Fraunhofer
IIS

FRAUNHOFER INSTITUTE FOR INTEGRATED CIRCUITS IIS

POSITIONING AND NAVIGATION

POSITIONING TECHNOLOGIES AND APPLICATIONS

COMPETENCE CLUSTER FOR POSITIONING IN NUREMBERG

There is the right positioning technology for any kind of application. Their applications might be very different in nature, like the determination of position of rescue forces in action, football players on the field or navigation in cities or buildings. In order to meet the variety of resulting requirements, Fraunhofer IIS has concentrated its expertise on "Positioning and Navigation" at one site in Nuremberg. Over 70 scientists organized in three departments combine their vast technical know-how.

CUSTOMER BENEFITS

The latest positioning technologies are being steadily advanced in the laboratories in Nuremberg. Our solutions range from wireless sensor networks and adaptive antennas to satellite navigation systems. Over ten different positioning technologies can be adapted, advanced, and combined as tailor-made prototypes and systems.

FOR EVERY APPLICATION THE OPTIMUM SOLUTION

We are able to provide a positioning solution which is adapted to the specific needs of our partners from the most diverse industrial sectors.
We offer the following services:
– overall system development
– licensing of software and know-how
– evaluation of positioning systems
– provision of dedicated prototypes
– transfer to production
– consultancy and feasibility studies
– consolidation of partners and consortia

TECHNOLOGY

Positioning systems are based on the measurement of the distance between an object and a reference point, the measurement of the angle between an object and a reference line as well as on the recognition of patterns.

AOA – ANGLE OF ARRIVAL

The real-time measurement of the angle of arrival (AOA) is suitable for indoor and outdoor applications. A robust infrastructure allows several hundred measurements per second and is capable of capturing moving objects with a minimum precision of one tenth of degree. The procedure is based on the determination of the angles of arrival of the signal to several antenna elements. By means of triangulation, the position can be calculated while also taking the movement data and references into account. The measurement of the angle works in almost every frequency band and does not depend on radio communication.

TOF – TIME OF FLIGHT

With the methods based on time-of-flight (ToF) measurements, we can achieve positioning accuracies of much less than one meter. If ultra-wide-band (UWB) radio communication is used, the radiated signals can even penetrate walls or objects. In principal, the receiver measures how long it takes for the signal from the transmitter to arrive at the receiver. Regarding to the Round Trip Time (RTT) procedure, both ways - forward and backward – are taken into account. Time difference of arrival (TDOA) systems operate with the differences of the measured signal travelling times at the infrastrucure points. Thus, up to 2000 measurements per object and per second can be determined in an extremely accurate manner. Although the effort required in the infrastructure nodes is considerable, it allows for small and robust tags.

RSSI – RECEIVED SIGNAL STRENGTH INDICATION

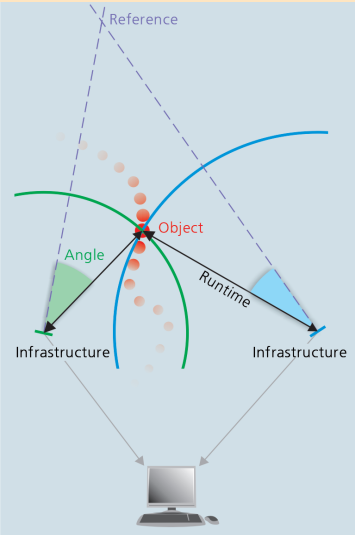
If communication networks are available, such as WLAN, GSM and UMTS base stations in cities and buildings, mobile devices can autonomously determine their position on the basis of a received signal strength measurement (RSSI). The positioning reaches an accuracy of a few meters. The infrastructure can also determine the position of individual objects by measuring the distribution of the received signal strength.

COO – CELL OF ORIGIN

Localization with the Cell of Origin (CoO) method works in a multicell radio network and simply detects the network cell the mobile user is currently logged in. More complex procedures evaluate the information of many cells.

NETWORKING AND COOPERATION

In a radio network with distributed objects, a relative position within the network can be determined by exchanging information between the objects and their resulting proximity. Combined with objects of known positions, an absolute determination of position can be achieved. This procedure is especially suitable for mobile ad hoc networks or self-organizing wireless sensor networks. In addition, the logical proximity relationships combined with methods for distance and direction determination can be applied to improve the accuracy of position.



