down to 200 µm
- µ-focus 3D CT, 200 kV, voxel size down to 10 µm
- µ-focus 3D CT, 225 kV, voxel size down to 2 µm
- µ-focus 3D CT, 225 kV, voxel size down to 1 µm
- portable 3D CT system 50 kV, voxel size 40 µm
- Minifocus 3D CT, 225 kV, special equipment for dual energy inspection
- Mobile 3D CT (RoboCT), 160 kV, voxel size down to 100 µm
- Tomolibri, multisensor coordinate measurement device, CT and optics, 225 kV, voxel size 10 μm^3 up to 100 μm^3, achievable accuracy: 10 µm with voxel size 100 µm
- Coordinate measuring machine Zeiss Contura G3 800 aktiv, error of indication of size of measurement MPE E = 1.8+L/300
- Refraction setup using Kratky collimator, 60 kV
- X-ray microscope, 40 kV, focus approx. 100 nm
- Keyence digital microscope with measurement function

- Thermography system with optical excitation (5 kW electr. power) and ultrasound excitation (2.2 kW electr. power). Infrared camera equipped with an MCT-detector for wave lengths from 3.7 to 4.8 µm, with 640 x 512 pixels and 117 Hz read-out rate (full frame)
- Automatic ultrasound inspection system with immersion tank for the automatic inspection of even large parts and electronically controlled xyz manipulator (accuracy < 1µm). 16 channel ultrasound inspection electronics suitable for the operation of conventional phased arrays as well as sampling phased arrays in the modes 1 x 16 and 16 x 16, inspection frequency 5 MHz, pulse repetition rate 10.000
- Optical sensors for industrial image processing, texture analysis, color image processing
- Endoscopy laboratory
- 3D imaging sensor
- HW/SW for image processing, high-speed cameras
- laser laboratory

Communication Networks

- HF-shielded chamber up to 18 GHz
- Stereo microscopes
- Signal analyzer up to 26 GHz
- Hi-speed 3 GHz oscilloscope
- Mixed signal oscilloscopes
- RF-signal generator up to 6 GHz
- Audio analyzer
- Climatic test cabinet, temperature range from -40°C to +180°C
- RF 4-port network analyzer up to 8 GHz
- Radio communication tester for DECT
- Convection reflow solder machine
- Portable spectrum analyzer up to 7 GHz with wideband measurement antenna for on-site testing

Power Efficient Systems

- Analog/digital system and circuit-level simulation tools
- Analog/digital measurement equipment
- Development tools for microcontrollers and programmable logic devices
- Battery test system
- Vibration source (shaker)
- Development and verification tools for navigation systems
- GNSS software tool kit
- GPS signal generator (Spirent)
- GALILEO signal generator
- SBAS signal generator
- GPS software receiver
- GNSS antenna platform
- INS signal generator (test tool for integration of GPS and INS signals) (Spirent)
- 2-axis rotary stage for intern and extern inertial sensor calibration
- Calibration software
- Motion Capture Suit (MOVEN)
- Inertial Sensor Data Simulation Tool (test tool for GPS- and inertial data integration)
- Pioneer 3 AT Mobile Robot

For Competencies and Equipment of the Division EAS see page 105

RESEARCH RESULTS AND APPLICATIONS

IMAGING SYSTEMS BUSINESS FIELD

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A team of two for the innovation of imaging and production systems

In the Imaging Systems business field, which focuses on camera technology, digital cinema and cognitive systems, the research and development spectrum has been continued and further developed by two departments since the beginning of the year. The motivation for this was a result of the increased demand for innovative systems for media, telecommunications and industrial applications.

The success of films such as AVATAR has increased the pressure for innovation on the film and media industry. New production technologies and new workflow concepts are now in demand. In addition to 3D and new storage technology and compact and intelligent camera systems, post-production and archiving systems have become major focal points for development, which both new departments offer attractive solutions for.

The main activities of the Electronic Imaging department are the development of compact High-End HDTV and so-called Point-of-View cameras, Stereo 3D camera systems as well as image analysis through cognitive systems. "Camera platforms", which offer future-oriented technologies in camera and sensor technology, as well as integrated processing and analyzing steps, data coding and wireless transmission or streaming solutions are becoming increasingly important. This technology allows camera systems to be flexibly adapted to the most diverse customer requirements.

The Moving Picture Technologies Department continues the globally renowned work and research for the world of digital cinema and TV. The development of new production systems and the integration into the digital workflow is achieved using innovative tools for post-production and archiving. In view of the trends and developments in the industry, in future the work on JPEG2000 and other data formats, digital archiving technologies as well as multi-processor technology will be stepped up a gear. This allows the developments to also be expanded to other media and IT sectors.

Powerful together

Both areas will use joint synergies in future to offer customer-oriented workflow concepts. The scientific networking through partnerships with the Dresden Division Design Automation and the Chairs of Hardware-Software-Co-Design and Multimedia Communications and Signal Processing offers a solid basis for maintaining the leading market position in the development of new camera and production technologies and for expanding other research topics.

... and in the future

The internationally renowned expertise for the development of camera technologies and digital cinema systems will gain in importance as a result of new projects in the field of post production and film archiving. The implementation of cognitive systems and the work on image analysis are being further developed in research projects. And 3D will become ever more important, from image recording to processing for the media, home and telecommunication sectors.

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Sponsored project "ReKoSys" – Reconfigurable cognitive systems

Overview

A typical problem in video surveillance is that the security guards record security-related events too late or miss them completely. This is especially true of long-term recordings, in which nothing in particular happens over a long period of time and which are therefore perceived as "boring". If, for example, a car is broken into in an underground car park, the staff may not recognize this immediately, especially if it happens within only a few seconds.

Together with the company Dallmeier from Regensburg, the Electronic Imaging Department has developed a procedure in the project "ReKoSys" (Reconfigurable Cognitive Systems) which increases the reliability of video surveillance systems and helps avoid the situations illustrated above. The project is financed by the Bavarian State Ministry for Economy, Infrastructure, Transport and Technology.

The fundamental idea of the development was to add so-called meta information to surveillance videos during their recording. This allows the relevant positions to be located quicker when reviewed later.

Some of the appropriate kinds of meta information are:
- moving objects can be identified
- objects move with a certain speed
- certain objects (for example cars, persons) can be identified
- faces or a certain number of faces can be identified

The system used consists of two components which communicate with one another: an intelligent camera system "ReKoCam", which has a digital camera which can also detect meta information such as movement, identifying characteristics etc., going beyond image recording. This meta information is supplied, together with the video data stream, to the second part of the system, a database and evaluation system, which the project partner Dallmeier developed. The information can be clearly assigned to the relevant video scenes thanks to event marking.

The "ReKoCam" system

Camera systems which have object recognition functions and a simple face detection function are already on the market. The aim of the research project, however, was to develop a camera system with increased computational power which also allowed for more complex recognition functions. The "ReKoCam" can be re-configured or re-programmed. Thanks to the use of cognitive technologies such as the training-based object detection, it offers a high degree of flexibility and is ideal for a multitude of detection tasks which go beyond mere surveillance functions. The system may be used, for example, in scientific disciplines (automated counting of animal populations) or in space travel (automated docking maneuvers).

The challenges in the development were:
- small construction size
- low dissipated energy
- safeguarding against interference
- high resolution in order to be able to detect small or far off objects

Numerous efficient components from the field of embedded systems, such as FPGAs (Field Programmable Gate Arrays), signal processors and microcontrollers with an embedded Linux operating system were used in order to be able to provide the required computational power under the given space restrictions.

The aim of this sponsored project was to research embedded systems and evaluate new technologies for security

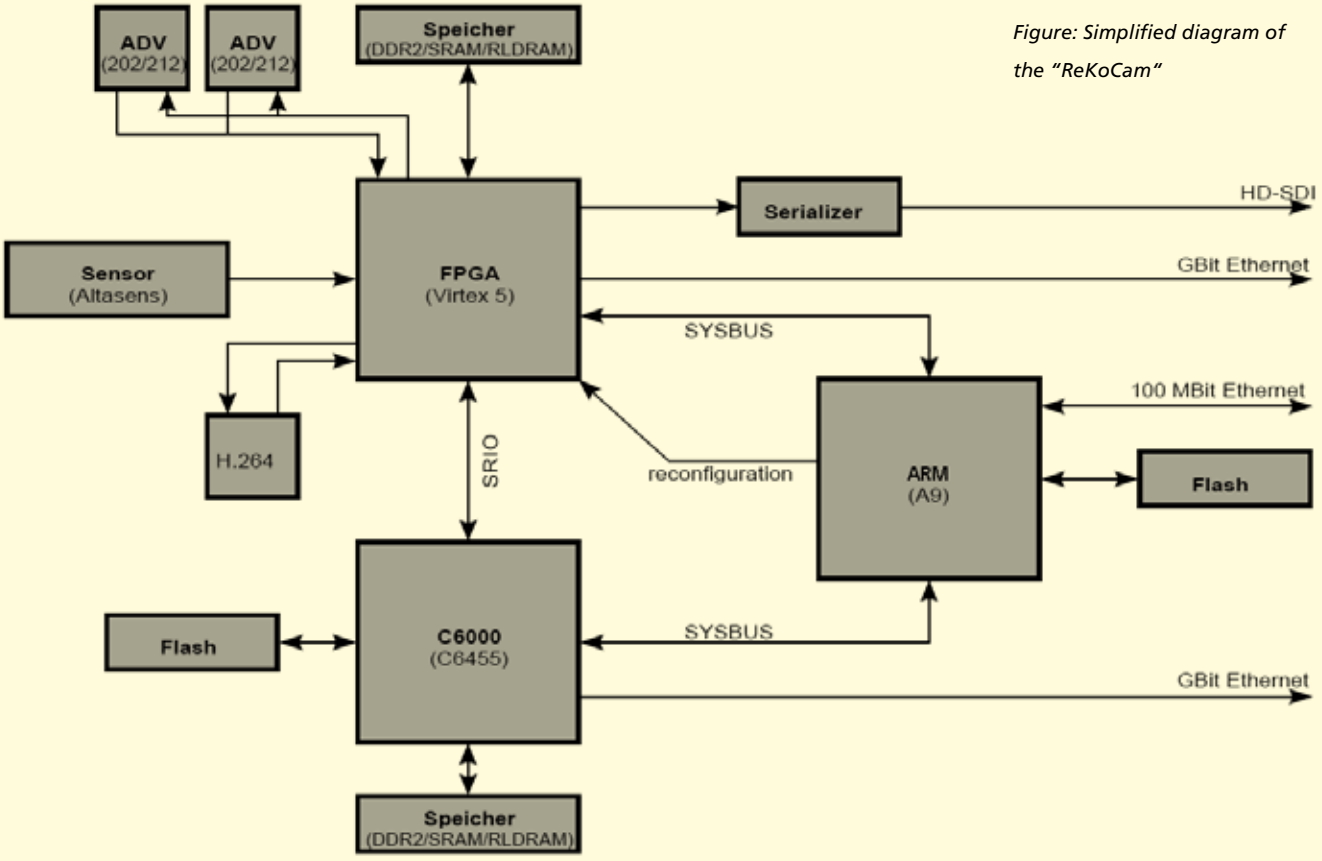

Figure: Simplified diagram of the "ReKoCam"

Picture above: "ReKoCam" laboratory model

and surveillance applications. In addition to the company Dallmeier, the Chair for Informatics 12 of the Friedrich Alexander University, which researched the feasibility of cognitive procedures for embedded systems within the "ReKoSys" project, was also involved. For the first time, scientists introduced a hardware platform in this project which is designed for complex image processing algorithms and recognition functions.

The "ReKoCam" platform therefore lays the foundation for a series of other camera projects in the Electronic Imaging Department.

MOVING PICTURE TECHNOLOGIES

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Post-production tools

Preparing film packages – but how?

Digital technology makes it possible: small and medium-sized film production businesses seize their opportunity on the "silver screen". Digital cinema advertising can be flexibly adapted to the respective audience. Post-productions assess their intermediate development steps in the cinema. What may sound simple and flexible at first, is rooted in expert knowledge on the technical specification for digital cinema. This makes the access and correct implementation of digital film copying for many productions difficult, costly or almost impossible.

The Moving Picture Technologies Department possesses the know-how necessary to be able to offer new tools. With the task of Digital Cinema Initiatives (DCI) to develop a test plan for digital cinema and the technical specification for the German Federal Film Board (FFA), recognized specialists are working on the implementation here.

When developing the well-known tools for post-production, easyDCP Creator and Player, the engineers concentrated on simple and correct execution to be able to create a Digital Cinema Package (DCP) and to be able to play it back on the computer in one's own post-production as a means of testing.

Creating the digital film package

The Digital Cinema Package DCP consists of images which are coded in the JPEG2000 format and packaged together with sound and subtitle information in so-called MXF containers (Media Exchange Format). A DCP can contain different language versions or various subtitles. The data can be assembled in digital film rolls in just a few clicks of the mouse. Another click and the DCP is generated. In order to allow every cinema server which meets the DCI specifications to read and project the DCP, even if smaller corrections were integrated, e.g. tone length adjustments, the main function of the easyDCP Creator is to ensure the packaging of the DCP. The enhanced version easy DCP Creator+ allows for the creation of stereo 3D film packages and coded 2D or 3D DCPs.

Security for digital film packages

One of the most important topics for filmmakers, productions and cinema operators is the protection against pirate copies. Digital films are protected with an AES key (Advanced Encryption Standard) in order to ensure that the film only reaches the desired cinema and cannot be seen on the Internet beforehand. A so-called Key Delivery Message (KDM), which contains the AES key and information such as the permitted play-back period in a form which can only be read by the cinema server, is generated to allow playback. Should a person attempt to interfere with the cinema server, the key is deleted immediately and the server can no longer be used.

Cue film!

Film producers and cinema operators fear nothing more than the blank screen. Color deviations, image-sound mismatches and other faults are also among the errors which should be excluded in cinema. As DCPs are normally played back via digital cinema servers only, work was being carried out to find a solution which avoids the time-consuming and expensive work steps from post-production to the cinema.

With the easyDCP Player software, the engineers have also managed to play back the final inspection of DCPs in full quality on a standard PC. This does not, however, replace CDI-compliant cinema server systems. As the JPEG2000 compression is used for a DCP, the player software uses the scalability of this coding procedure. The material is played back on the PC in real time as a result of the various levels of

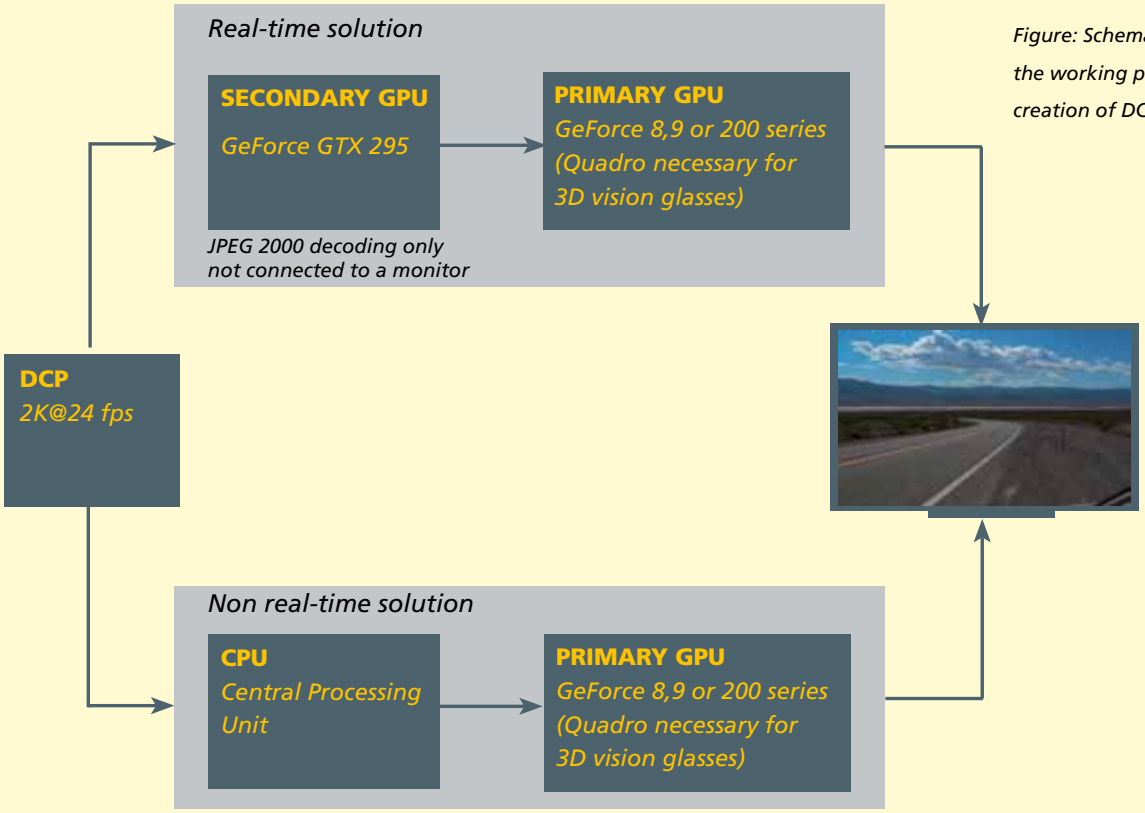

Figure: Schematic diagram of the working processes in the creation of DCPs

resolution. The fluid playback of the DCPs in full resolution depends on the CPU performance. However, by connecting a video card for additional computer support, real-time decoding of the JPEG2000 data is possible on almost any PC, in other words a final examination without juddering.

Success bears out

The demand for tools which allow DCPs to be created correctly is great. The easyDCP tools are now well-known software tools which are valued in the sector. More than 200 systems are currently tested and used by film producers, post-production houses and film schools all around the world.

What's next?

The creation of digital film packages is not only a job for cinema production, cinema advertising or post-production. Large film studios in particular have acknowledged the advantage of these Fraunhofer developments and test the use for the quick production of their daily copies. Film archives are also showing great interest in the further development for the areas of digital archiving and fast access copies.

IMAGE PROCESSING AND MEDICAL ENGINEERING

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Overview

The strengths of the Image Processing and Medical Engineering department (BMT) lie in medical image processing, vital sensors and signal processing. As a research and development service provider for industry and small and medium-sized businesses, the department supports businesses throughout the entire chain of the innovation process for medical products. In addition to their R&D services, the scientists support the development process from start to final approval including regulatory requirements. In cooperation with the University Hospital Erlangen, the Medical Technology Test and Demonstration Center (METEAN) in the BMT department also allows associated examinations and studies to be carried out. With the Medical Technology Test and Demonstration Center METEAN of the BMT department, Fraunhofer IIS is able to conduct associated tests and studies in cooperation with the Erlangen University Hospital.

Sensors and signal processing

A prominent example for the successful strategic alignment of the department is its participation in the BMBF leading-edge cluster "Medical Valley Europäische Metropolregion Nürnberg (Medical Valley EMN)". The aim of the cluster is to develop the metropolitan region over the long term into a "model region for optimum health care". BMT is a partner in the key project "Barrier-free Health Assistance". This involves the provision of new services which significantly increase the quality of life with the aid of intelligent sensors and radio-based communication. In this way, persons suffering from dementia can remain in the familiar environment of their homes much longer as the technical support offers them the greatest possible level of safety.

With the technological orientation towards miniaturized, power-efficient and radio-networked systems, the department continues to pursue the trend "Monitoring and Assistance Systems" in order to optimize the constant application in everyday life. The aim is to help every age bracket of the population lead healthy lifestyles using intelligent monitoring systems and digital companions.

Image processing

The competencies in the area medical image processing are focused on computer-aided microscopy (CAM), computer-aided diagnosis (CAD) and computer-aided intervention (CAI). The processing and analysis of microscopic image data and the development of microscopic systems have been a research and development topic in the department for many years. The HemaCAM system for automated microscopic blood count analysis is currently being approved as a medical device in cooperation with an industry partner.

Focus in the field of CAD is on endoscopy, dermatoscopy and mammography. The CAD systems provide image-based diagnostic assistance to the physician. By finding and displaying comparable reference cases, if required, even in real-time during the examination, the system provides an objective "second opinion" and therefore supports a case-based conclusion.

The research in the field of computer-aided intervention aims to provide surgeons with new aids and surgical instruments. Examples of these are a laser operation instrument for gently opening the skull during brain operations and a surgical instrument for minimal-invasive surgery which helps the surgeon as regards the orientation and execution of an operation.

IMAGE PROCESSING AND MEDICAL ENGINEERING

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Reference architecture for seamless connectivity and interoperable use of heterogeneous services

Although there has been a great deal of discussion on telemedical applications in recent years and they have been the topic of numerous research and development projects, comprehensive applications are still scarce. The reasons for this are complex. On the one hand, the level of acceptance of telemedical applications in population groups varies greatly. Older people, for example, take a more negative stance towards innovative technologies than younger generations. The fear of stigmatization is another reason why many target groups do not want to use certain telemedical services. In addition, many health insurance companies are reluctant when it comes to the financing of certain telemedical services, not least because of a cost-benefit analysis difficult to calculate. In addition to social and economic barriers, the various interests of all the interest groups involved in the topic of telemedicine also make things more difficult. A lot of the specified communication standards are not used by the manufacturers of medical sensors and applications, for example. Therefore, many so-called "isolated applications" exist on the market, which make a standardized data exchange almost impossible.

Two of the most important requirements when integrating medical data into telemedical infrastructures are a standardized data representation and a clear communication protocol. In the following, a reference architecture is described which is co-developed by Fraunhofer IIS in the framework of the EU project OASIS. The telemedical system combines various existing standards and can be flexibly used in various applications through an open interface system. A motion sensor is used as an example to show how individual components and sensors can be integrated in the overall system.

Project example and application scenario

At Fraunhofer IIS, the field of medical sensors and signal processing focuses on motion monitoring, activity measurement, motion classification and individual quantitative recording of the activity level of persons. A motion sensor which, when worn on the body, can also detect when a person falls, was developed for this reason. The challenge here was to reliably detect any falls of an elderly person and, if necessary, to automatically trigger an emergency call to relatives or responsible care staff.

Such a motion sensor, however, only covers a very specific and small area of telemedical assistance which, for example, can allow elderly persons to stay at home for longer. If it is actually to become reality for the elderly to live longer within the four walls of their home, an extensive range of supporting and user-oriented services must be packaged and offered.

In the EU project OASIS, more than 30 project partners are developing an innovative system for the seamless connectivity and interoperable use of the content of various services and ontologies. More than a dozen types of services are being interconnected for the benefit of the elderly, whereby the variety of services and content is particularly impressive. The services range from dietary advice, elderly-friendly transport information services, brain and skills trainers to biometric authentication interfaces.

Besides the development of medical sensors, Fraunhofer IIS is also involved in the development of an innovative, expandable reference architecture (called COF: Common Ontological Framework) for the organization, maintenance and application of heterogeneous ontologies. This reference architecture makes it possible to interconnect hardware components and services in any combination, to use the data and contextual meta information of various objects and services together and to guarantee the interoperability of all integrated devices and services.

Figure: Standardized transmission and storage is a basic requirement to be able to use and visualize data from different sensors in a telemedical system, such as heartbeat or breathing in the example shown

Results and practical relevance

Establishing a standardized end-to-end telemedical infrastructure and implementing a generic framework which works independent of concrete data formats and ontologies are fundamental requirements for the introduction of telemedical services and assistance systems in everyday life. Many of the services which previously existed as isolated applications could be embedded in extensive telemedical infrastructures at a low cost. This could therefore reduce costs as well as the development time for developers of new devices and services, as they could resort to specific communication protocols and interfaces. Fraunhofer IIS is committed to the realization and implementation of standardized transmission protocols and storage formats for medical data in telemedical applications in order to create the requirements for the interoperability of the systems. Furthermore, scientists are available to provide advice and support for all concerns relating to standardized data representation and communication protocols.

IC-DESIGN – ANALOG SYSTEMS

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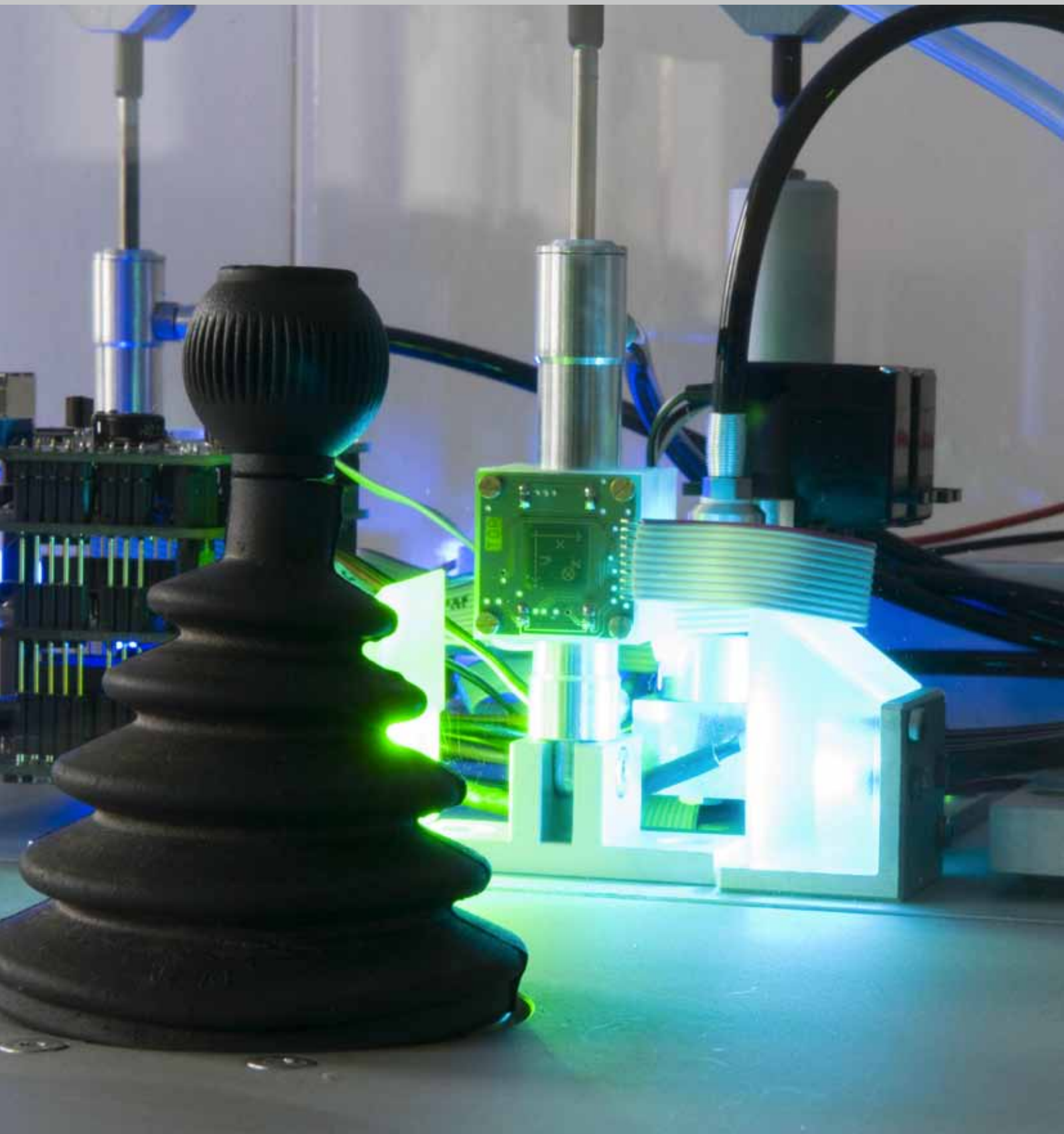

Mixed-signal ASICs and IPs

The design of mixed analog/digital integrated circuits is one of the core competencies of Fraunhofer IIS. The range of services includes the development of application-specific integrated circuits (ASICs), the development of functional blocks (IPs) for system-on-chips and design services. The cooperation with industrial semi-conductor manufacturers allows the use of a wide range of semi-conductor technologies. The main emphasis of the design is on the 180 nm and 90 nm CMOS technologies. Regular multi-project wafer (MPW) runs with various semi-conductor manufacturers in the EU-sponsored project EUROPRACTICE allows Fraunhofer IIS to offer its clients complete solutions from IC-design, prototyping, small-batch to high volume production.

ASICs for the data highway

The work partly focuses on the design of ASICs for fast data transmission via various transfer media. Thus several sponsored projects are working on the development of new transmitter and receiver components for the optical gigabit transfer via multimode fibers. Moreover, the long standing successful cooperation with Inova Semiconductors was continued with the development of the APIX2-ASICs for the multifunctional data transmission with 3 Gbit/s via twisted pair cables primarily for automotive applications.

ICs for positioning and current sensor technology

The 3D Hall sensor technology HallinOne allows for innovative solutions for robust, multidimensional position sensors. The development of HallinOne standard products began in 2009 with the partner austriamicrosystems AG and has been successfully continued; first prototypes will be available before the end of 2010. Other applications are being developed with customer-specific ASICs. The electromobility and energy efficiency trend has spurred the clients' interest in HallinOne-based current sensors. Several studies and development projects are currently underway. The readers of the "Elektronik" trade journal voted a current sensor for battery monitoring "Product of the year 2010". The sensor is based on a Fraunhofer IIS ASIC and manufactured by the industry partner Robert Seuffer GmbH.

Image sensors and nano-optical structures

Together with the Electronic Imaging department, the development of customer-specific image sensors for medical and industrial applications was successfully continued. New approaches in analysis electronics were introduced and new concepts for analog/digital implementation were developed. The combination of image sensors with nano-optical structures opens up new application fields in image processing. The nano-structures are optimized and the first applications in industrial image processing are developed in joint projects with semi-conductor manufacturers and users. An operational prototype of a high-speed polarization camera was presented for the first time.

Wake-up receivers

Low energy consumption is an important factor for self-sufficient wireless sensor networks. An analysis of the energy balance shows that a significant proportion of energy available is used for listening to requirements (receiving). However, in the case of larger networks, a clocked receiver operation for energy saving leads to response times which are too long. A wake-up receiver with ultra-low current consumption was therefore developed. Together with the system departments of the institute (for example Electronic Imaging), demonstrator applications for wake-up technology are being identified and implemented.

IC-DESIGN – ANALOG SYSTEMS

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Integrated CMOS image sensors

Motivation

The detection of light using photodiodes was one of the first sensor principles which scientists carried out using silicone. The photosensitivity of pn-junctions was known long before the discovery of the MOS transistor (Metal Oxide Semiconductor). Individual approaches for implementing photodiodes, analysis circuits and linear sensors were already being pursued in the 1990s in the IC-Design – Analog Systems (ICD-A) department. Since 2004, the staff has been promoting the implementation of image sensors systematically. In addition to scientific questions, the cooperation with various technical departments, in particular with the business unit Image Systems, was also essential for this decision. This made it possible to have a joint marketing potential from one source, starting from the development of image sensors and cameras to customer-specific image processing systems.

Sensors for industrial image processing

Applications in industrial image processing require image sensors which provide for recording without motion artefacts. For this to happen, all pixels must be exposed at the same time. This process is called "global shutter". Standard image sensors, which are, for example, integrated into photo cameras and mobile telephones, do not have this function. Fraunhofer IIS has designed an image sensor which allows for such recording in high speed and good resolution. Information for the design of the sensor was obtained in the research project "CMOS image sensors for professional camera systems". The project was funded by the Bavarian Research Foundation.

The sensor contains 2880 x 1620 pixels, organized in a checkboard pattern. This checkboard pattern means the frame rate can increase to 1000 images per second. Furthermore, the selected sensor architecture allows the frame rate to increase to well beyond this value, by only reading out sections of the sensor. The scientists have attached particular importance to the power consumption in order to keep the self-generated temperature of the sensor low in the case of exclusive passive cooling. Dust-proof cameras, for example, are operated without ventilators for use in crash tests.

In order to read out image information accurately, the ICD-A department has developed a new method for converting the photodiode signal into a differential output signal. The sensor has 64 differential outputs, which are each operated with a speed of 40 million pixels per second. The Electronic Imaging department of Fraunhofer IIS has developed a special camera for this sensor.

