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 OSTMHHD
- 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 OSTMHMD
- 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 OSMTHMD