

Performance and Sensitivity

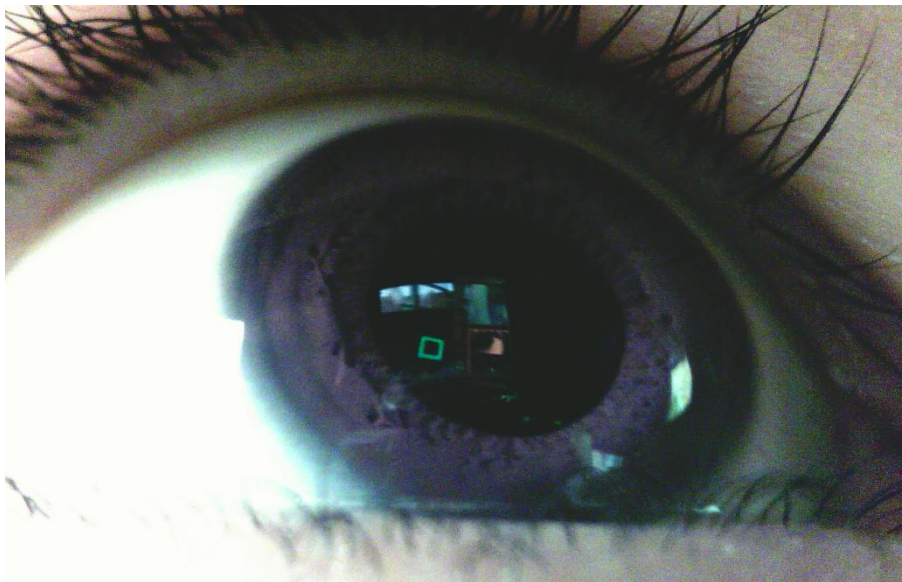
Analysis of ~~INDICA~~:

INteraction-free **DI**splay **CA**libration

for Optical See-Through Head-Mounted Displays

Yuta Itoh and Gudrun Klinker

TUM, ISMAR2014, 12th Sep 2014



Head-Mounted Displays

Non Optical See-Through



Optical See-Through OST-HMD

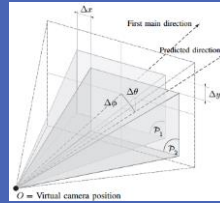


Consistency issues in OST-HMDs

Temporal



[Zheng '14]

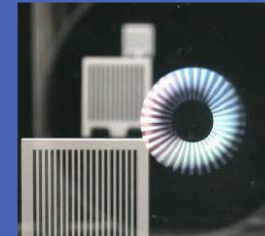


[Didier '05]

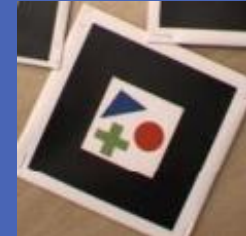
Visual



[Kiyokawa '01]



[Liu '08]



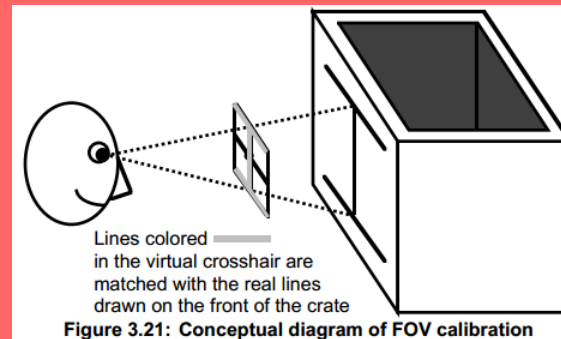
[Lee '09]

Social

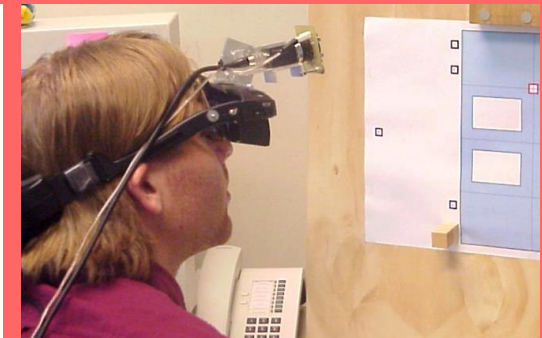


Image from Google
Glass: Don't Be A
Glasshole | Mashable

Spatial



[Azuma '95]



[Tuceryan '00] [Genc '02]