Outlook

With this project, the IC-Design – Analog Systems department has expanded its competence in developing complex image sensors. In future, Fraunhofer IIS will therefore be able to offer the entire development chain, from image sensors and cameras to industrial and medical image processing. In addition, combining this with nano-structured pixels opens up diverse application possibilities in spectral and polarization applications. New approaches are, for example, image sensors which are constructed like the eye of an insect and thus do not require a lens. In this way new application areas which require extremely flat cameras can be developed.

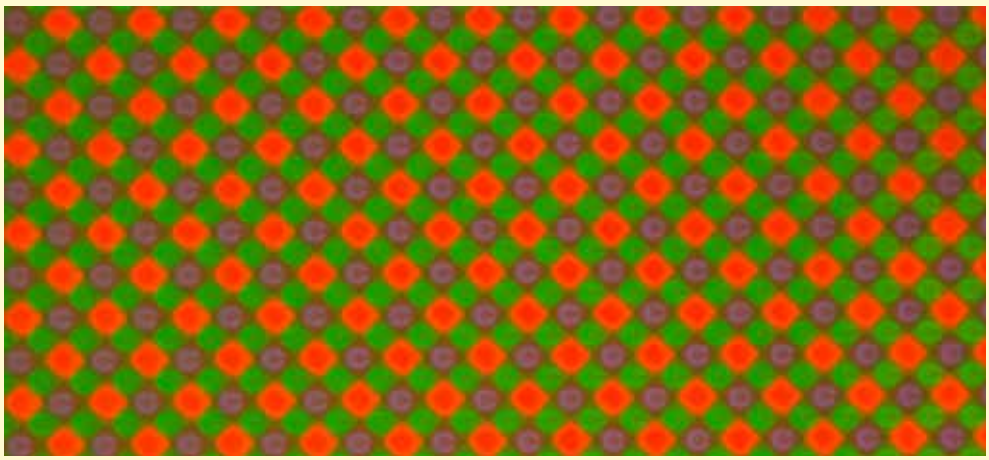

Figure 1: Microlenses in a check-board pattern

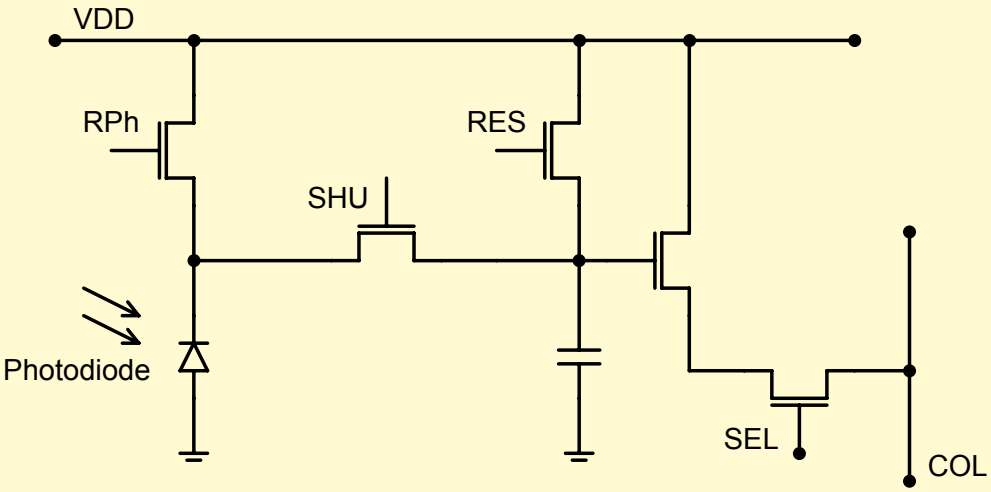

Figure 2: 5-Transistor Global Shutter Photodiode

VDD: Supply voltage
RPh: Reset Photodiode
SHU: Shutter
RES: Reset
SEL: Select
COL: Column

Image (above): Testing platform with Fraunhofer IIS image sensor

IC-DESIGN – DIGITAL SYSTEMS

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The department IC-Design – Digital Systems (ICD-D) consists of the groups Design Services and System Level Design at the Erlangen location as well as the Competence Center Net Access Technology in Nuremberg. In addition to mere chip design, the department also carries out work on the topics of embedded systems and energy efficiency.

Designing digital integrated circuits

Scientists in the ICD-D department are developing digital and mixed analog/digital circuits for external partners. Commercial tools are used for simulation, synthesis, test insertion, layout and verification in close cooperation with the IC-Design – Analog Systems department (ICD-A) for this purpose. The implementation is realized in standard CMOS technologies. The technology portfolio used at present ranges from 350 to 65 nanometers. External partners often want the possibilities of the used semi-conductors to be exhausted, which requires a highly elaborate design, in order to be able to manufacture the integrated circuits as cost-efficiently as possible. The main areas of application are special wire bound communication systems, sensor signal processing and automation technology. The designs must increasingly fulfill requirements as regards safety and reliability, which requires additional measures in the design process.

The department has further developed the APIX chip sets (Automotive Pixel Link) for a new semi-conductor generation this year again. This involves processes for high speed data transmissions via twisted pair wires cables. The technology can be used in the image data transmission from cameras to pixel displays in the automobile. The majority of the circuits currently developed are used in drive technology and motor control. In addition, the scientists are working on optimization strategies for a JPEG 2000 image coding within an internal research project in cooperation with other departments. Based on this, intellectual property (IP) can be build for corresponding circuits at a later stage.

Energy efficiency

The topic of energy efficiency is a common theme in almost all projects: lower power consumption is becoming increasingly important in the implementation of circuits and systems. There is still enormous potential for energy saving with hardware architectures and hardware-related software. This can be achieved, for example, through targeted selection or change of operational parameters such as clock frequency or supply voltage but also by switching off individual functions which are temporarily not required, or by adapting memory architecture. On the application level, the main focus is also shifted to circuits and embedded systems which allow an efficient use of electrical energy.

Some of the projects which were started in the last few years are now in the implementation stage. At present, scientists are developing the application software for an intelligent gateway of electricity meters on an ARM processor (Advanced-RISC-Machine). Moreover, the Fraunhofer System Research for Electromobility (FSEM) is working on an E-Car Communication Manager (ECM) which ensures the charging procedures are balanced and accounted for in the smart grid. A first demonstrator for an intelligent power supply unit was also constructed, which improves energy efficiency through communicating with the embedded system to be supplied and corresponding control strategies. A project which measures the effective and idle power consumption of industrial bulk consumers has been started.

A fundamental aim from the perspective of circuit and system design is to improve the overall energy balance when using permanently operated circuits to control and monitor the energy flow. As regards the time lag of energy consumption, the control technology still has to become considerably more efficient.

IC-DESIGN – DIGITAL SYSTEMS

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Communication and charging management platform for E-Mobility applications

Fraunhofer IIS is participating with two activities in the Fraunhofer System Research for Electromobility. The project comprises 33 Fraunhofer institutes and is funded by the BMBF. The Power Efficient Systems department contributes with R&D on circuits and algorithms for battery management. The Project Group Net Access Technology of the IC-Design – Digital Systems department is developing a communication platform for charging management and is working on connecting it to the smart grid.

To ensure electric vehicles can function as intelligent components in the future energy network, charging or feedback procedures must be time variable and aligned with the current energy supply as well as with the renewable energy resources. Availability and usage requirements must also be incorporated in the calculation of a "charging strategy" and billing procedures must be supported.

The integration of a so-called E-Car Communication Manager (ECM) into the vehicle environment supports two different scenarios: on the one hand, charging using an on-board charger and, on the other hand, the use of a charger in an external charging station.

All communication links and processes run on an ARM9 processor system with ECOS and Java as operating systems. The basic software is complemented by an OSGi framework developed at Fraunhofer IIS and a flash file system. This means new versions or other application software can be uploaded on request. As little personal data as possible should be transferred or stored for privacy protection reasons, including the usage requirements of the driver.

The charging strategy is calculated based on rates which are temporally variable (supply conditions). This means that the charging cycles are controlled via an incentive-based „Demand-Side-Management". It must be ensured that the supply conditions communicated to the user, which, in legal terms, represent an offer, are recorded. Therefore as a first step, the calculations for determining the charging strategy in the vehicle are carried out on the ECM.

The process is as follows:

– obtain supply conditions after plugging in the charging cable

– determine a charging strategy from availability requests, supply conditions and a simple model of the battery

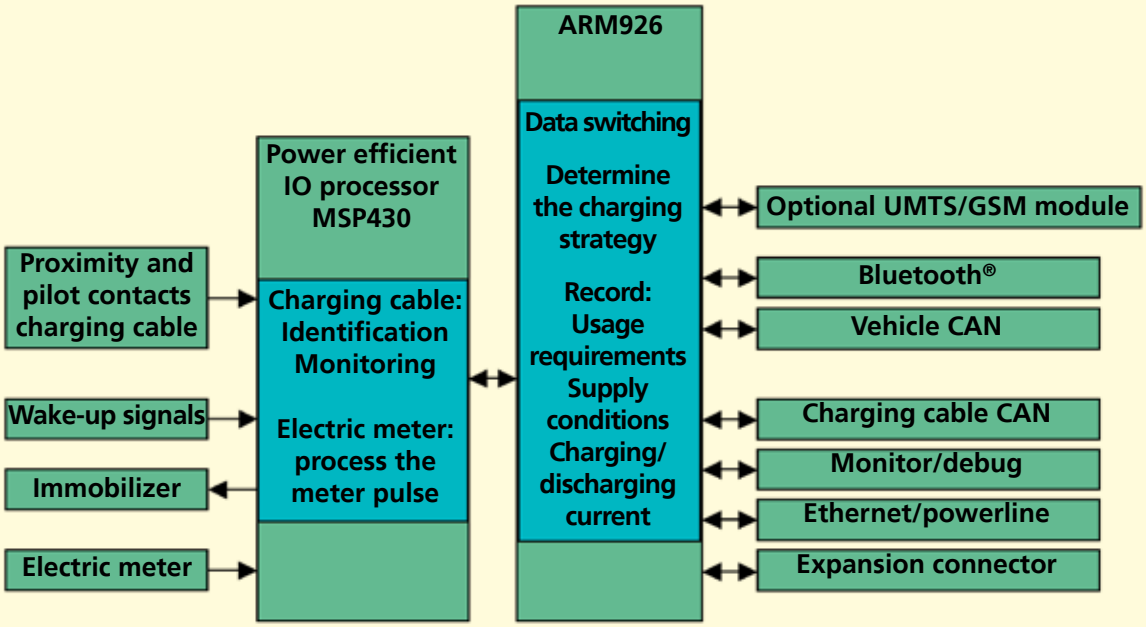
– give the charging performance values to the energy management system

– re-calculate the charging strategy in case of changed input parameters

The charger is controlled by the energy i.e. battery management system for safety reasons. The energy flow is also measured and recorded when using the on-board charger.

The ECM also functions as a gateway between CAN buses, a Bluetooth® interface and Ethernet. This makes communication between the CAN bus inside the vehicle, an external charger, a Demand-Side-Management system in the building and an control panel in the form of a personal digital assistant possible.

The modular system means it is possible to easily adapt the software or transfer parts of it, for example, to the charging station. Furthermore, this architecture allows new regulatory requirements, such as future signature and coding procedures, to be easily implemented. The platform also carries out safety-related monitoring of the charging cables due to the close functional link with the communication connections. This means safety-related functions can be easily validated;



Block diagram of the E-Car Communication Manager. The ECM is the central platform for Demand-Side-Management and bill processing and as a gateway; it coordinates all important communication interfaces for various charging scenarios.

they run on a separate processor which communicates with the main processor via a serial interface.

As is shown in the figure, all functions necessary for the Demand-Side-Management and bill processing are made available on the ECM. Also available are communication interfaces for the components required in the vehicle and the environment during the charging process.

COMMUNICATIONS

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The main activities of the Communications Department are the development of digital broadcasting systems as well as satellite-based and terrestrial communication systems with a broad coverage. R&D in the field of broadcasting systems focuses on technologies for mobile reception, e.g. as used in cars. Examples for this developement are the DVB-SH standard (DVB Standard for the broadcasting of satellite services to handheld devices) and the ESDR standard (ETSI Standard for Satellite Digital Radio). The Communications department has significantly contributed to the standardization and development of prototypes and chip sets for both of these. The technologies have also been successfully tested in the field (see technical article).

Satellite-based radio systems are particularly suitable as an efficient solution for the distribution of large data quantities and coverage of large areas like countries or even continents. In addition to the radio services for audio and video signals, data services are playing an increasingly important role. However, simple unidirectional transmission is usually insufficient for data services. Systems with return channel (the data quantity in the backward direction is often significantly lower) or fully meshed bidirectional communications are gaining in importance. In projects such as DENISE (a project co-funded by ESA for the development of a return channel for satellite systems in the S-band) and MoSaKa (mobile satellite communication in the Ka-band, see also technical article DVT), technologies for mobile satellite communication are the focus of research. System solutions are developed and validated in field tests in cooperation with European partners. The department is essentially responsible for the work on the physical layer, i.e. digital modulation procedures, associated error protection, channel equalization and multiplex and multiple medium access control (MAC) concepts.

MIMO (multiple input multiple output) technologies have so far been of little importance for satellite applications. An improvement in bandwidth efficiency while maintaining the robustness in multipath propagation will be required for efficient satellite distribution in the future. MIMO concepts are therefore becoming increasingly relevant for satellite applications.

Terrestrial transmission systems can be divided into three groups:

- broadcasting systems and other unidirectional data distribution
- base-station-oriented networks
- bidirectional transmission without preinstalled network infrastructure

The aim of various research projects in the area of terrestrial transmission is bidirectional transmissions over large distances, e.g. wireless modems for ranges of up to 100 km. The Communications Department is designing new waveforms for this allowing efficient and robust transmission over large distances.

A large range of platforms and methods are available for the implementation of research results. FPGA-based platforms, for example, the DT4K Series or so-called embedded modules allow both the development of prototypes as well as devices for small production batches. For higher production volumes typical methods such as software defined radio (SDR) or the design of integrated circuits are important. Flexibility in the development of SDR platforms particularly facilitates the cost-effective integration of various standards within a terminal. Although this introduces new applications, it also increases the system complexity. The Communications Department approaches these challenges with the core competencies in physical layer and broad system know-how.

COMMUNICATIONS

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The J-ORTIGIA project

Based on its many-years of experience in the field of satellite-aided broadcasting, Fraunhofer IIS has developed new concepts for mobile reception and integrated them as standards. The institute's large range of services has also made it an important partner for implementation. Pilot installations help test and demonstrate the efficiency of new technologies and increase their acceptance.

The J-ORTIGIA consortium is a team sponsored by ESA, which implements and tests concepts for a satellite-based and terrestrial supported distribution of multimedia data. The aim of the J-ORTIGIA project is to verify technologies which are used for the ESDR (ETSI Standard Satellite Digital Radio) and DVB-SH (DVB standard for the broadcasting of satellite services to handheld devices) standards as well as to construct pilot networks. Fraunhofer IIS has also assumed the role of component verification in the J-ORTIGIA project.

New technologies

The technologies used for ESDR and DVB-SH should significantly improve the reception quality in difficult environments. This means:

- Reliable mobile reception of satellite signals in urban, densely wooded or obstructed reception areas.
- Improved fixed reception of satellite and terrestrial signals on the outskirts of the coverage area or with strong shadowing.
- Higher bit-rates possible with the same satellite power.

Higher level modulation procedures combined with low-rate error correction codes and long time interleavers also allow a strong reception, even if large signal portions are transmitted incorrectly due to temporary shades. As a result of the storage of soft information in the receiver, this technology (called "Class 2" in the DVB-SH context) requires a relatively large amount of memory in the receiver. However, this is not too much of a disadvantage given the cost-efficient availability of memory components (DDR-RAM).

Phase 1 of the J-ORTIGIA project

In the first phase of the J-ORTIGIA project, the activities of all project partners were pooled from April 2008 to March 2009 in order to carry out a large-scale field trial in Japan. As there was no suitable satellite available in Europe in 2008, the Japanese research satellite ETS VIII was used. With an additional three terrestrial transmitters west of Tokio and live feed via the server (DT4080) developed by Fraunhofer IIS, a complete test network was installed in Japan. Moreover, three receivers developed by IIS were used in the test vehicle.

Standards such as ESDR offer a high degree of flexibility and allow a trade-off between throughput (e.g. number of programs) and transmission security. The systematic analysis of the measurement results focuses on the following aspects:

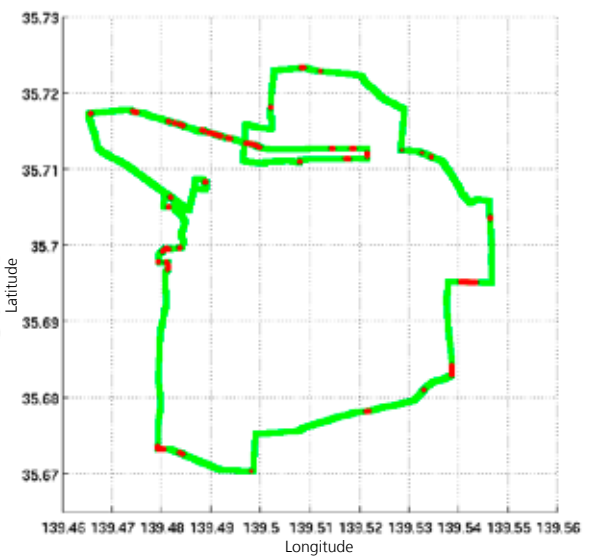
- Quantification of the availability of satellite components for networks alone, without any terrestrial transmitter infrastructure
- Quantification of the diversity gain through parallel deco ding of the satellite and terrestrial signal

The partners involved in the J-ORTIGIA project were able to demonstrate and quantify that

- terrestrial transmitters are only necessary in urban areas in order to achieve a high quality of service
- in addition to providing a good service quality outside of cities, the so-called class 2 technology also offers a significant reduction in the number of required terrestrial transmitters in general

Phase 2 of the J-ORTIGIA project

From April 2009 to June 2010 the implementation and verification of the DVB-SH standards was the main focus of the work. DVB-SH and ESDR use the same concepts developed



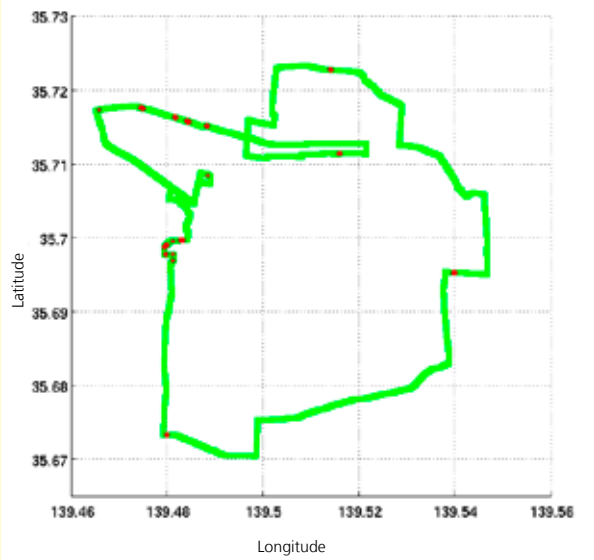


Figure: Measurements of the satellite availability along the 25 km long test route through various environments (forest, suburb and city)

Image (above): The J-ORTIGIA team at the field tests in Japan

by Fraunhofer IIS. The support for DVB-SH in industry as well as the availability of compatible and real-time capable products triggered the shift in technology within the project.

A prototype receiver created based on the DVB-SH chip set (see also technical article IDT) developed at Fraunhofer IIS. The close interconnection of these activities allowed the design to be transferred to the "Embedded Module" platform designed by Fraunhofer IIS at an early stage and allowed it to be used in laboratory and field tests. In addition to the efficiency test, the interaction with the components of other manufacturers was also investigated. Detailed analyses of the interference situation using nearby UMTS base stations and the quantification of the gain of multiple antenna in receivers were the main activities in this phase.

Conclusions and outlook

Fraunhofer IIS has made a strong showing in the J-ORTIGIA project: In the testing and marketing of DVB-SH transmitters, as an operator of its own DVB-SH transmitter on the Erlangen public utilities tower, through active participation in standardization committees, through early implementation of prototypes and through a strong connection with industry partners. In addition to the commercialization of the DVB-SH chip set, work is already underway on the expansion of the DVB-SH standard. At present, the work is particularly focused on the integration of a low latency return channel. This will allow for services such as voice-over IP, messaging, recording of sensor data and emergency systems in combination with attractive broadcasting services.

INTEGRATED DIGITAL TERMINALS

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Driving forth media content and services

The development of new terminals with new innovative service and media provisions is at the heart of the Integrated Digital Terminals department. The aim is to drive forth media content and services by determining a sustainable concept for a transmission system together with the client. Following this, all system components are realized, validated and integrated. It is only the combination of clever business ideas, customized system architecture and their successful implementation and market launch that determines the economic success of an idea.

Based on established or new technologies, the department designs hardware and software-based receiver components and integrates these in a corresponding receiver application. The result of this development process is generally a terminal reference design with the core components HF frontend, baseband processing for modern digital radio and communication systems (channel decoder) as well as audio, video and data applications (service decoder). The range of services of the Integrated Digital Terminal department therefore ranges from the design and the development of prototypes to the consumer product.

Along the supply chain: from idea to product

The department's work mainly focuses on the further development of existing terminal architectures, their technologies as well as the discovery of new fields of application. In this respect, the development of a DAB receiver as a software solution for embedded systems was an important step in the direction of consumer products. A solution for DAB/DMB/DAB+ was developed for Texas Instruments, which now acts as a reference design for the efficient series production of a "software defined" multi-standard receiver in the automobile industry.

The transmission standard "Digital Video Broadcasting – Satellite Service to Handheld Devices" (DVB-SH) was the focal point of the establishment of new technologies in the form of a product last year. As a new broadcasting standard, DVB-SH allows television services to be distributed to mobile telephones and mobile terminals via satellite. A DVB-SH demodulator, one of the key components of terminals, was developed together with the Communications department of Fraunhofer IIS for the actual realization of this product idea.

Given the developments in the field of DVB-SH baseband technology, Fraunhofer IIS was chosen as a partner for the European Commission project SafeTRIP. The aim of the project is to design an integrated system platform for a telematics system in vehicles and to offer a new security service for persons and vehicles via satellite connection. The Integrated Digital Terminals department assumes a decisive role both in the system specification as well as in the design and development of a DVB-SH demodulator.

INTEGRATED DIGITAL TERMINALS

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DVB-SH: Television on the go thanks to satellite transmission

Multimedia content has become a key part of our everyday life. The desire to be universally available, be it at home, in the car or even on a swimming trip to a lake is therefore only too easy to understand. This leads to a growing demand for transmission technologies which are optimized for mobile reception. Digital broadcasting procedures are ideal for the bandwidth-efficient supply to any number of mobile terminals. As with normal stationary television, these allow any number of receivers to be supplied at the same time with the same media content.

The DVB-SH standard

Digital Video Broadcasting – Satellite Services to Handheld Devices (DVB-SH) is a transmission standard for a digital radio system which consists of a satellite and additional terrestrial infrastructure. The advantages in comparison to conventional, purely terrestrial systems are the large territorial coverage which is achieved by the satellite as well as a higher reception quality in congested urban areas, which is achieved through the combination of terrestrial and satellite reception.

In general, there are two system architectures for DVB-SH: DVH-SH-A uses OFDM (Orthogonal Frequency Division Multiplex) for the transmission from satellite to earth as well as for terrestrial transmission. With DVB-SH-B, however, TDM (Time Division Multiplex) is used for satellite transmission and OFDM is used for terrestrial transmission. Furthermore, there are two classes of terminals (class 1 and class 2), which differ in the extent to which they cope with brief interruptions in the receiver signal.

From standard to terminal

Fraunhofer IIS was involved in the development of the standard and its validation in field tests right from the beginning. However, there are also a lot of development stages from the approval of a transmission standard such as DVB-SH to the finished terminal, most of which can be carried out at Fraunhofer IIS. In the case of DVB-SH, the Integrated Digital Terminals department concentrated on the development of the DVB-SH demodulator.

This demodulator is one of the key components of a terminal which is responsible for the reproduction of multimedia content from digitalized receiver signals. The signal received by the antenna is processed and digitalized before it is used as an input for the demodulator. As an output, it then supplies the data package, which has been corrected for transmission errors, with the actual audio and video data in digital form. To make the digital multimedia content visible and audible for the terminal user the output of the demodulator is finally processed by an audio/video decoder.

In order to test whether the demodulator is functioning correctly and efficiently, a signal generator (which was also developed at Fraunhofer IIS) is required. This is a simplified transmitter with the additional possibility of reproducing signal faults using channel models. It illustrates the reversed functionality of the demodulator, namely to generate a DVB-SH compliant signal for the transmission through air from the digital multimedia data packages.

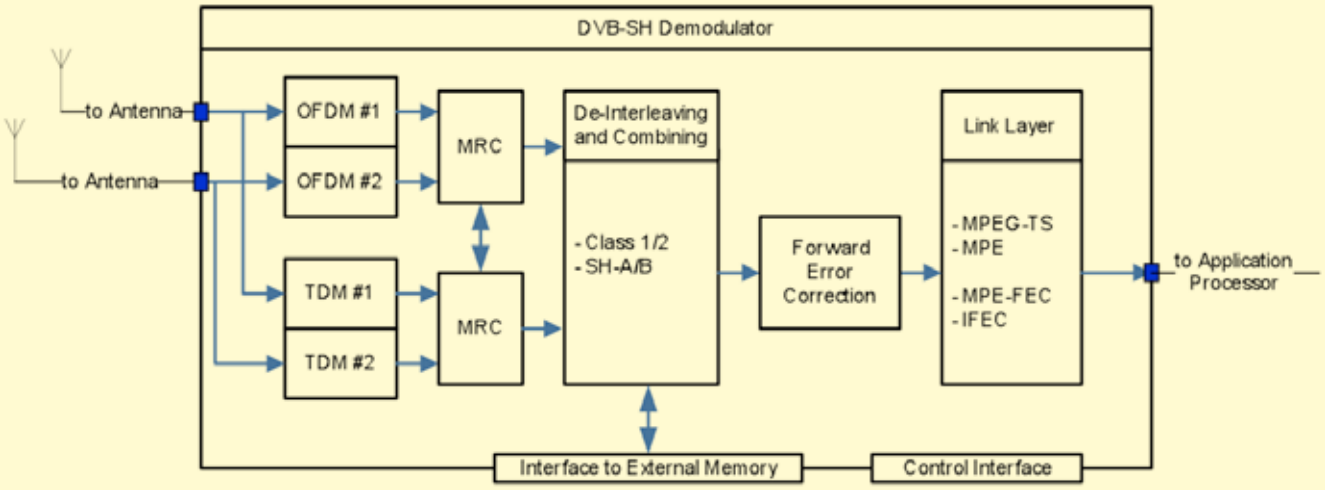

Figure: Block diagram of the DVB-SH demodulator developed at Fraunhofer IIS

MRC: Maximum Ratio Combining
FEC: Forward Error Correction
MPEG-TS: MPEG Transport Stream
MPE: Multi Protocol Encapsulation
IFEC: Inter-Burst FEC

The receiver technology

The DVB-SH demodulator developed at Fraunhofer IIS is highly configurable and ideal for use on various hardware technologies. The realization as an integrated circuit with the aid of standard cell processes makes it especially suitable for use in terminals with high production volumes, such as car telephones or mobile telephones. For low production volumes, such as in the area of field test and reference receivers, a field programmable gate array (FPGA) can be used.

In addition, the architecture supports a multitude of configuration possibilities, such as the number of independent receiver paths. This allows the architecture to be optimally adapted to the respective application. A standard configuration with two TDM and two OFDM demodulators is illustrated in the figure. This configuration provides for a system with two independent receiver antennas, the signals of which are combined in the demodulator to increase the reception quality.

AUDIO AND MULTIMEDIA

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Audio and multimedia

In the Audio and Multimedia business field more than 120 engineers and scientists develop and market key technologies for applications in the communication, broadcast, consumer electronics, online media and software markets. The business field is therefore intensely involved in international standardization committees and actively contributes to the development of standards. By interconnecting standardization, development and implementation, the Fraunhofer IIS can offer new audio and multimedia standards at a very early stage as production-ready software for integration in professional and consumer products. This work has allowed the institute to obtain a leading position in international competition in the past few years.

Two of the greatest challenges in the field of audio and multimedia in the next few years will be the availability and commactivity i.e. the linking of communication and interactivity. With the increasing networking of all devices, in future the consumer will expect media content to be available anywhere at any time. Moreover, given the distribution of high-quality HD content, the users also demand high-quality, interactive communication systems.

Availability

In the networked gigabit society, all content will be available anywhere and at any time. This is associated with a growing demand for transmission bandwidth, which can only be partly served even by new technologies such as Long Term Evolution (LTE) or fiber optics. The bandwidth will therefore remain a scarce commodity and the efficient transmission of audio and multimedia content will remain a necessity in the future too. Online media and digital radio systems will continue to compete with one another but will also complement and support each other. In accordance with these trends, the Audio and Multimedia business field develops and licenses efficient codecs and new services for online media and digital radio.

Last year the British radio service provider TwoFour licensed the audio codec High Efficiency AAC (HE-AAC) by the Fraunhofer IIS for use in BBC online radio. As a means of satisfying the growing demand in the mobile market too, since February 2010 the Fraunhofer IIS has been offering this and the most common MPEG audio codecs as implementation both for the android operating system as well as many other processor platforms and operating systems. The efficiency and quality of these implementations are key factors in the client's decision to use products from the Audio and Multimedia business field: the Software Defined Radio by Texas Instruments based on the Jacinto Platform therefore uses the DAB codec implementations of the Fraunhofer IIS. The first mp3 player by Samsung with mp3HD functions has been on the market since February 2010 and the Logitech Squeezebox Touch has been supporting HD-AAC (High Definition Advanced Audio Coding) since March.

Both HD-AAC as well as mp3HD guarantee the best sound quality through lossless compression. The integration of the new surround codec MPEG Surround into international standards such as WorldDMB, Digital Radio Mondiale, DVB, Open IPTV Forum, ISDB and DLNA was also further promoted last year.

Furthermore, last year the Audio and Multimedia business field also pushed the development and distribution of new services for digital radio. Since April 2010, in the USA TotalTraffic+ has been using the open standard Journaline, developed by Fraunhofer IIS, for the transmission of text messages. At the IBC in Amsterdam, the employees of the business field have introduced Diveemo, a new video service for Digital Radio Mondiale. Among other things, Diveemo allows very large areas to be supplied with educational programs. The new service can therefore guarantee access to school education in remote parts of Africa, for example.

The audio activities in the business field were expanded again last year. The founding of the group "High Quality

Audio Coding“ meant these activities could be intensified further. The group manager is Nikolaus Rettelbach.

Commactivity

With the increasing distribution of HD content, recipients will also be expecting a significant improvement in telephone and communication systems in future. While television and cinema are being upgraded to HD, 3D and surround sound, the quality of telephony has largely remained static in the past few decades. New technologies from the Fraunhofer IIS promise to put this situation right. Future communication systems will not only offer significantly improved quality but will provide for increased interactive elements, for example games in real-time. This consolidation of communication and interactivity can be summarized under the term Commactivity.

Commactivity was also the motto of the business field Audio and Multimedia at the CEBIT 2010. Two reproductions of living rooms at the Fraunhofer trade fair booth were connected with one another via an audio communication engine. This allowed visitors to play board games with one another via lounge tables with integrated touchscreens. The outstanding speech quality of the audio communication engine let the visitors forget the distance and gave them the feeling of being in the same room. The participants in the Mobile World Congress 2010 were also able to experience this. Together with the Fraunhofer Heinrich-Hertz Institute HHI, Fraunhofer IIS presented telephone conversations in CD quality via the future mobile radio standard LTE-A (Long Term Evolution Advanced) for the first time. The Fraunhofer audio communication engine was also used here. In September 2010, the introduction of Low Delay Video at the IFA then completed the Fraunhofer communication technologies. Based on the H.264 standard, it’s not only telephone conversations which can now be made via IP connections in a previously unseen quality, but also HD video calls and conference calls. The Low Delay Video-Codec was used for the first time in the EU project “Together Anytime, Together Anywhere“, in which the codec was developed. The aim is to simplify the communication and interaction between groups of people who are physically and temporally divided.

