

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

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Head Mounted Display Calibration for AR

AR needs a perfect overlay of reality and augmentation.

⇒ Display Calibration

Easy for **Video** See-Through HMD

More complex for **Optical** See-Through HMD

HMD Calibration

Video See-Through HMDs:

- Computer generated Calibration Matrix

Optical See-Through HMDs:

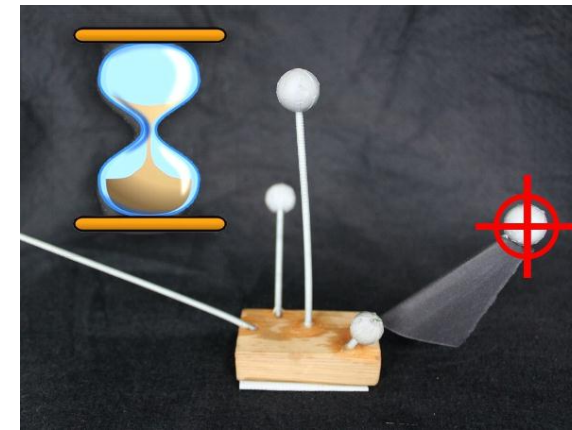
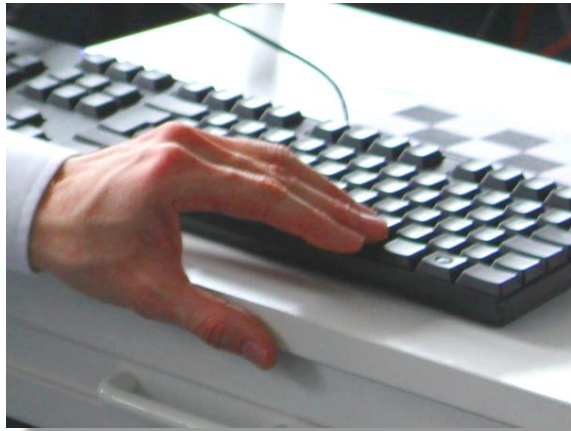
- SPAAM
- Human in charge of data
- Errors

SPAAM Calibration

- Calibration Matrix from 3D-2D correspondences
- User generates correspondences
- First: User aligns 3D-Point with 2D-Point
- Then: User confirms the alignment

Has the Confirmation Method an influence on the quality of the Alignments?

Evaluation of different confirmation methods



Setup

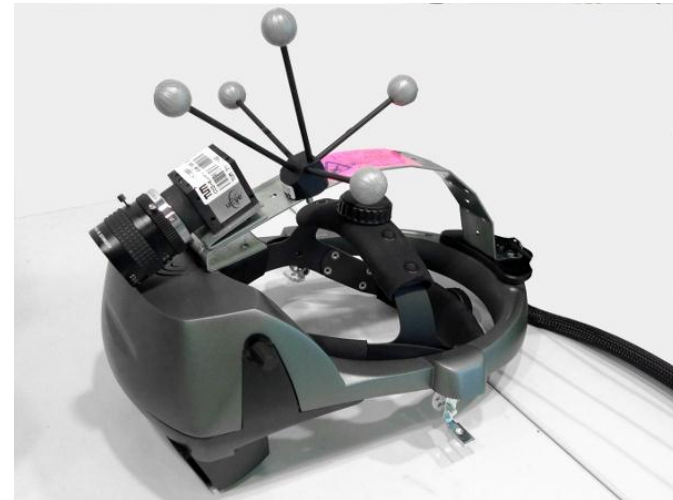
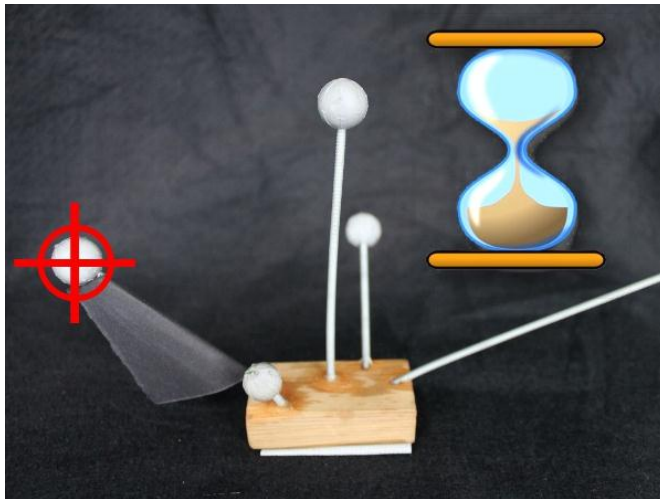


