

# DEPTH COMPENSATION MODEL FOR GAZE ESTIMATION IN SPORT ANALYSIS

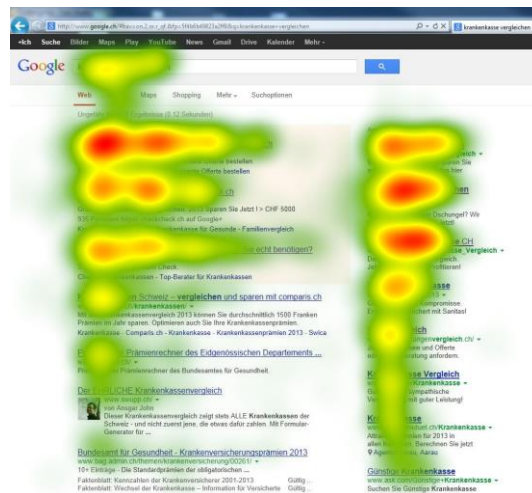
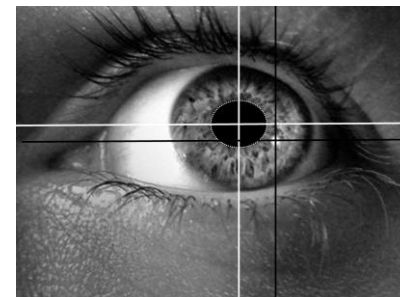
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# WHAT IS EYE TRACKING?



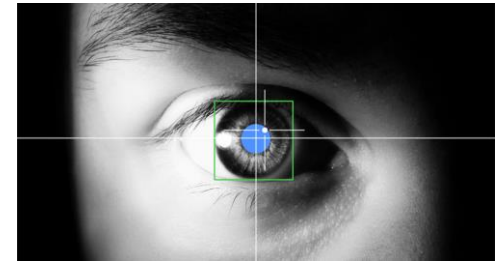
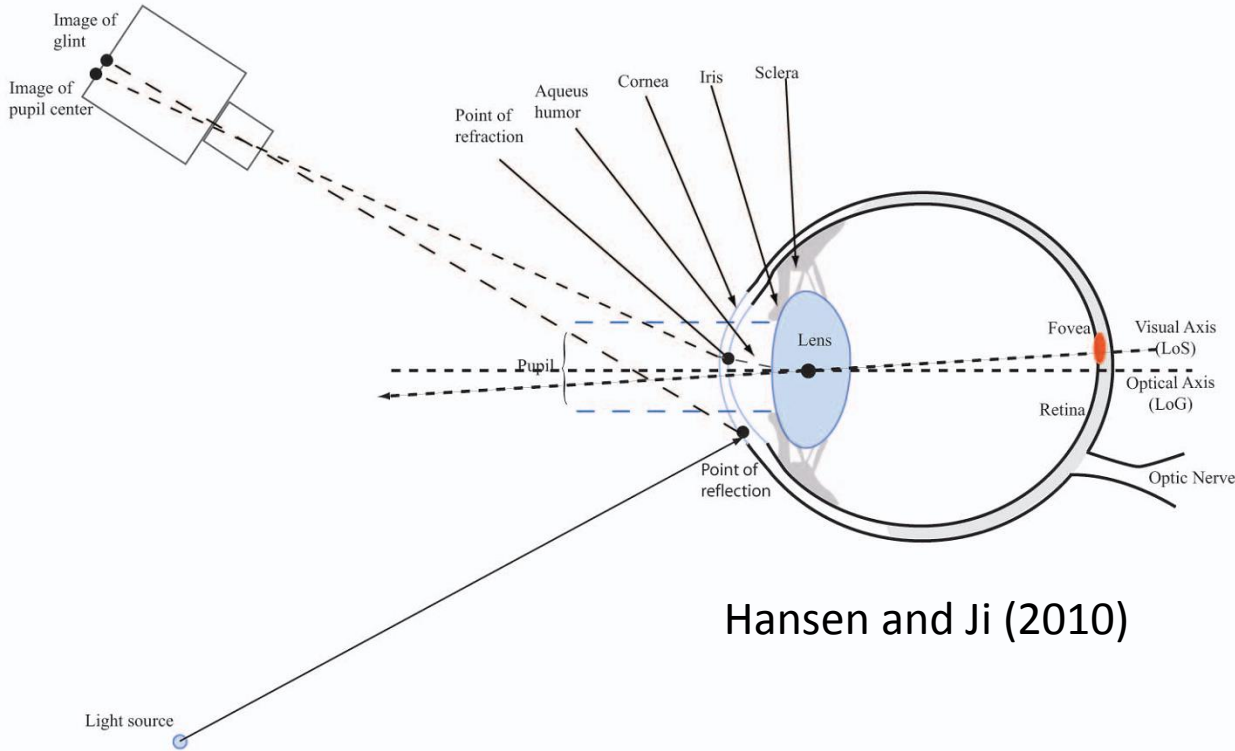
## DANS, RÖN OCH JAGPROJEKT