Spatial Consistency of OST-HMDs

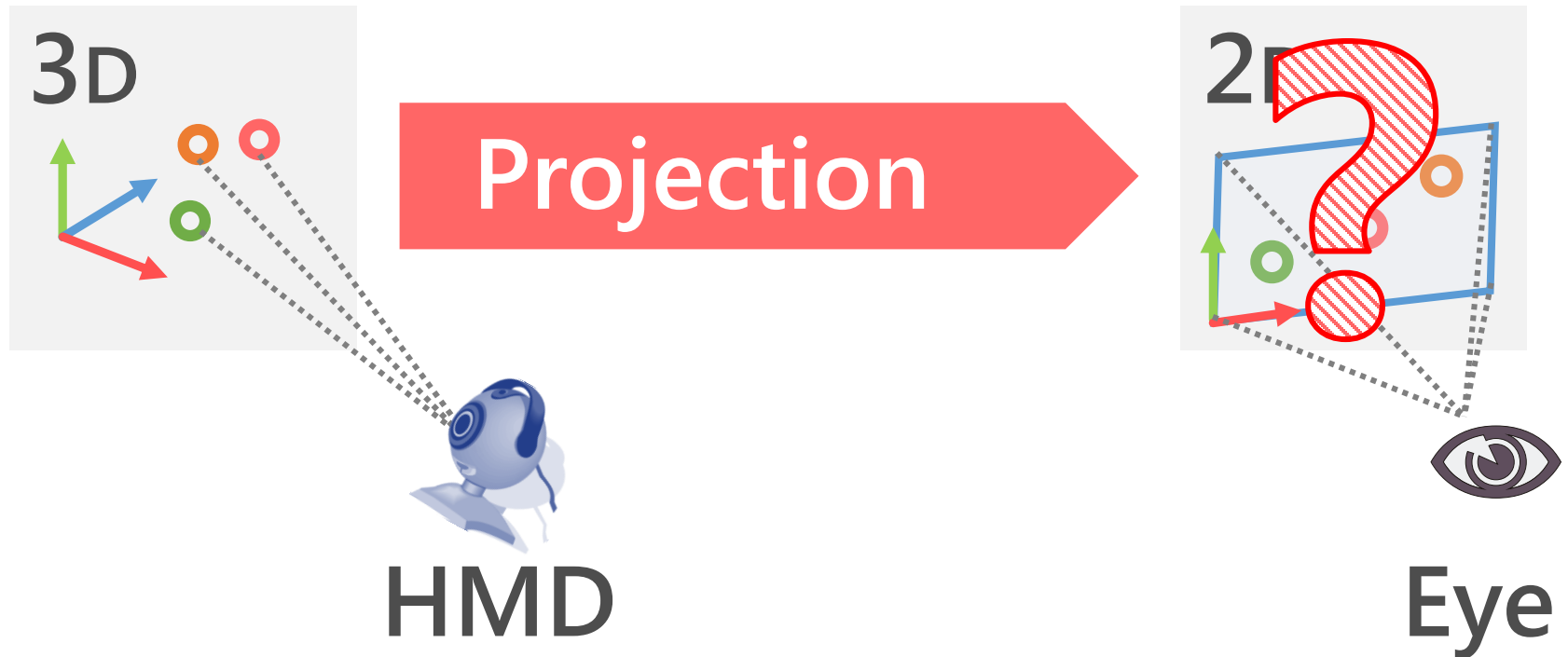
Not consistent

Consistent



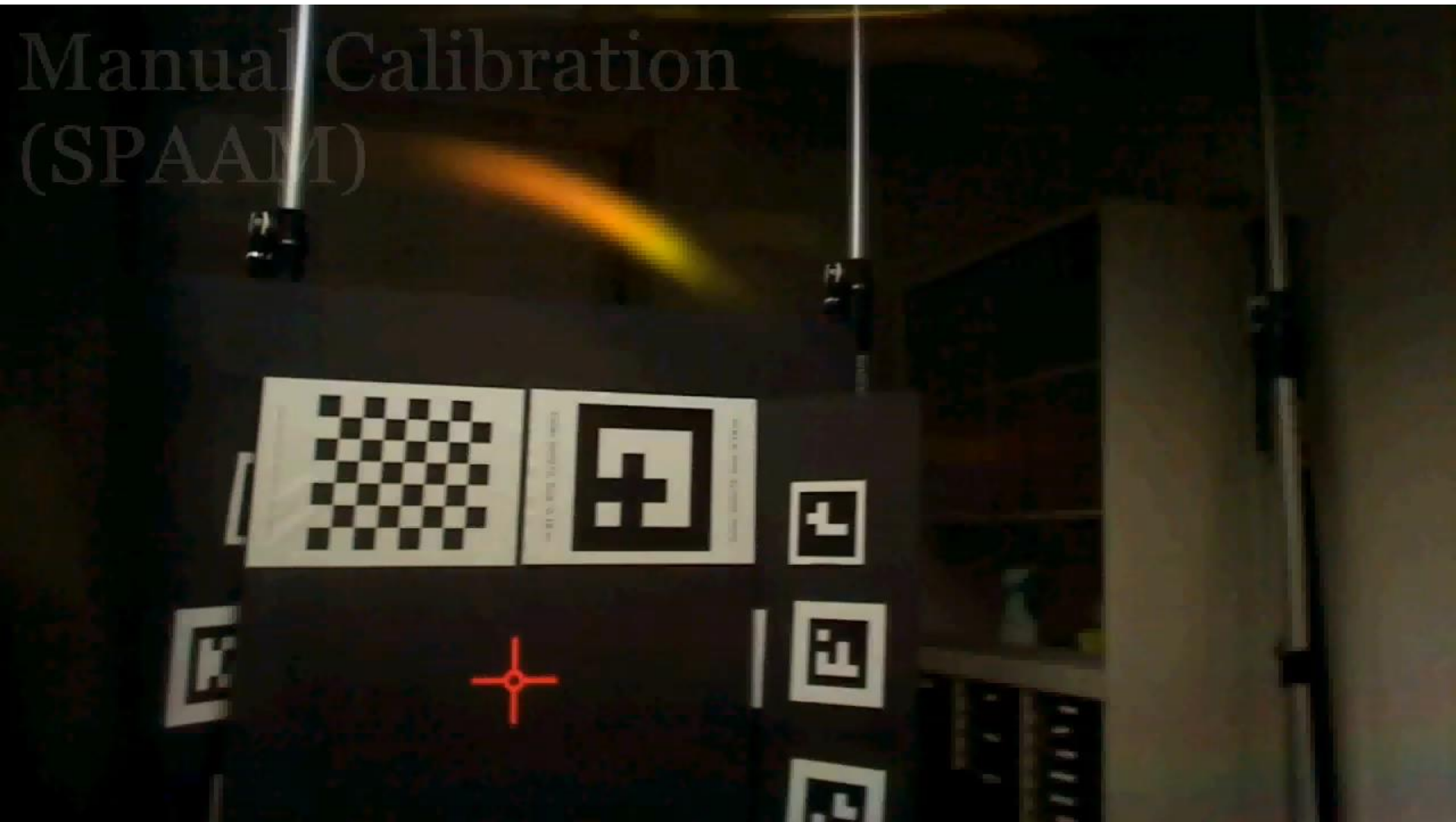
Spatial Calibration of OST-HMD

Find a **Projection** from 3D to 2D

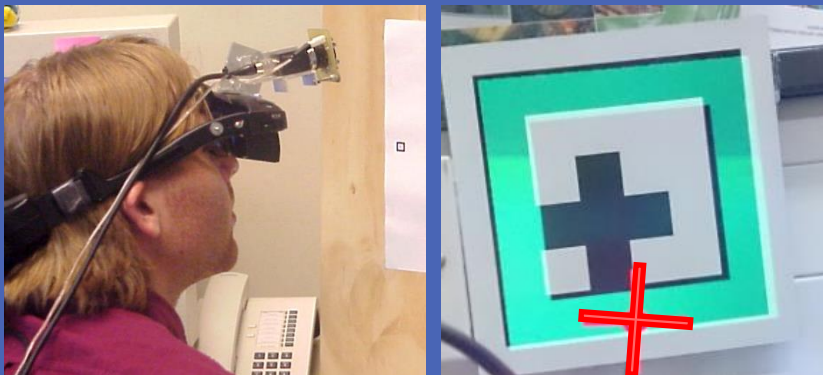


Manual Method needs user interaction

Manual Calibration
(SPAAM)



