

Design and Evaluation of a Gaze Tracking System for Free-Space Interaction

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Motivation

- Goal: Free-Space interactions with simultaneous real-time Gaze-Tracking
- Needed:
Mobile Gaze-Mapping with known accuracy in space
- Existing approaches have problems:
 - often not truly mobile
 - often no accuracies reported or only rough ones
 - detailed accuracy evaluation is laborious

Separate Tracking System

Bardins et al. 2008

Screen Content Detection

Lander et al. 2015



Approaches

Screen Edge Detection

Turner et al. 2012

Visual Marker

Bader et al. 2009

Design decisions

- Gaze-Mapping:
 - **scene camera** VS separate tracking system
 - **visual markers** VS screen edge/content detection

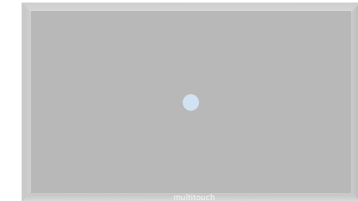
Overall System



eye

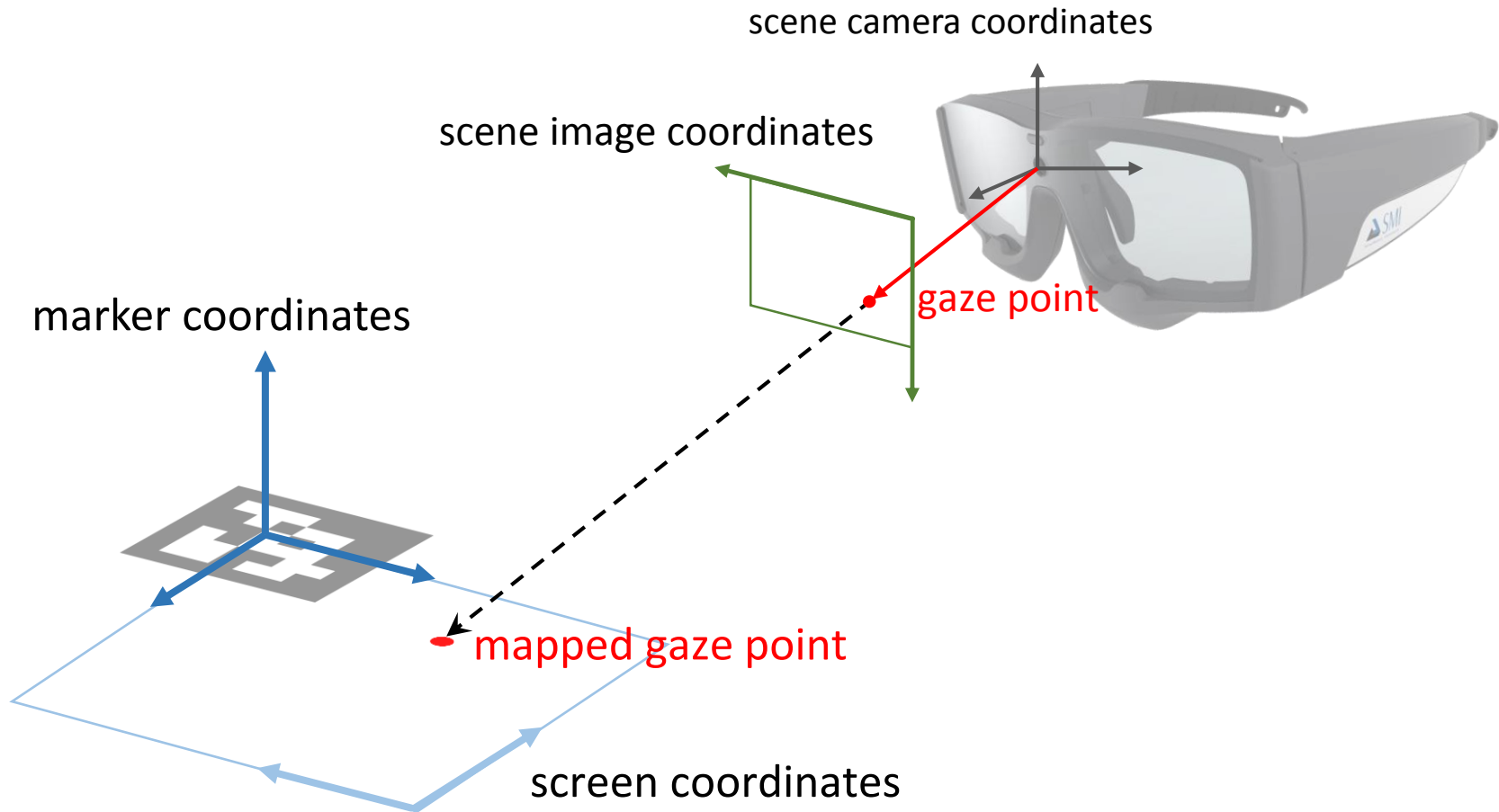


scene camera

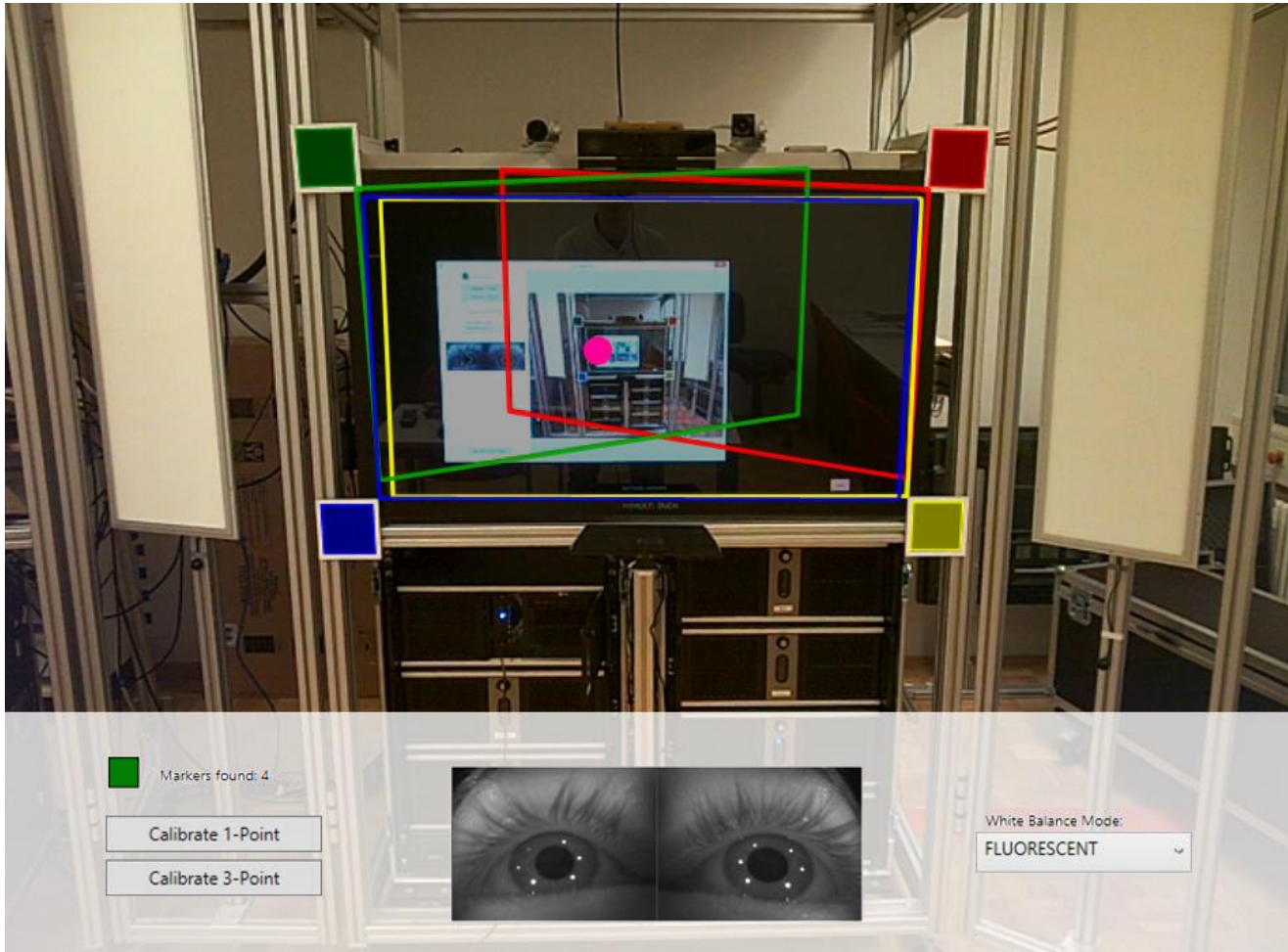


display

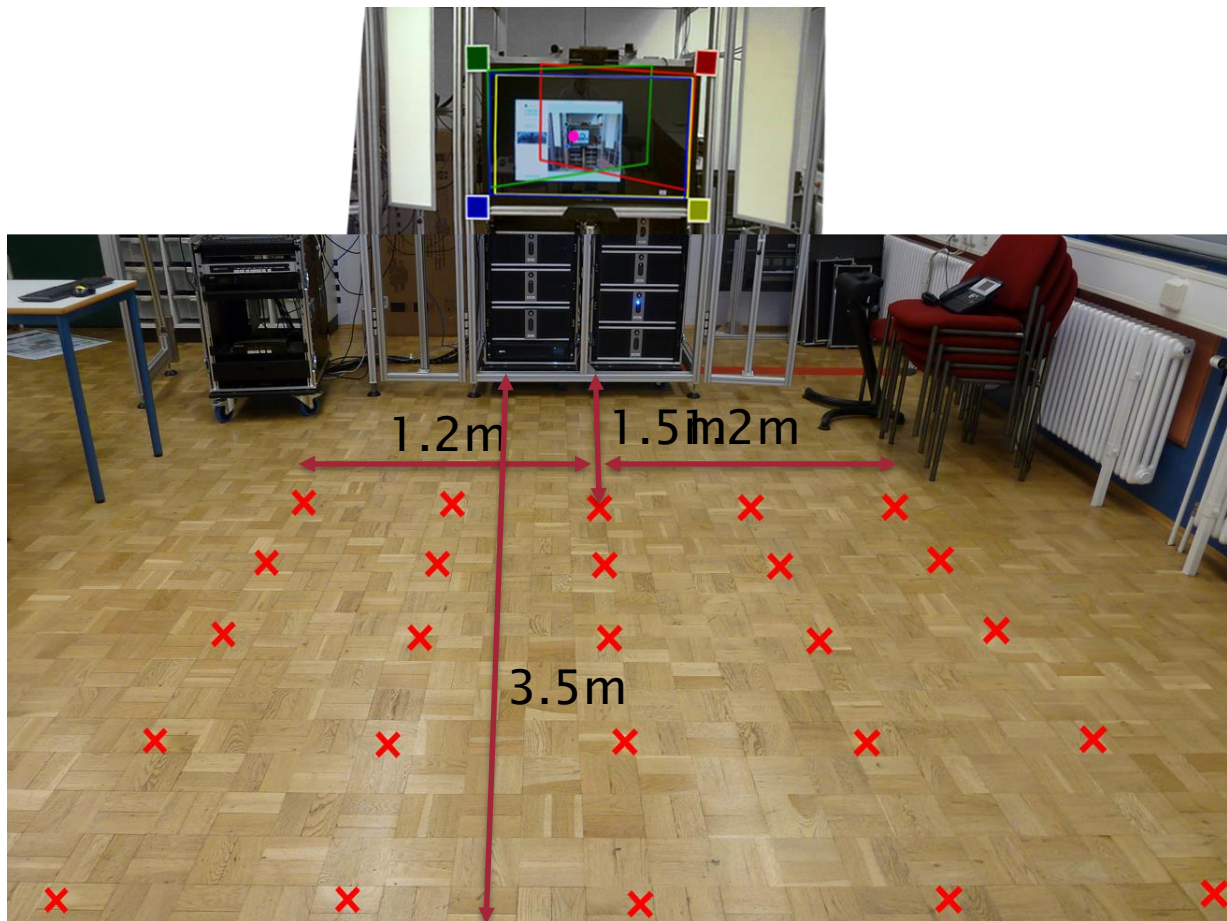
Gaze Mapping (1 / 2)



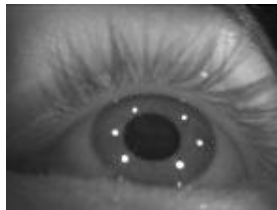
Gaze Mapping (2 / 2)