På jakt efter ungdomars kroppspråk och den "synkretiska dansen", en sammansmältning av olika kulturars dans, har jag i mitt färfärd under hösten trott mig på olika arenor inom skolans värld. Nordiska, afrikanska, syd- och östeuropiska ungdomar gör sina röster höra genom sång, musik, skrik, skratt och gestaltar känslor och uttryck med hjälp av kroppspråk och dans.

Den individuella estetiken framträder i kläder, frisyer och symboliska tecken som förstärker ungdomarnas "jagprojekt" där också den egna stilen i kroppspråken spelar en betydande roll i identitetsprovnigen. Upphållsrummet fungerar som offentlig arena där ungdomarna spelar upp sina performance-liknande kroppspråk

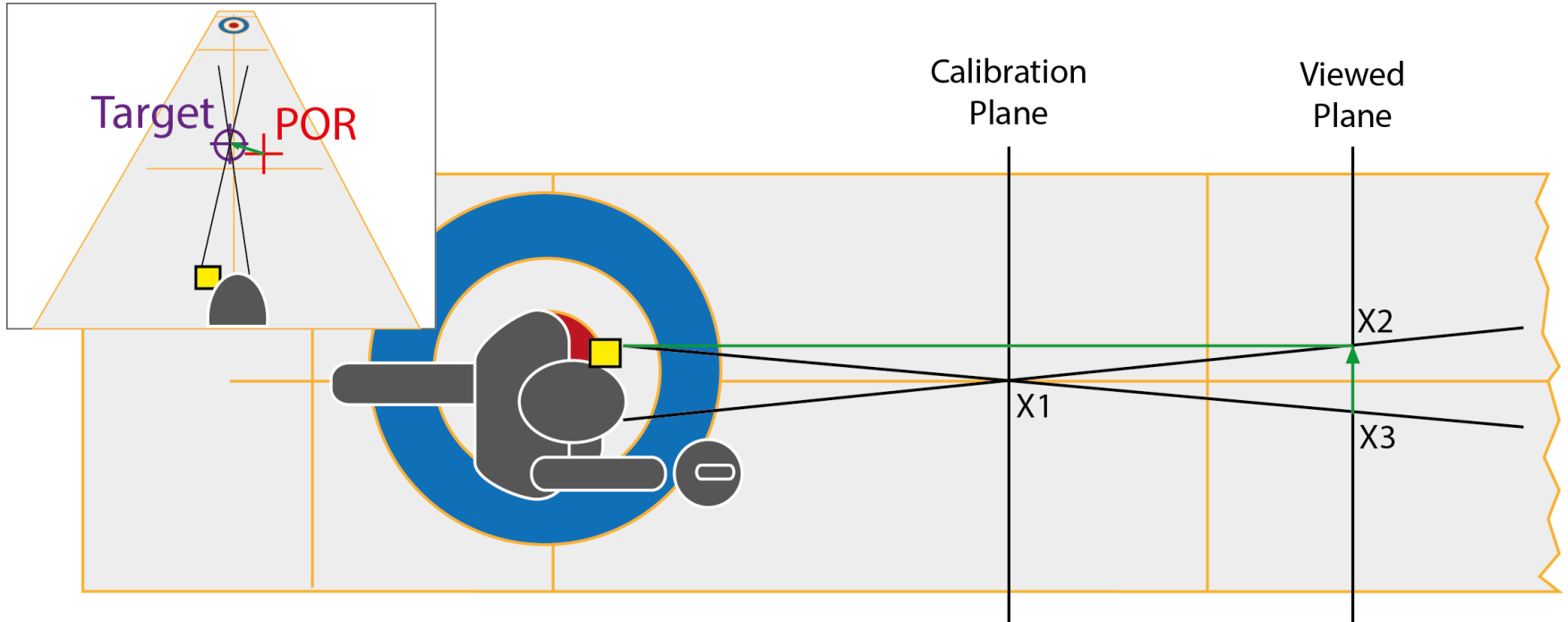
# GAZE ESTIMATION PROCESS

## Ocular parameters analyzed by the gaze estimation method



# PARALLAX ERROR

## Example of parallax error during a curling daily training session

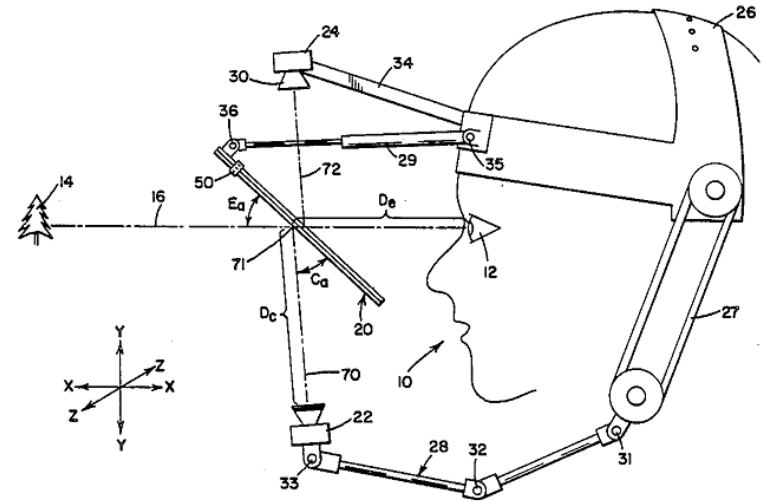


# DEPTH COMPENSATION MODEL

Valez and Borah (1989) proposed a **physical setup** to remove the effects of parallax error