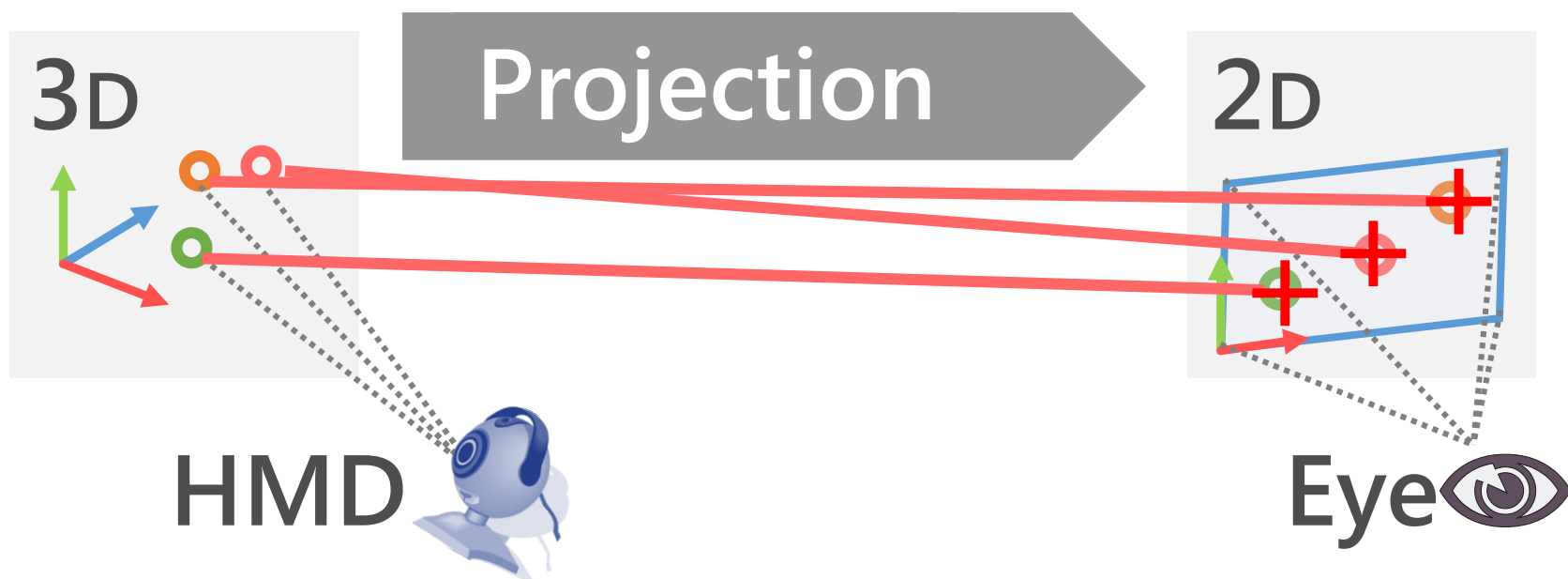
Manual Method needs user interaction



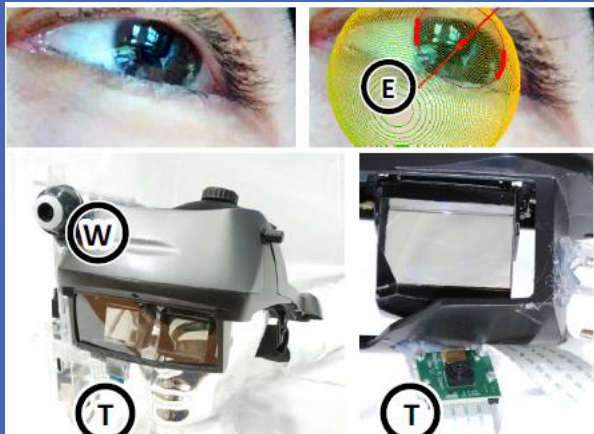
SPAAM

Single Point Active Alignment Method

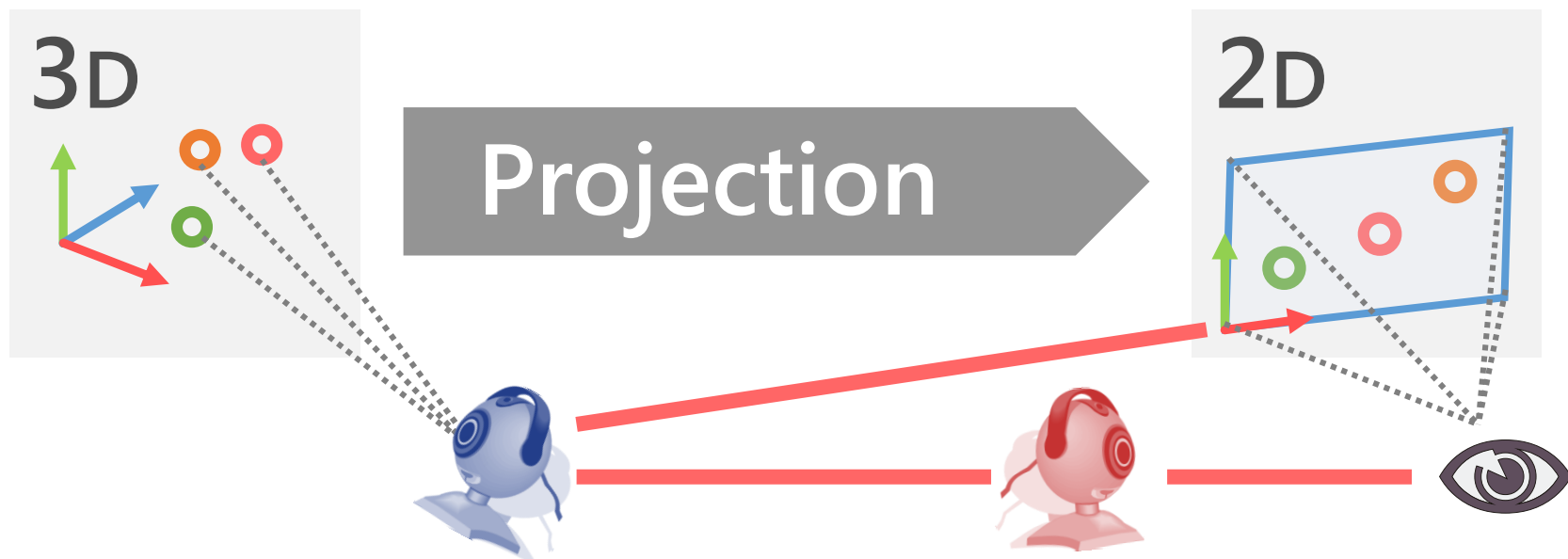
[Tuceryan '00] [Genc '02]