Accuracy Analysis: Covering Space



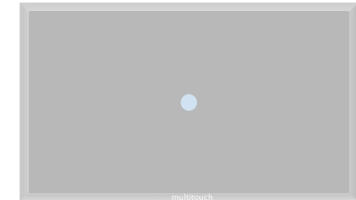
Accuracy Analysis: Eye Tracking



eye

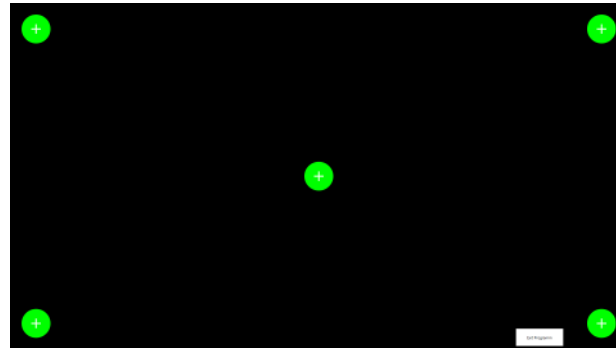


scene camera



display

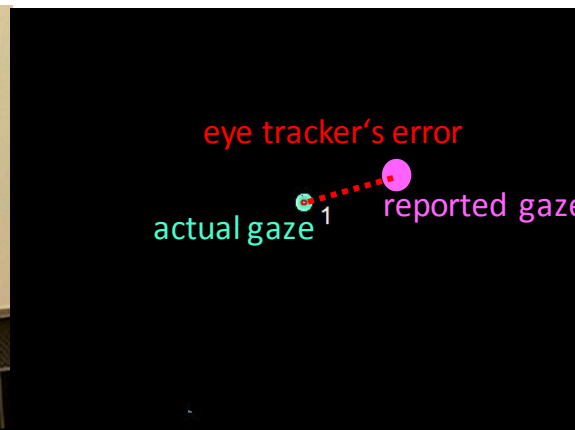
Accuracy Analysis: Eye Tracking



point pattern used on-the screen

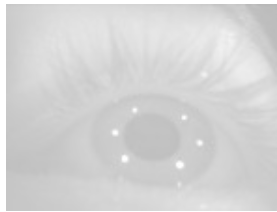


scene image with 1-point on-screen



processed scene image

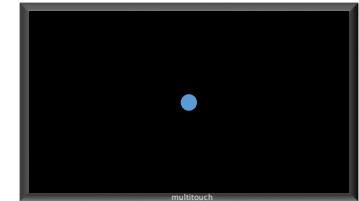