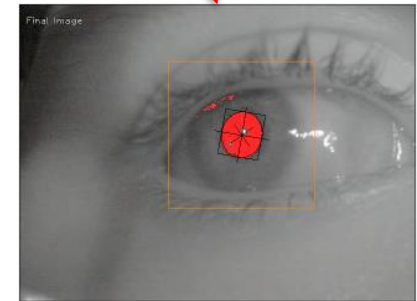
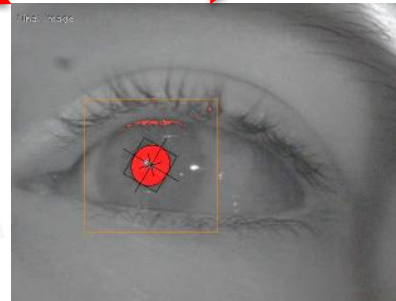
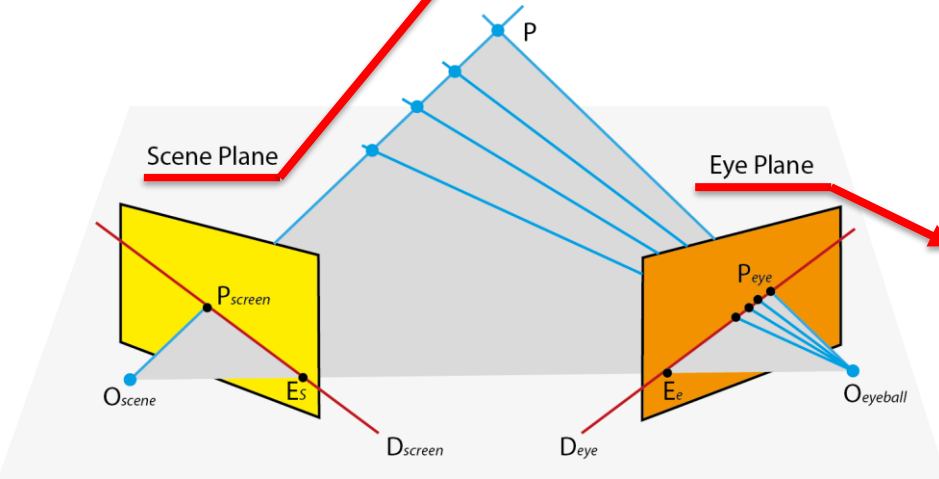
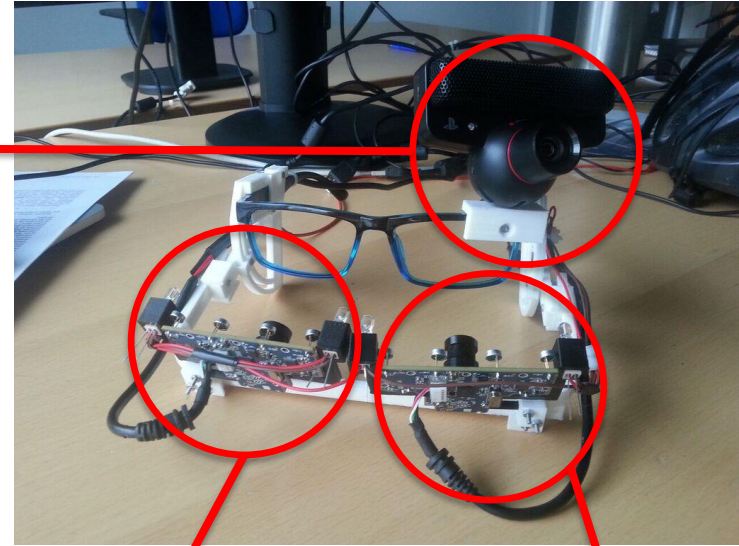
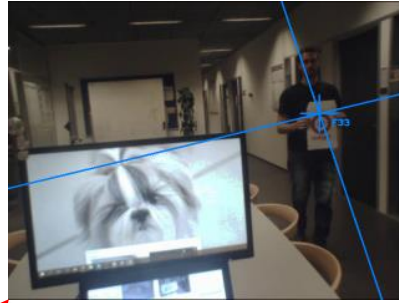