Automated Method interaction-free



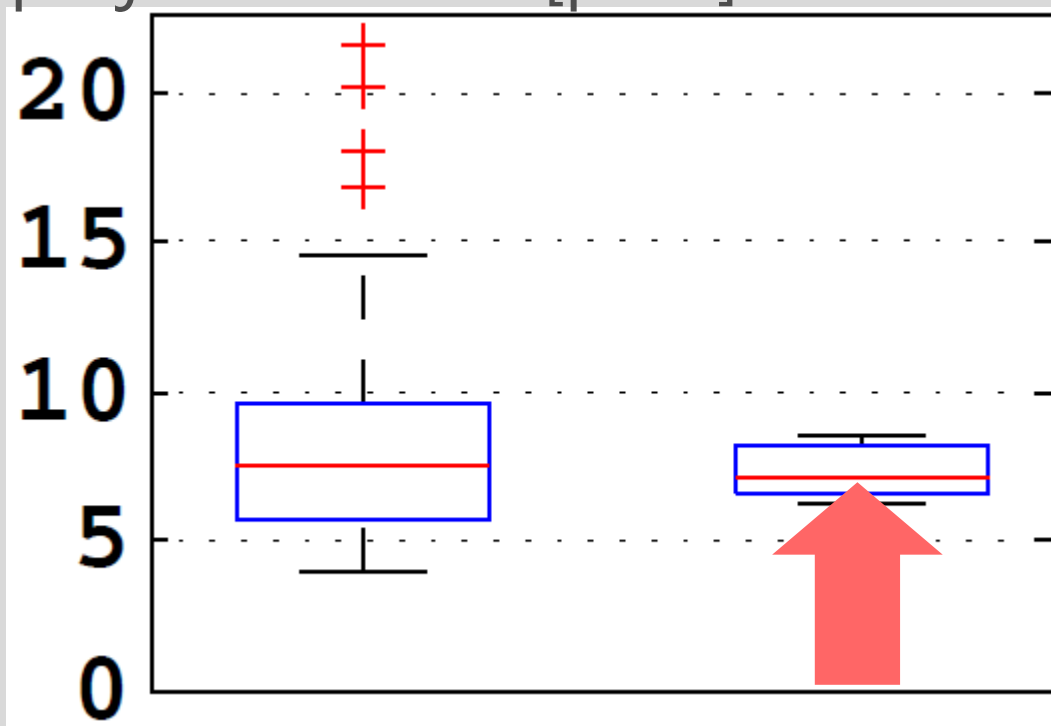
INDICA Interaction-free
Display CALibration [Itoh '14]
→ tracks the eyeball center



Problem of ~~INDICA~~

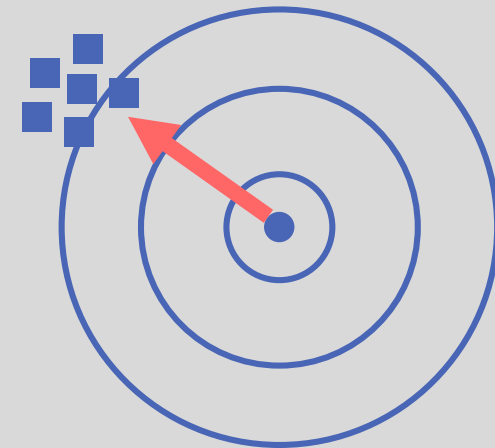
- Large **systematic error**

Reprojection Error [pixel]