The group “Communication and Acoustics“ was founded under the supervision of Fabian Küch to provide extra support in these central areas of the business field.

With Fraunhofer into the future

Fraunhofer IIS gives the technological answers to the key challenges in the media world 2010+. The institute’s future-oriented technologies and products will further strengthen its leading position in the international competition. And in the future too, Fraunhofer IIS will continue to significantly influence and create new business models in broadcast, online media, music distribution, communication and interaction through forward-thinking developments.

AUDIO

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The interactive audio future

Up until now the Internet user has had to make a decision: either they download a piece of music with the usual bit-rate, which they can only use to passively enjoy the music, or they want to work interactively with a piece of music, for example to change the volume of individual instruments according to their own taste. However, this requires a much higher data quantity as all instruments have to be downloaded as individual tracks but each with the bit-rate of a complete piece of music. In future this decision will no longer be necessary. A new ISO/MPEG standard allows both at the same time – bit-rates of a stereo piece of music and the possibility of interactive playback.

In the standardization committee the new technology operates under the name "Spatial Audio Object Coding" (SAOC). Here audio objects can be individual instruments or vocals but also participants in a teleconference or conversation and sound effects within a radio program. A mono or stereo downmix is firstly generated by the encoder from all existing individual input signals and this is then coded with any audio codec (for example AAC). The downmix can either be automatically or manually created by a sound engineer. Parametric side information is allocated to the individual objects, and then embedded in the downmix signal. The bit-rate of the stereo file therefore only increases by a few kbit/s per object. On the decoder side, the audio objects are directly reproduced in the desired number of audio channels and the user can adapt the playback to their individual taste thanks to the installed rendering engine. SAOC is compatible with existing transmission technology and all reproduction devices. Should there be no SAOC decoder available, the side information is ignored and only the downmix signal is reproduced. Investigations on possible target markets have so far shown four different areas of application.

MPEG SAOC for remix and karaoke – experience the individual music mix

In addition to the passive reproduction which has existed so far, in the field of music SAOC gives the client the opportunity to adapt the music to their taste or the respective situation. For example, a karaoke mode can be selected for the playback, in which the volume of the audio object "vocals" is minimized so that the user can sing to it themselves. In the same way they can fade out any instrument and play to the song themselves.

For the user, more interactivity for remix and karaoke means:

– creating music which corresponds to individual preferences
– karaoke applications are possible thanks to the fading out of singers

MPEG SAOC for communication systems – no more incomprehensible telephone conferences

SAOC also offers a clear improvement in comparison to today's systems when it comes to the increasingly popular teleconferences. A conference partner can acoustically scatter his dialog partner around the room or rather across the speakers. Moreover, participants with lower volumes can be made louder and those with loud disturbing background noises can be made quieter so that the speech intelligibility increases and thus the listening effort decreases.

For the user, more interactivity for communication applications means:

– no differences in volume between the participants in a telephone conference
– individual arrangement of the conference participants on your own loudspeaker system

MPEG SAOC: MPEG Surround for Audio Objects

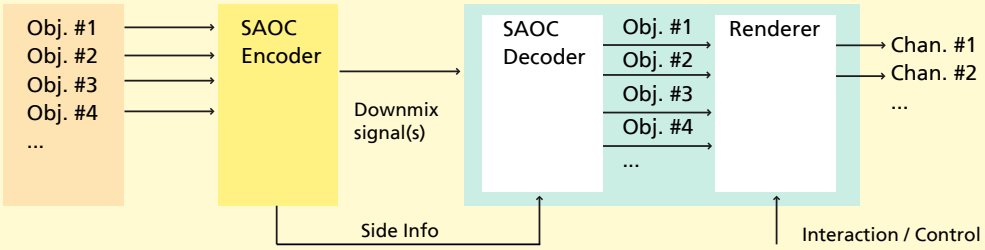

Figure: Schematic diagram of the functionality of MPEG SAOC

– the ability to assign text and images to individual participants means they can be identified more easily during the meeting.

MPEG SAOC for broadcast systems – customized TV and radio sound

A third application option is in the field of broadcast, TV transmissions in particular. Viewers of a live sport transmission can decide themselves whether they want more of a stadium atmosphere or want to hear more from the commentator. Television can also become much more enjoyable for those who wear a hearing aid. These persons often have difficulty understanding the dialogue in films due to the loud sound effects. SAOC can enhance the dialog and reduce the sound effects.

For broadcast applications more interactivity means:

– TV and radio program users can customize the audio playback to their individual needs
– radio stations can offer cost-efficient additional services, for example for the hard of hearing

MPEG SAOC for game and learning applications – directly at the heart of the gaming world

Furthermore, SAOC can also be used for online games. Gaming scenes can be designed more realistically through skillful positioning of the sounds and the saved audio bit-rate means there are more bits available for video coding and thus higher image quality.

For game and learning applications, more interactivity means:

– developers can flexibly design sound scenes and conserve bit-rates
– users can customize the audio scenes from learning applications for their own needs in order to achieve the greatest possible learning success

MULTIMEDIA REALTIME SYSTEMS

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Telephone conferences without disturbing echoes

Acoustic echoes arise from acoustic couplings between the loudspeaker and microphone in telecommunication devices. These effects often occur when using hands-free devices. The acoustic feedback signal is transferred to the far-end subscriber and there the speaker hears a delayed version of their own speech. This disturbance distracts the participants and can make a normal conversation almost impossible. Effective echo suppression is therefore essential, especially for connections with longer signal delay times in order to hold meetings which are as natural as possible via telephone conference.

Figure 1 schematically illustrates the general problem in the suppression of acoustic echoes. The far-end signal, which is emitted by a loudspeaker, travels to the microphone directly as well as via the reflected paths. The task of echo control technology is to remove the disturbing echo from the far-end subscriber without changing the signal of the near-end speaker.

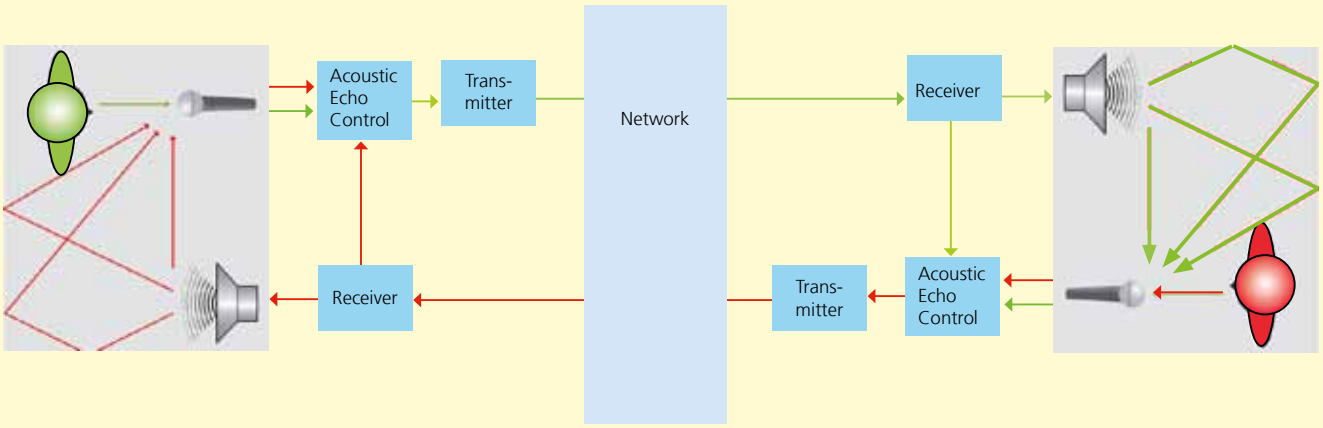
With the Acoustic Echo Control from Fraunhofer IIS it is possible for both parties to communicate without any disturbance during a telephone conference. This new technology relies on Fraunhofer's know-how about the human perception of sounds. The filterbank used shares important features with the filterbank of conventional perceptual audiocodecs.

The Fraunhofer Acoustic Echo Control also uses a simplified physical model of the acoustic echo path in order to obtain a reliable estimation of this. The model is illustrated in a schematic diagram of the room impulse response in figure 2. You can see that the signal delay is caused by the distance the direct sound covers from the loudspeaker to the microphone. In addition, changes in the spectral color of the loudspeaker signal which are caused by the superposition of early reflections in the room are also taken into consideration. The late reverberation is also included in the model. The corresponding model parameters are constantly updated during the operation, based on a correlation analysis of the loudspeaker and microphone signal. By using this adaptive physical model, the Fraunhofer Acoustic Echo Control functions reliably for various changing acoustic environments. This means that the microphones can be moved freely in the room or that the noise environments can be changed without any problems e.g. by opening a window.

Reliable echo suppression can be achieved for late reverberation times of up to several hundred milliseconds. Due to a separate calculation of direct sound propagation time, it is also possible to capture delays of a couple of hundreds of milliseconds. This allows for the Fraunhofer Acoustic Echo Control to not only operate directly at the near-end but also in other central distribution locations within a communication network.

To ensure a natural sounding communication, in which all participants have the feeling they are in the same room, the audio quality must also be correct. The Acoustic Echo Control of Fraunhofer IIS therefore not only supports the 8 kHz sampling rate of a telephone connection but also sampling rates of 16, 32, 44.1 and 48 kHz. This not only allows speech to be transmitted in a completely natural sound but all types of audio signals including music and background noises. Moreover, the disturbing echoes are even reliably suppressed in multi-channel systems such as stereo or 5.1. An integrated module to suppress disturbing background noises also improves intelligibility and contributes to an enjoyable telephone conference.

One factor which is particularly important for the manufacturers of teleconferencing systems is the very low complexity of the entire procedure. The Acoustic Echo Control has already been successfully presented to numerous service providers and leading industry representatives from the communication



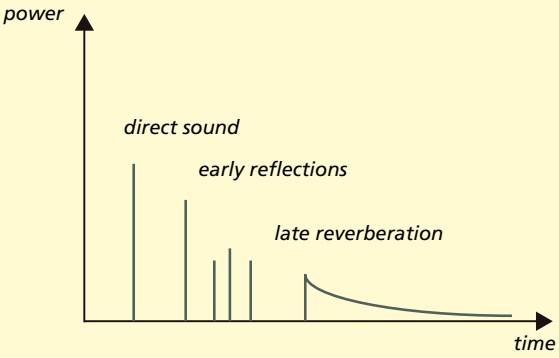


Figure 1: Schematic illustration of the suppression of acoustic echoes

Figure 2: Schematic illustration of a room impulse response

sector at conferences and trade fairs across the world. Furthermore, Fraunhofer is using the technology to participate in the EU sponsored project "Together Anywhere, Together Anytime TA2". This project is to develop new procedures and concepts in order to make the communication between groups via the Internet, for example when playing games together, easier and of better quality. Sophisticated signal processing, which includes everything from the preparation of microphone signals to multi-channel loudspeaker reproduction, ensures that the distance between persons can be removed in any living room without any great installation work. The technology should be able to be integrated in existing devices such as televisions, settop-boxes and Hifi systems in the future. With the Acoustic Echo Control, teleconferences and team games in which natural conversations with the other persons are almost impossible due to the technical obstacles will hopefully soon become a thing of the past.

WIRELESS DISTRIBUTION SYSTEMS / DIGITAL BROADCASTING

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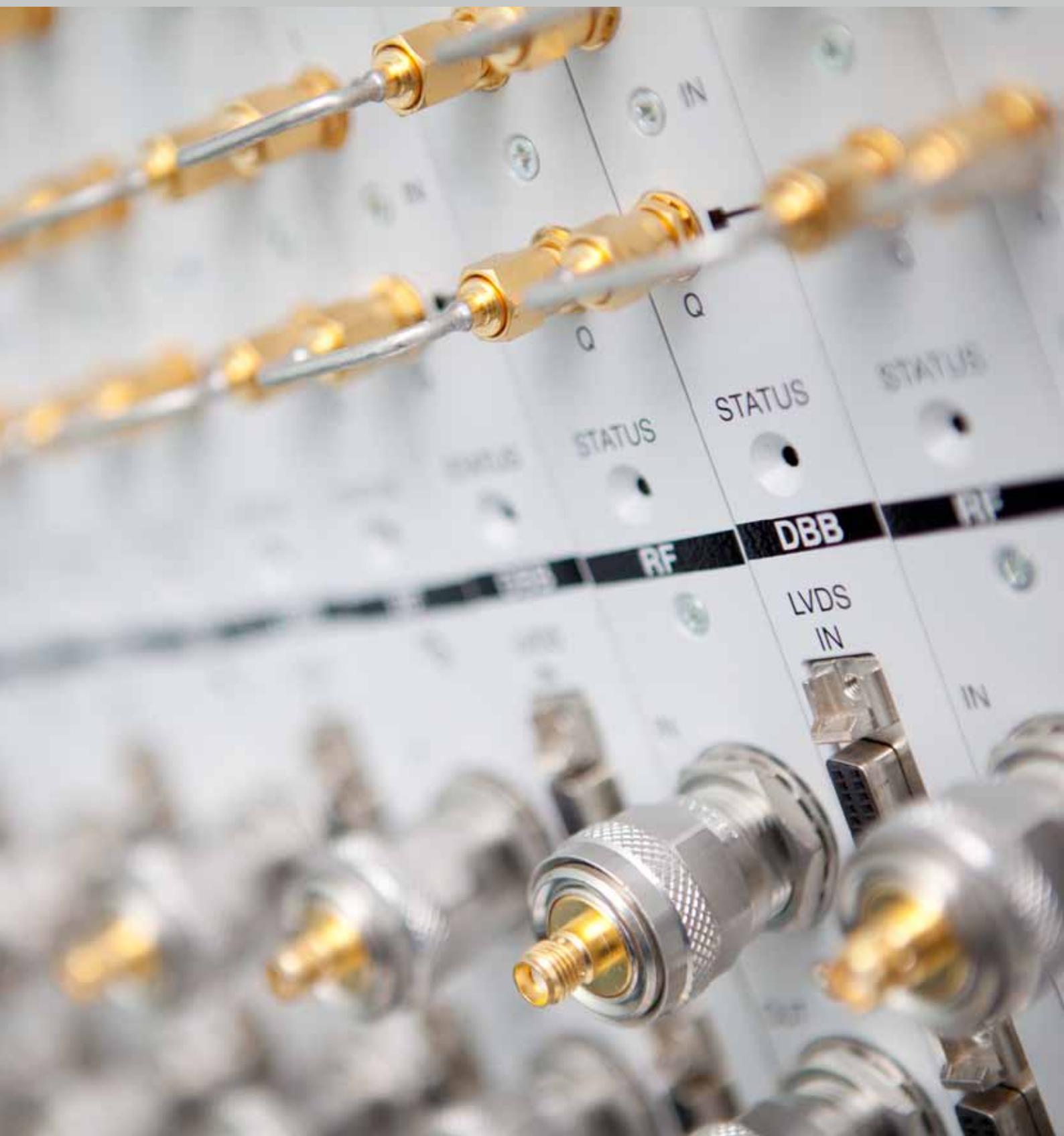

The Project Group Wireless Distribution Systems / Digital Broadcasting DVT in Ilmenau has been expanded again during the reporting period and will have 11 employees by the end of 2010. Thanks to its establishment in the Ilmenau University of Technology, the project group managed to acquire highly qualified graduates and post-doctoral academics. This reinforced the main areas of activity in the fields of distribution technology and coverage predictions.

One main focus was the work on the "Mobile Satellite Communication in Ka-Band (MoSaKa)" project sponsored by the German Aerospace Center (DLR). Together with the project partners DLR – Institute for Communication and Navigation, the company IABG and the Technical University of Ilmenau as well as departments of Fraunhofer IIS in Erlangen, the first important mile stones in the development of mobile satellite communication systems were reached in the project.

In the scope of the project "MILADY", valuable results in the field of channel modeling and coverage predication were compiled in cooperation with the Communications Department at Fraunhofer IIS. In the field of tactical radio systems, the project "National Broadband Waveform" brought forth a partnership with other Fraunhofer institutes and universities.

The project group expanded and completed its infrastructure and technical facilities. After the antenna tower was constructed on the test ground "Am Vogelherd" in 2009, the shell work for a laboratory building was started. The central part is a high frequency measuring cabin on the roof of the building. In connection with the antenna tower it will create a system for dynamic measurements on mobile satellite systems (see also technical contribution).

In addition to this, a system for the synthesis of spatial radio channel models "Over The Air (OTA) Test" is also realized in the cabin. Here up to 32 antennas arranged in a circle in the measuring cabin irradiate a measuring object placed in the middle and create a wave field with an accurately defined spatial structure through the superimposition. The system uses measurement to characterize the transmission to devices with integrated multi-antenna systems, such as those, for example, used in the new generation of mobile radio (Long Term Evolution LTE). This is financed by the central strategy fund of the Fraunhofer-Gesellschaft.

The already close cooperation with the Ilmenau University of Technology and its DVT subject area in the fields of channel modeling, ripple control systems in long wave as well as OTA test procedures was further intensified.

DVT is also partnering with the Ilmenau University of Technology in the field of cognitive radio systems. This involves the adaptive use of currently statistically allocated radio resources which are unused at present and thus allow the limited electro-magnetic spectrum to be utilized more efficiently. The planned OTA system will provide the opportunity for experimental verification of research results.

WIRELESS DISTRIBUTION SYSTEMS / DIGITAL BROADCASTING

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Test system for mobile satellite communication in Ilmenau

Overview

The Project Group Wireless Distribution Systems / Digital Broadcasting DVT in Ilmenau is working on the construction of a test system for mobile satellite communication (SatCom). A 50 meter high antenna tower carries the transmitter and receiver subsystems for the simulation of a satellite; other components are located in a laboratory building, like the three-axis motion simulator. This is obtained in the project "Mobile Satellite Communication in Ka-Band (MoSaKa)" funded by the German Aerospace Center (DLR). The goal of the MoSaKA project are the development of high bit-rate compact terminals, the development of technologies for the Ka-band and the development of architectures for hybrid networks. In addition to the main applicant Fraunhofer IIS, the specialist fields of the Ilmenau University of Technology, the DLR Institute for Communication and Navigation IKN as well as the Industrieanlagenbetriebsgesellschaft mbH IABG are working together as a consortium on this research project. Selected scenarios are set to be demonstrated with the test system in 2012. The system itself is set to be put into operation in 2011 and be available to industry partners as a test platform.

The test system

The test system is to be used to investigate the efficiency of mobile SatCom terminals. To do this, the system must be able to reproduce the two aspects "satellite" and "mobility" of a real mobile satellite application. The satellite is represented by the antenna tower, the mobility is achieved through a satellite channel simulator and the motion simulator mentioned above. Trees and buildings which appear and pass by in the transmission path between satellite and terminal have different levels of impact on the signals of a SatCom terminal, which is reproduced by the channel simulator. As SatCom terminals are generally equipped with directional antennas, these must be pointed at the satellite and constantly tracked. The motion simulator generates vehicle movements which the antenna tracking system has to compensate.

Test options

Conventional tests with operational satellites generally investigate the parameters "antenna diagram of the SatCom terminal" as well as the "dynamic behavior of the antenna tracking system through road tests". A mobile SatCom terminal in operation must be able to guarantee the following criteria to comply with the frequency regulation:

- the antenna must be constantly aimed at the satellite during motion and emission of signals
- the SatCom terminal must not stream onto or interfere with neighboring satellites
- the SatCom terminal must comply with the guidelines in terms of the Federal Immission Control Act
- at the same time, the functionality of the SatCom terminal itself may not be impaired by signal interruptions (fading)

These points can only be partially investigated during a normal measuring drive. With the help of the test system scientists can investigate all parameters of a SatCom system with little effort and without the risk of interfering with real satellites. A complete end-to-end test can be carried out in the Ku- (12/14 GHz) and Ka-band (20/30 GHz) for linear or circular polarization with the following individual test options:

- antenna diagram
- dynamic behavior of the antenna tracking system in elevation and azimuth for various roadway situations
- measurement of the undesired emissions to neighboring satellites

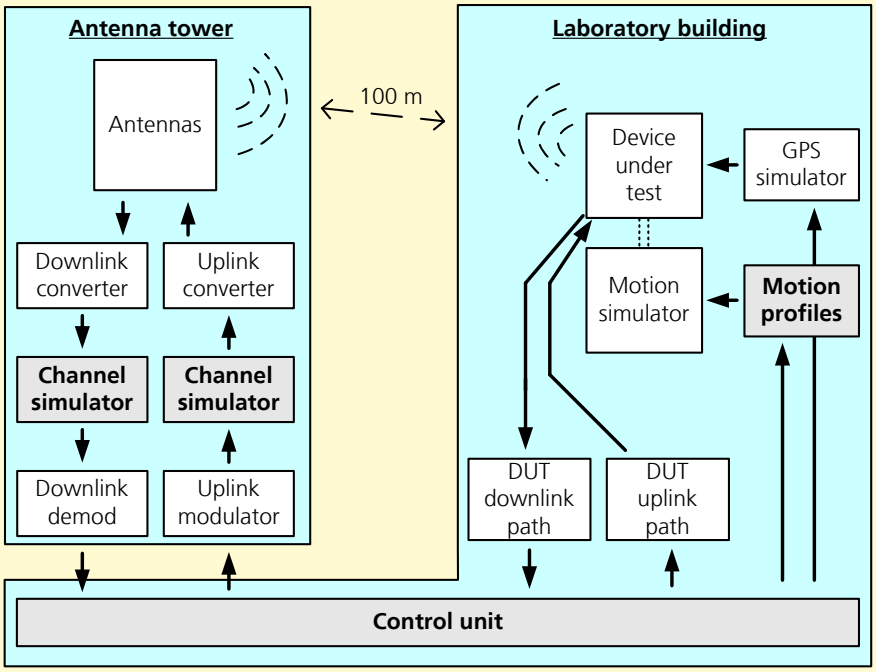

Figure: Block diagram of the test system for mobile SatCom terminals

– transmission behavior for forward/return link
– end-to-end efficiency

The following sub-systems/components are contained in the test system:

– satellite channel simulator with reproduction of nonlinearities of a real satellite
– three-axes motion simulator with the following features:
  – payload: max. 900 mm diameter and max. 50 kg
  – rotation angle: roll and pitch + 45 deg, yaw continuous
  – rotation speed: max. 300°/s
  – accelerations: max. 1000°/s2
– reproduction of an "interfiering satellite" for interference measurements; the angular distance to the main satellite can be freely selected between 1° and 3°.
– HF cabin (40 dB reflection, 80 dB transmission attention in the direction of the core of the building) with a RF transparent window towards the antenna tower and in the direction of operational satellites.

The test system can be expanded for other frequency bands.

RF AND MICROWAVE DESIGN

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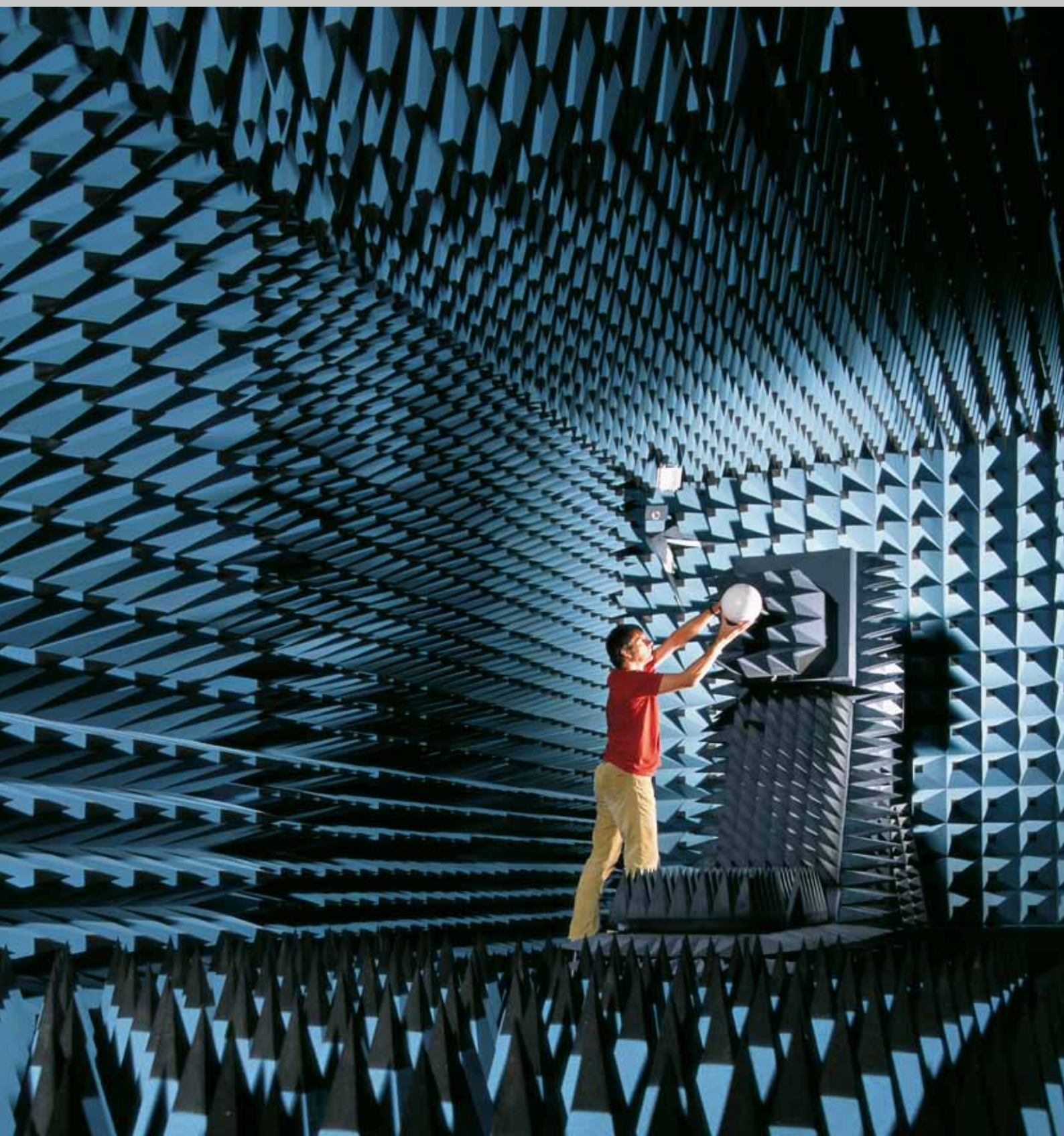

High-frequency technology at Fraunhofer IIS

High-frequency and microwave technology has been a core competency of Fraunhofer IIS for more than 20 years. The 45 scientists are currently working on the latest developments for wireless technologies, equipped with measuring technology up to a frequency of 60 GHz. A well-established design process guarantees clients excellent support from research and development to the final product. Small and medium-sized businesses such as BIJO-DATA GmbH, and large companies such as Lufthansa Technik AG have already been impressed by the skill and innovative power.

What does the institute offer to partners?

Fraunhofer IIS produces RF systems in the fields of radio communication, radio positioning and antennas. Radio communication covers a wide range of services from narrow band data transmission to digital radio. The development of radio nodes themselves, radio receivers, modules for satellite communication or software defined radio platforms require an in-depth understanding of circuit design. This includes fast digital signal processing of high frequency signals. Tailor-made radio systems with a long range or high bit-rate help the customer gain market lead and added value. Developments in the field of local area transmission and RFID (Radio Frequency Identification) complete the offer of wireless communication systems.

The work of the department in Nuremberg focuses on radio positioning to track the position of persons or objects as a special form of wireless technology. Integrated in an environment in which more than 70 scientists are working with localization, Fraunhofer IIS develops innovative positioning and tracking systems. They are currently focusing on procedures for time of arrival, angle of arrival, event detection, sensor fusion and their applications. The antenna is a key component for wireless systems; the spectrum in the development ranges from small embedded antennas to controlled multi-antenna systems. A large test chamber for up to 40 GHz is available for evaluation which is carried out during development, which is also offered to clients for their own testing.

Where are high-frequency systems used?

Communication technologies in high-frequency technology are ultimately used wherever terminals and self-contained distributed systems are found. Modern applications are found in security technology, logistics, production, automobile technology, in Ambient Assisted Living (AAL), medical technology as well as in sport and leisure. RFID is the key to optimizing processes in logistics applications and to saving costs. The integration of RFID labels in materials such as metal or fiber composites expands the area of application as far as including aeronautics. Secure wireless systems with long ranges are required for measuring electricity and water consumption. In driver assistance systems, high-precision positioning of persons at risk in road traffic can save lives. The future market AAL is also very interested in positioning technologies asking for wireless mobile sensors for a long, self-determined life.

The range of services at Fraunhofer include the execution of studies and the realization of complete custom-made systems all the way to licensing. Fraunhofer IIS integrates its expertise into numerous research projects. A pilot project with the aim of establishing an ESI (Embedded Systems Initiative) application center is currently being launched. Fraunhofer IIS contributes to ESI – based in the metropolitan region Nuremberg – with resource-optimized radio systems. Many years of experience, numerous projects and successful partnerships stand for Fraunhofer IIS competence in the field of RF technology.

RF AND MICROWAVE DESIGN

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Infrastructure-based localization

Radio positioning, a core competence of the RF and Microwave Design Department, is focused on the design, development and provision of infrastructure-based positioning systems.

The principle of radio positioning is based on three measureable values:

- the signal delay time which a wave requires for distribution, used for measuring distance
- the phase differences of a signal at the elements of a group antenna, used to determine direction
- the ratio of receiver performance to transmission performance, used to indicate location

Time of Arrival (ToA)

The distance is calculated from the product of the measured signal delay time between two points with the speed of light. The correlation between the received signal and the known ideal signal is often used to determine the arrival time. An interpolation of the correlation curve increases the high time resolution through a more exact calculation of a characteristic point (ToA value) on the correlation course. As multi-path tracks lead to overlapping correlation pulses, the direct track must be identified and isolated, even in the case of a low time lag.

Kalman filters or "machine learning" methods are used to correctly calculate this time in real-time. The principles derived from the time of arrival such as determining the round trip time or the time delay on arrival improve the stability and accuracy with reduced time and effort.

Round Trip Time

The distance between two points is calculated from the difference between the time measured between two transceivers and their processing time. The results are considerably improved through at least one other measuring process, initiated by the opposite transceiver. This method has been used successfully at Fraunhofer IIS as a means of locating persons in rooms.

Time Delay on Arrival (TDoA) and hyperbolic triangulation

Three-dimensional coordinate calculation requires at least three distance values. To reduce measurement errors, however, the difference between at least four distances, respectively their ToA values, is used. The transmitter position is then determined by a non-linear system of equations. The WiTrack system of Fraunhofer IIS uses major over-determination with 12 receivers to guarantee a reliable positioning of the transmitters worn by people.

Angle of Arrival (AoA)

Based on the distribution of the radio signal as an almost level wave in the far field, time of arrival differences can be determined as a phase shift between antenna elements in different locations. Linear group antennas are integrated into the Fraunhofer IIS system. Subroom-based evaluation procedures such as MUSIC or ESPRIT are used for high precision, and reconfigurable special processors provide for the necessary high real-time computational power at a low cost. The analysis of the MUSIC spectrum is primarily beneficial if tracking procedures are used in the case of multi-paths and several hypotheses are analyzed. New systems for the protection of pedestrians in road traffic as well as the positioning of forklifts in logistics are based on this technology.

