HEAD-TO-BODY-POSE CLASSIFICATION IN NO-POSE VR TRACKING SYSTEMS

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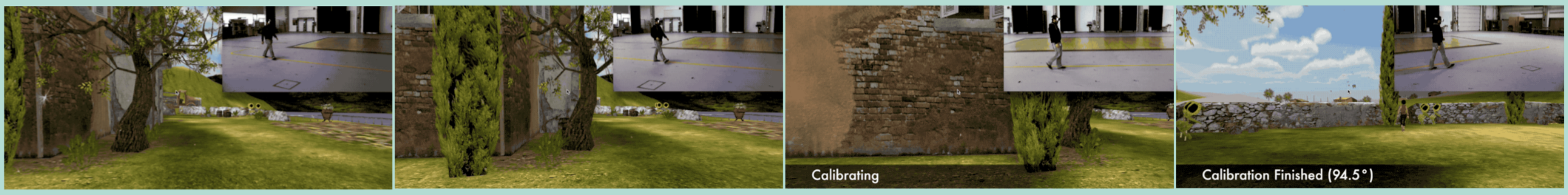


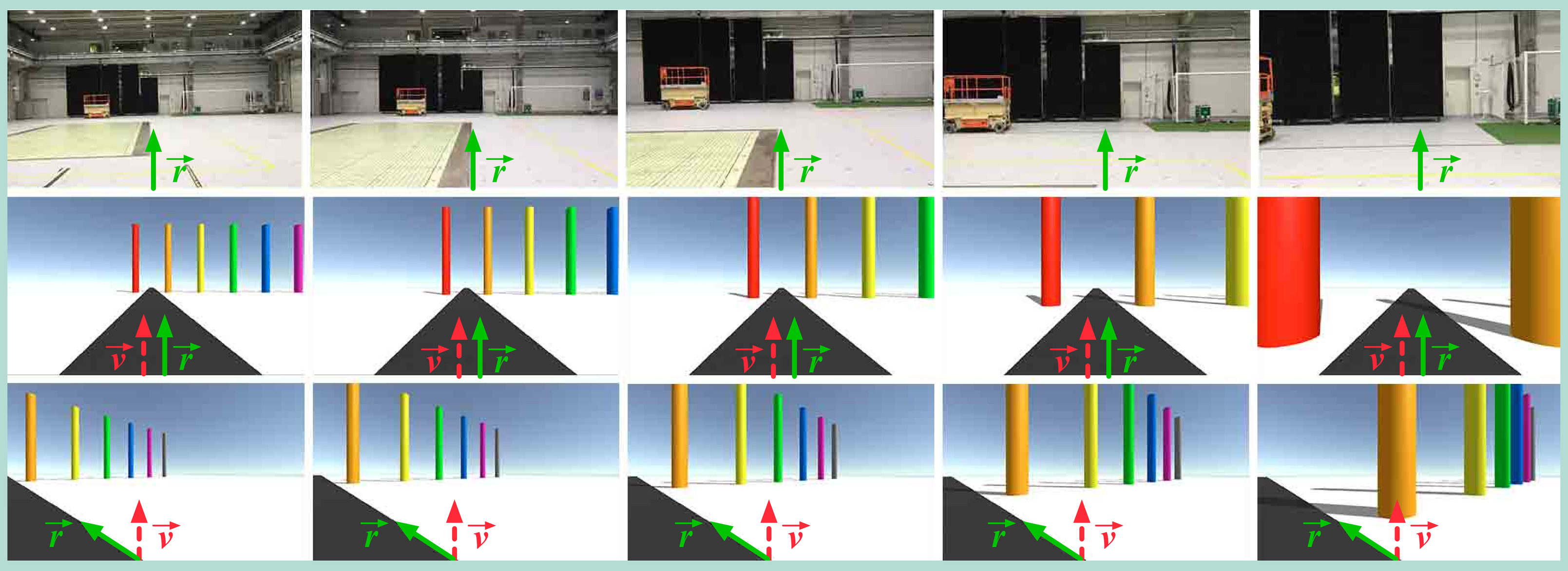
(Re)Calibration process of a 90° yaw orientation drift. Real (foreground) and virtual world (background).

INTRODUCTION

Pose tracking does not yet reliably work in large-scale interactive multi-user VR. Our novel head orientation estimation combines a single inertial sensor located at the user's head with inaccurate positional tracking. We exploit that users tend to walk in their viewing direction and classify head and body motion to estimate heading drift. This enables low-cost long-time stable head orientation.

PROBLEM DESCRIPTION

Low-cost no-pose tracking systems provide positions but only yield relative/wrong head orientation.