The proposed depth compensation model is based on **pure translation** motion

$$x' = x + Kt/Z$$

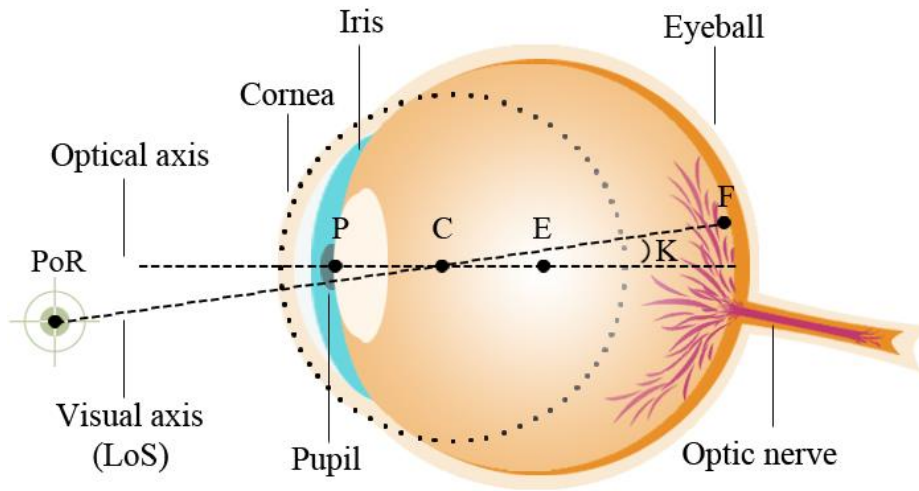


Valez and Borah (1989)