Accuracy Analysis: Gaze Mapping



eye

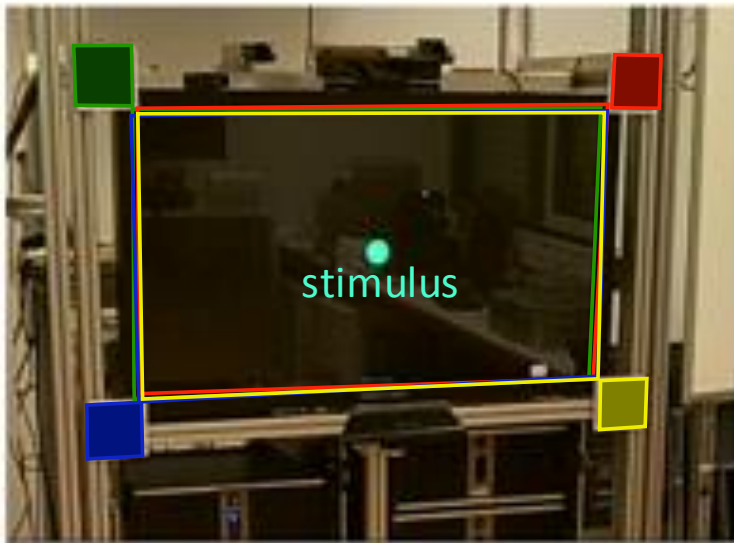


scene camera

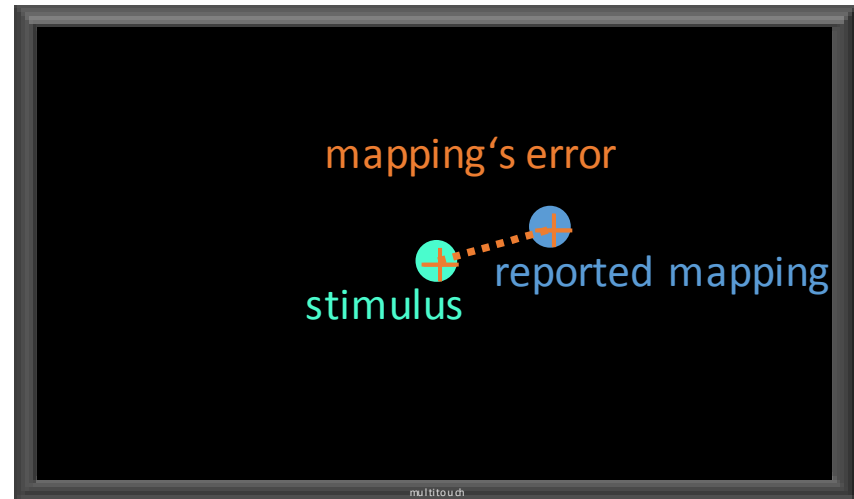


display

Accuracy Analysis: Gaze Mapping

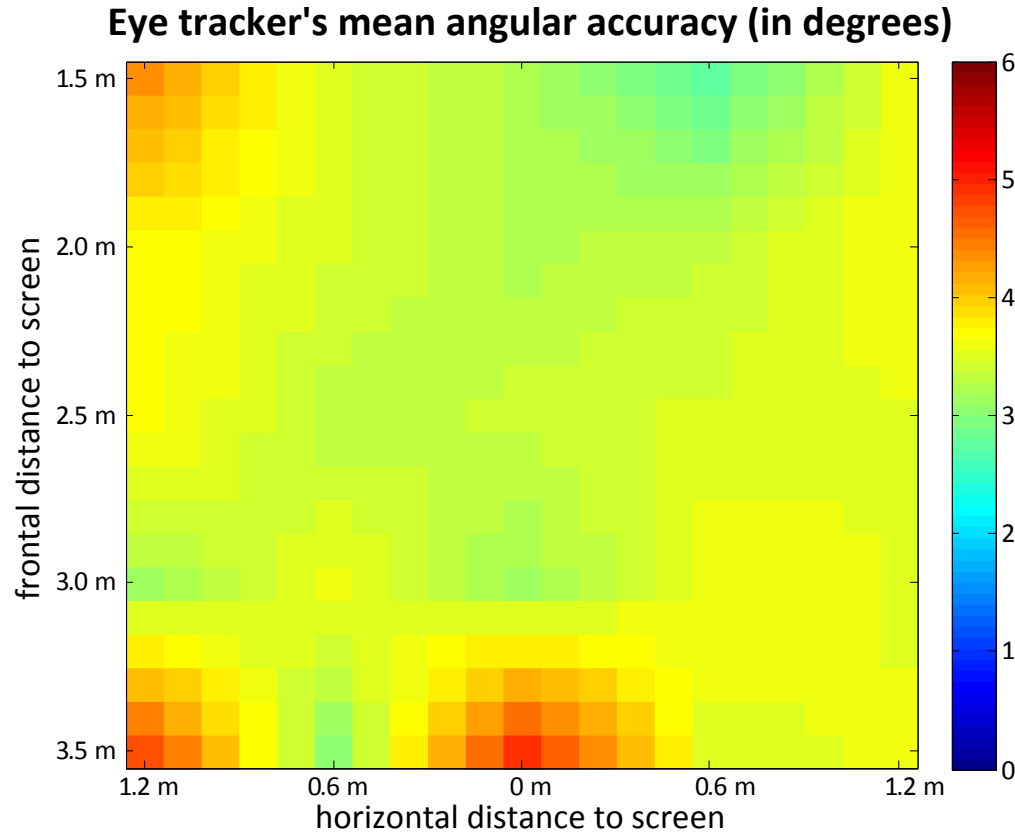


scene image for mapping the gaze



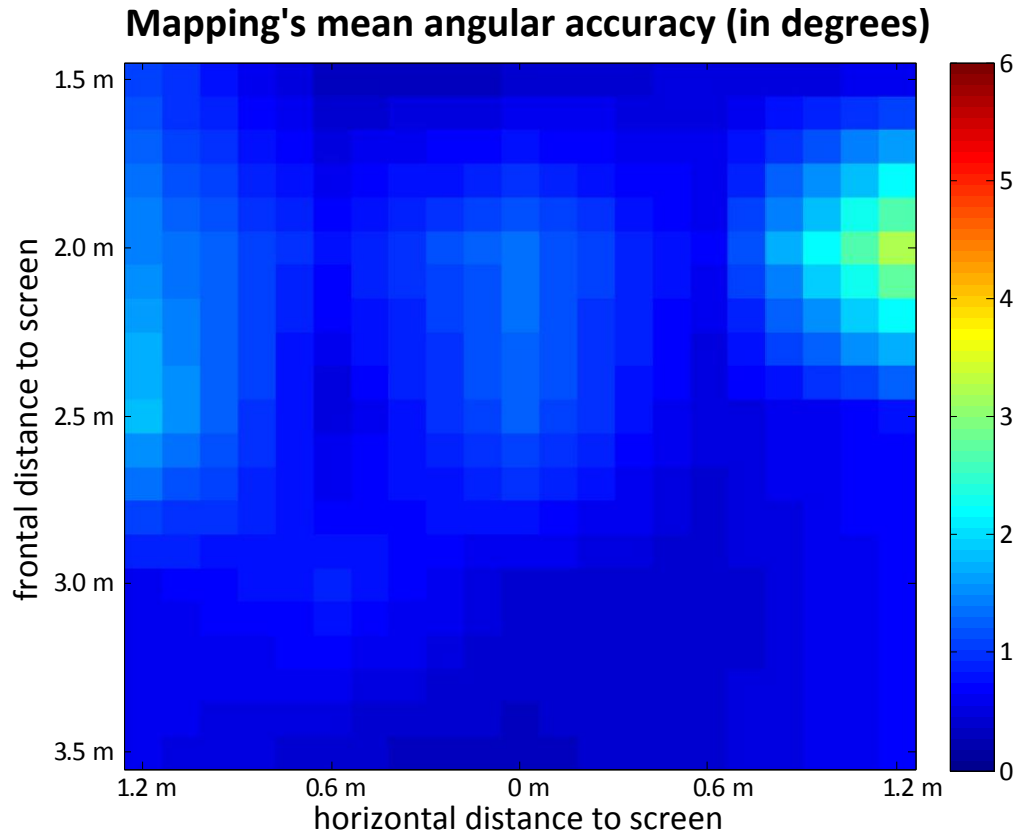
mapping result in-screen coordinates

Results: Eye Tracking



mean angular accuracy: 3.6° (SD = 3.4°)

