

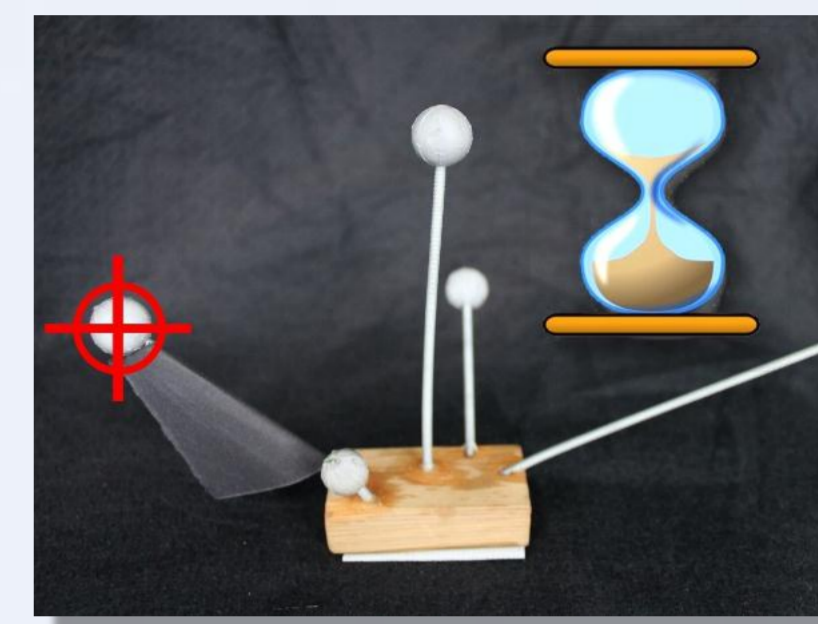
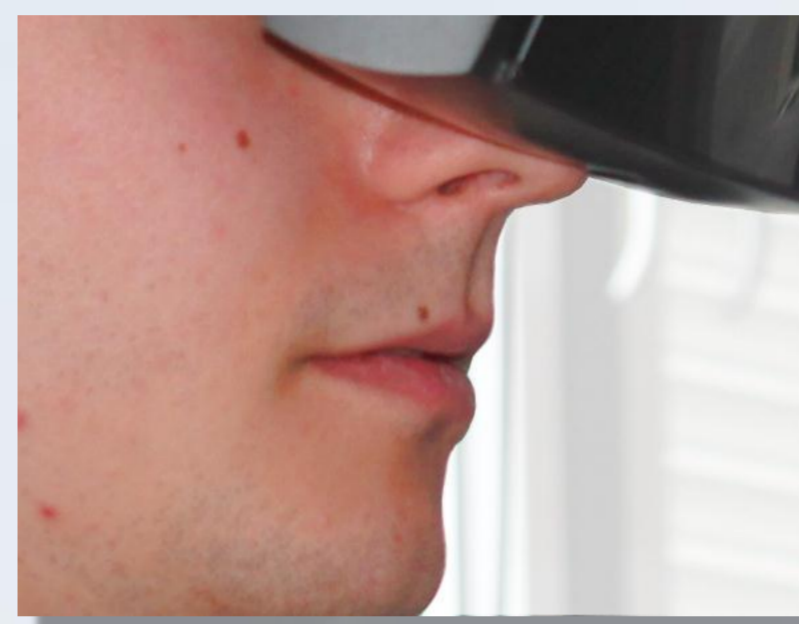
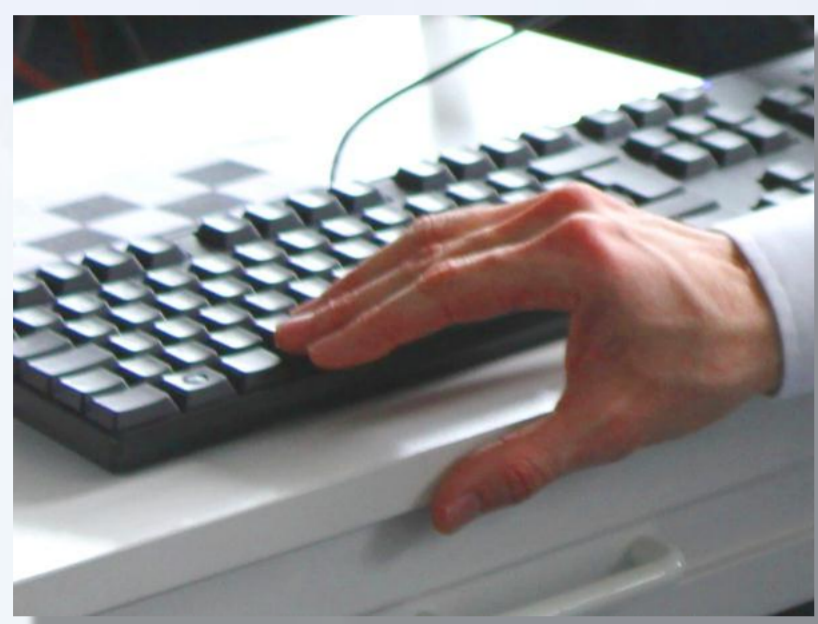
An Empiric Evaluation of Confirmation Methods for Optical See-Through Head-Mounted Display Calibration

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Abstract: The calibration of optical see-through head-mounted displays (STHMD) is important for correct object alignment in augmented reality. Any calibration for OSTHMDs requires users to align 2D screen points with 3D world-points and to confirm each alignment. We compared four confirmation methods: Keyboard, Hand-held, Voice, and Waiting. The

Waiting method, designed to reduce head motion during confirmation, showed a significantly higher accuracy than all other methods. Averaging over a time frame for sampling user input before the time of confirmation improved the accuracy. A further expert study proved that the achieved results with a video STHMD is also valid for optical STHMD calibration.