Evaluation Design

- Between subjects
- 24 users (6 users x 4 methods)
- 180 correspondence points per user

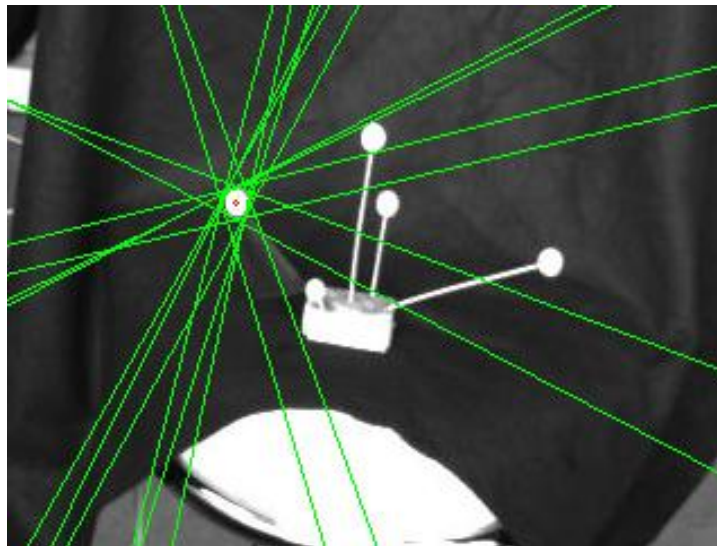
Evaluation

- 2D crosshair on the display
- Small 3D sphere on a target
- Align 2D and 3D point
- Confirm the alignment (Keyboard, Button, Voice, Waiting)



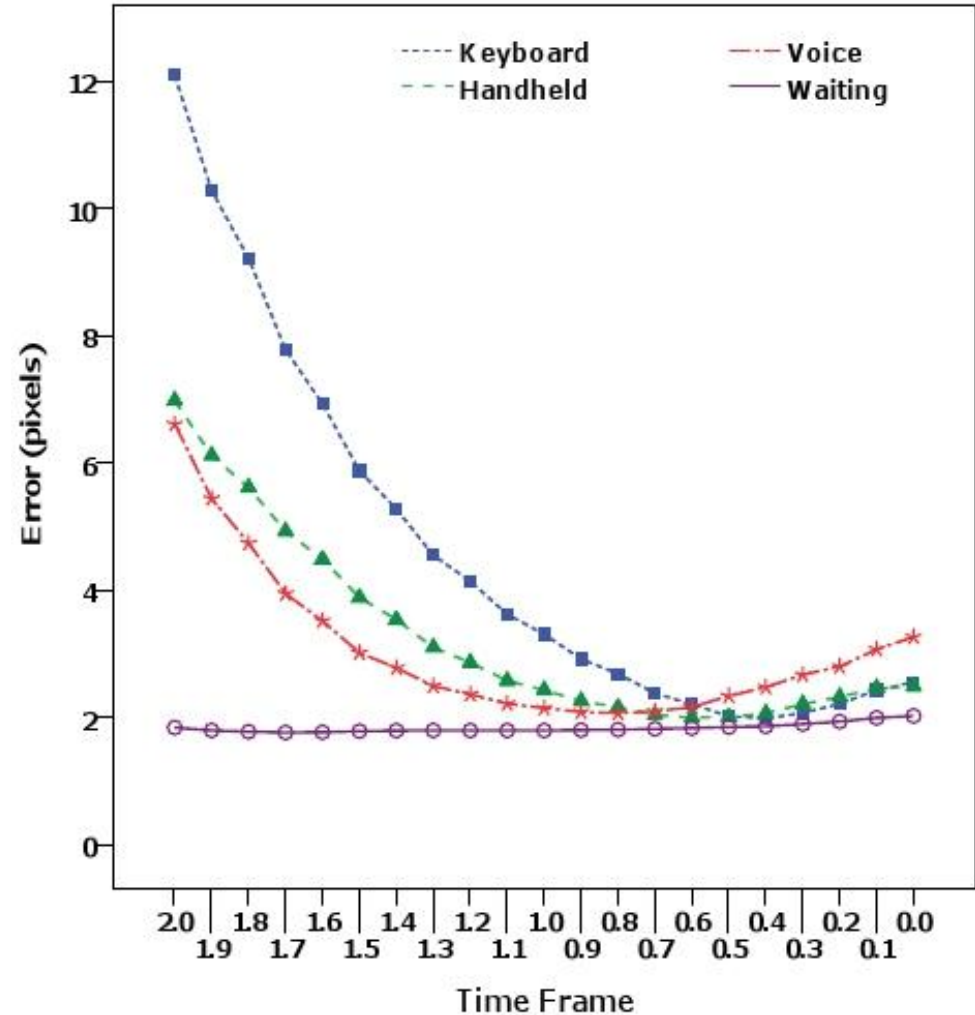
How to measure the misalignment?