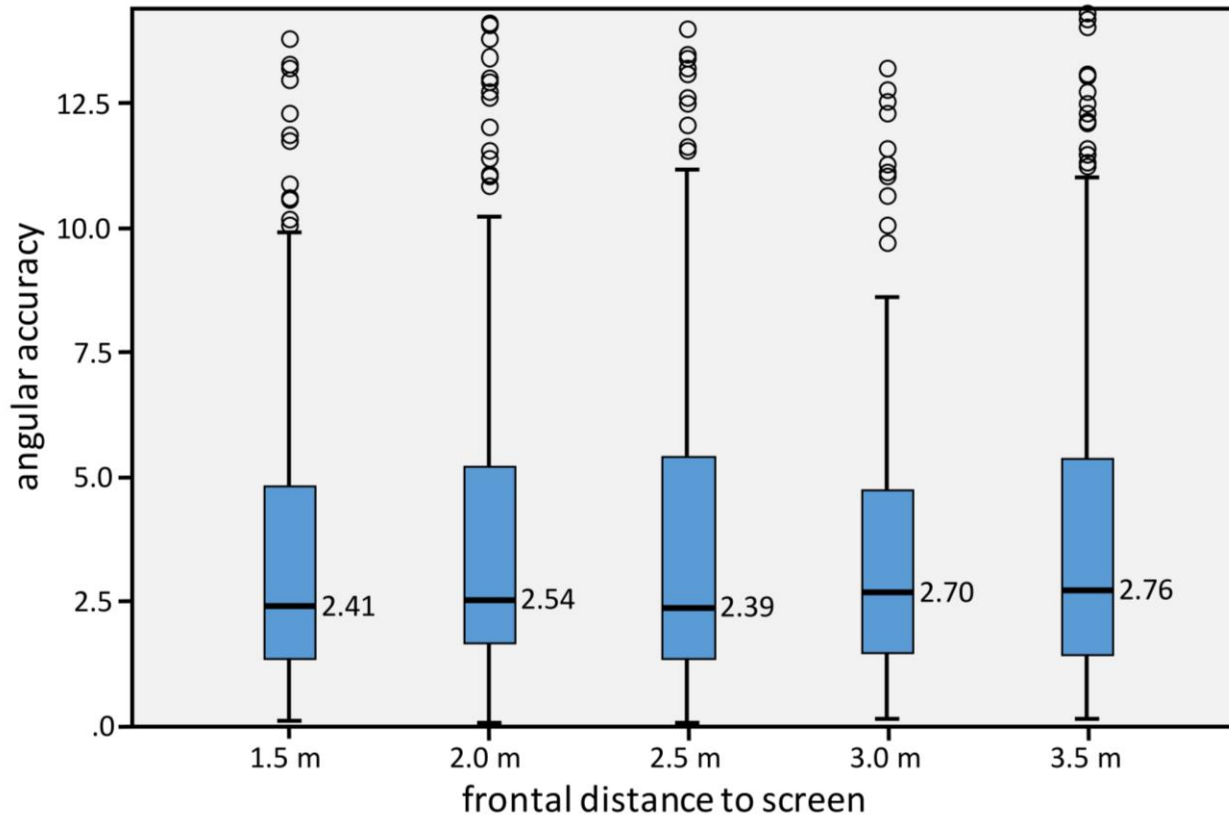
Results: Gaze Mapping



mean angular accuracy: 0.8° (SD = 2.3°)