# GAZE ESTIMATION METHOD



## Gaze estimation aspects evaluated during the assessment:

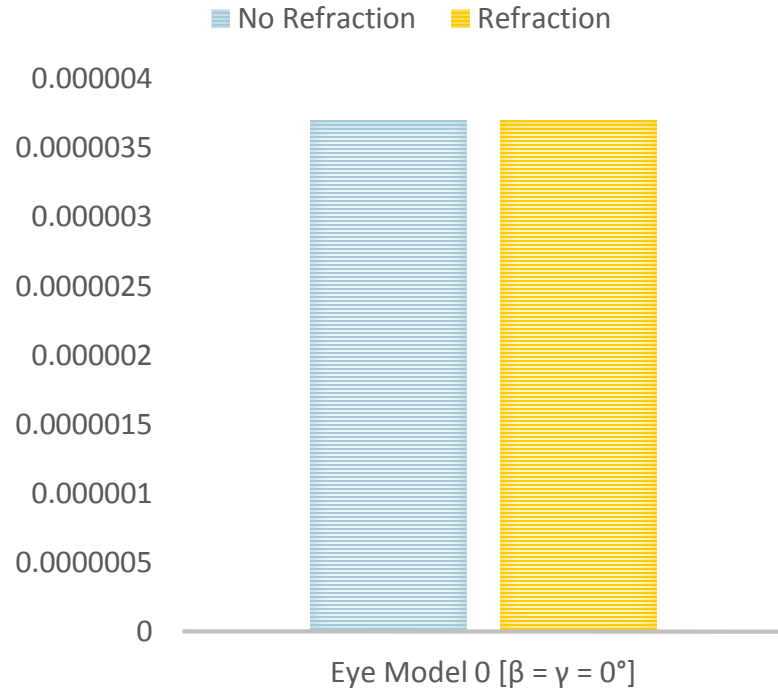


Narcizo et al. (2013)

1. Refractive index of aqueous humor [ $\alpha$ ]
2. Number of calibration points [ $N$ ]
3. Horizontal [ $\gamma$ ] and vertical [ $\beta$ ] angle kappa offset
4. The influence of noise in the eye features detector [ $P_C + \lambda$ ]
5. Depth movements along to the calibration plane [ $z$ -axis]