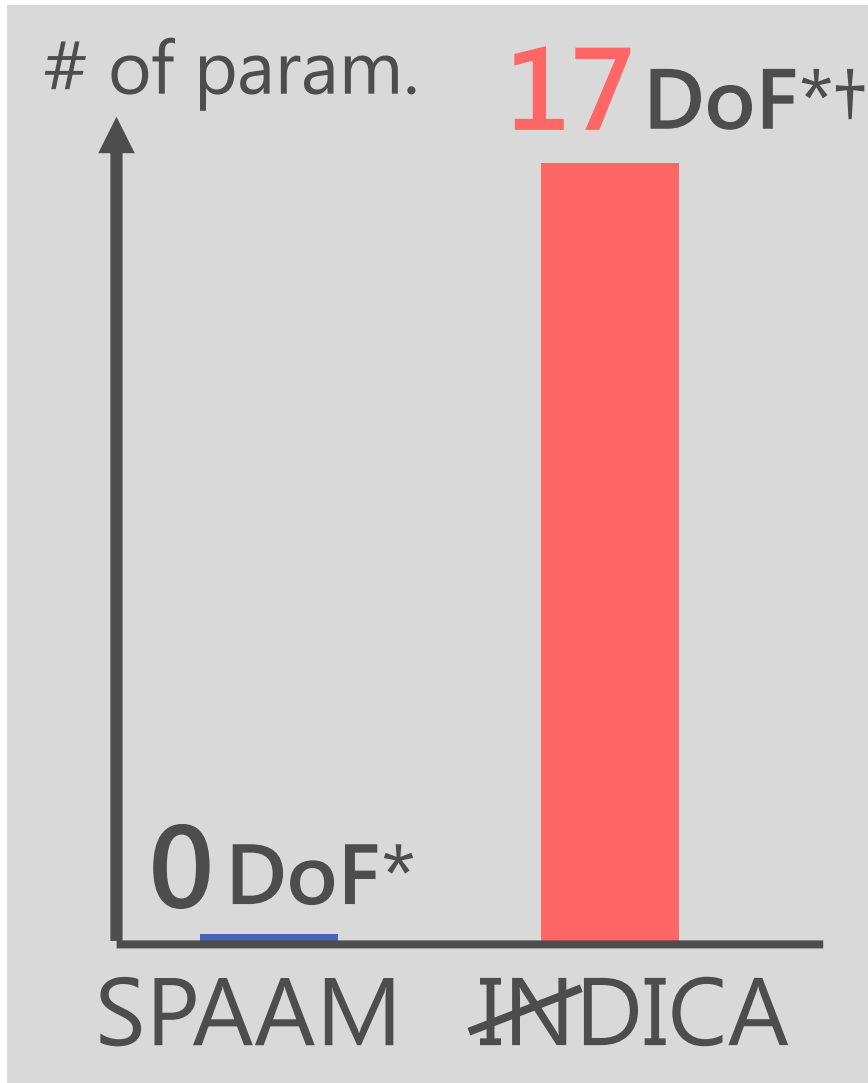


Repeated
SPAAM

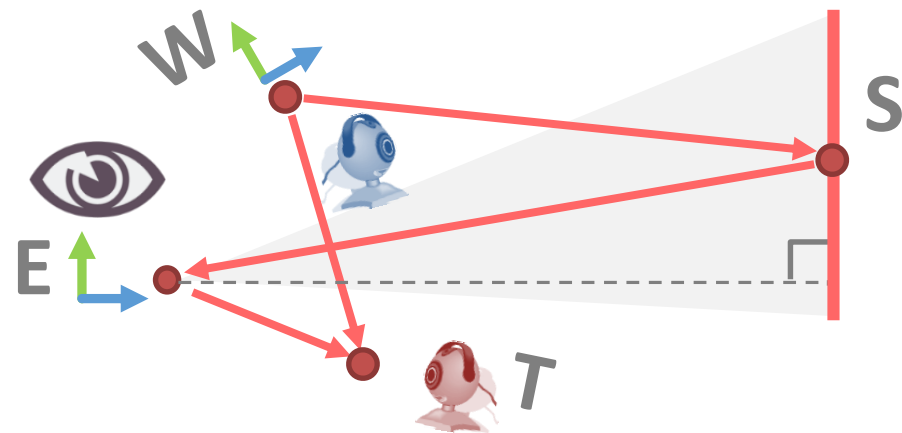
~~INDICA~~



~~INDICA~~ needs intensive precalibration



How sensitive is ~~INDICA~~ to the parameters?