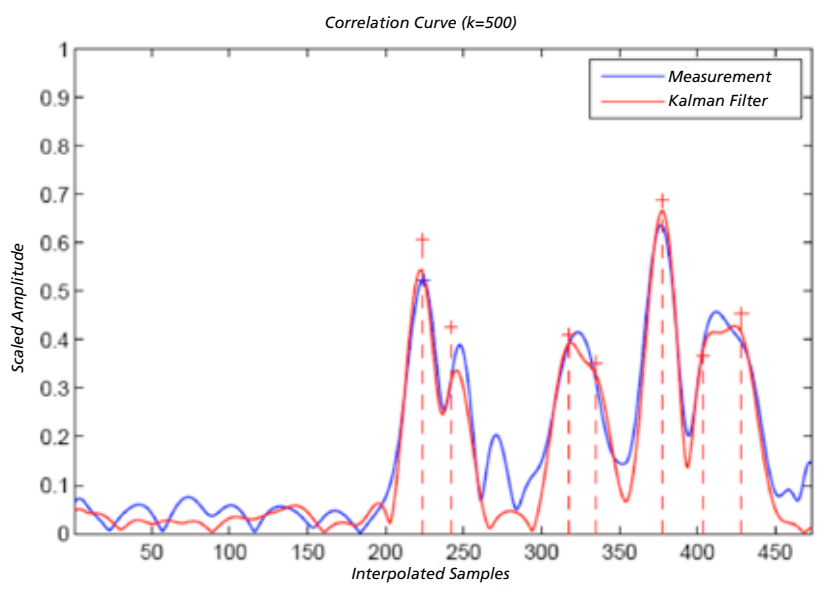

Figure: Correlation curve of the time of arrival with multiple paths

Measuring field intensity

As a result of the free space attenuation, the field intensity decreases in direct relation to the distance between the transmitter and receiver. A reproducible field intensity carpet is also distributed in stable inhomogeneous environments. The technology "awiloc" from the Communication Networks department picks up this local field intensity distribution and uses it to implement self-positioning in available WLAN networks. The measured field intensity is also used as an indicator for the plausibility of ToA and AoA measurements as shades and reflections can be detected.

Fusion of local information

The data from other sensors such as altimeters, motion sensors and magnetic field detectors perfectly complement the procedures in radio location described above. The combination of various technologies with complementary features is the key to robust localization systems. The fusion of local data is therefore the central component for tracking in the positioning system "LOKii" from the RF Microwave Design Department. The modular concept implemented consists of a three-tier procedure of sensor data fusion, high level fusion and gradual prediction. This allows new sensors, measuring guidelines and available external systems to be quickly integrated and to be transferred to a multitude of applications.

CONTACTLESS TEST AND MEASURING SYSTEMS

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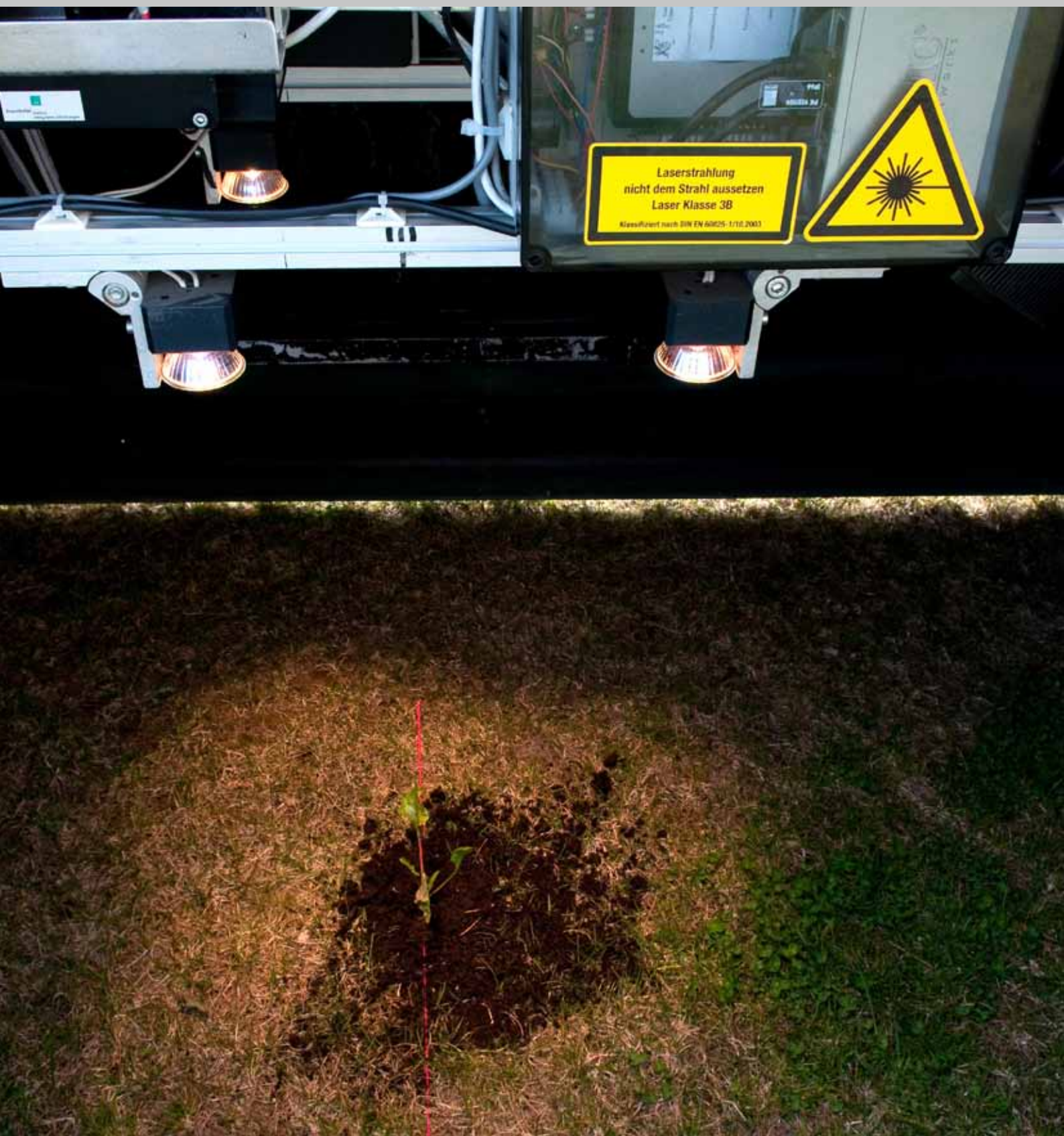

Overview

The main focus of the Contactless Test and Measuring Systems Department is on the development of specialized X-ray cameras and fast optical 3D measuring systems. Both of these areas benefit from the core competencies of the department in the fields of optical camera technologies, software solutions, system design as well as mechanical construction. The majority of the employees is active in both fields of work and can therefore apply the research results to both fields.

Specialized X-ray cameras

The idea of constructing an X-ray camera protected against radiation damage based on a modular CCD (charge-coupled device) camera concept was realized for the first time in August 2006 with a custom X-ray camera for welded seam testing. As the CCD cameras themselves are not exposed to any radiation, they do not suffer damage and thus do not show associated signs of ageing like conventional X-ray cameras. In this concept, X-ray radiation is converted into visible light by a scintillator screen. After appropriate corrections, the partial areas of the scintillator recorded by the individual cameras can be assembled into an overall image. The X-ray camera XEyeS used to test welded seams has been in continuous daily use at high X-ray energies for more than four years without any recognizable deterioration in image quality. Based on this concept, the X-ray camera XEye2020 with an active surface of 20x20 centimeters was developed as its successor.

Several of these cameras have been in continuous use at an automotive supplier since early 2009. The latest version XEye4020 with an active surface of 40x20 centimetres is used both in radioscopic systems of a major car manufacturer as well as in computed tomography systems in the field of science. The department has built a customized version of this camera with 32 million pixels for the Alfred Wegener Institute for Polar and Marine Research (AWI). The AWI employs it in a CT system designed by Fraunhofer EZRT (see technical article there).

Optical 3D measuring systems

This field of work was originally created for applications in the area of tire production, which is still its main focus. The first TireChecker tire test system was commissioned by a tire manufacturer in April 2000 and tests approx. one million tires for dented side walls each year. So far more than 100 TireChecker systems have been commissioned with several system partners. These test systems are in operation in Europe, Asia and Africa.

For monitoring the tire building process the scientists of the BMP Department have developed the SpliceChecker system. This system is used by several tire manufacturers to monitor the winding of materials on the tire building drum. One of its benefits is a reduction of waste during production, which leads to corresponding savings in material and energy. Another important application for optical three-dimensional test systems are 3D sorting systems, which are capable of separating several millions of parts per hour into two quality levels according to 3D features with high accuracy.

The measuring system for assessing plants in early growth stages in the field, which has been developed over the past three years in cooperation with a seed producer, was revised both in terms of its hardware and software in order to increase the throughput in field use. This allows even more types than before to be analyzed regarding their leaf area and number of leaves per plant.

For agricultural applications, the department developed a portable optical 3D scanner for assessing plant growth, in cooperation with a seed producer

CONTACTLESS TEST AND MEASURING SYSTEMS

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XEye X-ray detector: Long term stability at high energies

X-ray technology is extremely important in non-destructive material testing. The X-ray detector respectively the X-ray image quality is crucial for the efficiency of this testing technology. Material defects can only be reliably detected with a very high image quality. While it was essentially X-ray films and image intensifiers which were used as imaging elements in the past, digital X-ray detectors have been increasingly used in the industrial as well as medical field for some years now. As the detectors are themselves exposed to X-ray radiation during image recording, a very high level of protection against radiation damage is vital for a constant image quality. This is especially important for industrial applications as this is where the systems are generally in 24/7 operation.

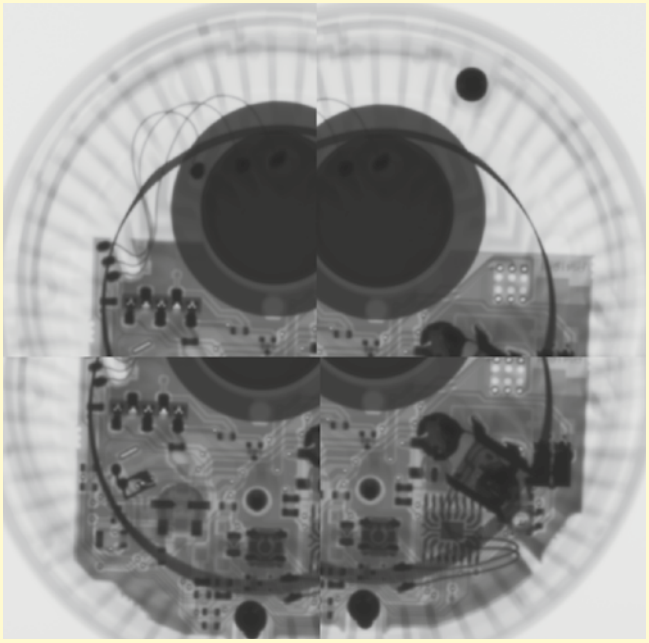
The dynamics, detective quantum efficiency, resolution, pixel defects and dimensions of the active surfaces as well as long term stability are the key features when assessing an X-ray detector. So far mostly flat panel detectors were used for industrial applications requiring large dynamic range. Although these offer a very good image quality, as a result of their construction principle they age very quickly in applications with high energies e.g. the testing of safety-related light metal alloy cast parts for the automotive industry. This is due to the fact that the semiconductor layer, which converts the photons into electrical imaging information, is directly in the path of the rays and thus accumulates damage by X-ray radiation with increasing duration. This results in noticeable pixel defects and visible remains of previous images, the so-called image lag. These image errors can lead to artifacts in automatic image processing.

The XEye X-ray detector, like flat panel detectors or image intensifiers, is an indirect conversion X-ray detector, i.e. the X-ray radiation is not directly detected but is detected via a scintillator which converts X-ray quanta into visible light. In order to obtain sufficient detective quantum efficiency, instead of being captured by one camera, the scintillator is captured by several cameras working in sync. After recording, these overlapping subframes are assembled to create an overall image with image errors being corrected to sub-pixel accuracy. As a result of the optical projection, it is possible to shield the entire detector electronics including the sensitive sensors against the X-ray radiation. The complete protection is the key factor for the long term stability of this X-ray detector. This modular concept based on individual cameras which are merged to create an overall image, also allows the development of X-ray detectors which are tailored to a specific testing task. Other advantages of the XEye are the lack of pixel defects and only a very small image lag which depends on the scintillator material alone.

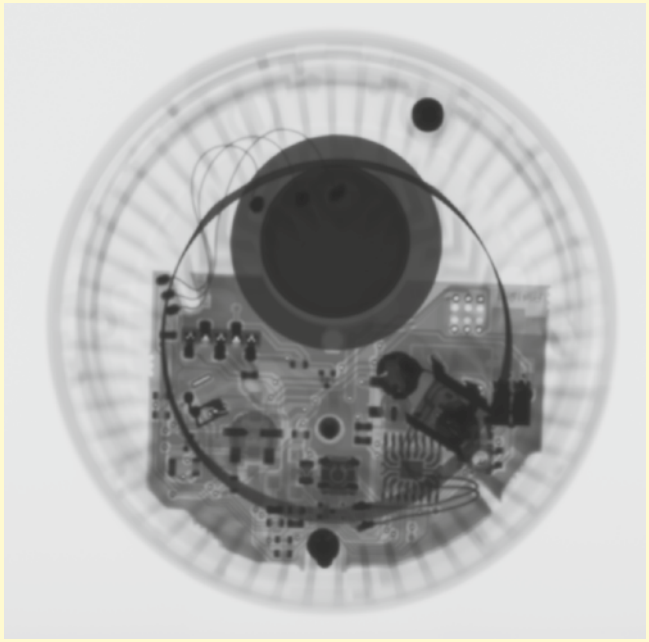
The first flat panel detector of this type with 4 megapixels, 52 µm pixel size and an active surface of 20x5 cm^2 has been in use in 24/7 operation by the company Butting GmbH & Co. KG since 2006 for testing of the longitudinal welded seams of stainless steel pipes. Continuously documented image quality tests with standardized image quality procedures, which must be carried out on each pipe, impressively demonstrate the constant image quality provided by the camera.

XEye detectors are now also available in 20x20 cm^2 and 40x20 cm^2. Depending on the application, these can be supplied with various pixel sizes, starting at 100 µm, and open up entirely new possibilities for X-ray systems in terms of testing time and consequently cost optimization. Flat panel detectors are usually only available with pixel sizes of approx. 200 µm or more.

XEye is a key part of the "Computed Tomography System for the Automatic Testing of Ice Drill Cores" presented by the Development Center for X-ray Technology (EZRT).



(a)



(b)

Figures: Uncorrected raw data (a) and corrected image (b)

Image: XEye4020 X-ray detector

The 32 megapixel camera developed for this project has an active surface of 40x20 cm² with a pixel size of 50 µm. Only by using this camera was it possible to reduce the measuring time by more than a factor or four while saving a high-precision detector motion axis for the otherwise necessary measurement range extension.

FRAUNHOFER IIS IN FUERTH

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The Fuerth branch of Fraunhofer IIS has been established in the Uferstadt Fuerth for more than 10 years now. At present, two departments and a research group of Fraunhofer SCS are working under one roof.

The Fraunhofer Development Center for X-ray Technology EZRT, a cooperative department of the Fraunhofer IIS and the Fraunhofer IZFP in Saarbrücken, the Fuerth branch of which is managed by Dr. Norman Uhlmann, and the department Process Integrated Inspection Systems (PRP) of Fraunhofer IIS managed by Dr. Thomas Wenzel carry out research in the area of industrial X-ray technology. The main activities of Fraunhofer EZRT are laboratory systems for material analysis, detector development, measuring technology as well as X-ray image processing, while the PRP Department focuses on turnkey developments and construction of X-ray systems for non-destructive inspection in the production process.

Both departments, which cooperate closely with one another, are also dedicated to educating and training users of X-ray technology. Together with the German Society for Non-destructive Testing DGZfP, they offer digital radiology courses for operators of X-ray inspection systems, primarily in the field of cast parts production. A new course, executed for the first time in October 2010, is devoted to the topic "3D Computed Tomography (CT)" and provides skilled workers, technicians and engineers who operate 3D CT systems with expert knowledge from the basics right through to special solutions for inspection tasks.

A research group of the Center for Intelligent Objects ZIO headed by Dr. Alexander Pflaum is also located in Fuerth. ZIO works on the development and application of so-called "Intelligent Objects" technologies. These include identification, communication and location technologies such as radio frequency identification (RFID), wireless sensor networks or localization procedures. These provide objects with their own intelligence, which allows information about the object, its environment and its history to be stored and communicated. Using this information, business processes and supply chains become more transparent, they can be quantitatively recorded and thus can be controlled. Concrete benefits for the business either result from cost reduction potentials, for example from a reduction in error rates or process throughput times, or from performance and turnover increases in the course of new technology-supported services or hybrid products.

At the future location Fuerth-Atzenhof a test hall for non-destructive X-ray inspection of large components with linear accelerator technology has been completed. The building, which is financed with the institute's own resources as well as with generous support from the federal government and the State of Bavaria, was inaugurated on October 21, 2010. In future, the linear accelerator will make it possible to subject large objects, for which conventional X-ray radiation technology does not suffice, to even the most complex tests. In the R&D facility, which is unique in this form in Europe, particularly large format objects will therefore be inspected using CT.

Areas of application will be security and surveillance, detection of dangerous and smuggled goods, non-destructive testing, quality control and error analysis in the automotive sector, aerospace and energy technology. Possible objects to be inspected are, for example, sea and air freight containers, fully assembled vehicles, large-format plate materials, airplane parts (wings, tail units, turbines), wind power stations or turbines and components of gas generators.

The inspection hall is set to be developed into an internationally unique industrial X-ray computed tomography center for the fields of non-destructive material characterization, production integrated component testing and process development.

DEVELOPMENT CENTER FOR X-RAY TECHNOLOGY

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Overview

Located in Fuerth, the Fraunhofer Development Center for X-Ray Technology EZRT, a joint department of Fraunhofer IIS and Fraunhofer IZFP in Saarbrücken, is dedicated to new developments in the field of non-destructive material testing with X-ray technology. The Fraunhofer EZRT works closely together with the departments "Process Integrated Test Systems" and "Contactless Test and Measuring Systems" departments in the field of industrial X-ray technology. The work here primarily focuses on laboratory systems for material analysis in materials development, the development of components such as detectors and X-ray tubes, measuring applications in X-ray technology and X-ray image processing.

Smallest mobile CT system in the world

In May 2010, the EZRT presented the computer tomography system CTportable at the CONTROL trade fair; with approx. 350x300x230 mm it is currently the smallest and lightest device in its market sector. This CT system is especially designed for use in the laboratories of universities and non-university research institutions, for example, in the fields of biology, geology and archaeology. However, this CT machine can also be used for industrial research, especially for non-destructive testing in quality assurance in the fields of the plastics, electronics, textile or ceramics industry.

Cooperation with universities

The EZRT continues to work closely with the Institute of Advanced Materials and Processes of the Friedrich Alexander University of Erlangen-Nuremberg, established in the same location in the Fuerth Technikum, in the Cluster of Excellence "Engineering of Advanced Materials" for the project "Computed tomography for the analysis of cellular and foamed materials and composites". The establishment of the new Fraunhofer Project Group X-ray Systems for Material Characterization, in close cooperation with the new Chair Material Characterization Using X-ray Microscopy in the faculty of physics and astronomy at the Julius Maximilians University of Wuerzburg, opens up completely new possibilities. The project group is established and headed by Prof. Dr. Randolf Hanke, former department head of the EZRT, who was appointed as professor at the University of Wuerzburg on July 1, 2010. The main activities of the project group will be the development of methods for X-ray imaging nano-material characterization, small angle scattering, X-ray optics for high-resolution CT, phase contrast X-ray as well as the development of high-resolution sensors. The close cooperation between the university chair and the Fraunhofer Project Group offers the opportunity to conduct basic research in the field of the nano-material characterization before the new topics are further developed by the Fraunhofer scientists for specific applications.

Based on the great success of the international symposium "NDT in Aerospace" held in December 2008 together with the German Society for Destruction-Free Testing DGZfP, Fraunhofer EZRT is organizing the second symposium this year together with the DGZfP and the Fraunhofer IZFP, which will take place in Bremen in November. Numerous research institutes and industry businesses from home and abroad have already registered.

DEVELOPMENT CENTER FOR X-RAY TECHNOLOGY

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Hand in hand with the satellite

The European satellite Cryosat2 measures the polar regions of the earth using radar. In addition to identifying the surfaces covered with ice, it also determines the layer thickness. The latter, however, can only be accurately determined with radar if additional information on the porosity of the ice is taken into consideration. Computed tomography procedures are used to generate this information. To do this, cores of 3,000 meters in length and 10 cm in diameter are obtained from the glaciers and tomographed in 1 meter long sections.

Two types of ice must be distinguished to analyze the data: corn snow, which appears down to a depth of 100 meters and is characterized by connected structures from air and material, and bubble ice, which is obtained from deeper regions and has separable air inlusions of different sizes and densities. In both cases, the core sections must be stored and tomographed at a temperature of -15°C.

The XEye camera developed by Fraunhofer IIS is used as an X-ray sensitive detector (more on this in the technical article from the BMP department). This detector is characterized by its large active surface of 40x20 cm with a pixel size of 50 µm. Combined with a very favorable afterglow performance of < 0.1%, it is the only such X-ray detector available on the market in the world.

The helical CT procedure allows long cylindrical objects to be measured seamlessly and is therefore the preferred means for generating three-dimensional volume data of the entire core. Despite a maximum core diameter of only 10 cm and a maximum magnification in line with the measuring field, this procedure produces data sets of approx. 140,000 projections of 64 megabyte each. A minimum voxel size of up to 12.5 µm can be achieved over the entire object.

However, given that, in the case of bubble ice, considerably smaller air inclusions are to be detected and analyzed, a higher magnifying image of the central area of the core must be used, which results in the detector being completely covered by the object's projection. A reconstruction which is as artifact free as possible requires information on the primary intensity in each individual projection for two reasons: on the one hand, any possible tube-related fluctuations in the intensity of the X-ray radiation must be compensated and on the other hand, projections where the object is not completely illustrated in a horizontal direction do not provide exact information on the radiation length. As a means of overcoming this problem, in the case of bubble ice, each core is subject to a two-tier measurement. While the helical CT procedure identifies the number and location of pores in the entire core, a sound multi-scan procedure, with which significantly higher resolutions are achieved locally, can be used to identify the pore volume distribution at a representative location in the core.

The overall porosity of the core can be determined by extrapolating this data for the entire volume. The multi-scan procedure records projection data sets of the object in different geometrical resolutions and thus obtains artifact-reducing additional information from lower magnifying data sets for high magnification measurements.

As an alternative, the gradient reconstruction procedure is suitable for making the transition between air and ice more visible. Instead of reconstructing absolute gray values, discrete gray values are derived. A multi-energy procedure is used for the examination of foreign body inclusions. In doing so, the core is recorded in two different X-ray spectra. The obtained three-dimensional volume data contains information on the attenuation coefficients of the materials, which in turn depend on the density and effective atomic number. Using a basis transformation, three-dimensional quantitative information is generated e.g. the density and effective atomic number.

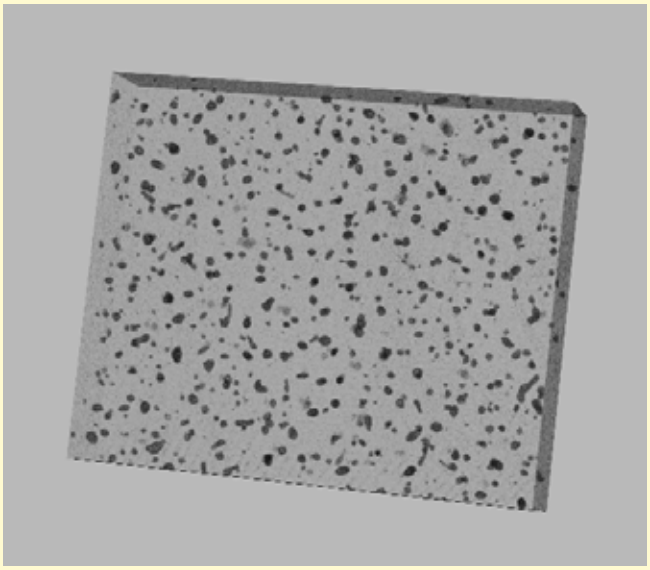

Figure 1: Bubble ice from a depth of 159 m. The separable air inclusions of different sizes can be clearly recognized here; voxel size: 16 µm

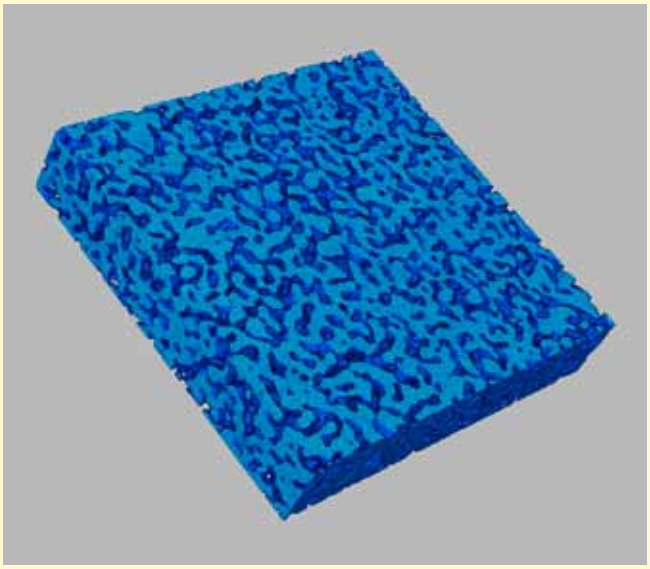

Figure 2: Section from a reconstruction of corn snow which was obtained from a depth of 35 m; voxel size: 56 µm

Materials which are particularly good to analyze in this procedure are those which form little contrast against air or water in the radiography. In the case of corn snow, air inclusions cannot, naturally, be separated and analyzed; only a medium porosity per layer can be calculated. Using a helical CT, the core is recorded with a comparably lower resolution. The gray values are linearized in a previously defined look-up table (LUT). Quantitatively comparable attenuation coefficients therefore develop in the reconstruction. The values obtained are placed in relation to the attenuation coefficients expected for compact ice; a medium porosity per layer therefore arises, which forms the foundation for the correlation to the radar measurements mentioned at the beginning.

PROCESS-INTEGRATED INSPECTION SYSTEMS

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Overview

With the creation of the department Process Integrated Inspection Systems (PRP) department in January 2009, the work focused on non-destructive testing topics, especially process integration, which until then had been part of the activities of the Development Center for X-ray Technology. However, the close and successful cooperation between the employees of both departments has remained the same.

As process-integrated inspection is essentially employed in series production, scientists are often confronted with tasks from the automotive sector as well as the aerospace industry. For example, chassis parts and light wheels, which are manufactured using casting processes, must be 100 percent inspected for defects.

The department PRP supplies the tried and tested automatic radioscopy technology for this. Version 7 of the inspection system ISAR (Intelligent System for Automatic Radioscopy) is being delivered to clients this year.

Ever since the first development phase in 1992, it has been continuously setting new standards regarding its efficiency: although a 2D image is incorporated in the evaluation, 3D features can now also be recorded and evaluated. ISAR now allows a defect volume to be calculated and not simply the projected surface. The viewing direction from which a defect is radiographed therefore becomes secondary. The adaptive classification procedures and an automatic adaptive reference image creation decrease the pseudo error rate even further.

Great progress was also made in the field of 3D component testing with computed tomography (CT) for use in the production line. The measuring and reconstruction times were reduced through the use of fast calculations on graphic cards and add important characteristics to 2D inspection, which are obtained when evaluating the volume data. The overall aim of this technology is to analyze the information contained in a component more efficiently in order to regulate the manufacturing process better and to prevent defects all together. PRP has all the necessary competencies for this technology: reconstruction mathematics, system know-how and real-time image processing.

As the procedures and systems mentioned previously are stationary, the aim of PRP is to make non-destructive testing, especially computed tomography, also available for mobile use. Robot-based CT systems for use in the servicing of aircrafts, for example, are one of the main areas of work here.

Optical inspection systems complete the portfolio of the department. Shiny and reflective surfaces, bores which can only be checked using an endoscope are among the applications of this quality assurance method. The consolidation with other modalities such as X-rays, thermography and ultrasound is to set new limits in component analysis in future.

The PRP department also offers its entire range of services in non-destructive testing for scientific services. This gives customers the opportunity to evaluate procedures and their advantages for their specific problems, to have series launches monitored in terms of testing or to use scientific advice for inspection test.

In addition training measures also guarantee know-how transfer. Courses are offered regularly in close cooperation with the German Society for Non-Destructive Testing (DGZfP). For example, a users course for computed tomography was started this year.

PROCESS-INTEGRATED INSPECTION SYSTEMS

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On-site computed tomography

X-ray computed tomography (CT) is one of the tried and tested procedures in non-destructive testing. A three-dimensional component inspection using CT has a significantly higher defect detection rate in comparison to a two-dimensional radiography (radioscopy); furthermore, the additional dimension makes it possible to characterize the errors in more detail.

Until now, objects had to be examined in a stationary X-ray system surrounded by an enclosed radiation protection cabin in order to be able to use the advantages of the 3D computed tomography. This substantially restricted the variety of types of testable objects. On-site computed tomography now offers the system mobility necessary for many applications, whereby the components required to record the raw data (X-ray tube and detector) can be moved around the object to be tested in a coordinated manner using a freely chosen manipulation system. In this respect, the CT is developed as an "on-site" procedure and opens up many areas of application which were previously excluded. These include, for example, the inspection of objects which previously could not be transported into a CT system due to the dimensions and weight, or the examination of assembly groups which are permanently integrated in systems and cannot be disassembled for test purposes.

Calibration methods specially developed for this system allow the X-ray source and detector to be individually positioned and guarantee that the components are accurately aligned to one another. Their coordinated movement around the object allows radiography images to be recorded from various angles, from which a spatial illustration of the test object can be reconstructed in connection with precise positioning data. The key advantage of this system is that the track on which the tube and detector are moved does not necessarily have to be circular. This is a great benefit if the freedom of movement for tube and detector is restricted due to the condition of the object. In such a case, the track can be selected so that any freedom of movement is optimally used and an adequate number of projections can be recorded from as many different radiographic directions as possible.

Depending on the planned inspection task and the possible motion tracks, there are various procedures available such as filtered rear projection, laminography or algebraic reconstruction methods. Many limiting conditions which come with traditional methods become obsolete through alternative procedures. Flexibility when selecting reconstruction procedures increases the quantity of system components in question as these can now be better optimized in terms of their application. This not only applies to the components X-ray tube and detector but also offers diverse possibilities for the use of alternative manipulator systems.

A demonstration system designed in the Process Integrated Inspection Systems PRP department shows the diverse application possibilities which become possible by combining various procedures and technologies. The manipulation devices of this system are based on two six-axis robot arms which are capable of moving the tube and detector on unlimited variable tracks within their working area. The calibration of the alignment of the robots, which move independently and work cooperatively, is carried out in the demonstration system using a laser calibration system.

The robot triggering is completely integrated in the CT software package "Volex" offered by PRP. In addition to this, a special simulated environment offers the opportunity to analyze and optimize the motion sequence of the robots. This simulation, which is used to prepare and plan measurements, models important characteristics of the test object and test environment. This model allows the working areas of the robots to be restricted in advance, in order to avoid collisions in the environment and to determine optimum motion sequences at the same time.

Figure: Schematic illustration of the demonstration system

Image (above): The demonstration system "Robot CT" during a measurement

In practice, mobile computed tomography is ideal for many applications, such as the inspection of selected sections of large objects. These types of testing jobs can often be found in the aerospace, ship-building or automobile sectors. In addition, this technology also allows the 3D testing of permanently fixed parts such as pipelines, supporting structures or power plant technology.

The scientists at Fraunhofer have already successfully completed several studies in cooperation with industry partners. Another main research activity is the current "on-site" analysis and monitoring of dynamic processes for quality assurance and diagnosis in real-time. This shows that computed tomography can be used for more than just the non-destructive testing of fixed components.

