

[DEMO] INDICA : Interaction-Free Display Calibration for Optical See-through Head-mounted Displays based on 3D Eye Localization

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ABSTRACT

A correct spatial registration of Optical See-Through Head-Mounted Displays (OST-HMD) w.r.t. a user's eye(s) is an essential problem for any AR application using the such HMDs (Fig. 1). Maintaining the correct registration demands frequent (re)calibrations for the end-users whenever they move the HMD on their head. Thus, a calibration technique should be simple and accurate for the universal, long-run use of the displays.

This demonstration showcases INDICA, an automatic OST-HMD calibration approach presented in our previous work[1] and ISMAR 2014 paper [2]. The method calibrates the display to the user's current eyeball position by combining online eye-position tracking with offline parameters. Visitors of our demonstration can try our both manual calibration and our interaction-free calibration on a customized OST-HMD.

Keywords: Optical see-through head-mounted display, HMD, calibration, eye tracking

1 WHY OPTICAL SEE-THROUGH HMD CALIBRATION?

Last year, 2013, was the dawn of commodity Head-Mounted Displays (HMD) as typified by Oculus Rift, Google Glass, and some other products (Recon Instrument's Jet, Optinvent's ORA, Space-glasses' Meta, etc.). We believe this trend will bring HMDs in the public limelight soon in the near future; they will be day-to-day tools for everyone rather than expensive gadgets only for professionals in academia and industry.

However, existing Optical See-Through HMDs (OST-HMD) are hardly comparable to its best self we long for, which would meet essential requirements for AR applications such as negligible latency, both high image resolution and wide field of view enough to cover human eye sight, and perfect spatial registration between the display screen and eye(s).

Our current work focuses on this spatial registration issue (Fig. 1). For a correct registration, users need to calibrate OST-HMDs w.r.t their eyes. As re-calibration is required whenever HMDs move on users' heads, it is preferable that the calibration procedure is simple for end users.

2 KEY IDEA FOR INTERACTION-FREE CALIBRATION

Existing methods [4, 3] require manual operations by users so that an OST-HMD system can understand the matching of 3D points in the world, 2D points on a screen and user's eye position (Fig. 2 left). However, with the frequent recalibration issues, this can be tedious and not acceptable for long-run day-to-day use.

The key idea of our method is to let an eye camera tracks user's eye position (Fig. 2 right) automatically, and make the calibration procedure user interaction-free.

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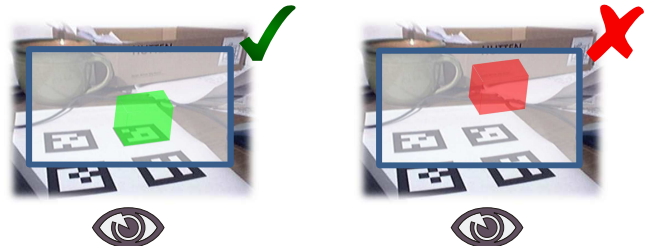


Figure 1: Spatial registration problem in AR applications with OST-HMDs. Aligned (left) and Misaligned (right) registration.

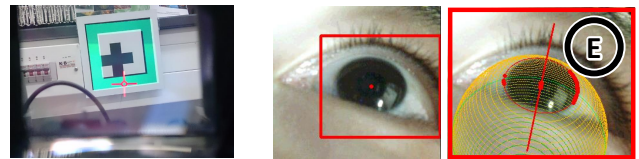


Figure 2: (left) User's view during a manual calibration, a virtual red crosshair (2D point) will be matched to the black square marker (3D point). (right) An estimated eye position during our interaction-free calibration.

3 HIGHLIGHT

We showcase our calibration method [1, 2] with a customized OST-HMD system (Fig. 3). Visitors can try out a standard manual calibration method (Fig. 2 left), and can compare the result with that of our automatic calibration through a simple AR visualization.

4 FOR RESEARCHERS USING OST-HMDS

Have you got frustrated or even disgruntled by some of limitations of OST-HMDs? If you have, please do visit our demo, share your experience, and see one of the issues is about to be resolved. We are happy to explain bit more detail about our method (Fig. 4). We will be also welcome to discuss any issues related to the limitations and possible solutions.

For example, our current system still lacks some important con-

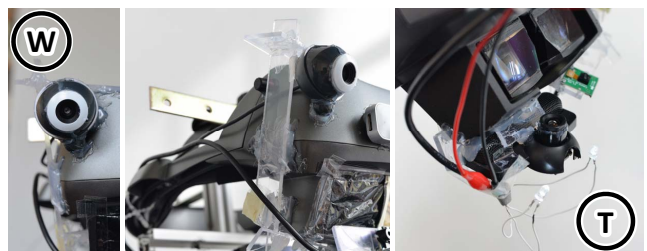


Figure 3: An OST-HMD setup used in our demonstration. A camera attached on top of the HMD, nVisor ST60, works as the world origin. A near-eye camera tracks the 3D eye position of a user's eye. Currently single-eye calibration is supported

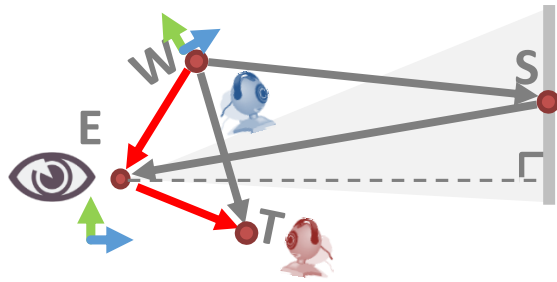


Figure 4: A schematic drawing of the spatial relationship of our interaction-free calibration.

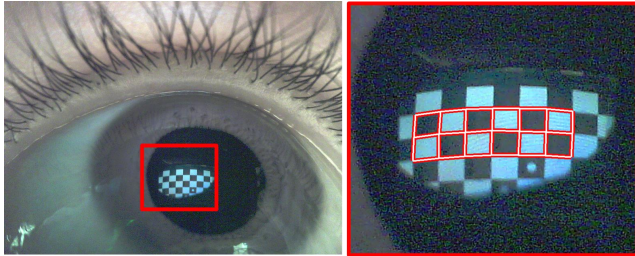


Figure 5: An example image of Corneal Imaging. It would be possible to calibrate OST-HMD via such eye reflection image.

siderations: distortion of the virtual display, the discrepancy the real eyeball and its model. A related approach we are currently seeking for the latter problem is to estimate the eye-HMD relationship automatically by corneal imaging (Fig. 5) .

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