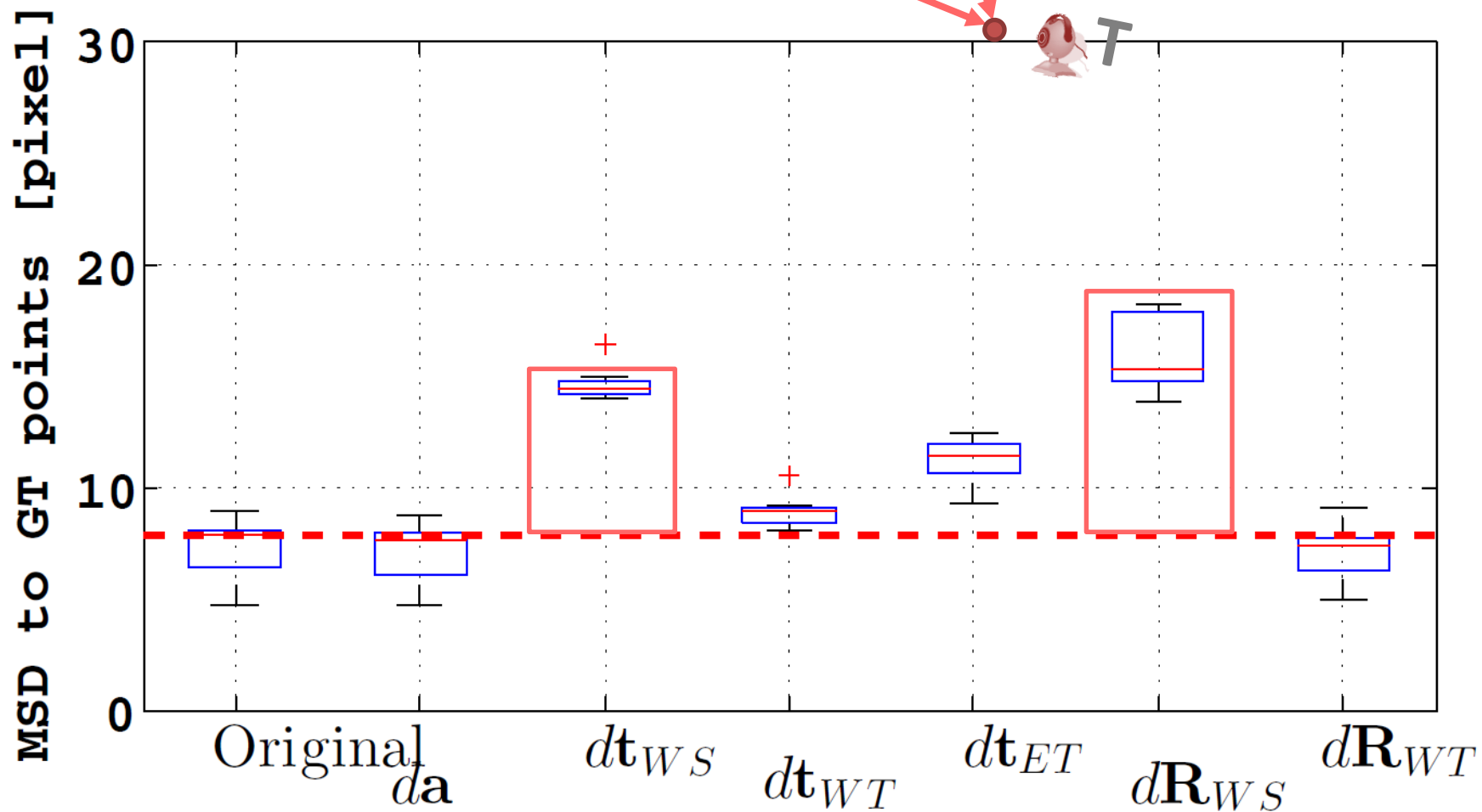
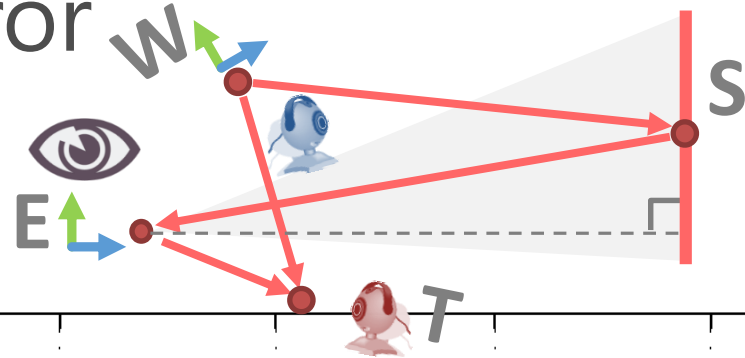


* Except for precalibration of the world tracking system

† Full setup

Observed Error of ~~INDICA~~

- Added artificial error to the real data



“Eye-HMD” Camera Modeling

- Is really a pinhole camera?
 - ▣ Human eyes are not simple
 - Optical and visual axes
 - ▣ HMD screens are not planer [Owen '04]
 - Retinal, Light-field