FRAUNHOFER IIS IN NUREMBERG

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The Nuremberg location headed by Dr. Günter Rohmer has grown to 120 employees in recent years. An appropriate piece of land was purchased in the Nordostpark for another building and test hall to be constructed in the future. In the first construction stage, the test hall is set to be available for the departments and institutes by mid 2011. Technologies in the fields of localization, RFID, logistics, energy, robotics etc. are to be tested under real conditions here as well as in an associated outdoor area and are demonstrated to potential clients. In addition to other activities, the Nuremberg location is also home to the Center for Intelligent Objects (ZIO) and the Fraunhofer Working Group SCS (Supply Chain Services).

The Power Efficient Systems Department primarily focuses on the research and development of solutions in the field of satellite navigation. It produces, amongst other things, receiver technologies for mobile terminals, automobile applications and measuring and control tasks. In addition there are also projects on power and battery management, wireless energy transmission, energy harvesting, energy supplies for sensors and RFIDs, sensor data fusion for seamless positioning and for navigation with inertial sensors.

The main activities in the Communication Networks Department are wireless voice and data transmission, intelligent objects, real-time positioning in wireless sensor networks and self-sufficient positioning using WLAN in cities and buildings. Solutions for the complete tracking of logistic goods and for improving patient logistics in hospitals were developed based on the s-net technology for wireless sensor networks. The partner consortium of the test environment WLAN positioning using the awiloc technology for self-sufficient localization in cities and buildings produced user service offers and solutions for professional users in the whole of Germany.

The main activity of the radio positioning group in the RF and Microwave Technology department focusing on "infrastructure-supported near-end location" is the development of client-specific positioning systems. Procedures for measuring the time of arrival, angle of arrival, event detection and sensor fusion are at the forefront of the work here. In addition to traditional applications in the security, logistics and "ambient assisted living" sectors, there are also projects from the field of sport such as the positioning of football or rugby players, for example. Furthermore, the scientists contributed to the field of cooperative driver assistance systems for the protection of pedestrians in road traffic through their exact location.

The Network Access Technology Competence Center deals with energy-efficient, networked, embedded systems, primarily with Java as an operating system. The main applications are in energy flow control and consumption recording for devices in the intelligent energy network of the future.

COMMUNICATION NETWORKS

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Overview

As part of the institute's larger research effort on positioning and communication, the work in the Department Communication Networks focuses on the three technologies "s-net" for wireless sensor networks, "awiloc" for localization in WLAN networks, and "DECT" for wireless voice and data networks. 22 people are working on the development of communication protocols, gateways, services, positioning procedures, software libraries and hardware modules. The technologies are tested under real test conditions and employed in projects.

Wireless sensor networks with s-net

The s-net system kit for the realization of high energy-efficient, wireless sensor networks provided the flexible platform for application-specific sensor network solutions in the reporting period. The EU research project MoDe (Maintenance on Demand) on the use of wireless sensor networks in the field of demand-oriented servicing of commercial vehicles started in October 2009. In January 2010, the test run of the OPAL Health project was launched. With publications in national and international press, the project, which is sponsored by the BMWi with the aim to improve asset management in hospitals, received a great deal of attention. At the CeBIT 2010, the Communication Networks Department presented a demonstrator for the BMBF funded key project Aletheia. Event-based data, such as incoming goods, and sensor-based data, such as the cooling of objects, were recorded, consolidated and analyzed. At the Bamberg hospital Am Bruderwald, the operation of the first test system in the project Olog-PAT was launched in May 2010. Olog-PAT is sponsored by the Bavarian state government and is set to contribute to the improvement in patient logistics. In a smart metering industry project, the s-net technology allows for the large scale collection of consumption data.

WLAN localization with awiloc

With the extensive offer of the awiloc technology for self-sufficient positioning in cities and buildings, licensees can easily realize their own navigation and location solutions based on the WLAN localization of the Fraunhofer IIS. In the MobileLocator localization software the porting on the terminal platforms Android and iPhone was at the forefront. In addition, the Communication Networks Department has expanded the training, recording and processing tools for obtaining reference data and the software for environment modeling. This then allows the licensee to obtain their own reference data. Existing reference data of German cities can be directly licensed. The Communication Networks Department was able to develop the coverage of the WLAN localization test environment used by many partners so that now subway areas and buildings are also recorded. As a partner of the test environment, the partner company infsoft was honored as "Selected landmark in the land of ideas" in 2009. Together with the partners of the test environment, Fraunhofer IIS has held two technology days in Nuremberg and Berlin. Here interested parties from Germany, Switzerland, Austria and France were able to get to know the ongoing projects, from city, museum, trade fair, shopping and restaurant guides and barrier-free route guidance to the emergency call system.

Wireless voice/data networks

The systems are based on the DECT standard and are designed for customized adaptations in professional areas of application. Thanks to an expansion of the security mechanisms, the operation of the DECT module is now better protected against attacks. As the second generation of a dual-band DECT module, the current M6 DECT radio module is available in Europe and the USA.

COMMUNICATION NETWORKS

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High energy-efficient, wireless s-net sensor network technology in hospital asset management

The OPAL health project, which is funded by the German Federal Ministry of Economics and Technology, is to demonstrate that hospital processes such as the management of medical devices, the monitoring of stored blood and the safety in transfusion medicine can be improved with only one single technology platform. The system consists of so-called smart objects, i.e. objects equipped with microelectronic modules able to communicate, which are based on the s-net technology for wireless sensor networks of the Communication Networks Department.

Basic technology of wireless sensor networks

A sensor network is a system consisting of spatially distributed nodes which interact with an existing infrastructure via radio or also independently with one another. A sensor node has a processing unit which, in addition to recording data, can also store or process data. The node can make decisions on a decentralized basis as regards applications logic.

In comparison to AutoID technologies such as RFID, wireless sensor networks can communicate actively and bi-directionally. This opens up new fields of application, such as positioning or condition monitoring, which rely on a prompt and active collection of data. Wireless sensor networks are therefore the ideal basis for smart objects. The s-net technology platform of Fraunhofer IIS incorporates many of the desired features:

– energy-saving communication: key is the media access protocol SlottedMAC, through which the network is operated in synchronization. This allows very low activity cycles for transmitting and receiving processes to be reached, which is an important requirement for a low energy demand.

– multi-hop communication: data is transferred from a terminal node to the gateway via several intermediate nodes. As a result, individual nodes only have to bridge shorter ranges at a lower transmitting power. This also brings advantages regarding electro-magnetic compatibility with other systems and low power consumption.

– positioning of the nodes: the sensor nodes are capable of identifying their own spatial position in the network. Positioning achieves a medium-level of accuracy of five meters, independent of the environment, and is extremely energy efficient.

– service-oriented communication: s-net supports several services or application components simultaneously. This is possible thanks to a so-called service dispatcher, which acts as a central middleware component between applications with the underlying log stack.

The OPAL health sensor network

Integrated into the s-net software architecture are three components which the project members have developed on an application level:

– asset tracking: this component transmits the current position of the node either at ten minute intervals or on request. Furthermore, each node can be addressed with one command in order to emit an acoustic signal to search for a certain device.

– condition monitoring: this service conveys the temperature of stored blood in a configurable interval. Each temperature value is also constantly stored on the node. Should the node not be able to transfer the current measurements, the system sends the values once the radio contact is restored.

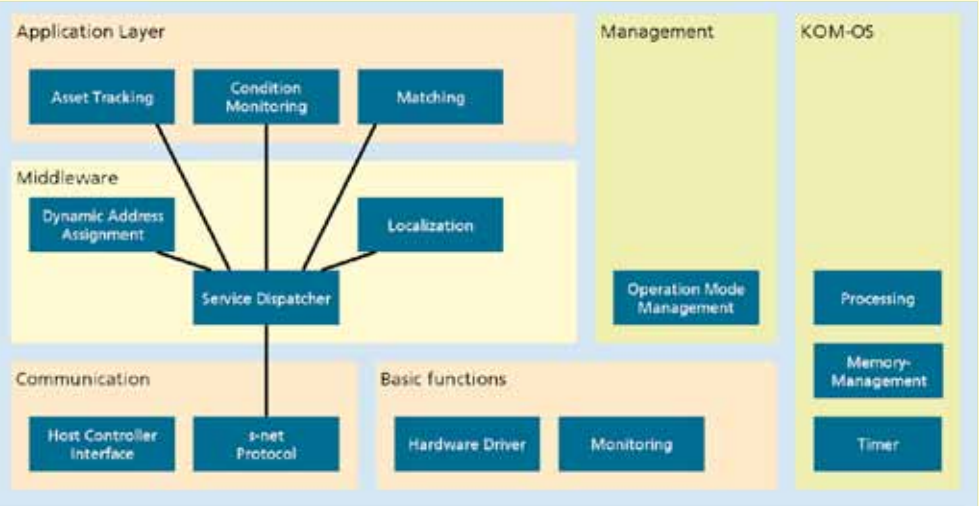

Figure: s-net system architecture

– matching: blood is allocated individually for patients in a blood bank. Potential mistakes can be avoided thanks to the smart object. When blood is allocated, the radio nodes of the blood bag are labeled with patient-specific information. The data on a patient's wristband can be compared on-site. Blood is only dispensed if both nodes match. Only the two nodes involved will directly communicate with one another.

The scientists have tailored the s-net protocol to specific hospital requirements. The duration of the periodic framework in which the transmitting and receiving processes take place is eight seconds. Other configuration parameters can be determined using a maximum of 700 nodes, the data throughput of the application components, the permitted latency with requests, the network topology and the desired operational duration of the mobile nodes.

Given this configuration, a smart object for device positioning has an average electricity consumption of 60 µA. A battery with a capacity of 1,200 mAh can operate the node for around 2.3 years.

Field tests

The test operation of the system has been running in the University Hospital Erlangen since January 2010. When complete, approx. 700 sensor nodes will be used in the surgical ward, intensive care and the blood bank. The field test is to document the suitability for daily use as well as to provide facts on costs and benefits of the approach.

POWER EFFICIENT SYSTEMS

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Overview

The employees of the Power Efficient Systems department conduct applied research and development with the following core competencies:

- positioning and navigation
- sensor data fusion
- battery and power management
- energy harvesting
- adaptive system software

Navigation

The Navigation group develops positioning systems both for satellite navigation standards GPS, GLONASS, Galileo as well as for geostationary satellite-based augmentation systems (SBAS) such as EGNOS. It develops integrated hardware components and software solutions, complete system solutions and prototypes for applications in the fields of mobile terminals, driver assistance systems, machine controls and precise measuring technology. These system solutions are either discretely integrated on printed circuit boards or monolithically integrated. In addition, software solutions for the baseband processing and the positioning complement the receiver know-how.

Multi-sensor systems

In order to allow a seamless navigation inside and outside of buildings, the Multi-sensor Systems group deals with the fusion of various localization technologies. Global navigation satellite systems (GNSS) are particularly inaccurate in buildings and cities. Inertial-based systems, for example, can help in this respect. With inertial sensors it is possible to determine the position and speed without any direct relation to the external environment. The group designs customized platforms with several sensors for locating and positioning as well as algorithms for the fusion and combination of the various sensor data. The scientists can calibrate their own and external small series of inertial measuring units as well as magnet field sensors on their own rotation table.

Integrated energy supplies

Battery and power management, battery monitoring, energy harvesting as well as wireless energy transfer are at the heart of the Integrated Energy Supplies group. One main area of research is the conversion of mechanical and thermal energy into electrical energy. Areas of application here are the supply of electronic circuits such as sensors or transceivers. Furthermore, Fraunhofer IIS works on innovative, future-oriented battery management systems for use in electric and hybrid vehicles, small and special vehicles.

Adaptive system software

The work here focuses on designing portable real-time software kits for embedded systems. This allows software modules to be customized to application requirements at a low cost. The services range from drive development, software adaptation to an existing real-time operating system to software infrastructure for component-based systems. An example of an application for the kit system is a flexibly configurable receiver for satellite navigation.

POWER EFFICIENT SYSTEMS

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Integrated voltage transformer for obtaining energy from the environment (energy harvesting)

Overview

Mobile electronic devices and systems usually have an energy store in order to meet the electrical energy demand. This must be charged or exchanged at regular intervals, which restricts the mobility of the user and results in additional maintenance costs. Alternatively, devices can be powered via cables and the mains supply. Although this means energy stores are unnecessary, costs arise for the installation of cables and the freedom of movement is restricted. A wireless, regenerative energy supply of mobile electronic devices would decrease costs, reduce environmental pollution caused by battery waste and allow for new applications.

Energy Harvesting

The energy harvesting technology uses energy from the environment, light, motion or temperature differences in order to power small electronic loads such as sensors, micro-controllers, transceivers or displays. Solar cells, thermo-generators or kinetic energy converters are used for this purpose.

Challenges

One of the challenges of energy harvesting is the processing and collecting of minimal quantities of energy. Environmental energy is, after all, usually only available in small quantities. The power output of energy converters is determined by their volumes and thus their price. Therefore, in order to realize small, cost-efficient energy harvesting systems, the smallest energy quantities must be processed. This is a great challenge for the power management and electronics of the device.

Voltage converter

As a special feature of thermo-generators, the output voltage generated is proportional to the temperature difference used. Only very small output voltages arise when using minimal temperature differences such as between human skin and the environment or very small thermo-generators. Typical voltages are 50 mV/K. Such low voltages are not sufficient to operate electrical circuits as the low voltages of the energy converters must be raised to the necessary electronic circuit level. Commercial voltage converters generally work from approx. 700 mV and are thus not suitable for energy harvesting.

Fraunhofer IIS has developed a special voltage converter which operates on a voltage as low as 20 mV. This means even minimal quantities of energy obtained from the environment can be utilized. Key components are a transformer and a self-conducting transistor (JFET Junction Field Effect Transistor). This allows electricity to flow through the primary winding of the transformer (L1 and L2) even with 20 mV. The anti-parallel wiring of the transformer creates a negative voltage in a capacitor (C1) which is connected with the JFET (T1) gate. If this voltage is as high as its threshold voltage, it interrupts the current path. The energy stored in the coil is now transferred to the outlet of the voltage converter via the diode (Figure 1).

In accordance with the coiling ratio of the transformer and the energy in the primary coil defined via this, a significantly higher voltage is generated in the output capacitor. This is enough to connect the MOSFET (T2) parallel to the JEFT via a feedback loop. The patented feedback loop ensures minimal loss in the voltage converter and thus guarantees maximum efficiency (figure 2). This depends on the input voltage and output current of the converter. The higher the input voltage, the better the efficiency.

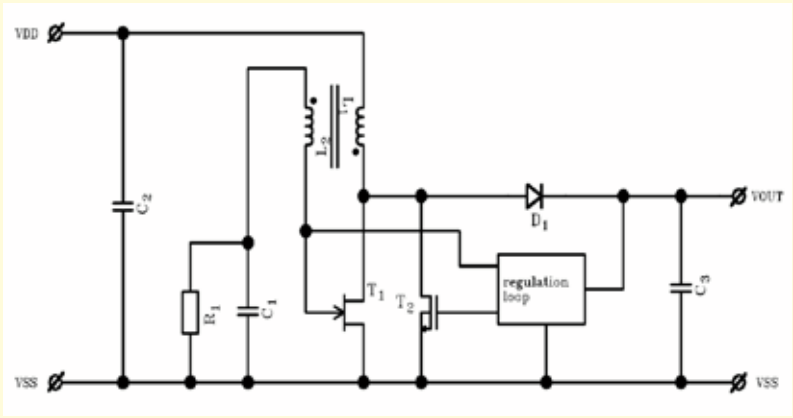

Figure 1: Circuit diagram of the voltage converter

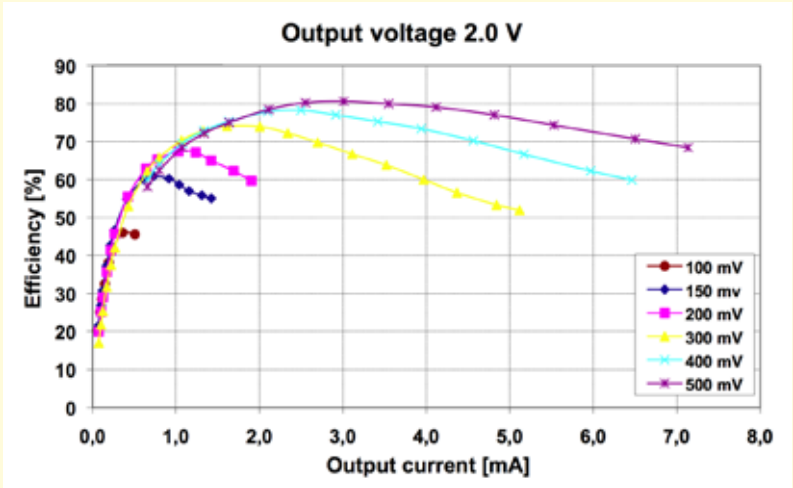

Figure 2: Efficiency of the voltage converter

Image (above): Voltage converter ASIC

Integrated circuit

In order to allow a cost-efficient miniaturized realization, all integrable components were created with a 180 nm CMOS semiconductor technology. It is only the transformer and outlet capacitor which are not integrated and must be used as external components. The chip has an edge length of 1.5 mm (image).

Applications and markets

The voltage converter is suitable for most thermo-generators available on the market. It is particularly essential where low temperature differences prevail, for example between the body and environment or in air conditioners and heating systems.

FRAUNHOFER CENTER FOR APPLIED RESEARCH ON SUPPLY CHAIN SERVICES SCS

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Innovative logistics solutions

Around 50 researchers and scientists from the Fraunhofer Center for Applied Research on Supply Chain Services SCS (formerly ATL) have been developing practical and innovative solutions for logistics systems since 1995. They provide businesses from industry, trade and services as well as public institutions with objective advice and conduct research for them.

In today's society, which is shaped by globalization and growing markets, competition is no longer only between individual businesses, but particularly between networks along the so-called supply chains. Effective and efficient management of these increasingly complex supply chains is therefore becoming ever more important and is increasingly influencing many areas of daily life. An example of this was the ban on flights over Germany and parts of Europe in April 2010, caused by the ash cloud created with the eruption of the Icelandic volcano Eyjafjallajökull.

The opinions of the SCS experts in the "Market" area were much in demand in order to assess the effects on the economy and to detect any supply shortfalls early.

The Siemens Building Technologies Division (BT) was supported by the "Networks" area in the simulation-based optimization of the demand management of ventilation systems. For the automation of large buildings, for example production halls, Fraunhofer SCS significantly contributed to the reduction in energy consumption while maintaining high control performance and low wear using a multi-criteria approach.

Which factors of success are important in marketing is one of the questions which the "Processes" business unit analyzed in the framework of a benchmarking study.

Together with the German Professional Association for Industrial Distributors (VTH), the scientists examined the performance of the marketing organizations and the statistical definition of Best Practices.

The "Technology" business unit was able to use its competences in a joint project with Lufthansa Technik Logistik and the HARTING technology group. Here scientists designed an innovative UHF tag (ultra-high frequency) which is used to permanently identify components both outside as well as inside the aircraft cabin.

A practical example from the "Health Care & Life Science" area is the "Olog-PAT" project, which is sponsored by the Bavarian cluster initiative Logistics and managed by Fraunhofer SCS. The aim of this is to create a system based on sensor networks to improve patient logistics in hospitals.

New "Service Factory" business unit

In 2010 Fraunhofer SCS established a new business unit. The Service Factory Nuremberg combines the innovative power of striving entrepreneurs, founders and experienced innovators in businesses with the respectability and decision-making security of science in order to develop innovative logistics services.

SCS – MARKET

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Roadmaps for AutoID applications

As an automation instrument of the cross-section industry logistics, the fields of application of RFID technology (Radio Frequency Identification) for support in transport, handling and storage processes are diverse. Businesses from many sectors in the shipping industry use logistics services, which also explains the wide-ranging implementation possibilities of RFID in practice. The RFID application shipping and batch tracing, for example, is used to increase the transparency of the flow of goods in logistics chains and is thus assigned to the logistics industry. In this case, however, the RFID integration and therefore support in logistics activity primarily takes place in the industry branches chemistry, food stuffs and daily provision as well as clothing.

The Fraunhofer RFID Application Map gives a comprehensive image of the currently existing RFID applications and their intensity of use. The foundation of this evaluation is the AutoID database developed by Fraunhofer SCS, which records case studies of various technologies such as radio frequency identification, positioning and wireless sensor networks (WSN).

Competitive edge through early recognition of innovations

The lack of transparency of the supply market of AutoID technologies continues to increase. Potential users can choose between a number of types of transponders with differentiated performance features. In addition, developments in the field of sensor networks, polymer and nano-technologies intensify this lack of transparency. Given the increasing complexity and size of the AutoID market, it is essential that technology suppliers and users constantly observe the market. The innovation radar operated by the Center for Intelligent Objects ZIO identifies and evaluates innovations from the areas of RFID and localization systems, integration platforms and system aspects, wireless sensor networks and energy harvesting as well as current application and market events.

The performance of AutoID technologies has improved enormously in the last year. Great progress was achieved in connection with memory size and data security in the field of radio frequency identification. In many areas technological challenges can be considered to be solved, whereby applications such as asset management or replacement parts logistics are increasingly prevailing on a product level. This can be seen in the aviation sector today.

Complete new technological developments were able to be registered with the integration of RFID data in video images or with the use of nano-particles for the cost-efficient production of electronic components and RFID transponders. Independently evaluated, the nano-technology is still in its infancy. The aim is that printed nano-RFID tickets should become cost-efficient enough in order to be able to use them for application in mass markets such as food retailing. The first "printing trials" carried out were successful.

The AutoID sector is opening up interesting paths in terms of sustainability. A research project which focuses on the development of biologically degradable production materials was recently launched.

The question as to which applications are right for which markets with which technologies and where the greatest potential can be found can be reliably and sustainably answered on this basis. On the one hand, it can be guaranteed that users receive a benchmark which applications have already been installed by their market participants. On the other hand, the areas of application with the greatest potential can be demonstrated for technology and research institutes, their most important requirements described and potential clients identified.

Application cluster	Sub-application	Idea	Test	Pilot	Roll-o.	Series
Management of container pools	Rolling containers	-------	-------	------x	-------	-------
	Standardized Euro pallets and wire-mesh boxes	-------	-------	x------	-------	-------
	Reusable plastic containers	-------	-------	-------	x------	-------
	Special containers for the production industry	-------	------x	-------	-------	-------
	Pool containers from waste management	-------	-------	-------	---x---	-------
	Reusable containers for liquids, gases	-------	-------	-------	---x---	-------
Tracking of large capacity containers	Change-over bridges i.e. swap containers	-------	-------	-------	---x---	-------
	Sea containers	-------	---x---	-------	-------	-------
Protection against counterfeiting and theft	Pharmaceutics	-------	-------	x------	-------	-------
	Expensive consumer goods	-------	-------	------x	-------	-------
	Consumer goods for daily use	-------	------x	-------	-------	-------
	Machine and system parts	-------	x------	-------	-------	-------
Tracking and tracing of consignments	Packages for courier, express, package services	-------	-------	x------	-------	-------
	Palleted goods in logistic systems	-------	-------	-------	---x---	-------
	Goods on a secondary packaging level	-------	-------	x------	-------	-------
	Goods on an individual product level	-------	------x	-------	-------	-------
Quality monitoring in goods transport	Fragile and dangerous goods	-------	-------	------x	-------	-------
	System performance for letter services	-------	-------	-------	-------	---x---
Warehouse management	Various product groups	-------	-------	-------	x------	-------
Servicing and after sales	Technical infrastructures	-------	-------	-------	x------	-------
	Beds and medical devices	-------	-------	x------	-------	-------
	Machines and vehicles in transport	-------	-------	x------	-------	-------

Implementation stage of logistic RFID applications in practice. The marker "x" describes the maturity of the individual implementation stages "application idea", "technology test", "pilot application", "roll-out" as well as "series use". The position of the marker shows the frequency of RFID implementations (far left = lowest frequency)

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Take a deep breath

Multi-criteria, simulation-based optimization using the example of demand control of ventilators

Anyone who wants to launch a new lawn-mower on the market considers which features and settings it requires or builds a prototype. For those, on the other hand, who want to construct building automations, sound systems for large rooms or even complete production lines, "trial and error" investigations on real prototypes are far too expensive or complex and exact theoretical considerations are often impossible given the high complexity. Nevertheless, the developer must make decisions about the settings or features of a new product with the greatest possible security.

The traditional procedure for analyzing complex real systems is examining using simulation. The effects of various settings can be tested for a variety of system versions without actually having to implement these. This notional analysis is generally restricted to the examination of a few standard settings which are based on experience values. The scientist subsequently selects the best of the tested settings manually.

This procedure, however, reaches its limits if no robust sound settings are known or if an optimal setting is required. The ideal solution to extensive planning security with high complexity is therefore simulation-based optimization. Using optimization algorithms, this allows the best settings to be found whereby critical components are adjusted in detail using simulation.

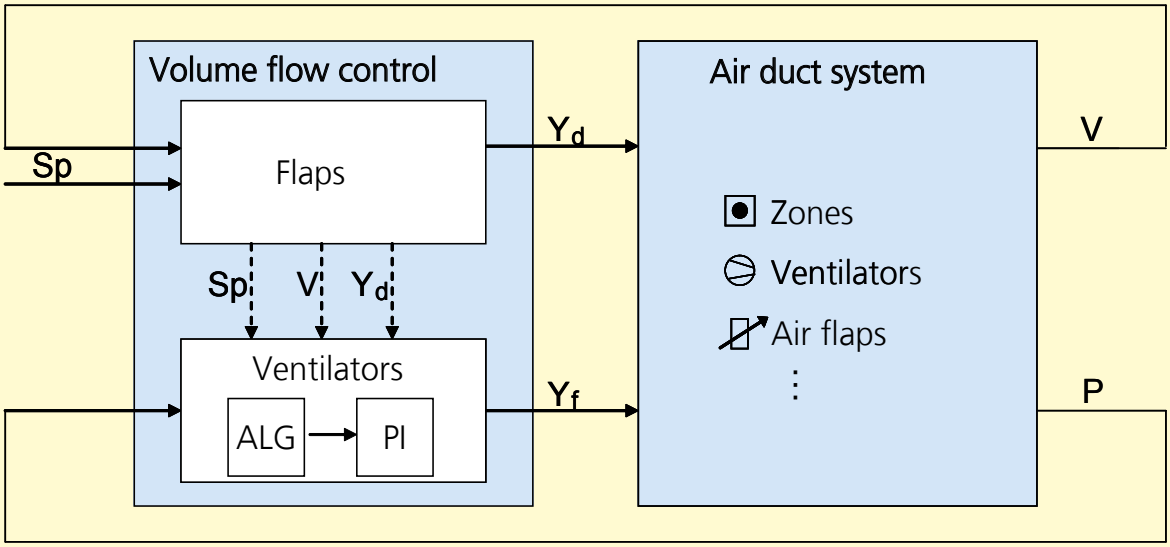
Intelligent buildings

In a joint project, Fraunhofer SCS and the Siemens Building Technologies Division (BT) have managed to achieve significant savings in the ventilation of buildings through a simulation-based improvement. Siemens has designed a demand-based ventilator control which only supplies a building with as much air as is necessary at that time. Given the large number of possible control settings, however, determining an energy-efficient, low-wear configuration of the ventilation system is a difficult challenge, which could no longer be solved by simply testing. Fraunhofer SCS solved this problem through simulation-based optimization implemented in Matlab/Simulink. Settings which, in comparison to standard values, achieved savings of over 40 percent were able to be determined in this way.

Multi-criteria optimization

The improved ventilator control not only provides for significant energy savings but also guarantees low wear of the ventilation system as well as a high control performance. Until now ventilation flaps as well as ventilators have controlled the air flow volume in a building. However, the more accurately such flaps regulate the flow volume, the more often they have to change their position and so the more serious the wear is. The joint research project solves this shortfall by minimizing the movement of the flaps with higher precision of the air supply.

In addition to the wear, control errors of such systems have also drastically been reduced and the quality improved. The scientists solved the problem using multi-criteria optimization: depending on the purpose, the three competing aims, reduced energy consumption, less wear and higher control performance have a different weight, which cannot always be quantified in advance. Fraunhofer SCS therefore offers a large variety of solutions, and leaves it to the client to choose the solution best suited. Descriptive graphic



Air duct system with variable volume flow control

Y_f: ventilator setting
Y_d: flap setting
V: volume flow
P: pressure
S_p: nominal value profile
Alg: algorithm
PI: PI controller

illustrations act as support as they make it immediately clear whether and to what extent an improvement in one of the three criteria is detrimental to the other criteria.

As this example of the ventilator control shows, (multi-criteria) simulation-based optimization is an efficient way to combine high complexity and planning security in the development of new products while saving time and money.

SCS – PROCESSES

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"PalletFlow" – a multi-modal transport solution for pallet goods

Increasing traffic and environmental pollution through road transport as well as increasing toll and energy costs are intensifying the efforts to shift goods from road to rail. Despite this, the percentage of combined traffic in the overall transport capacity is still very low. Capacity constraints, busy terminals and a transport service which is not focused enough on the needs of the economy are the main causes for the lack of quality and acceptance. The result: unsatisfied clients who increasingly would like to use rail but due to a lack of real alternatives continue to use trucks.

It becomes apparent in surveys that competitive multi-modal solutions primarily require flexibility as regards collection and delivery as well as a cost-efficient transfer process between road and rail. This particularly concerns the number of palleted goods which are transported by truck throughout Europe in large volumes. This number has grown increasingly in recent years. In the paper industry, for example, output tonnages of 200 full trailer trucks per day from one production location to destination locations 600 to 1,000 km away are a common occurrence.

With its technical/operational solution, the joint project PalletFlow in the scope of the Intelligent Logistics research project focuses exactly on this so-far unexploited transport potential of combined transport.

The fact that today the majority of licensed trucks on German motorways are side-loading is also taken into account. These so-called curtain-siders are ideal for the horizontal transition between road and rail with conventional forklifts. This type of transition with industrial trucks is still used today but only to a limited extent and without the opportunity of a universal consignment and batch tracing for pallets. PalletFlow develops this new dimension, which is becoming increasingly important for the consumer goods and capital goods industry (key word: security in batch tracing), with a universal identification and positioning system.

The PalletFlow system is designed for doubly interrupted transport, in which the initial and final leg are carried out on road transport and the main leg on rail (see figure). In principle, singly interrupted transport with a track connection at the shipping or receiving end is also possible. Short regional trips per truck allow combined collection and delivery trips with high capacity while in the main run shuttle trains commute between the hubs in the direct block train services.

The reliability and efficiency of the system is supported by innovative identification and positioning technology: the load units i.e. the pallets, which are labeled with an RFID tag, form the basis. During the handling process, the stored EPC (Electronic Product Code) is read out using an automatic, RFID-based identification system in order to retrieve further information, such as the destination of the goods, from the data bank, which is connected via radio networks, and to show it in the display of the lift truck cockpit. This allows paths, times and misrouted goods to be minimized during the handling process; but also to detect and avoid delays in the entire system at an early stage. In addition, locating units in the transport vehicles provide for a universal shipment tracking of the goods throughout the entire transport chain. The efficiency of the handling process is also increased through future-oriented sequence planning for loading the freight cars.

An important component of "PalletFlow" is, however, the integrated supply model, which is to offer higher service quality to existing and new clients of rail. To facilitate this, a service center is established, which, as a central contact partner for clients on-site, continuously monitors the transport process and ensures the resources are supplied to the hubs in good time.