Hypothesis:

- Acknowledgement methods do have an influence on the Calibration quality.
- Averaging the input data in a time interval before acknowledging, increases the quality of the input data.
- “Waiting” as acknowledgement method leads to better input data.

User Study:

The experiment aimed at evaluating the influence of the different acknowledgment methods on the accuracy of the input data (correspondence points) for the HMD calibration process.

Structure:

- Between-subject, repeated measures, single-session design
- 24 participants aged between 23 and 53 (mean age 28.9, std. dev. 6.05)

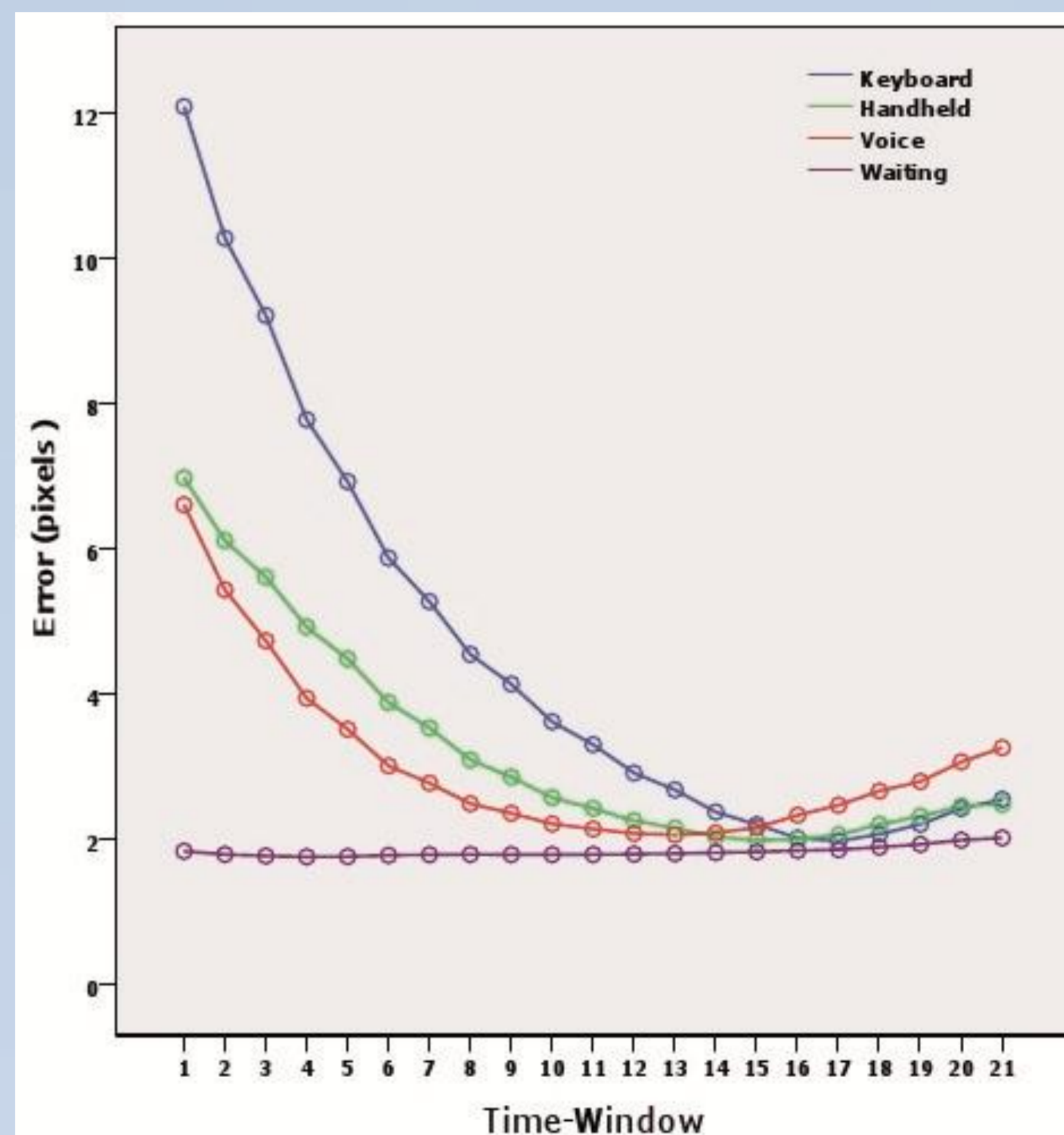
Task:

- Collect 2D-3D correspondence points for HMD calibration
- Confirm the selection using one of the four acknowledgement methods (keyboard, button, voice, waiting)
- 9 correspondence points in near and far distance each
- 10 repetitions generate 180 correspondence points

Analysis Method:

To calculate alignment errors, we used a video see-through HMD and recorded the video. On this video, we can calculate the misalignment by the user (pixel distance of the 3D point-image on the screen to the 2D point).

We also analyzed the influence of averaging the data in different time frame sizes. In the image on the right, you see different time frame sizes (#1 = [t-2.0sec, t]; #2 = [t-1.9sec, t]; ...), each ending at the time of confirmation [t] (#21).



Results:

The Waiting method produced the best results for the calibration. Averaging the data in a time frame which ends at the time of confirmation, also increased the quality of the calibration data. In the picture above, a time frame of 0.6 seconds before the confirmation (Time-Window #15) gave the best results.

Validation of the Results:

To validate the results, we conducted an expert study with an OSTHMD to compare the different calibrations made with the different methods. This study confirmed the results of the previous study.