# INFLUENCE OF REFRACTION

## Refractive index of aqueous humor [ $\alpha = 1.366$ ]

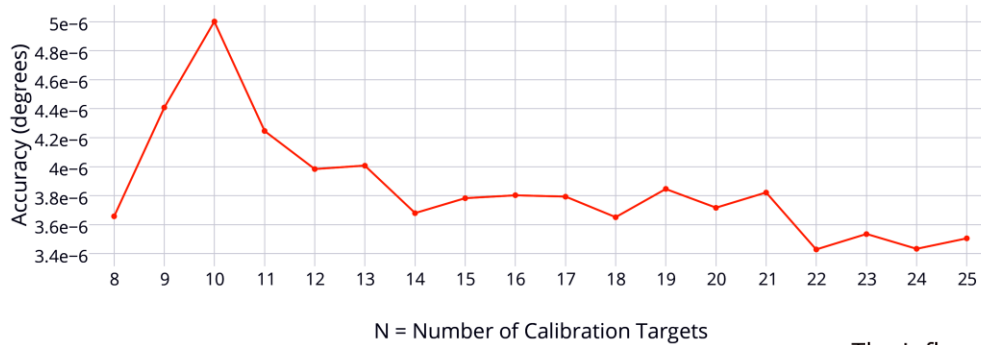




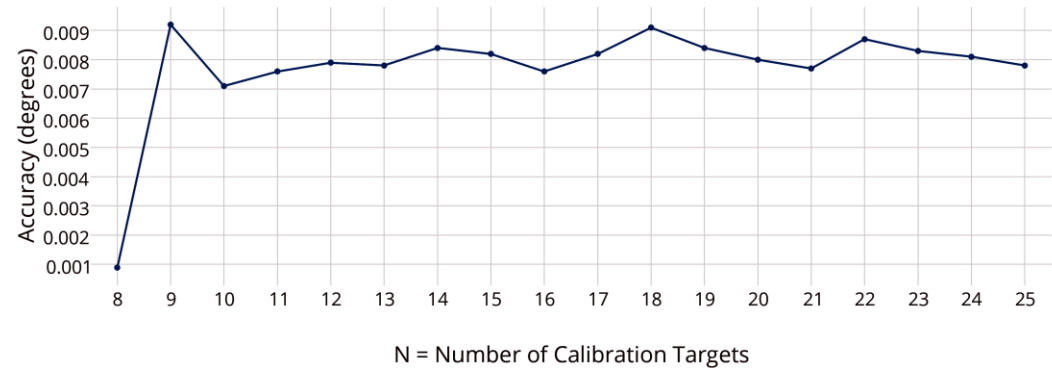
# NUMBER OF CALIBRATION POINTS

## Number of calibration points

The Influence of the Number of Calibration Targets with Eye Model 0



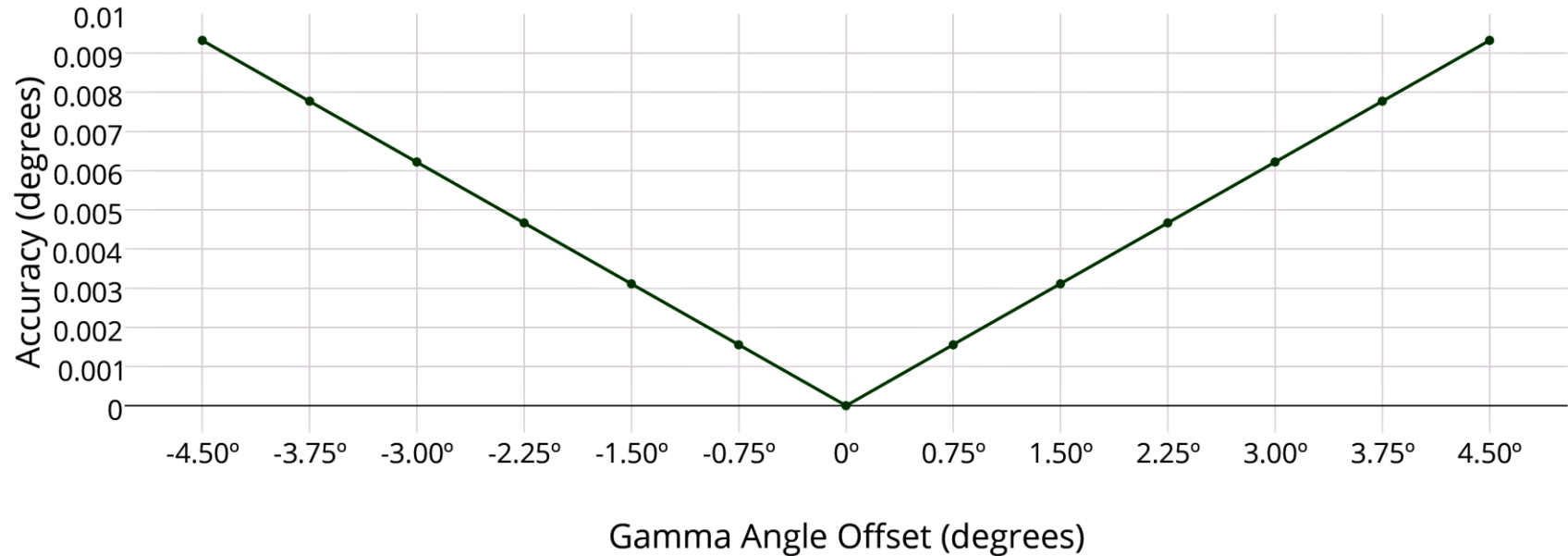
The Influence of the Number of Calibration Targets with Eye Model 1