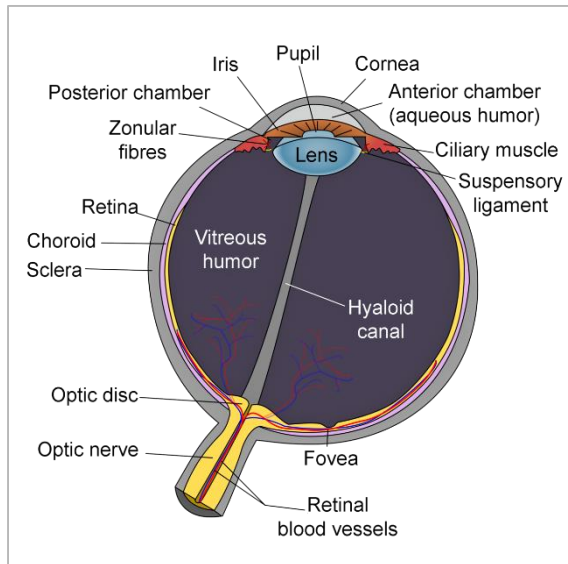
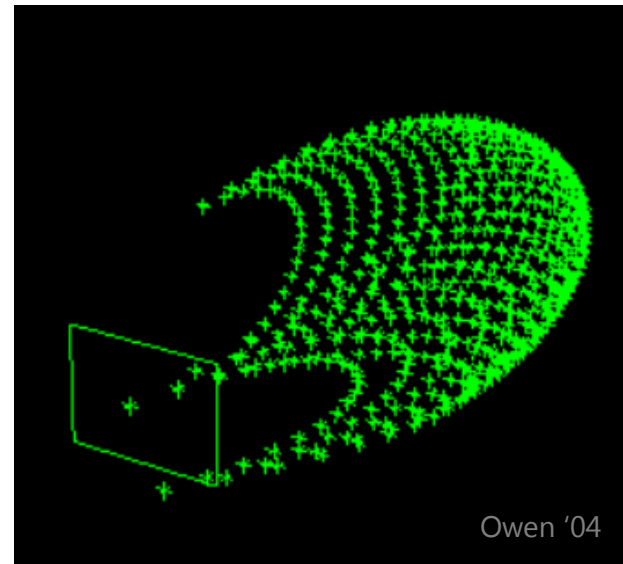
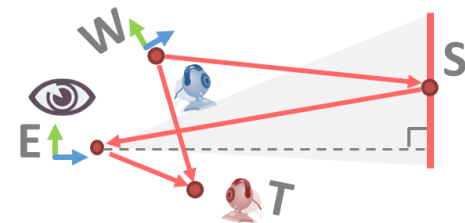
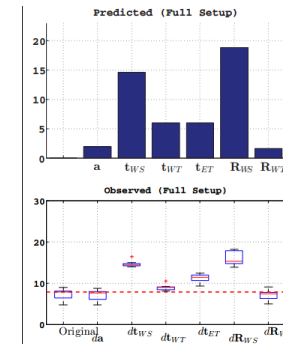
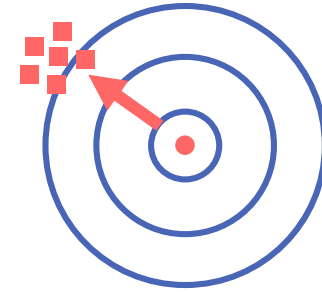


Image by Soerfm

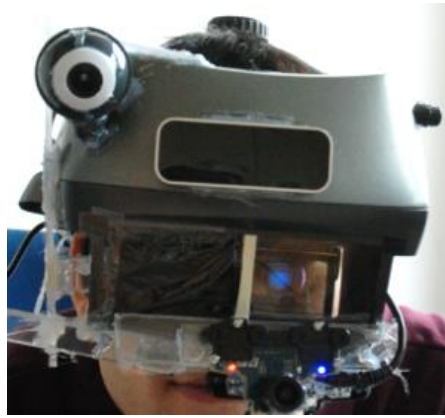
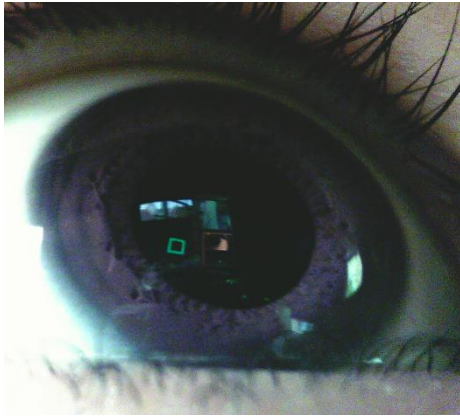


Summary

- Automated OST-HMD calibration, ~~INDICA~~, still has **systematic errors**
- Sensitivity analysis helps us to **identify** the error sources
- Better **eye-HMD modeling** is desirable



Any questions?



[D04] INDICA Demo

[T08] OST-HMD calibration tutorial

▣ Jens Gurbert and Yut Itoh

Slides <http://stctutorial.icg.tugraz.at/>



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