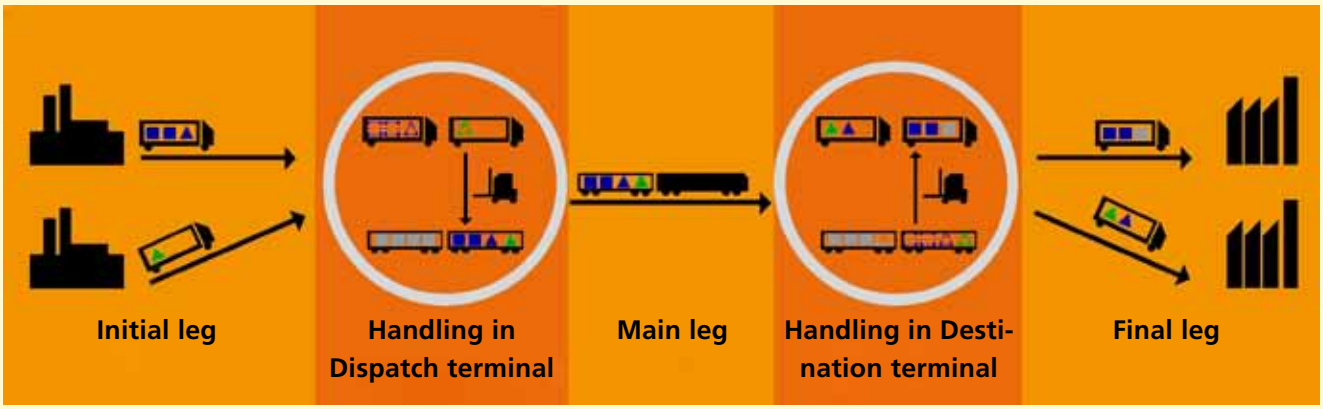

Figure: Structure of a "PalletFlow" hub

The "PalletFlow" project plan can be sub-divided into two phases: scenarios which contain various assumptions on the feasibility of the system were defined to assess the market potential in phase 1. In the average scenario, an implementation potential of approx. 63 million tons of palleted goods per year was calculated for national and international transport. This would correspond to 3.5 million full truck loads or a CO_2 saving of approx. 1 million tons.

In phase 2 the system is technically implemented: after completing a demonstrator phase in which the individual components are tested and coordinated, several real pilot runs are carried out for the final calibration of the system.

The joint project is to be expanded over the medium and long-term to international transport in particular, especially towards Austria and Italy.

SCS – TECHNOLOGY

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Efficient and fast integration of smart object technologies

In addition to barcode and radio frequency identification, wireless sensor networks and localization systems outside and inside of buildings can improve the connection between material and information flow and thus solve a whole series of practical problems which commercial enterprises are increasingly struggling to deal with. Today the market offers corresponding products for each of these technologies, which work well for themselves. Innovative integration platforms are necessary here in order to operate different technologies parallel with another and to integrate them into business processes.

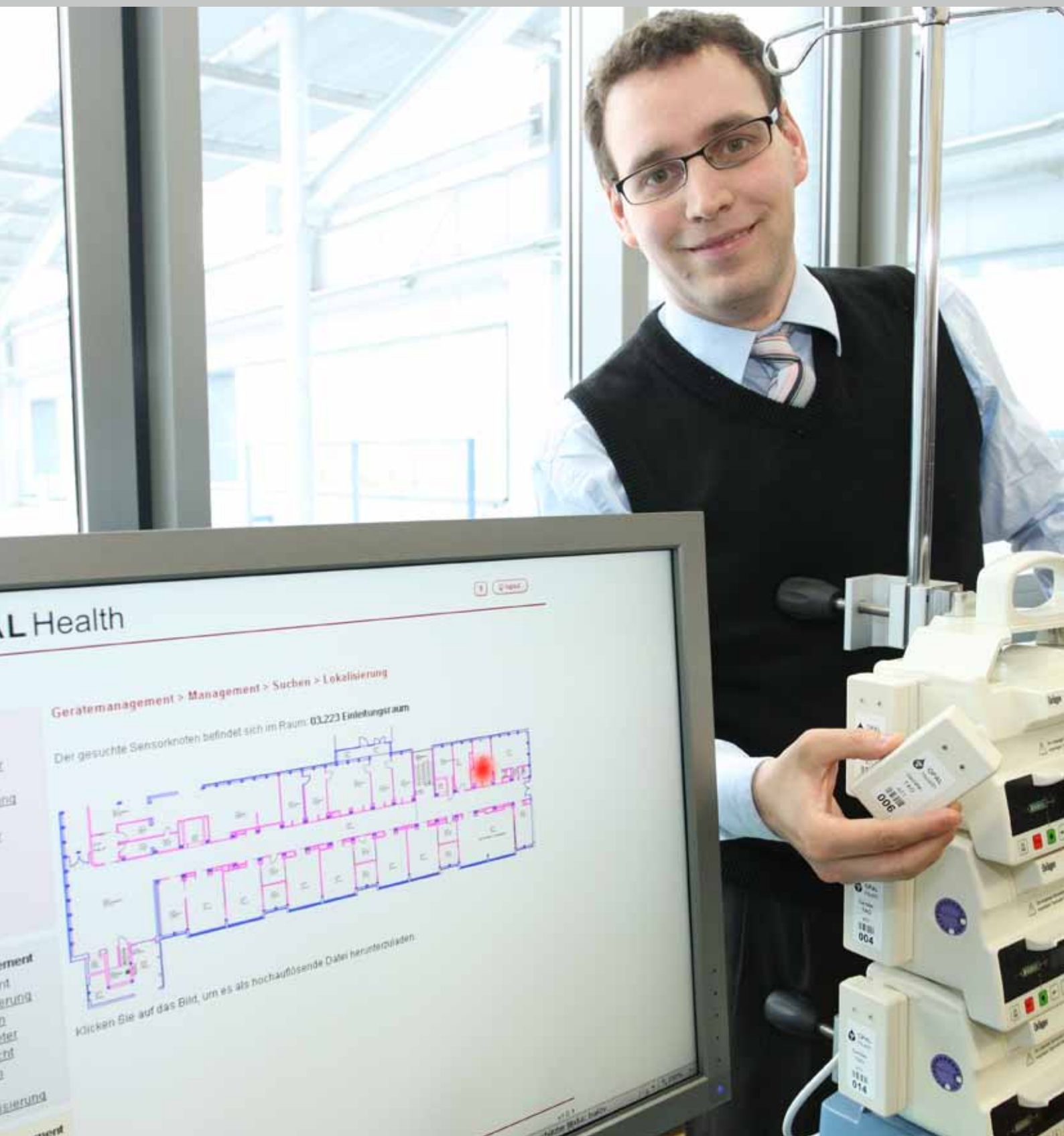
For a number of years now, scientists at the Center for Intelligent Objects ZIO managed by Fraunhofer SCS have been working on a reference platform in which various technologies can be integrated. In this platform each technology can be quickly and reliably adapted to the existing framework. A prerequisite for this is that the individual technologies are mastered perfectly by the developers. ZIO therefore relies on very close cooperation with other technical departments of Fraunhofer IIS, where RFID systems, wireless sensor networks and localization solutions are developed from scratch right through to market maturity.

In cooperation with the suppliers, the reference platform, in a first step, is to be used to develop RFID platforms of existing suppliers which are available on the market and to adapt them to the special requirements of more complex smart object technologies by Fraunhofer IIS. Furthermore, this platform can be used as a foundation to specifically realize adapted integration solutions for niche markets with unique requirements. As an example, it is likely that the centrally organized middleware platforms today will tomorrow have to be distributed on, for example, intelligent gateways between wireless and wired world of information as well as on intelligent microelectronic labels. The previous work of ZIO supported this approach.

Modular and mobile software services, from which an integration platform is created, will make creating decentral middleware solutions in years to come significantly easier.

Fundamental work on this was already carried out a few years ago in the scope of the EU funded project SMMART. The aim was to support processes related to replacement parts logistics in the aviation industry with a unique RFID integration platform. This platform was then further developed for the integration of wireless sensor networks in the hospital environment in the OPAL Health project (photo) sponsored by the BMWi. It has been used in the University Hospital Erlangen since January. The 700 sensor nodes support temperature monitoring of blood products within the hospital, ensure that the blood product matches the patient by using a matching procedure which is carried out before the transfusion and simplify the asset management in the hospital. They are accordingly attached to blood bags, patients and to expensive medical devices. The integration platform guarantees that the data transfer between the individual nodes and the various software systems of the hospital functions perfectly.

At present the existing platform is being developed even further in the various projects. In the Olog-PAT project, for example, positioning services for patients are integrated into the hospital environment. In the Fraunhofer in-house project Galileo, the reference platform available today is linked with systems for satellite-based positioning. The applications and sectors in which it is and can be used are diverse. At present various applications are being developed in the construction, food, logistics and health industries.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DIVISION DESIGN AUTOMATION EAS IN PROFILE

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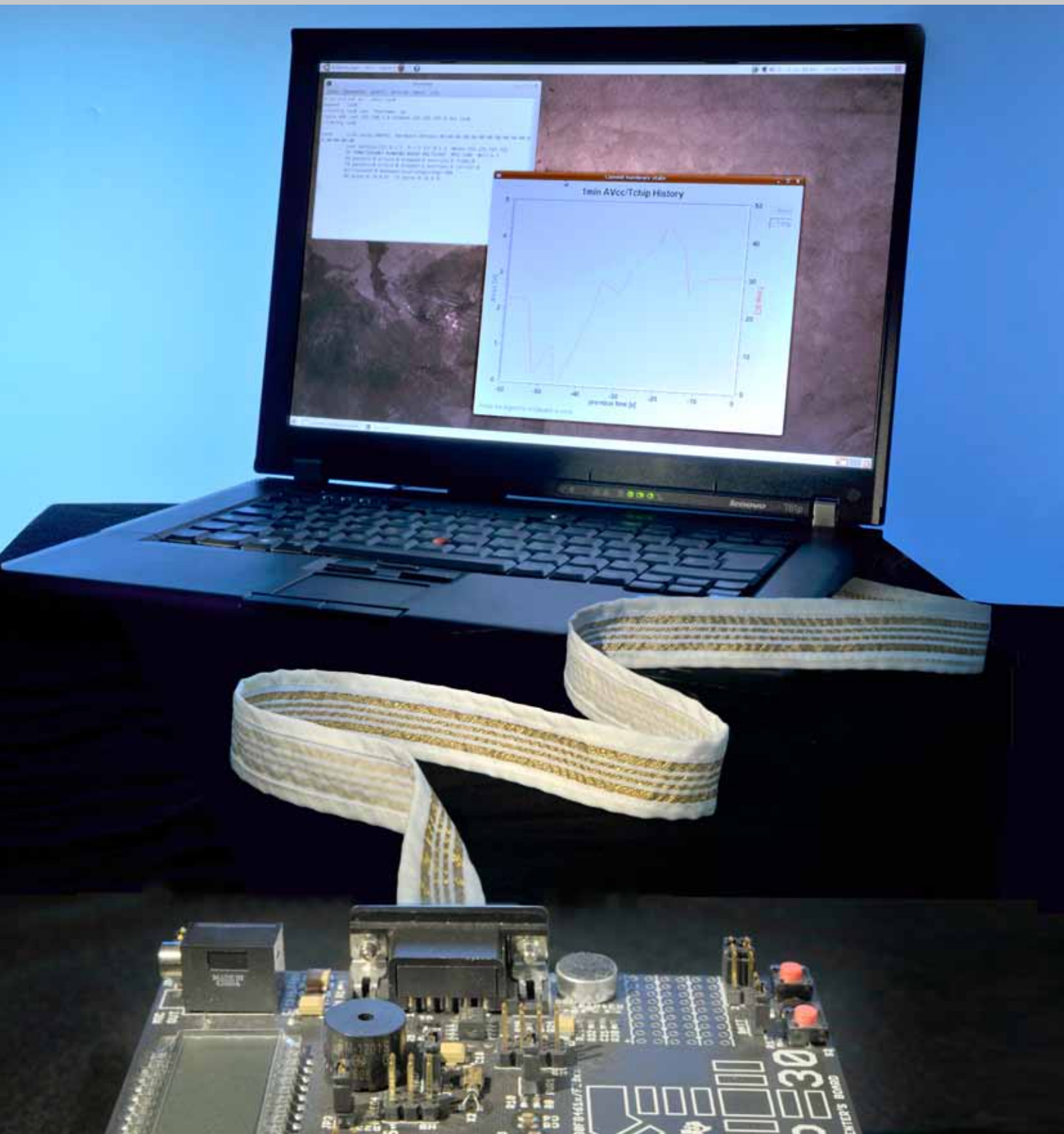

The research carried out by the Dresden division of Fraunhofer IIS increasingly supports the design of multi-physical systems.

The Dresden Division Design Automation EAS develops methods for the computer aided design of electronic and heterogeneous systems and prototypes of hardware/software systems. The resulting models, methods and tools developed allow the fast implementation of product specifications in circuits, assembly groups or devices and complement commercial tools and application specific development processes. The research staff at the Dresden division work in the three departments of mixed signal systems, digital systems, and heterogeneous systems, and in the software systems group which also provides IT services for the institute.

The research and development of production-ready and yield-oriented design and of the design of complex systems under constraints continue to be a focal point. The impact of manufacturing technology (materials, structures) and/or of operating conditions (temperature, vibrations) on the electrical behavior of elements, components, and circuits is modeled and considered in the design. Design methods for minimizing these influences on the entire system characteristics enable circuits with a higher functional reliability and appreciable lifespan to be developed. In particular, parasitic effects such as parameter variations in manufacturing, electrothermal and electromagnetic couplings and aging mechanisms are considered for different CMOS technologies and for 3D chip integration.

A high level of expertise in the design of systems with greater complexity and heterogeneity under basic conditions is a key area of focus. The methods developed include modeling, simulation, verification, analysis, prototyping, testing, and diagnosis and take into account the prescribed conditions such as minimal power loss, high functional reliability (robustness), and the timing to be complied with. The division's cooperation in the design standard SystemC AMS for modeling and efficient simulation of analog and mixed signal systems is to be highlighted in this context. System components or parts of circuits can be modeled at various abstraction levels and interconnected. Detailed examinations of the electrical properties in a precisely modeled circuit part are thus also possible in the entire system, which accommodates demands and wishes in practice. Furthermore, non-electrical parts such as those contained in sensors, for example, can be described and simulated with SystemC AMS.

System developments to prove the performance of design processes (demonstrators) and to prove the functionality of new products (prototypes) are increasingly gaining importance. An example is designing electronics for the integration into textile surface structures, so-called smart textiles. The electrical components are connected to the textiles through electrically conductive materials amongst other things, as shown in the picture. Investigations in the area of optical picture recording with CMOS image sensors have led to findings concerning the resolution and speed achievable. Previously conducted experiments indicate that an adequate implementation is possible. Thus the designing of a novel image sensor has started. Further developments concern more accurate optical and magnetic measuring systems, robust sensor networks and a new ranging receiver for measuring the signal running times, from which the orbit position of a TV satellite can be determined.

Measuring station for investigating signal and energy transmission characteristics of conductive textiles

DIVISION DESIGN AUTOMATION EAS IN FIGURES

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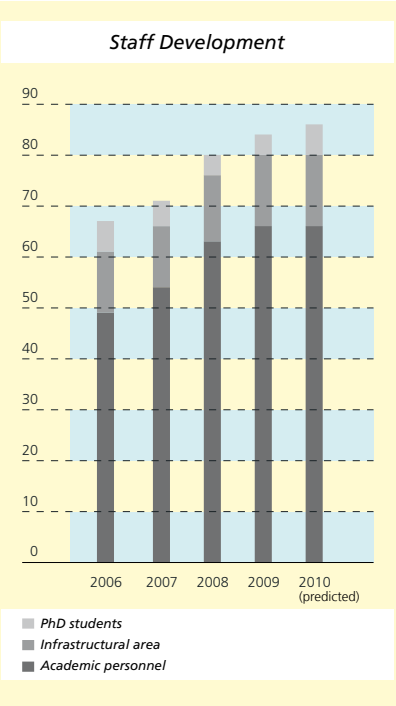
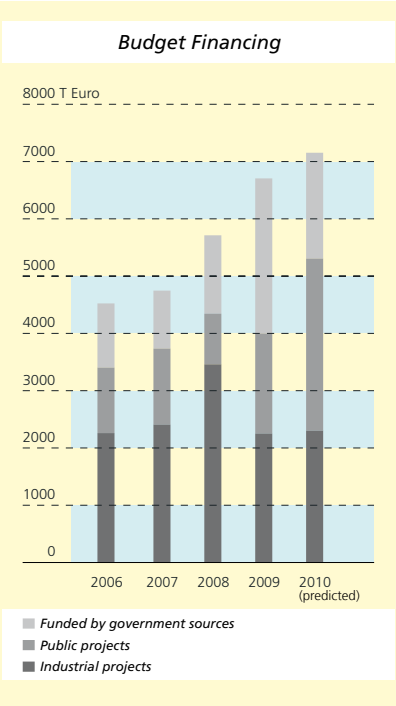
Employee development

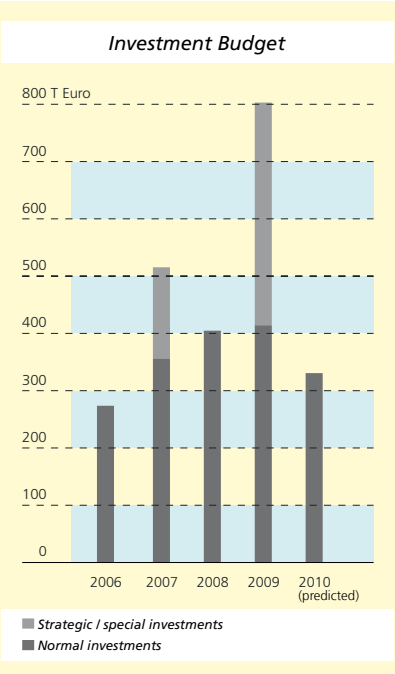
Despite a decrease in revenue in 2009, the Dresden Division Design Automation EAS was able to maintain its number of research staff and also hire two additional PhD students. The employment figures are shown in picture 1. The highly qualified research staff mainly consists of graduate specialists who have mainly completed their studies in the areas of information technology, computer technology, physics and mathematics. Approximately one third of the research staff have a Ph.D. Currently, six PhD students and several research staff are working on their theses. The institute supports the scientific qualification of its competent staff and at the same time ensures the implementation of a key part of the necessary preparatory work. Three students from the University of Cooperative Education Dresden are completing the practical component of their degree at the institute.

Budget

The operating budget is mainly determined by the personnel costs. The Dresden division of Fraunhofer IIS benefits from the growth of the economic sectors of most microelectronic users on average and the further development of manufacturing technologies by semiconductor companies. However, the effects of the economic crisis and especially the structural crisis in the semiconductor industry can be seen in the decrease in revenue in 2009, especially in the reduction of the share of financing from industrial projects compared to previous years, as can be seen from picture 2. A balanced budget is achieved this year through increased acquisition in public support programs and new potential project partners and contracting bodies. The economic growth gives hope that the industrial revenue will reach its original scope again in the next few years.







In addition to the so-called normal governmental funding, the proportion of government funding also includes an additionally acquired fund from internal Fraunhofer FuE projects amounting to 235,000 euros in the current year.

Investment budget

Investments in the expansion and renovation of highly available and high-capacity computer science and tools for developing hardware and software are necessary to maintain a competitive edge and to be able to remove the burden of routine tasks and extensive accounting from staff. During this year, this has once again affected expansions in the area of IT, special file, terminal and high-performance computer servers, as well as workstations and network technology. Parts of the funds were used for laboratory equipment which serves research into innovative high-precision image sensors and optic and magnetic measuring systems. As a result of the relatively large investments over the past year, a smaller amount is required in 2010. Picture 2 shows the annual investments made over the last five years with an indication of the amount of special investments.

Skills

- CAD/CAE methods, processes and tools for simulation, analysis, synthesis, optimization, verification, test generation and diagnosis
- Modeling methodology, model generation, model reduction, development of behavioral and circuit models for electrical systems and behavioral and structural models for heterogeneous systems
- Strategies for the verification of complex system designs, verification methods consisting of simulative and formal processes
- Coupling of tools (e.g. of various simulators) with one another and of tools (models) with hardware, prototyping
- Development of innovative hardware/software system components in the areas of telecommunication, digital radio, the automotive sector, age-based assistant systems (ambient assisted living)
- Development of design platforms for sensors and sensor networks, industrial controls, communication systems
- Modeling of sensor elements (optically, magnetically, fluidly), development of novel optical image sensors

Equipment

- High-performance computing infrastructure with more than 250 workstations and PCs, file server, computer server, terminal server and two parallel computers (grid cluster)
- Commercial design systems from CADENCE, MENTOR, SYNOPSYS, XILINX and many others
- Simulators such as ANSYS, COSSAP, HSPICE, MATLAB/SIMULINK, SABER and many more
- Own tools for simulation, synthesis, analysis and verification, special SystemC AMS simulator and error simulator
- Laboratory workstations for construction, commissioning, measurement of electronic and optical components and devices

DESIGN AUTOMATION / DIGITAL SYSTEMS

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Development of robust smart textiles: metrological recording of the effects of humidity

Introduction

"Smart textile" are innovative textile products which develop as a result of the integration of nanoelectrical components in textile structures. In the form of "intelligent clothing", they enable fully innovative applications in sport, health care and occupational safety. Here the energy and information transmission between the electronic components requires extremely robust solutions with a low energy loss and high level of comfort. Conductive textile structures lend themselves to this which result, for example, from the weaving or embroidering of low-resistance fibers. Smart textiles represent highly complex embedded systems whose efficient development requires appropriate methods for the inter-domain design process. The prerequisite for this are models of the components used. To verify the robustness of a smart textile product at an early stage, additional models of error sources such as humidity and perspiration are required.

Humidity as an influential factor

The use of smart textiles can be problematic due to distinct hygroscopic properties under the influence of humidity. The liquid absorbed by the conductive textiles affects their conductive parameter and the transmission properties linked with this. In addition to direct effects such as the gravimetric humidity of the textile, other indirect influential factors are to be considered for a representative analysis. Fluids which consist of water from polar molecules with a high maneuverability have a distinct frequency dependency due to orientation polarization. As chemical components in a liquid, free charge carriers also influence the electric parameter. The resulting transmission properties of the conductive structure result from the characteristics of the individual influential factors.

Measuring procedure and test set-up

The development of extensive transmission and error models requires a measuring procedure to correlate the electrical parameter, the gravimetric humidity and the salinity of the test fluid. Based on the findings of an initial experiment, a suitable measuring procedure for the computer-assisted determination of model parameters was designed and implemented in the form of a test set-up. The long-term determination of the amount of fluid contained in the textile was carried out using a Mettler Toledo precision scale XS4002SDR which was expanded by a problem specific fixture for textile transmission lines (see diagram 1). An Agilent precision LCR meter E4980A was used to determine the conductive parameter which was connected to the device being tested. Control software enabled the synchronized determination of the measured values of the precision LCR meter and the precision scale. The recording period can be freely configured with a resolution of 100 ms. This enabled the recorded parameter to be monitored in high-resolution. The measuring procedure resulting from this enables a detailed comparison of the conductive parameter depending on the gravimetric humidity.

The representative measuring results from a woven two-wire structure made from Elitex yarn can be seen in diagram 2. Furthermore, the test set-up developed offers the opportunity to use various measuring devices to record the transmission properties.

Summary and future prospects

In order to be able to simulate environmental influences with suitable error models as early as the design process, comprehensive analyses are required. Based on detailed theoretical prerequisites, a test set-up which can be flexibly used to determine the effect of liquids on electric properties has been presented. Further functional improvements are planned for optimum recording of the parameter.

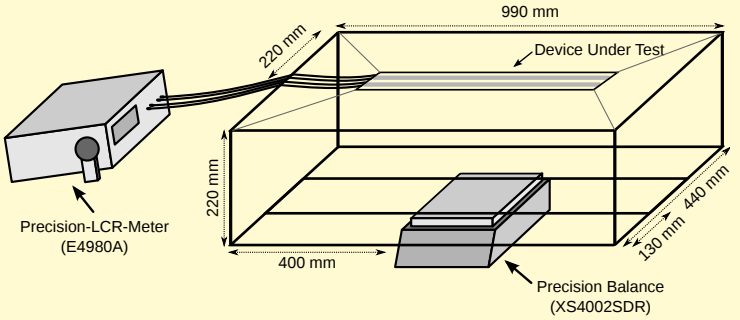

Diagram 1: Diagram showing the test set-up

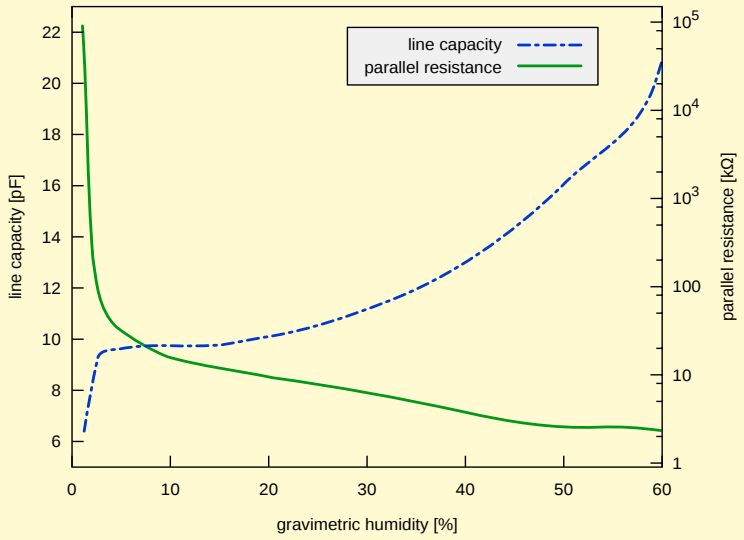

Diagram 2: Measurement of the line capacity and of the parallel resistance of a textile pair of leads at 100 kHz

The replacement of the precision LCR meter by a network analyzer with a metering range of 9 kHz to 6 GHz enables an improved examination of the frequency dependency and the calculation of the S-parameter of the textile structures.

In order to create a model library, the measuring procedure described will be applied in the future to various textile conductive structures. Apart from geometric measurements, different base materials, such as conductive yarns or stainless steel, will play an important role. The results of these investigations will be used for obtaining practical application recommendations and applications.

DESIGN AUTOMATION / HETEROGENEOUS SYSTEMS

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Design support for condition monitoring systems

Introduction

High functional reliability and availability is an important requirement for technical systems and plants which is increasingly gaining importance. The key influential factors for the interruption of technical systems in operation today are deterioration, wear and also overcharging which can lead to spontaneous failure. In addition, other factors include misuse by operators or even deliberate manipulation which could entail damage or deterioration. A robust system design is therefore essential. However, dimensioning for rarely occurring load conditions or the additional integration of duplications into the system are often associated with significantly higher costs and can thus only be reasonably implemented in few application fields. Permanent condition monitoring during operation presents itself as a resource here which also enables a damage prognosis based on knowledge of physical interrelations. As a result, unscheduled failures of the plant and downtimes associated with this could be avoided.

Condition monitoring and damage prognosis

Condition monitoring systems are characterized by the fact that the condition of a part is determined and evaluated with the help of intelligent signal processing and classification algorithms by using existing measurement signals or through the integration of additional sensors. A probability of failure can be predicted by using statistical methods. This enables a needs-based maintenance and servicing strategy to be developed.

The essential challenges when designing condition monitoring systems (CMS) of this kind are choosing the measured variables and sensors, the signal preprocessing and the extraction of characteristics such as their intelligent linking with a condition statement for the components or the entire system.

The complexity of the design task increases with the number of sensors and measured variables, if, for example, wireless sensor networks are used for the monitoring of transport infrastructures (e.g. bridges and roads) or of transportation means (airplanes, trains).

Model-based design of condition monitoring systems

In the Department of Heterogeneous Systems, methods and tool support for designing high-performance conditioning monitoring systems are researched. Usage of a particular design framework makes it possible to experiment with sensor signals with different types of signal processing and feature extraction and to evaluate their suitability for determining the desired statement. High-capacity classification algorithms are available for the linking of extracted individual characteristics for a statement about the current condition and for the prognosis of changes in the system. Through routines for automated code generation, the fast transfer of algorithms to the target hardware is ensured. Interfaces in the system allow physically motivated system models to be incorporated in the development process. In particular, the option of targeted variation of model parameter enables a comprehensive evaluation of the performance of the signal preprocessing and the classification rating to be carried out using simulations. Through this, efficiency can be increased in the development and the robustness of the algorithms improved.

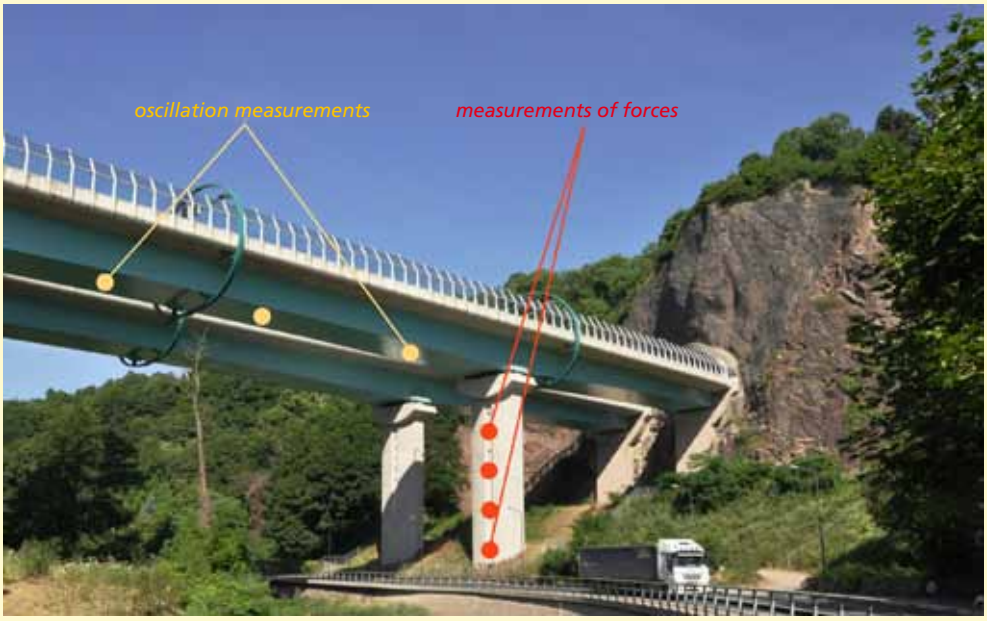

Figure: Measurement of forces and oscillations at different parts of a bridge on a motorway

(above) Example of target hardware for implementation of the condition monitoring system

Applications

The modular construction of the design framework and the linking with other research activities at the institute, e.g. in the area of sensor networks, open up a wide spectrum of applications. This ranges from the monitoring of individual components, e.g. pumps or electromotors, to complex plants, e.g. plumbing systems, bridges, wind turbines. In the process, the linking of many signals of similar type to form an overall statement in a complex sensor network is also supported as is the sensor data fusion of various measured variables for damage prognosis on a cost-intensive individual component. An example of this is the monitoring and damage prognosis on axial piston pumps.

On the basis of their excellent performance parameter, these pumps are a central component of technical systems, e.g. of construction machines or process engineering units. In a current research project, model-based algorithms are developed for condition monitoring and damage prognosis for system components. The starting point here are oscillation measurements on the pump housing which are carried out both on the real object and can be simulated on the mathematical model. The measuring results are conveyed to an application specific signal processing in which statistical methods are also used in addition to spectral analysis. The characteristics determined in this way are evaluated using a classification algorithm based on neuronal networks.

DESIGN AUTOMATION / MIXED SIGNAL SYSTEMS

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Simulation of Digital Circuits considering Process Variations

Motivation

With the ever-shrinking structures of current integrated circuits manufacturing process variations gain increasing influence on the yield, since they often can not be scaled to the same extent as the structure widths. Current digital design methods consider parameter variations by characterizing the cell properties for certain disadvantageous values of these parameters – so-called Corners. The circuit is dimensioned such that it works even under assumption of these worst-case conditions for each individual cell, which is often too pessimistic. With the aim of taking parameter variations into account also at higher level of abstraction in the design flow, a novel simulation model for digital circuits was developed in the context of the BMBF-funded project Sigma65.