# ANGLE KAPPA OFFSET

Horizontal  $[-4.5^\circ \leq \gamma \leq 4.5^\circ]$  and Vertical  $[\beta = 0^\circ]$  angles

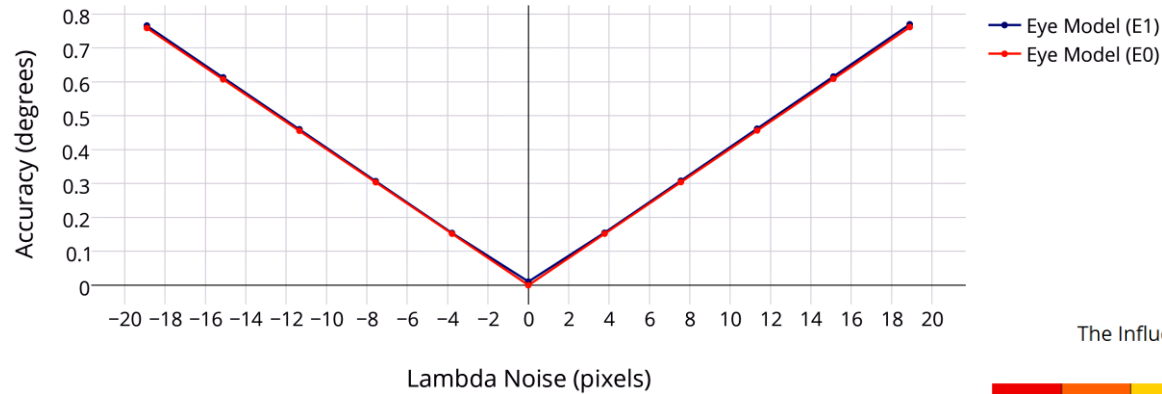
The Influence of Angle Kappa



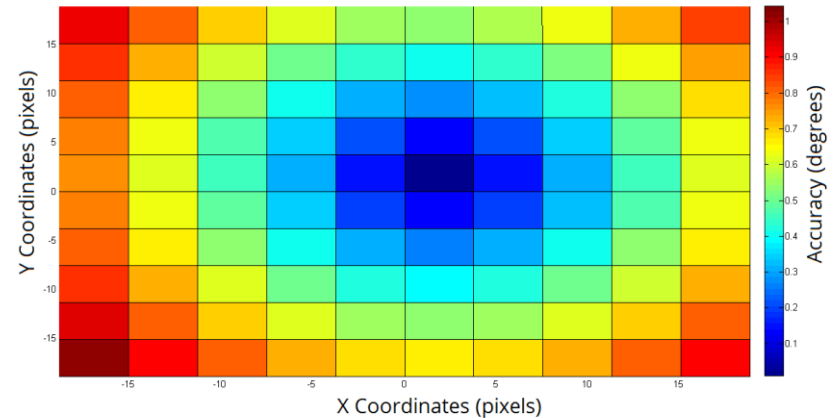
# NOISE IN THE PUPIL ESTIMATION

Noise ( $\lambda$ ) added to the pupil center ( $P_c$ ) coordinate [ $P_c + \lambda$ ]