Angle or runtime measurement allow for the positioning of objects.

GNSS – GLOBAL NAVIGATION SATELLITE SYSTEM

Satellite-based navigation can be used independently of additional infrastructure. In the geodetic field of application, positions can be measured with a precision of just a few centimeters. Owing to the availability of new systems, such as Galileo and GPS, by means of our technology this precision with its high availability and reliability can be utilized for new fields of application. In order to achieve this goal, we develop customer-specific, broad-band multi-standard receivers.

INS – INERTIAL SENSOR SYSTEMS

Inertial sensors build autonomous modules which measure the own body's acceleration and rotation. Based on these measurements it is possible to extrapolate the positions of the system. They are not influenced by environmentally-caused interferences and are very suitable as support technology for radio-based localization technologies in poorly radio covered areas, such as tunnels or cellars. Inertial sensors also offer the possibility to classify types of movements (going, running, cycling). This additional information can be made available for the positioning systems.

SENSOR FUSION AND COOPERATION

As the requirements are frequently comprehensive and dependent on application and use, mostly the utilization of one technology alone might not suffice. Instead, it is more reasonable to combine heterogeneous technologies in a smart manner and to integrate them in one platform. This allows to exploit all the benefits of the technologies are combined and the corresponding weak points are counterbalanced. Wireless, robust localization can thus be realized with most diverse physical requirements. By combining the individual technologies it is possible to seamlessly and transparently switch over e.g. from indoor to outdoor applications or from car to pedestrian navigation.

EVENT RECOGNITION

Frequently, applications do not aim at the acquisition of position data. Instead, the decisions, control actions and findings which are based on reliable positioning data are important. For this reason it is essential to recognize events, such as critical situations, in time and to make them available to the user. By means of artificial intelligence, such events can be accurately derived from the position data and suitable measures can be taken.

ENVIRONMENT MODELS

Besides the position of an object, many applications also require information on the context. Here, the environment models enable, for instance, the visualization of information on the location, a "search for the closest neighbor", storage of additional information, routing, or monitoring of safety areas. In addition, the positioning accuracy can be improved by means of map matching. Modeling can take place for individual objects or rooms in buildings up to entire city models and existing geo information can be taken into account.

FIELDS OF APPLICATION

LOGISTICS AND PRODUCTION

Our seamless positioning enables better transparency and more efficient processes. The matching of reality and stored data is automated.

Application examples: retail security systems, tracking and tracing, tool positioning, asset tracking, container monitoring, autonomous vehicles and positioning of forklifts.

SPORTS

In sports, positioning systems offer new types of information for spectators, media, coaches and athletes. The system achieves a minimum accuracy of one centimeter even under heavy mechanical stress.

Application examples: positioning of players and ball in rugby, soccer and other games, real-time training analysis, fitness analyses, team tactics and athlete safety.

SAFETY

Regarding to safety, maximum reliability is essential. Knowing the position and movements of persons and objects is decisive.

Application examples: positioning of emergency and special task forces of fire department, police and security agencies, monitoring of premises, first aid for public events, automatic camera work.

HEALTH AND QUALITY OF LIFE

With respect to health and quality of life, discretion and reliability are our first priority. Our positioning technologies provide more autonomy to people and help minimize risks.

Application examples: movement recognition for dementia patients, emergency call systems, guidance for blind people, support for wheelchair users.

TRAFFIC AND AUTOMOTIVE

In the traffic and automotive field, not only the support of the driver, but also the protection of pedestrians plays an important role. Our precise, reliable and highly-available positioning system with an accuracy of less than one meter opens up further fields of application in this market.

Application examples: driver's assistance systems for collision avoidance, vehicle control and precise machine control systems for agriculture and construction.

INFORMATION AND ENTERTAINMENT

In order to obtain current public and commercial information anytime and anywhere, it is necessary to autonomously identify one's own position for location-based services inside buildings and in cities.

Application examples: guidance systems for fairs, shopping malls, museums, train stations and airports, tourist guidance systems, city navigation systems, navigation systems for local public transport, mobile marketing, pedestrian navigation.

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