- VSTHMD instead of OSTHMD
- Computer graphics measure the difference

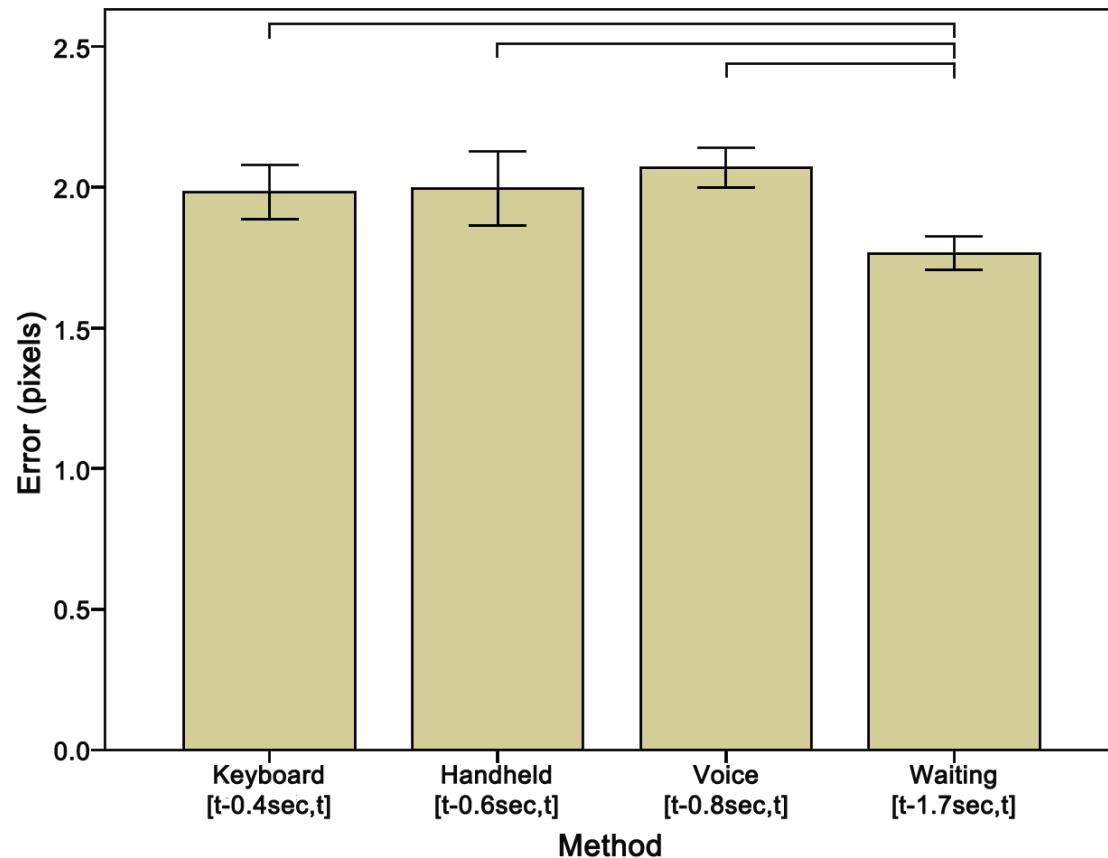


Improve Correspondence Data by Averaging

- Average correspondence points in different time frames
- All time frames end at time of confirmation
- Waiting method results in the best quality



Results



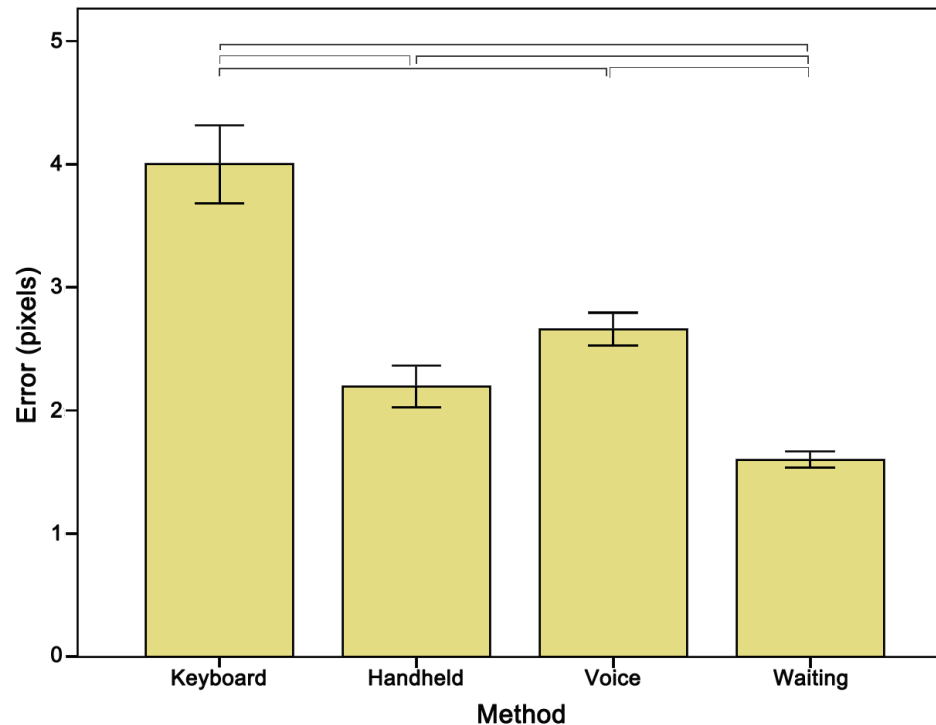
Mean Error (in pixels) for each method using the best time frame for each

Validation of Results (numerically)

- Does a lower residual error also reduce the quality of the overlay? – YES
- Comparison of the User-Generated Matrices with the Ground-Truth (Computer Vision-Generated) Matrices
- Projecting 3D points back to the Display and compared the results

Validation of Results (numerically)

- Waiting method significantly better than the others



Validation of Results (OSTHMD)

- Second Study with OSTHMD
 - SPAAM Calibration with 4 Methods
 - Augment a Chessboard with inverse pattern
 - Subjective results
- ⇒ Waiting best

Conclusion

- Confirmation methods DO have an influence on the quality
- Waiting method improves calibration quality
- Averaging of the Correspondence Data further improves the results
- VSTHMD can be used to compare the Confirmation Methods instead of OSTHMD