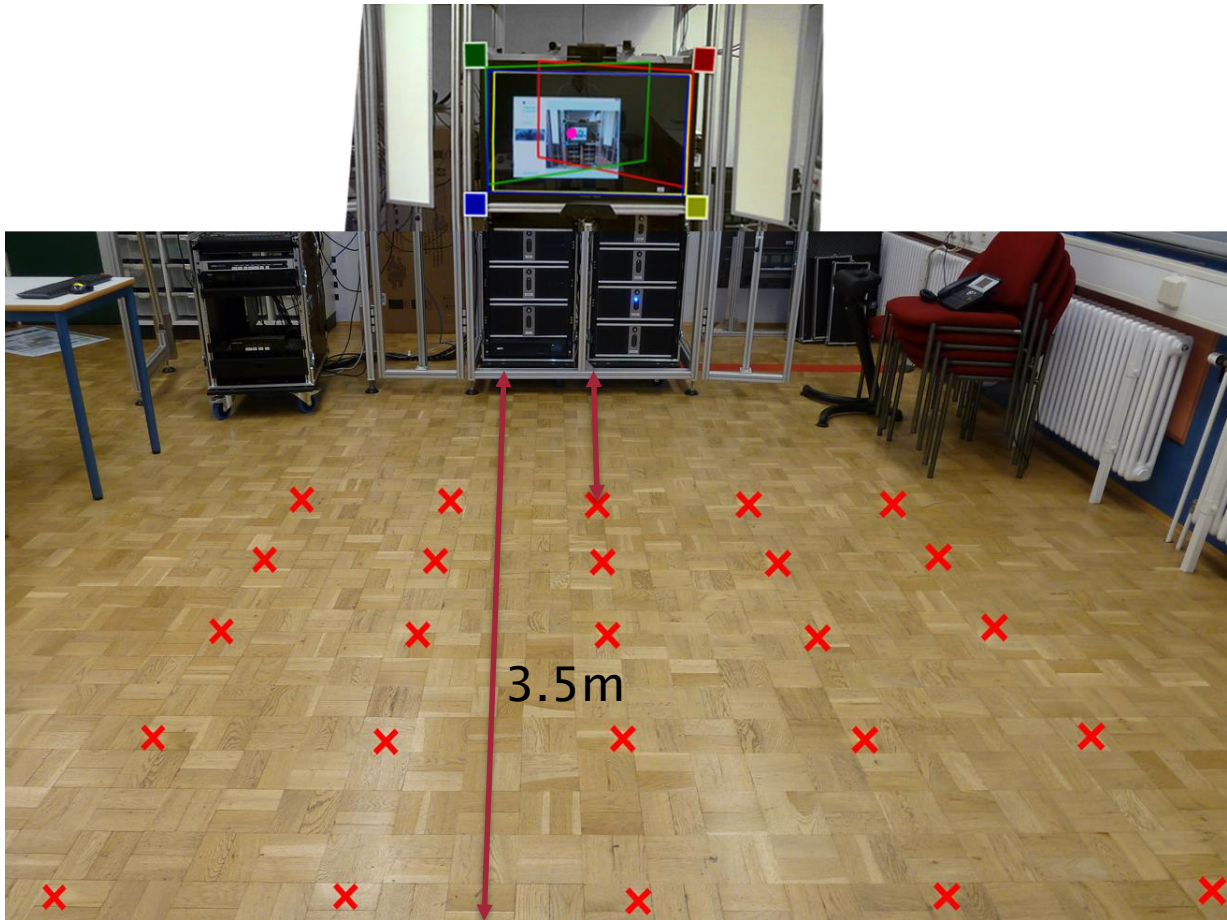
Results: Overall

Overall angular accuracy for different distances (in degrees)