Methodology

With this model a statistical digital power simulation framework could be implemented that allows to describe at cell level the effects of process variations on the cell's timing and power properties and to simulate at circuit level the power consumption and timing behavior in dependence on these process variations. Using a special VHDL cell model the methodology additionally considers the slope time of the digital signal edges, which allows to directly access the cell library tables during simulation and avoids a prior static timing analysis (STA) step as needed in the traditional design flow. Precondition for the statistical parameter analysis is a cell characterization that additionally determines the sensitivities of the cell properties regarding the considered parameters and adding these sensitivities to the cell library. The available nominal values for cell delay, output slope time and switching energy – each filed as function of input slope time and load capacitance as well as for different input pin configurations – are then complemented by corresponding tables for each parameter containing the sensitivity values. After a conversion into VHDL these data can be used by the cell model to look up actual values for cell delay, output slope time and switching energy for each incoming value-change event. From the energy value, additionally a current flow through the cell during switching can be calculated, which allows by superposing them to estimate the main current consumption of the whole circuit over time. The values for input slope time needed for the table look-up are carried by a user-defined data type together with the logic value during simulation from cell to cell. The load capacitance of the cell is calculated once by an STA tool and is passed as a generic parameter.

The statistical properties of the whole circuit are then determined using the Monte Carlo simulation method. As a result the user gets e.g. the frequency distribution of path delay, mean power or maximum current. Besides that because of the direct consideration of signal slope times during simulation the method can provide a higher accuracy at a similar performance compared to the traditional digital simulation flow which makes it also suitable for the analysis of glitches and glitch power.

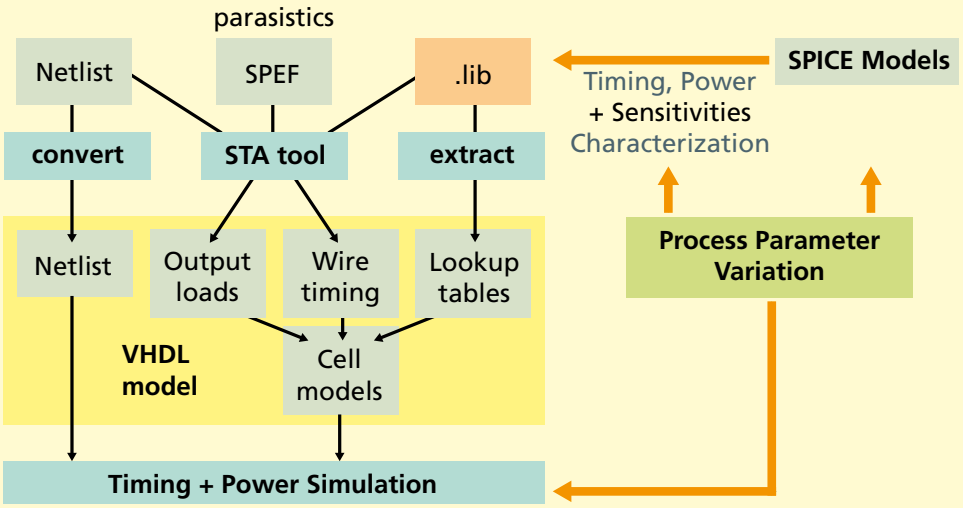

Figure 1: Novel methodology for statistical digital simulation

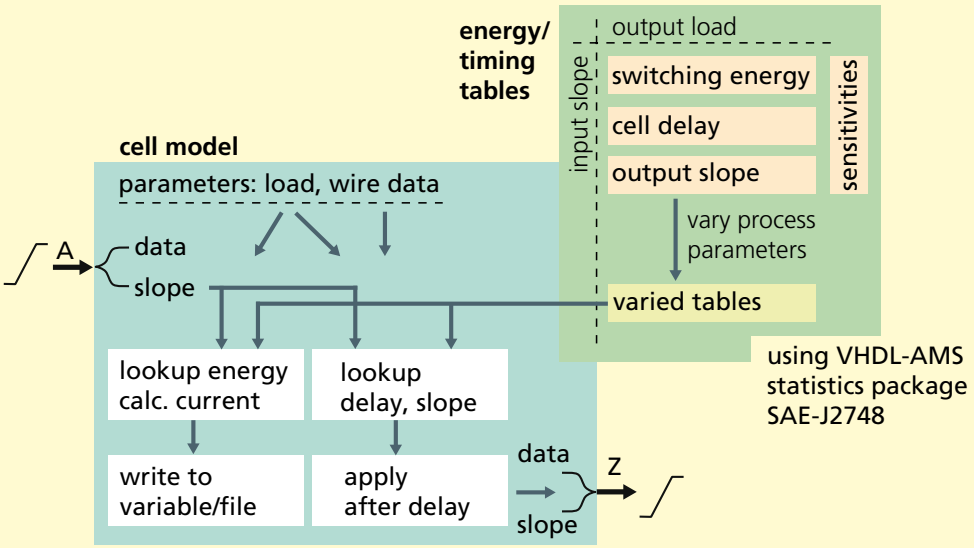

Figure 2: Structure of the VHDL cell model

DESIGN AUTOMATION / SOFTWARE SYSTEMS

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Designing reliable and robust wireless sensor networks

Overview

Wireless sensor networks (WSN) are gaining increasing importance in various application fields, e.g. in home automation, building management, or in the public health sector. To some extent, they include a large number of network nodes. They are therefore too complex for a traditional development using prototyping and debugging. Rather, new methods are required which enable WSN applications to be efficiently designed. Simulation makes an important contribution to reducing the time required for designing but also increases the quality of design. The latter is particularly important for the application fields specified above, as a high level of reliability and robustness must be ensured here.

The scientists at the Design Automation Division EAS in Dresden are developing a simulation framework to support the design of complex wireless sensor networks. In the process, they are cooperating with a local medium-sized company, the "dresden elektronik ingenieurtechnik gmbh" in the joint research project "Development of Methods for Designing Robust and Reliable Wireless Sensor Networks" (RoSeNet). This is supported by the Saxon State Ministry for Economic Affairs Labor and Transport.

WSN simulation framework

The WSN simulation framework extends existing network simulation approaches. It comprises of the following tasks:

- Evaluation of reliability and of the application specific robustness of a WSN application and of measures for their improvement.
- Perform a holistic simulation (application(s), sensor/actuator behavior, communication, and environment).
- Implementation of models of real protocol stacks models in order to be able to use the application to be designed both in the simulation and on the target hardware similarly.
- Handle the trade-off between mastering the complexity and the speed-up of the simulation required for this as well as the necessary accurary.

In addition to these general modeling and simulation tasks, the evaluation of the WSN applications also includes other aspects such as the modeling of the energy consumption of the nodes and the degree of utilization of other resources such as processor load and main storage.

Channel modeling and obstacles

All of the specified application fields of wireless sensor networks pose specific challenges for modeling and simulation. Channel models in building automation should serve as an example here.

A channel model which is used for simulations in this application field must consider obstacles (e.g. walls), multipath reception (due to fitments, etc) and interferences (e.g. through moving people or WLAN transmitters (among other things)).

In this simulation framework, the EAS uses a pragmatic and efficient so-called multi-wall channel model. Interferences are statistically modeled. The effects of multipath reception are incorporated into Monte Carlo simulations in combination with an analysis of critical constellations.
A so-called "obstacle manager" recognizes obstacles for any possible connection between nodes using optical ray tracing and calculates the resulting attenuation. In the

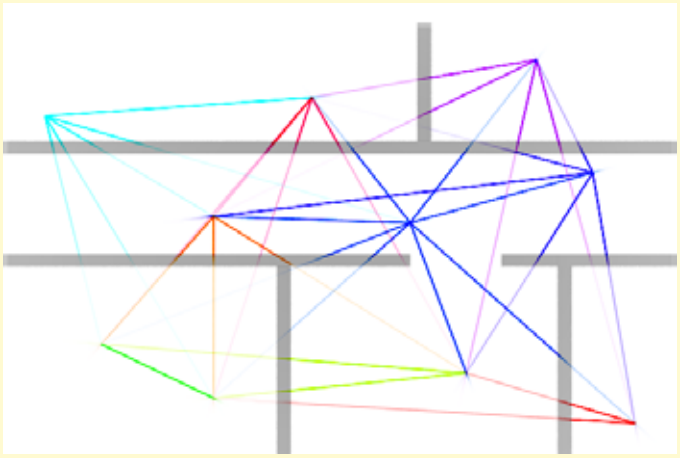


Diagram 1: Optical ray tracing for the treatment of obstacles between connected nodes

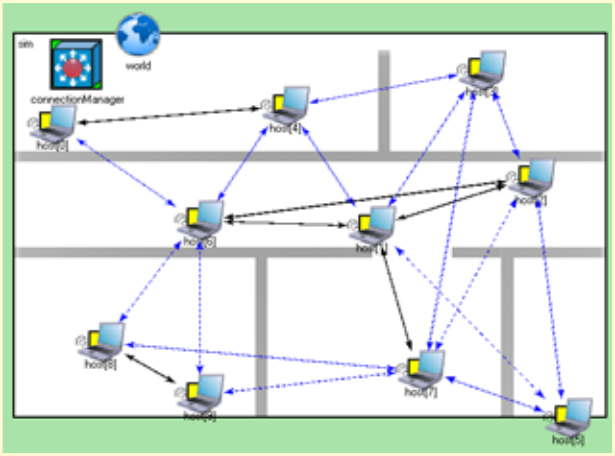


Diagram 2: Connections between WSN nodes in consideration of the ray tracing based "obstacle manager"

process, the attenuation is modeled as the transparency of the obstacles.

Diagram 1 demonstrates the ray tracing in the simulation framework for an example with ten nodes, rendered by the ray-tracing module of our simulation framework.

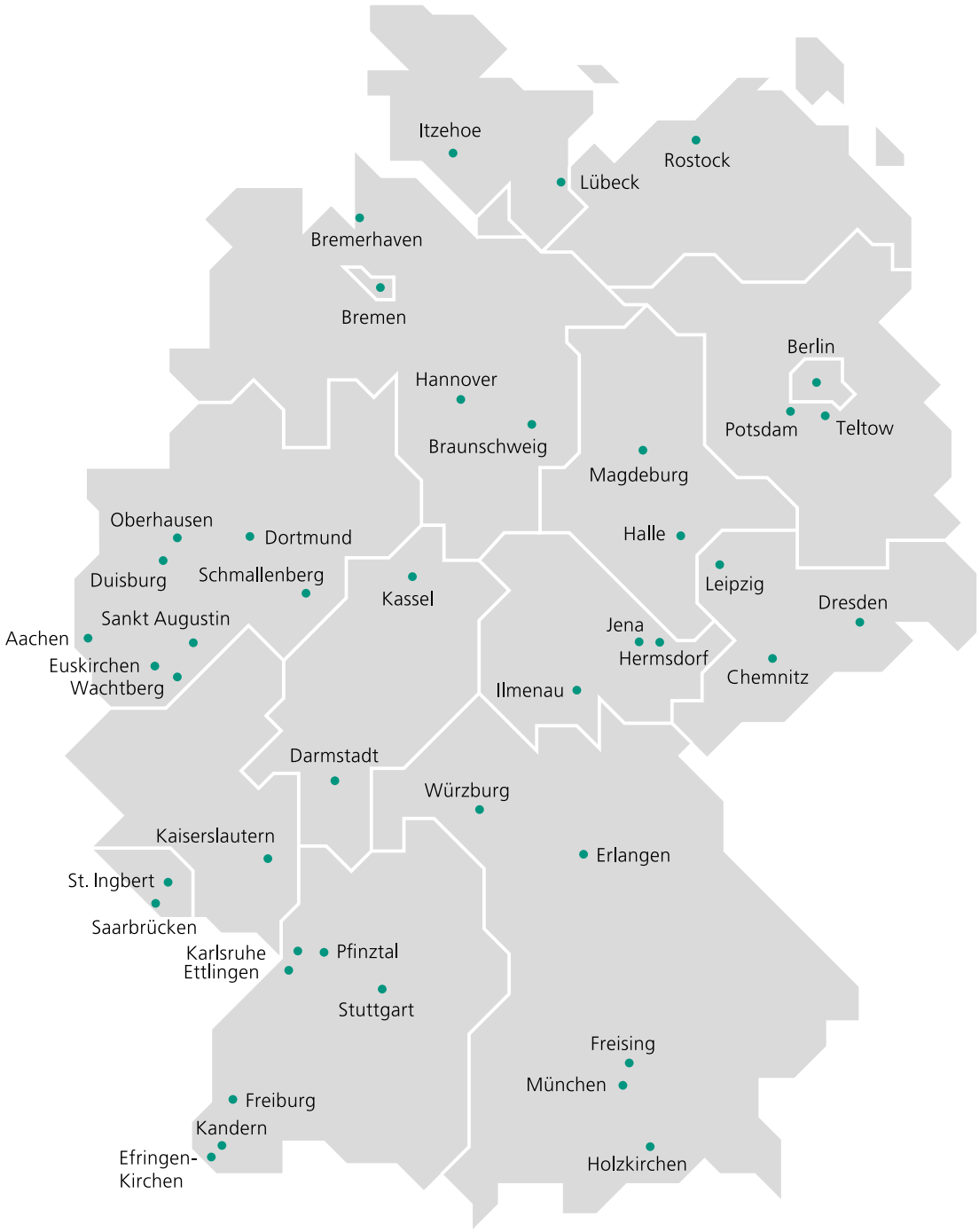
Diagram 2 shows the effects for the physical connections of these nodes. These are reduced to the nodes which can "hear" each other on principle, whereby the walls which the radio signal has to pass through are considered.

Future activities

Further studies are focused on reducing the complexity of the simulation using models on various abstraction levels, on models for the self-sufficient energy supply of nodes as well as a connection of modeling on an application level with the network simulation framework. This will be extended by activities for user-friendly operation, such as the automatic importation of 3D building models and the handling of various network scenarios.

FRAUNHOFER-GESELLSCHAFT, GROUPS, ALLIANCES AND COOPERATIONS

THE FRAUNHOFER-GESELLSCHAFT



Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the research organization undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration.

At present, the Fraunhofer-Gesellschaft maintains more than 80 research units in Germany, including 60 Fraunhofer Institutes. The majority of the 17,000 staff are qualified scientists and engineers, who work with an annual research budget of €1.5 billion. Of this sum, more than €1.3 billion is generated through contract research. Two thirds of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Only one third is contributed by the German federal and Länder governments in the form of base funding, enabling the institutes to work ahead on solutions to problems that will not become acutely relevant to industry and society until five or ten years from now.

Affiliated research centers and representative offices in Europe, the USA and Asia provide contact with the regions of greatest importance to present and future scientific progress and economic development.

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance to the future, the Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation process. Applied research has a knock-on effect that extends beyond the direct benefits perceived by the customer: Through their research and development work, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe. They do so by promoting innovation, strengthening the technological base, improving the acceptance of new technologies, and helping to train the urgently needed future generation of scientists and engineers.

As an employer, the Fraunhofer-Gesellschaft offers its staff the opportunity to develop the professional and personal skills that will allow them to take up positions of responsibility within their institute, at universities, in industry and in society. Students who choose to work on projects at the Fraunhofer Institutes have excellent prospects of starting and developing a career in industry by virtue of the practical training and experience they have acquired.

The Fraunhofer-Gesellschaft is a recognized non-profit organization that takes its name from Joseph von Fraunhofer (1787–1826), the illustrious Munich researcher, inventor and entrepreneur.

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Fraunhofer

FRAUNHOFER GROUP FOR MICROELECTRONICS

The Fraunhofer Group for Microelectronics (German abbreviation VμE) has been coordinating the activities in the fields of microelectronics and microintegration since 1996. Its membership consists of 13 institutes and research institutions as full members, and three institutes as associated members, with a total workforce of around 2,700 and a combined budget of roughly 255 million Euro. The purpose of the Fraunhofer VμE is to scout for new trends in microelectronics technologies and applications and to integrate them in the strategic planning of the member institutes. Fraunhofer VμE also engages in joint marketing and public relations.

The activities of the group concentrate largely on establishing joint focal research groups and projects. In this way, Fraunhofer VμE is able to provide innovative small and medium-sized enterprises, in particular, with future-oriented research and application-oriented developments that will help them to gain a decisive competitive edge. The group pools the core competencies of its member institutes in the areas of:

- Semiconductor technology
- Communications technology

and the application-oriented business areas

- Light
- Security
- Energy-efficient systems and eMobility
- Ambient assisted living AAL
- Entertainment

The central office of the Fraunhofer Group for Microelectronics is acting as a coordination center. Working closely with the member institutes, it is the connecter between science, industry and politics.

Members

Fraunhofer Institutes for

- Applied Solid State Physics IAF
- Digital Media Technology IDMT (associated member)
- High Frequency Physics and Radar Techniques FHR
- Integrated Circuits IIS
- Integrated Systems and Device Technology IISB
- Microelectronic Circuits and Systems IMS
- Telecommunications, Heinrich-Hertz-Institute, HHI
- Open Communication Systems FOKUS (associated member)
- Photonic Microsystems IPMS
- Silicon Technology ISIT
- Non-Destructive Testing IZFP (associated member)
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- Communication Systems ESK
- Modular Solid State Technology EMFT
- Electronic Nano Systems ENAS
  and the
- Fraunhofer Center Nanoelectronic Technologies CNT

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Fraunhofer
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FRAUNHOFER INFORMATION AND COMMUNICATION TECHNOLOGY GROUP

Shorter innovation cycles have turned IT knowledge into a perishable commodity. The Fraunhofer Information and Communication Technology Group (ICT) provides support in the form of customized studies, technology consulting and contract research for new products and services. In addition to feasibility studies, it also investigates end-user acceptance and produces market analyses and cost-benefit assessments. The Fraunhofer ICT Group comprises 14 institutes as full members and three associated members, representing a workforce of roughly 3.000 employees. Its central office in Berlin serves as a one-stop shop, referring customers to the appropriate contacts.

The complementary focal fields of the participating institutes cover the entire value chain of the ICT industry. The ICT Group conducts activities within a wide range of business fields, including information and communication technologies for:

– Medicine and Life Sciences
– Traffic and Mobility
– Culture and Entertainment
– E-Business
– E-Government
– Production
– Digital Media
– Software
– Security
– Communication Systems
– ICT for Financial Services

The member institutes possess considerable experience in the innovative development of new technologies, particularly mobile networks and data transmission, information security, software engineering, knowledge management and information logistics, e-learning, embedded systems, electronic commerce, virtual and simulated reality.

Members

Fraunhofer Institutes for

– Algorithms and Scientific Computing SCAI
– Applied Information Technology FIT
– Communication Systems ESK (associated member)
– Computer Architecture and Software Technology FIRST
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FRAUNHOFER GROUP FOR DEFENSE AND SECURITY

In accordance with its self-conception, the Fraunhofer-Gesellschaft not only supports the economy, but is also engaged with social tasks. Ever since its founding, the Fraunhofer-Gesellschaft has been committed to the Federal Ministry of Education and Research as well as the Federal Ministry of Defence and covers the by far largest part of the Ministry of Defence's institutional research due to its outstanding performance.

As a result of new security threats and the corresponding political consequences, a new endangering situation emerged nationally as well as internationally. The multifaceted and networked public and private infrastructures of today's industrial societies appear to become increasingly vulnerable, given the complexity of possible threats, and therefore need new security solutions in order to protect their citizens. At the same time, previously clearly defined boundaries between interior and foreign security disappear, resulting in extensive consequences for types and deployment of modern security technologies. In particular, the armed forces of the German Bundeswehr are technologically as well as logistically confronted with the different threats of many operational areas. In order to fulfill these tasks while having the necessary protection equipment at one's disposal, it is the aspiration of defense and security research to develop adequate solutions.

Against this background, five of the Fraunhofer Institutes have consolidated in November 2002 with the aim of coordinating and focusing on their research activities within this field. Founding members of the Group for Defense and Security (VVS) are Fraunhofer IAF (Institute for Applied Solid State Physics), Fraunhofer ICT (Institute for Chemical Technology), Fraunhofer INT (Institute for Technological Trend Analysis), Fraunhofer EMI (Institute for High-Speed Dynamics, Ernst-Mach-Institut), Fraunhofer IITB (Institute for Information and Data Processing). As a further member, Fraunhofer IIS (Institute for Integrated Circuits) entered the group as a guest. The central office is located at Fraunhofer EMI in Freiburg.

In 2009, the group registered strong growth, now consisting of eight member institutes. In accordance with the Federal Ministry of Defence's long-term plans to concentrate the principally financed research capacities of the resort, as well as to open up the technological defense research institutes to the civil market, the three research institutes of the former Research Establishment for Applied Natural Sciences (FGAN) were incorporated into the network of the Fraunhofer-Gesellschaft. The new members of the Group for Defense and Security are: Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR, Fraunhofer Institute for Communication, Information Processing and Ergonomics FKIE and Fraunhofer Research Institute for Optronics and Pattern Recognition FOM in Ettlingen – by fusion, FOM and IITB will form the Fraunhofer IOSB in Karlsruhe as of January 1, 2010. The incorporation of these institutes, nationally as well as internationally strengthens the group by improving its performance in the area of reconnaissance and guidance systems, thus reinforcing the entire field of defense and security. At the same time, the individual institutes become part of the scientific system of the Fraunhofer-Gesellschaft and are able to improve and enhance the civil use of research results.

- Research purely in areas of military technology
- Support of the military technology industry through corporate research
- Strategical research in response to the demands of the European security and defense policy
- Support of research projects in the area of defense and security that cannot be confined to an individual institute
- Guarantee of the dual-use research and the know-how transfer between civil and military applications
- Security research

Members

Fraunhofer EMI Institute for High-Speed Dynamics, Ernst-Mach-Institut
Fraunhofer FHR Institute for High Frequency Physics and Radar Techniques
Fraunhofer FKIE Institute for Communication, Information Processing and Ergonomics
Fraunhofer IAF Institute for Applied Solid State Physics
Fraunhofer ICT Institute for Chemical Technology
Fraunhofer INT Institute for Technological Trend Analysis
Fraunhofer IOSB Institute for Optronics, System Technologies and Image Exploitation (by fusion of FOM and IITB as of January 1, 2010)
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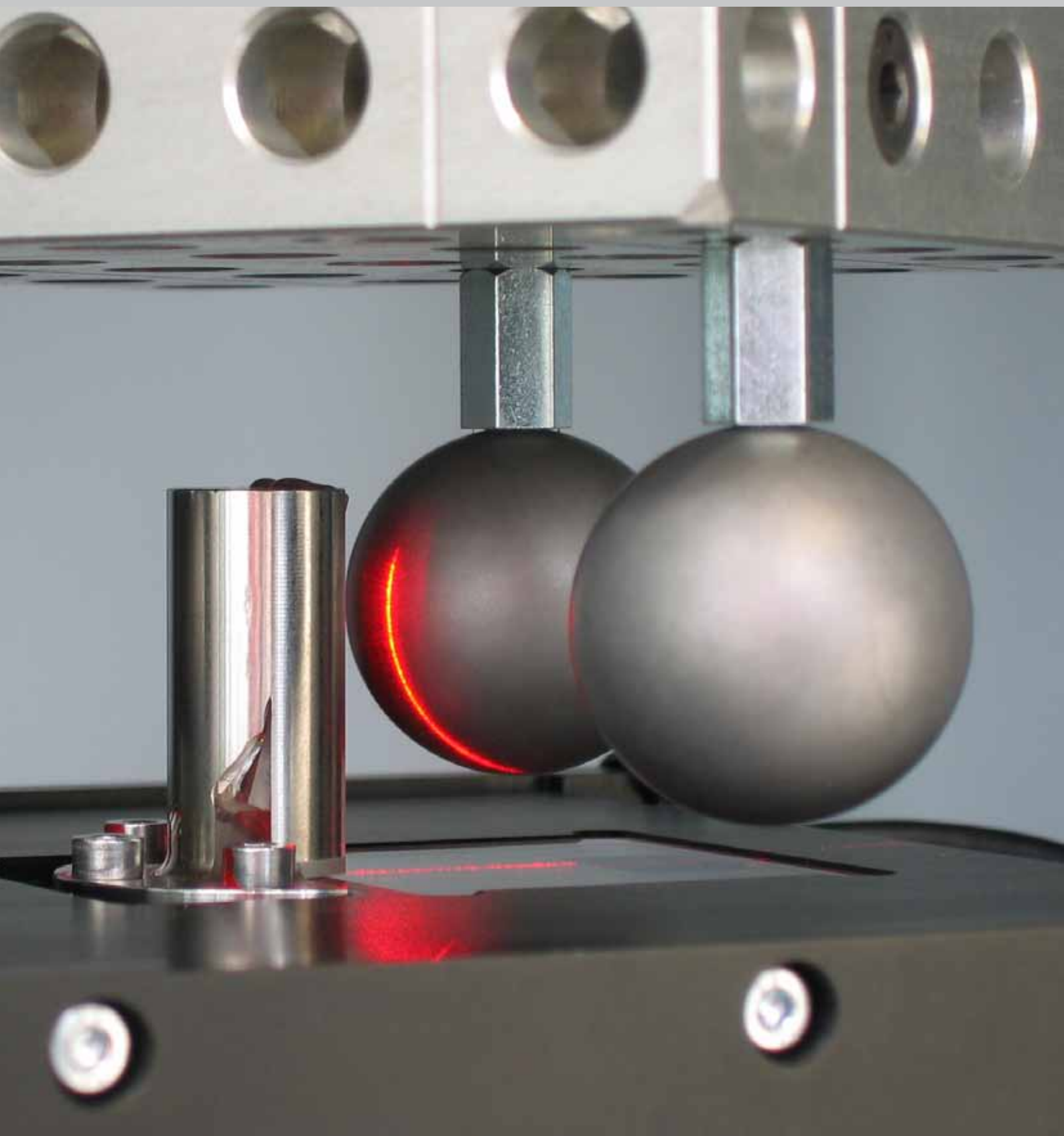

Non-Contact Measurement and Image Processing – 3D Measurement Market Analysis

Overview

The trend towards increased manufacturing productivity and quality has led to rapid development in production engineering and automation, with image processing playing a major part. 14 of the Fraunhofer-Gesellschaft's 60 institutes are currently active in the field of machine vision, each focusing on different aspects. To provide a single point of contact for potential clients and to exploit synergies derived from a broad base of scientific knowledge, the central office of the Fraunhofer Vision Alliance was established at Fraunhofer IIS headquarters in Erlangen. It can forward inquiries to the person whose expertise and location best meet the requirements. For demanding development projects, teams may be drawn from several institutes and funding will be sought.

Providing insight

What is relevant to tomorrow's market must be developed by today. Based on quantitative analysis and evaluation it is possible to gain a realistic perspective on future developments and to verify emerging trends. The publications of Fraunhofer Vision Alliance provide profound knowledge to facilitate the decision making processes. Most recent example is the 2010 market analysis "3D Measurement in the German Automotive and Auto Supply Industry".

Calibration unit for optical 3D measuring systems (Photo: Fraunhofer IFF, Magdeburg)

Collecting information

A survey among 5000 representatives of companies along the entire automotive value chain serves as database for the empirical analysis, complemented by practical background information derived from published sources. With the inclusion of similar surveys conducted in 1999 and 2003, long-term changes of the last 10 years become more visible. The general economic market environment of the automotive and auto supply industry is being portrayed by means of published benchmark figures like turnover, growth, employment and perspectives.

Creating transparency

Main objective of the analysis is the detailed documentation of 3D technology presently employed in the German automotive and auto supply industry from a system user's point of view. It includes the evaluation of the latest market developments and resulting research trends as well as the assessment of the expansion of practice-oriented technologies based on typical demands and measuring objects. The study comprises essential aspects regarding equipment capacity, handling and usability like measurement uncertainties, measuring time, and individualization and automation potential.

Recognizing potential

The juxtaposition of contactless and tactile 3D measurement technology allows conclusions to be drawn about user behavior pinpointing user ideas and needs in regard to potential improvement. Technological aspects play as important a role as the market situation regarding provider services, customer satisfaction and economic viability. The market analysis introduces structured portraits of relevant providers of 3D measuring systems and provides the user with a detailed insight into the state of the art of hardware and software development.

FRAUNHOFER ALLIANCE DIGITAL CINEMA

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R&D for the movie experience of the future

The driving force to further develop digital cinema were novel technologies and trends revolving around 3D. The development and introduction of solutions linking production directly with new systems for post-production and archiving become increasingly important for successful and cost efficient procedures. The unforeseen international triumph of James Cameron's film AVATAR has spurred the transition to and investment in digital cinema technology.
The member institutes of the Fraunhofer Digital Cinema Alliance respond with new developments for the transformation of digital production and projection technology, setting the standard for innovation in joint industry projects. When it comes to the success of innovations in a highly competitive market, a client will look for production workflows based on smoothly geared systems and formats, internationally acclaimed standardization milestones, and scientific expertise. For years Fraunhofer HHI and Fraunhofer IIS have been renowned suppliers of television and cinema technologies and systems. In cooperation with universities and industry partners the PRIME project on production and projection technologies for immersive media was launched. Funded by the BMWi (Federal Ministry of Economics and Technology) the project consolidates the development of camera technology, assistance systems, transmission and projection technology for stereoscopic 3D images for the cinema screen, but also for home entertainment and games.

Fraunhofer IIS developments, like the compact microHDTV camera, are used in various stereoscopic camera setups, side-by-side or mirror deflection. In cooperation with the project partner KUK-Filmproduktion, Fraunhofer scientists in Berlin developed STAN (stereoscopic analyzer): This assistant tool feeds the cameraman during 3D shooting with important information on the distance. A feedback he needs to put the focal point exactly onto the moving object and to present the audience with a pleasant and lifelike 3D image experience. Other PRIME developments and pilot movies are to follow.

Digital cinema made easy with Fraunhofer

Fraunhofer IIS develops new software tools, which are of great value for small and medium-sized productions to convert image content into standards-compliant digital cinema packages (DCPs). The objective was to create a straightforward and easy-to-use software tool. Following a test phase, the easyDCP extended version was developed including 3D DCP and encryption capability, plus player software. Many productions, post-production facilities and film schools take advantage of easyDCP's great potential: Simple, flawless DCP creation and quality control on the PC. A lot of the control steps are possible already in the post-production studio, not only on the digital cinema server. Larger movie studios use easyDCP for the production of so-called dailies – footage from the current day.

February 2010 marked the inauguration of the TiME LAB – Tomorrow's immersive Media Experience Lab – at Fraunhofer HHI. The Lab uses high-resolution projection technology to create a 180 degree panorama in a high-end presentation room, while 128 loudspeakers and patented IOSONO technology by Fraunhofer IDMT provide a stunningly lifelike multimedia environment. The lab's foundation partners – the Berliner Philharmoniker and the Film and Television Academy "Konrad Wolf" – will use the TiME LAB to try out new presentation formats for content and develop new forms of content for this special presentation environment.

Joint high-profile activities

Some of these developments were presented to the public at IBC (International Broadcasting Convention) 2009 and the NAB (National Association of Broadcasters) convention in April 2010, in both of which the institutes participated together. The joint Fraunhofer IBC booth has been an important constant in the Alliance's customer acquisition and PR efforts in 2010. Members of the Fraunhofer Digital Cinema Alliance are the Fraunhofer Institutes IIS, IDMT, FIRST and HHI.

FRAUNHOFER AMBIENT ASSISTED LIVING ALLIANCE

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Fraunhofer Ambient Assisted Living Alliance

The Fraunhofer Ambient Assisted Living Alliance (AAL) was founded by six Fraunhofer institutes in 2007 to market complete solutions in this area. The solutions offered include a variety of functions to improve the user's comfort at home and work, or to facilitate social care at home and in nursing homes, and the provision of mobile services.

Spearheaded by Fraunhofer IIS and its Image Processing and Medical Engineering department, a group of Fraunhofer institutes developed applications related to health and medical engineering with focus on the Fraunhofer frontline theme "Assisted Personal Health" and with the aim to establish a separate Fraunhofer Alliance. In the light of the growing convergence of AAL and Personal Health solutions, another seven Fraunhofer institutes joined the Alliance AAL in November 2009. Since then the AAL has been focused on the areas Assisted Living (AL) and Personal Health, which suggested the consolidation of both thematic areas.