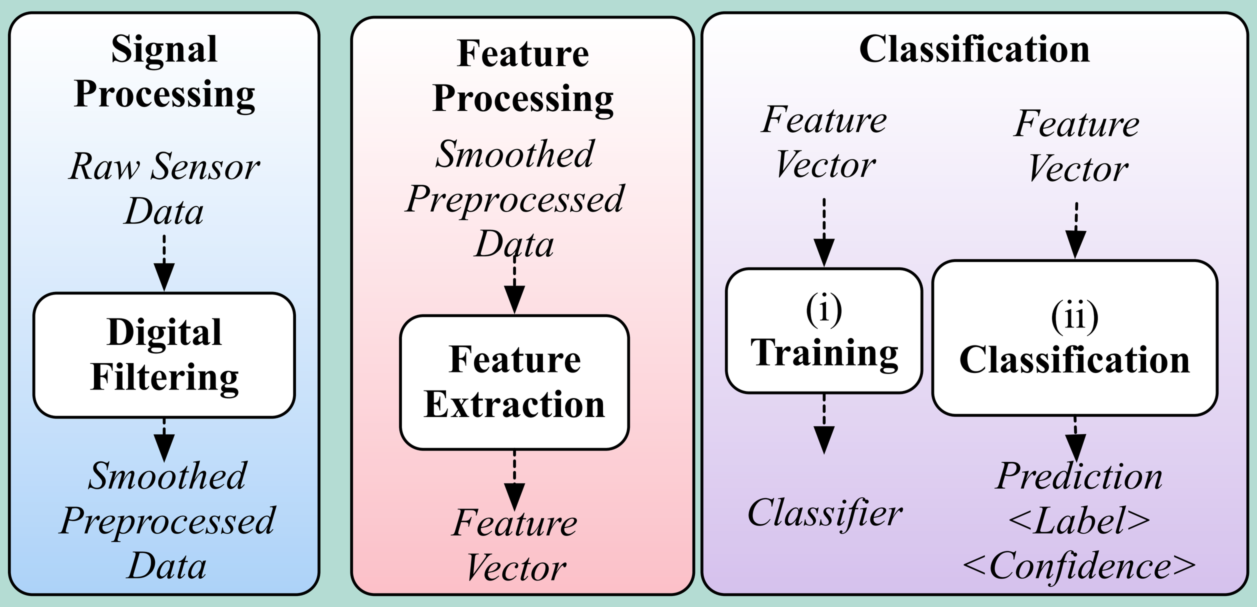
Wrong orientation results in a mismatch of the real ($\vec{r}$) and virtual world ($\vec{v}$) and lead to to motion sickness:

- No drift: $\vec{r}$=$\vec{v}$ feels natural;
- With +45° yaw drift: $\vec{r}$!=$\vec{v}$ feels unnatural.

IDEA

We exploit that humans walk in their viewing direction ($\vec{m}$=$\vec{r}$) and implement a Supervised Machine Learning pipeline:

- Extract features from sensor signals;
- Classify the relation between real movement direction ($\vec{m}$) and head orientation ($\vec{r}$);



Combine the classification with absolute trajectory information to estimate the absolute orientation.

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MACHINE LEARNING PIPELINE

Signal Processing:

- Raw accelerometer (*acc*) and gyroscope (*gyr*);
- Sliding-windows of $200Hz$ = 1*s*;
- Digital filters: Savitzky-Golay (*SG*); low-/high-pass (*IIR*)-filters;
- Extract rotations, pose and motion.

Feature Processing:

- Extract feature vectors (40x1): [μ] Mean: starting spot of the current gait cycle; [*std*] Standard deviation: intensity of signal fluctuations; [*pca*] Principal Component Analysis: highest variance/information density; [*corryz*] Correlation between the Y- and Z-axes: variant head orientation.

Classification:

- Training and runtime evaluation of a Support Vector Machine (One-vs-All).

RESULTS

Training at fixed orientations [−45°; −30°; −15°; 0°; +15°; +30°; +45°] on a group of 34 subjects, 8*h* (split: 70/30%) of natural walking in a VR environment rendered at const. 60 frames/s yields a correct classification of 86%.

Features \ Streams				- - - acc^{SG}	- - gyr^{SG} -	- acc^{IIR}_{grav} - -	acc^{IIR}_{lin} - - -	- - gyr^{SG} acc^{SG}	- acc^{IIR}_{grav} gyr^{SG} acc^{SG}	acc^{IIR}_{lin} - gyr^{SG} acc^{SG}	acc^{IIR}_{lin} acc^{IIR}_{grav} gyr^{SG} acc^{SG}
μ	-	-	-	66	47	68	34	61	61	62	62
-	*std*	-	-	63	75	64	69	57	56	58	59
-	-	$corr_{yz}$	-	14	14	6	9	65	73	69	68
-	-	-	*pca*	64	12	65	11	64	68	70	71
μ	*std*	$corr_{yz}$	*pca*	73	42	72	41	81	84	83	**86**

Due to a naive post-processing step (corrects false predictions such as impossible rotations from 45° to +45° within 5*ms*) we classify the absolute head-to-body orientations correctly in 95% of all cases (in 259μs).

CONCLUSION

We use inaccurate positions and noisy inertial sensors mounted at the head while VR users move on an arbitrary walk and unnoticeably correct the absolute head orientation.

IN COOPERATION WITH

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