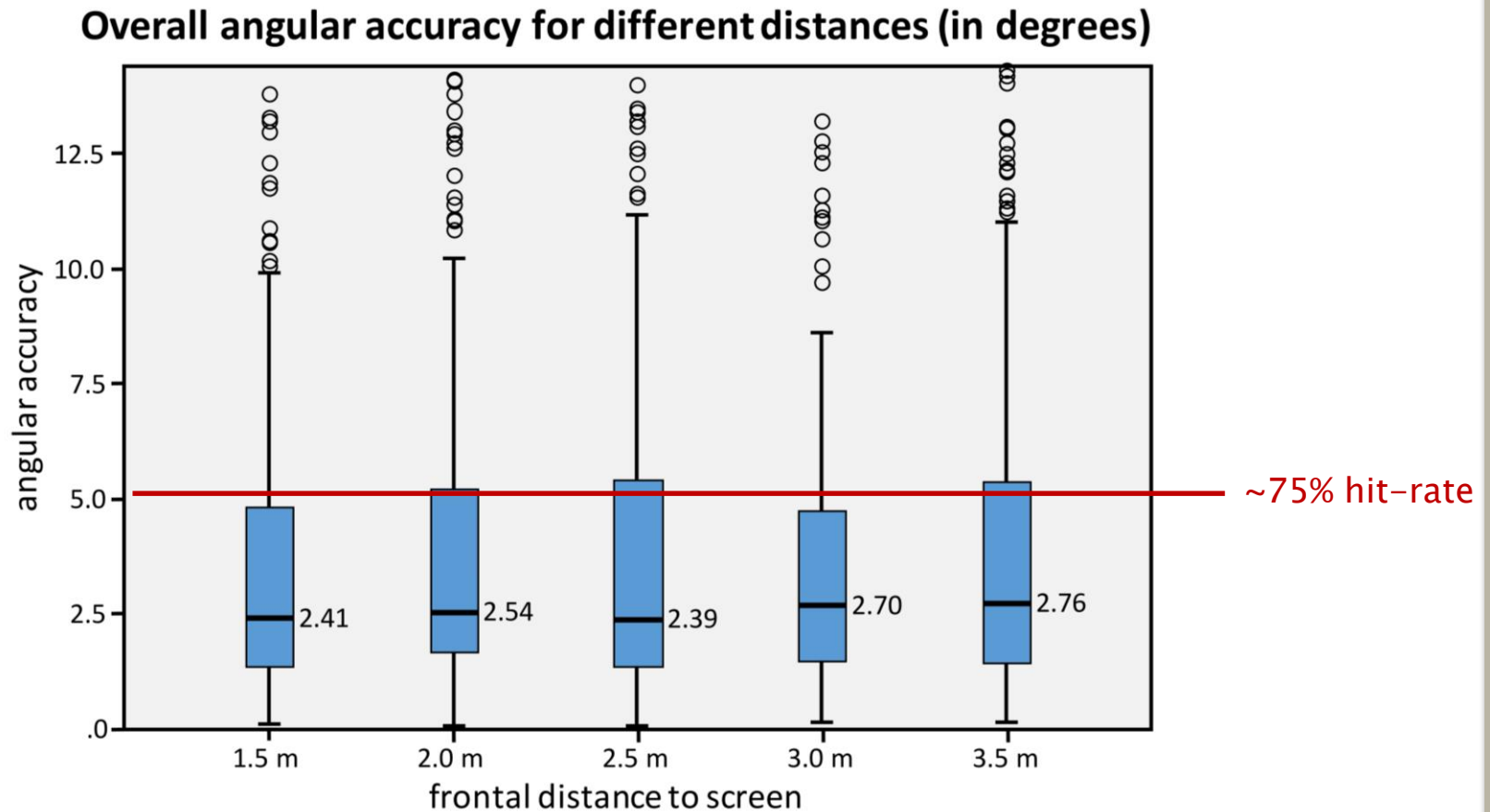


mean angular accuracy: 4.2° (SD = 6.1°)

Accuracy Analysis: Covering Space



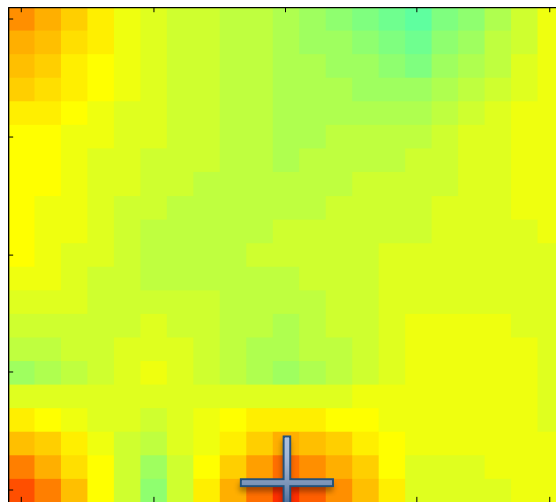
Results: Overall



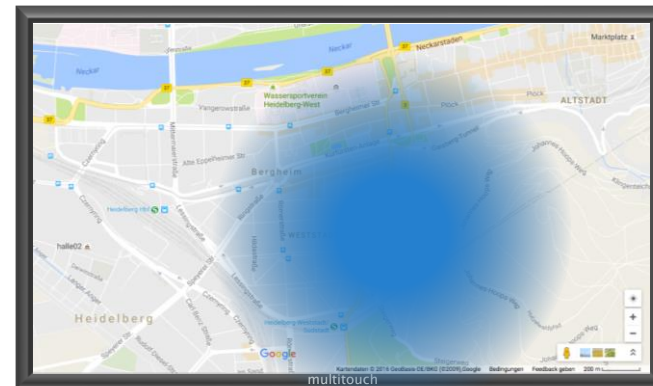
mean angular accuracy: 4.2° (SD = 6.1°)

Summary

- „Classical“ Eye-Tracking and Marker-Based mapping
- Automated accuracy evaluation without manual labelling
- Useful for:
 - Standalone Eye-Tracking applications with global threshold
 - Multimodal applications with adaptive gaze accuracy



user's position



on-screen gaze accuracy