Ready for the future with Assisted Living and Personal Health

As a result the Alliance AAL was expanded and restructured in November 2009 operating the two areas Assisted Living and Personal Health. Assisted Living comprises assistance systems pertaining to home and lifestyle, work, recreation and leisure, as well as private health-related applications. The area Personal Health comprises personalized prevention, diagnostics and therapy, health and emergency assistance related to regulated healthcare.

Portable and easy-to-use sensor technology, like this T-shirt with integrated respiratory measuring system, are essential elements of mobile, persona health assistance

Dr. Reiner Wichert of Fraunhofer Institute for Computer Graphics Research IGD is spokesman of the Fraunhofer Ambient Assisted Living Alliance. Dipl.-Ing. Thomas Norgall, Image Processing and Medical Engineering department at Fraunhofer IIS, is deputy spokesman and head of the area Personal Health.

This strategic structure allows the Alliance to cover a broad spectrum of competencies. Its numerous projects turn out a large variety of individual applications, which typically require project-specific platforms and infrastructures. The Alliance's forward planning provides for a universal modular platform, which can be employed for a broad range of AL and Personal Health projects. To guarantee interface specification and ad-hoc interoperability at a semantic and process level, international standards like those of Continua Health Alliance or the ongoing EU-IP project UniversAAL, which are linked with the Alliance, shall be drawn upon.

National and international cooperation

The Alliance represents the Fraunhofer-Gesellschaft in the thematic areas AAL and Personal Health. Its members conduct market analyses and studies, organize joint trade show appearances, promotional campaigns, are responsible for request/bid management and project planning. The Alliance strives to influence the design of R&D programs and regulatory framework conditions both domestically and internationally. For this purpose, the Fraunhofer Alliance AAL cooperates with national and international organizations and associations. Special synergies derive from the cooperation with the Fraunhofer Personal Health Innovation Cluster and the Medical Technology Test and Demonstration Center METEAN, which are rooted in the BMT department of Fraunhofer IIS.

CENTER OF EXCELLENCE FOR MEDICAL TECHNOLOGY

The Medical Valley European Metropolitan Region Nuremberg (EMN succeeded in being recognized as a Center of Excellence for Medical Technology among a highly competitive group of contenders in the second round of the Leading Edge Cluster competition. The competition is held by the Federal Ministry of Education and Research as part of its High-Tech Strategy Germany. The cluster's management is in the hands of Medical Valley EMN, which looks after the interests of the network members, organizes their cooperation, and takes on administrative tasks. In a conceptual strategy plan the members agreed to the four frontline themes: Diagnostic Imaging, Intelligent Sensor Technology, Therapeutic Systems (personalized medicine), and Ophthalmology.

Technological competencies of Fraunhofer IIS

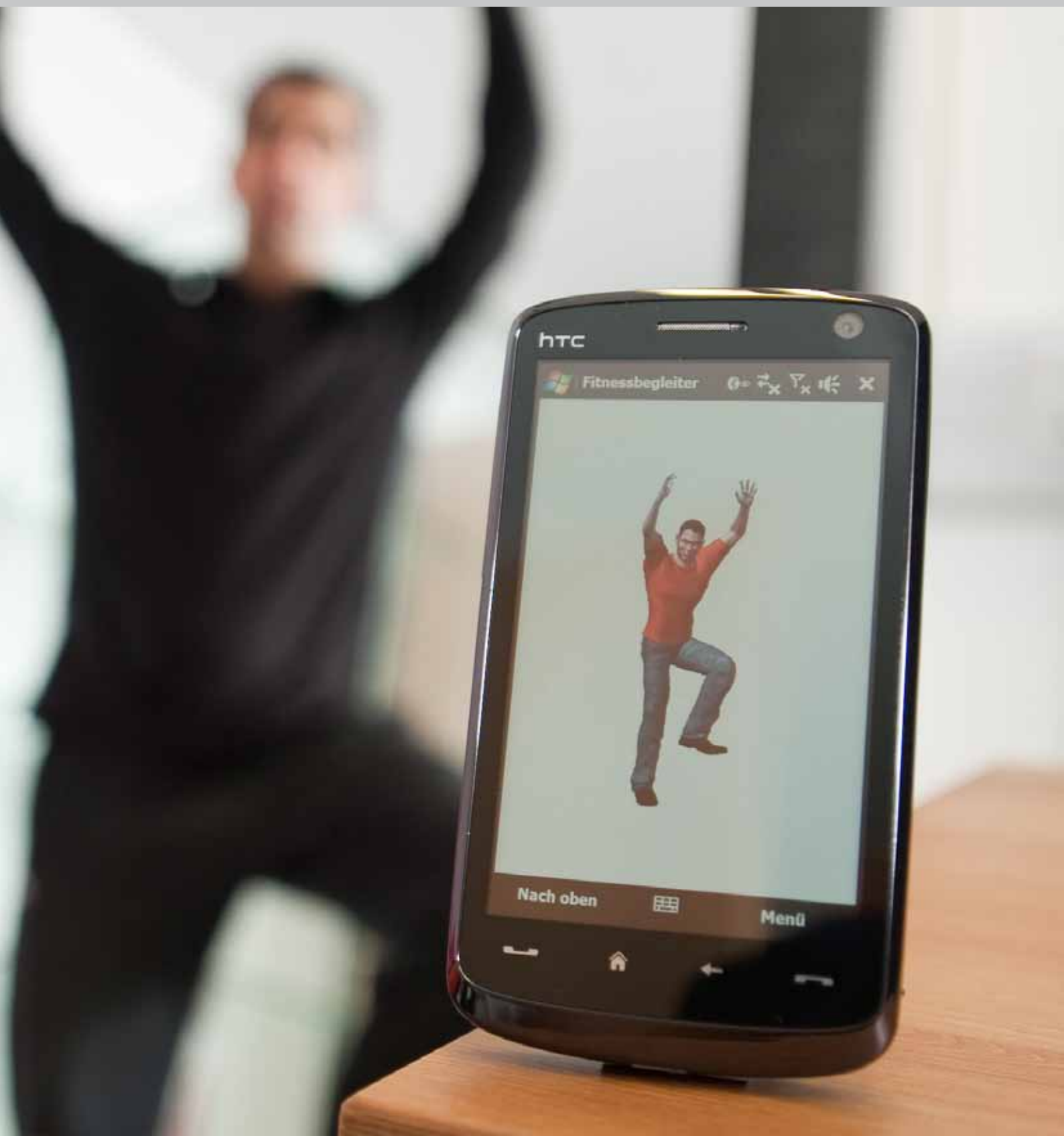
Research activities pursuing the frontline theme Diagnostic Imaging with focus on computer assisted diagnosis (CAD) is one of the core competencies of Fraunhofer IIS in the field of medical technology. Digital mammography is the most effective technique available for the early detection and diagnosis of breast cancer and a crucial component of any screening program. One of the most difficult tasks in the context of mammogram interpretation is the discrimination of benign and malignant lesions. Objective of the leading-edge cluster project "Integrated Breast Care" is to develop a system for the computer-assisted discrimination of benign and malignant mammographic masses and clusters of microcalcifications in digital mammographies (MammoCAD).

Several projects with the frontline theme "Intelligent Sensor Technology" address the concept of assistance systems based on technologies like medical sensor technology and navigation, communications technology, as well as data integration and -management. Objective is to create easy-to-use, mass market assistance systems and services, which support a wide spectrum of application areas and also cater to the sports, wellness and recreation markets. The departments KOM, LOS, HF and BMT of Fraunhofer IIS are involved in these projects. The scientists work on solutions for seamless positioning and for the integration of medical sensor technology in textiles.

The cluster defined three frontline projects from a pool of more than 40 projects. The Diakonie Neuendettelsau (social welfare Neuendettelsau) as coordinator and Fraunhofer IIS initiated the project "Barrier-free health assistance" in the research area "Intelligent Sensor Technology". Partners are "Heitec AG" and "Nash Technologies". Project objective is the concept of a modular intelligent assistance system, which offers specific assistance to people in the most diverse situations. The assistance system is embedded into a complex setting of services including the functions "on-person data collection", "immediate feedback for user", "forwarding the information to relatives, call centers, medical emergency services", as well as the "initiation of situation-specific actions based on the provided information".

Starting point was to meet people's needs and wellbeing, rather than the potential of technological advances. The use of technology in the innovation chain is therefore tailored to the requirements of the target group. A crucial aspect is to examine the acceptance of assistance systems and their ethical assessment, especially pertaining to the employment of innovative technology, and the health economic evaluation of the application cases. Customer-oriented services have to meet the standard of high functional safety, operational safety, data safety, and everyday practicality.

The research activities have to build a future-oriented foundation for barrier-free health assistance, which will be of crucial importance to the social sector and healthcare. This is possible only with the development of a broad-spectrum technology platform and by setting standards, as implemented in a first step in assistance systems for people developing senile dementia.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Nach oben
Menü

FRAUNHOFER INSTITUTE FOR DIGITAL MEDIA TECHNOLOGY IDMT

Dipl.-Medienwiss. Julia Edling | +49 3677 467-310 | julia.edling@idmt.fraunhofer.de

2010 has been the year of new product developments for Fraunhofer IDMT. Many of the products have the potential to set the next trend for the entire digital media market and for digital home entertainment. The innovative flat panel speaker (photo) was received by the media and among trade fair visitors with great interest.

With a depth of only 24 millimeters the speaker elegantly blends into any interior design setting and can be mounted directly onto or integrated into a wall or furniture and still delivers full sound reproduction – a playback quality unequalled by conventional planar speakers. Flat panel speakers have proved to be extremely popular amongst music lovers of all sorts, attracting an enormous number of visitors at the Long Night of Technology held by the Ilmenau Technical University on May 28.

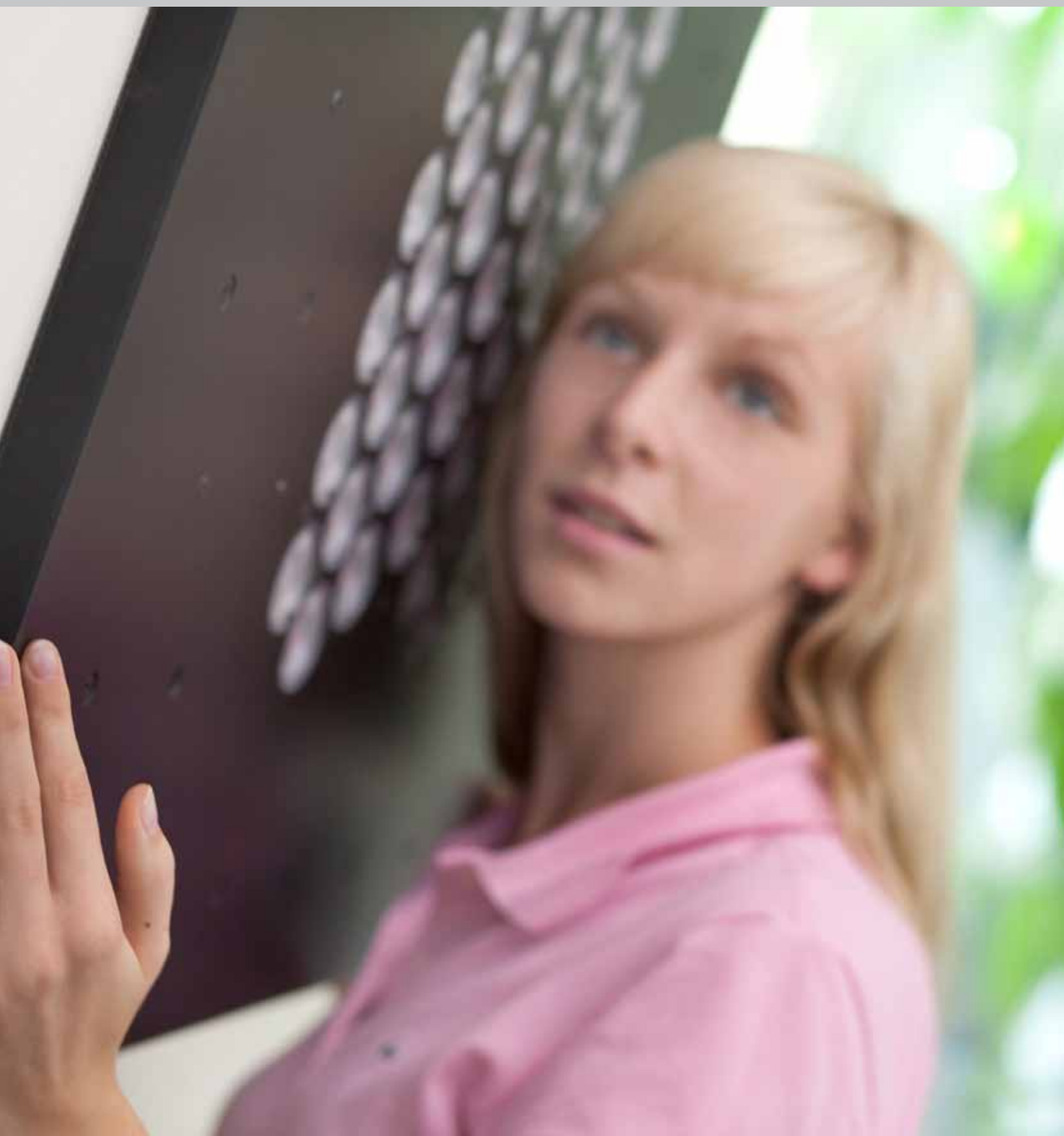
This popular cultural and scientific event attracted more than 10.000 visitors, many of which took the opportunity to get the latest on recent research results from Fraunhofer IDMT. The digital musical instrument Audanika SoundPrism developed by Fraunhofer IDMT drew large audiences at the well-attended event. It is now possible for musical laymen to create melodic sounds intuitively, without any previous knowledge about music. Audanika SoundPrism translates music theory into geometric forms which can be manipulated using a touchpad, like the iPad or iPod. The spin-off Audanika GmbH was founded in August 2010 to market SoundPrism.

A further highlight which was positively received by all and in particular the specialized press was the presentation of the first car ever with integrated surround sound system based on the Wave Field Synthesis technology. With Audi AG as project partner, the institute presented an Audi Q7 equipped with 62 loudspeakers at a journalist's workshop which sparked tremendous enthusiasm among the media representatives.

Attracting vast media attention and hard to top when it comes to relevance, IDMT presented the "Vuvuzela Filter" just in time for the 2010 World Cup. Thanks to the plugin, the fans were able to enjoy the pleasures of noisemaker-free soccer. The filter was used to broadcast the games on the campus of the Technical University Ilmenau and was received with obvious excitement and enthusiasm by the viewers.

The two Fraunhofer IDMT branch labs were able to present their first research results during the reporting period. Since its development, the learning through movement concept Hopscotch has inspired and motivated children, teachers and parents alike. The idea to answer general knowledge questions by jumping on a dance mat and to combine playtime fun with learning paves the way for new didactic approaches. The Oldenburg colleagues of Fraunhofer IDMT are partners of the Lower Saxony research network Design of Environments for Ageing with the aim to develop and evaluate new information and communication technologies for those environments. First technical solutions developed in cooperation with the project group were presented to the public at the CeBIT 2010 fair, including a personal activity assistant and a household assistant.

Fraunhofer Institute for
Digital Media Technology
IDMT



FRAUNHOFER USA
DIGITAL MEDIA TECHNOLOGIES

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Fraunhofer USA Digital Media Technologies provides Marketing and Distribution Support for Fraunhofer IIS Audio and Multimedia Technologies at International Exhibitions and other Occasions:

AES New York, October 9-12, 2009:
Support of the introduction of new MPEG audio technologies.

CES Las Vegas, January 7-11, 2010:
Market launch support for MPEG Surround for digital music distribution.

Mobile World Congress Barcelona, February 15-18, 2010:
Market launch support for Fraunhofer Audio Communication Engine for Internet telephony.

NAB Las Vegas, April 12-15, 2010:
Marketing support for MPEG Surround for digital radio systems.

IBC Amsterdam, September 10-14, 2010:
Marketing support for digital radio systems technologies.

Fraunhofer USA

The Audio and Multimedia Office of Fraunhofer USA, Inc. "Digital Media Technologies" (DMT) continued its dynamic growth in 2009 by taking on new staff and exploring market opportunities for new technologies like Voice over IP (VoIP).

In close collaboration with Fraunhofer IIS in Erlangen the team in San José, CA, introduced new audio formats to the American market. Examples are lossless HD-AAC and MPEG Surround – both developed to improve the sound experience of consumers for content purchased through music and video download services. The new audio codecs and related technologies enabled a far more realistic and improved quality of teleconferencing applications.

With the initiation of U.S. business deals, Fraunhofer USA significantly stimulated Fraunhofer software licensing. What is more, Fraunhofer DMT played a strategic role in the product planning process, hosted the semi-annual meeting of the executive board of Fraunhofer USA in San Francisco, and trained Fraunhofer IIS members in North-American corporate culture.

Fraunhofer USA Digital Media Technologies, a division of Fraunhofer USA, Inc., promotes and supports the products of Fraunhofer IIS in the U.S.

25 YEARS OF FRAUNHOFER IN ERLANGEN

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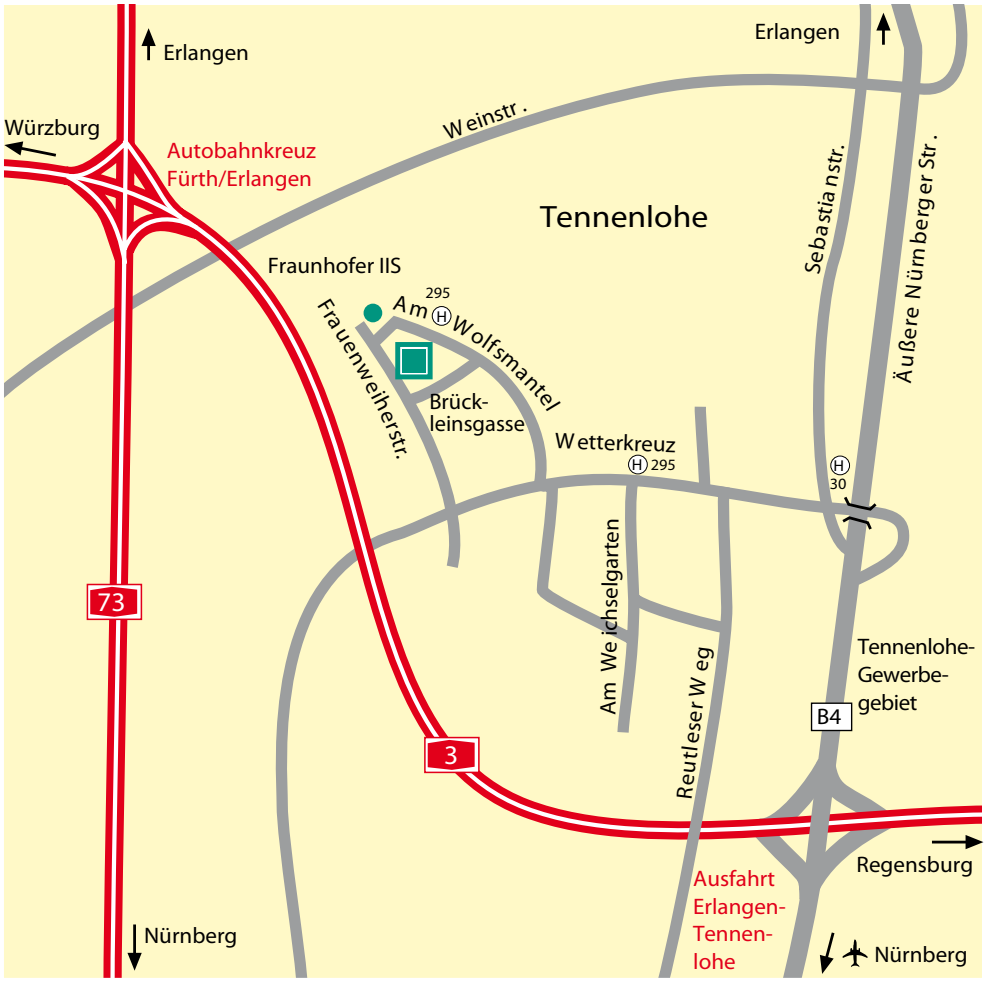
25 JAHRE FRAUNHOFER IN ERLANGEN

Founded in 1985, the two Erlangen institutes Fraunhofer IIS and Fraunhofer IISB celebrated their 25th anniversary in 2010. The two institutes crowned their anniversary with a gala event on July 20 hosted by TV moderator Ursula Heller. Numerous distinguished guests joined the ceremony and personally congratulated the two directors Professor Gerhäuser and Professor Frey in their speeches. The anniversary publication "25 Years of Fraunhofer in Erlangen" published in July looks back at the highlights of the shared history of both institutes.

HOW TO FIND US

Fraunhofer Institute for
Integrated Circuits IIS
Am Wolfsmantel 33
91058 Erlangen



Main Building of the Fraunhofer IIS with antenna tower

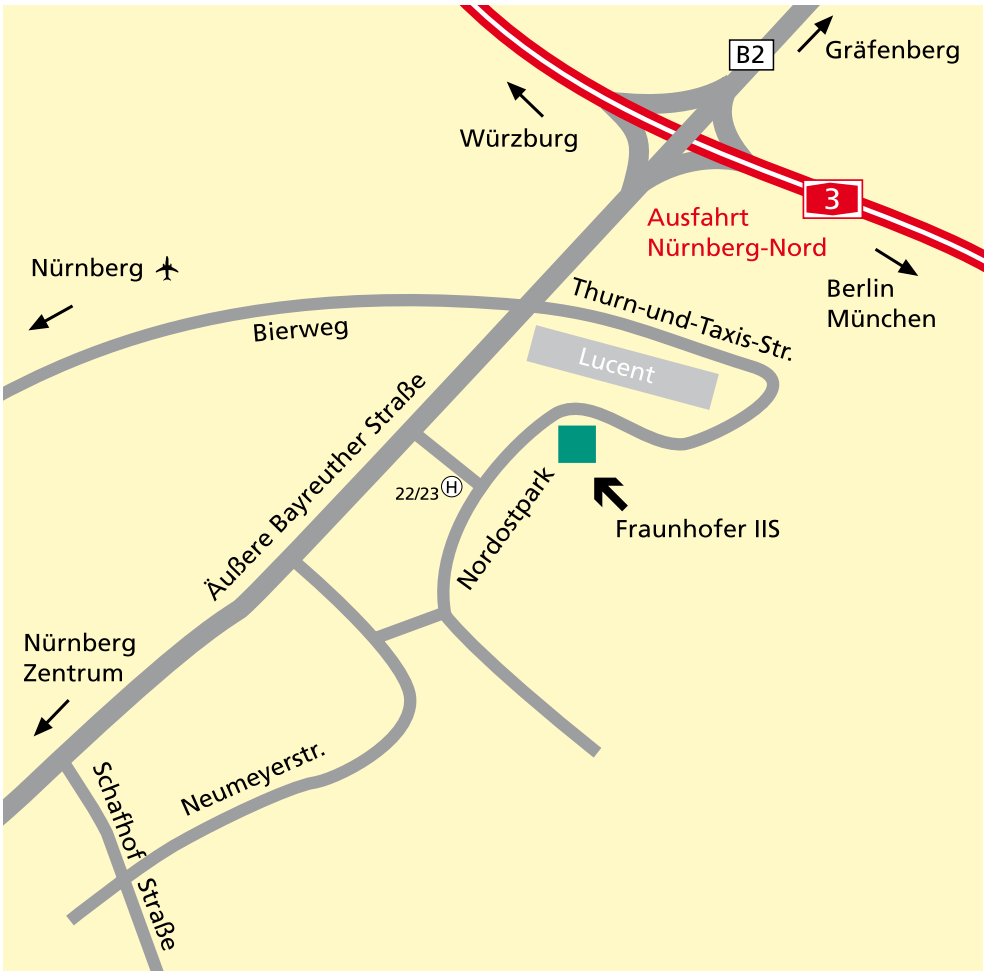
Fraunhofer Vision Alliance

By car: Fraunhofer IIS is located near the Nuremberg airport at the intersection of highway B4 Nuremberg-Erlangen and freeway A3 Regensburg-Frankfurt. Follow A3 until exit Erlangen-Tennenlohe, then follow B4 heading for Erlangen and take exit Erlangen-Tennenlohe following signs to Erlangen and continue on highway B4 until exit Tennenlohe-Gewerbegebiet, Wetterkreuz. At the traffic lights go straight for two blocks, before hotel Tennenloher Hof turn right onto Am Wolfsmantel. After 500 m you will see Fraunhofer IIS on your left. Visitor car parking is available in front of the building.

Arriving at Erlangen train station: Take bus no. 295 with destination Tennenlohe leaving in front of the Erlangen main station. After a ride of about 25 min exit at bus stop Brückleinsgasse right in front of Fraunhofer IIS.

Arriving at Nuremberg airport: The taxi ride from the airport takes approximately 20 minutes.

Fraunhofer IIS
Location Nuremberg
Nordostpark 93
90411 Nuremberg



Location Nuremberg

Fraunhofer Center for Applied Research on Supply Chain Services SCS

Department Power Efficient Systems LOS

Department Communication Networks KOM

Project Group Net Access Technology

Wireless Location Group

By car: Nordostpark is located directly at highway B2, at the Nuremberg city limit, within two minutes driving distance from freeway A3. Exit freeway A3 at Nürnberg-Nord and follow B2 in the direction Nuremberg. You will enter Nuremberg on Äußere Bayreuther Straße. After 400 m turn left following the signs into Nordostpark. Proceed for 100 m, turn left and follow the street to the first gateway to the right. Please contact the Fraunhofer IIS reception at Nordostpark 93.

By train: Arriving at main station take subway U2, direction Flughafen (airport). Exit the subway at station Herrnhütte and take bus no. 22 or 23 heading for Nordostpark. Exit the bus at Nordostpark-Mitte.

By plane: Enter Subway U2, direction Röthenbach and exit at subway station Herrnhütte. Take bus no. 22 or 23 heading for Nordostpark-Mitte. A taxi ride from the airport takes approximately 15 minutes.

Fraunhofer IIS
Location Fuerth
Dr.-Mack-Straße 81
90762 Fuerth

Location Fuerth

Development Center X-Ray Technology

Process-integrated Inspection Systems

Center for Intelligent Objects ZIO

By car: From the north: Follow freeway A3 until intersection Fürth-Erlangen. Change to freeway A73 heading for Nuremberg. Exit the freeway at Nürnberg-Fürth. Turn right onto Ludwig-Quellen-Straße and, at its end, turn left onto Kurgartenstraße. Turn right at the next intersection onto Dr.-Mack-Straße. After 200 m you will find us on the right-hand side.

From the south: Taking freeway A6 or A9, change to freeway A73 at intersection Nürnberg-Süd respectively Nürnberg-Feucht in the direction Bamberg (Nürnberg-Centrum). At exit Nürnberg-Fürth turn right onto Nürnberger Straße.
At the next intersection turn right onto Ludwig-Quellen-Straße. For further directions see: "From the north".

By train: Arriving at Fuerth main station or Nuremberg main station take subway U1 to station Stadtgrenze. Exit the subway station and cross Nürnberger Straße. At the Aral gas station turn right onto Kurgartenstraße. At the second intersection turn left onto Dr.-Mack-Straße. We are located on the right in "Uferstadt" (approx. 7 minutes walking distance).

By plane: Arriving at Nuremberg airport take subway U2 heading for Röthenbach. At station Plärrer change to subway U1, direction Fürth Stadthalle. Exit the subway at station Stadtgrenze. For further walking directions see: "By train".
A taxi ride takes approximately 20 minutes.

Fraunhofer IIS
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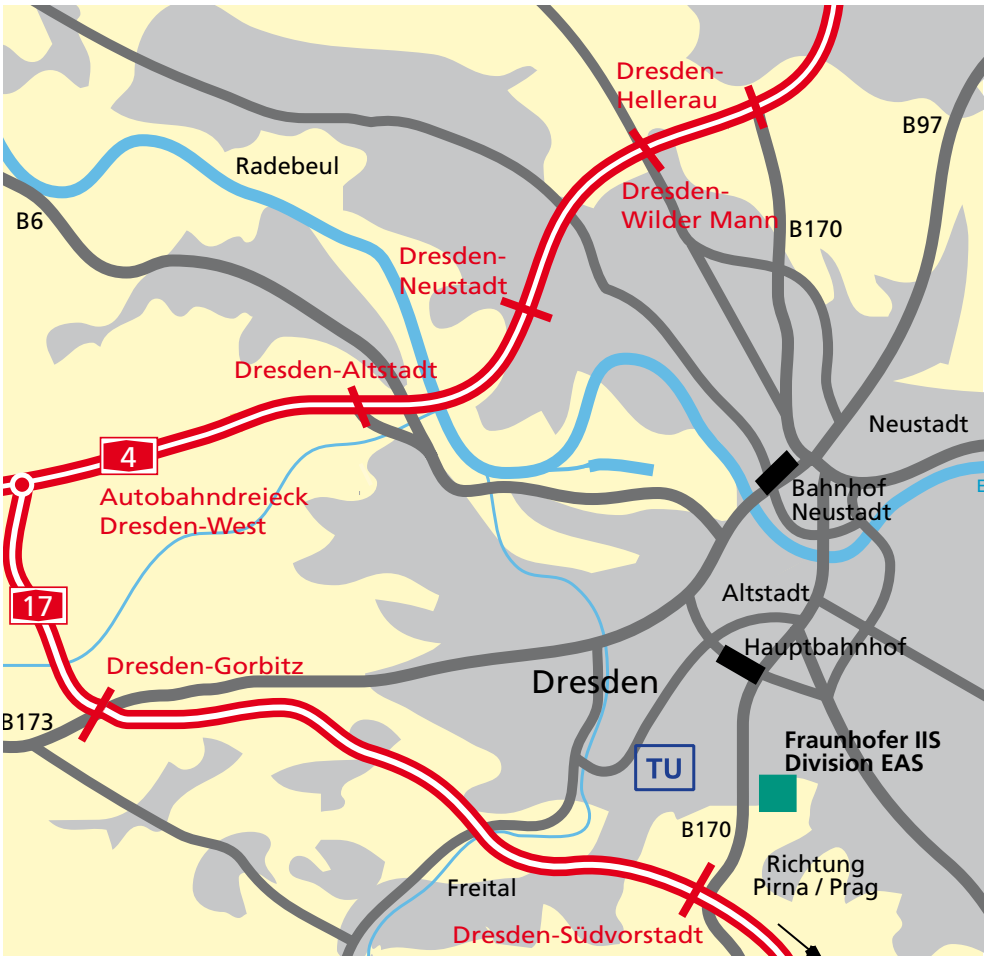
Zeunerstraße 38
01069 Dresden



Fraunhofer IIS
Design Automation Division EAS

By car: Take the A4 freeway and continue until you reach the "Autobahndreieck Dresden-West" freeway junction. Turn onto the newly-built A17 freeway, heading towards Pirna/Prag. At the "Dresden-Südvorstadt" exit, drive onto the B170, following the "Dresden Zentrum" signs. Stay on this road (Innsbrucker Straße, then Bergstraße) for 2.8 km. At the intersection of Bergstraße and Zeunerstraße, turn right onto Zeunerstraße. After 300 meters, you will arrive at Zeunerstraße 38.

Arriving at Dresden train station: Exit Dresden main station at east side and go to bus traffic junction "Am Hauptbahnhof". Take bus no. 72 destination Coschütz or bus no. 76 destination Mockritz. Get off at third stop at Mommenstraße (about 5 minutes). Cross Bergstraße B710 and turn onto Zeunerstraße. To reach Fraunhofer IIS at Zeunerstraße 38 is a five-minute walk from the bus stop. Alternative: Take a taxi, the Branch lab is located about 2 km from the main station.

Arriving at Dresden airport: Take a taxi or the S-Bahn (suburban commuter railway system) for the 15 km to Fraunhofer IIS. Take the commuter railways until Dresden Hauptbahnhof (main station). For further directions please see "Arriving at Dresden train station".

Editorial Notes

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