The Influence of Noise



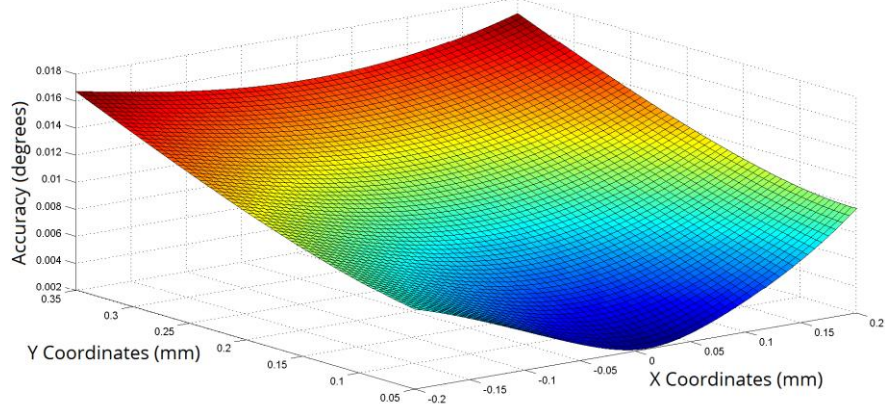
The Influence of Noise Added to Pupil Center with Eye Model 1



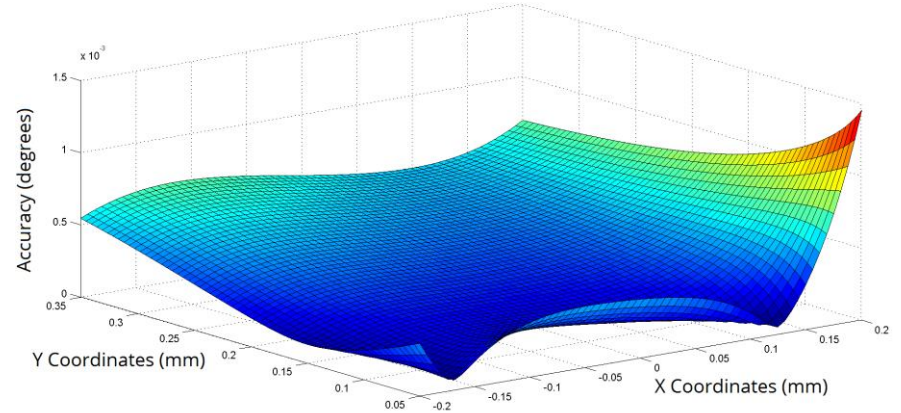
# CHANGES IN DEPTH

## Depth movements along to the calibration plane [z-axis = 95cm]

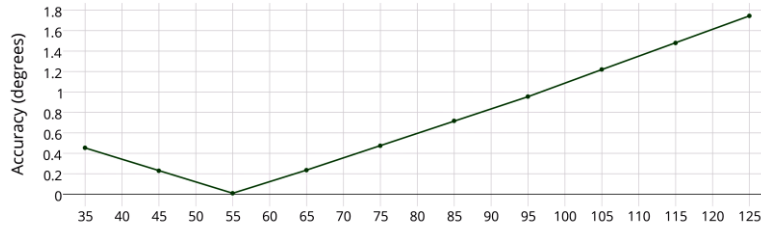
The Influence of Parallax Error on a Viewed Plane 95 cm Far Away from the User Position



The Influence of Parallax Error on a Viewed Plane 95 cm Far Away from the User Position

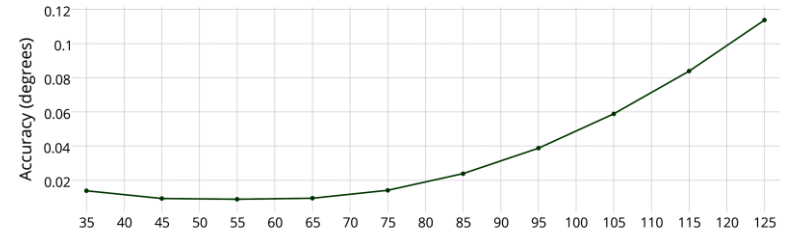


The Influence of Parallax Error



Distance Between the User Position and the Viewed Plane (cm)

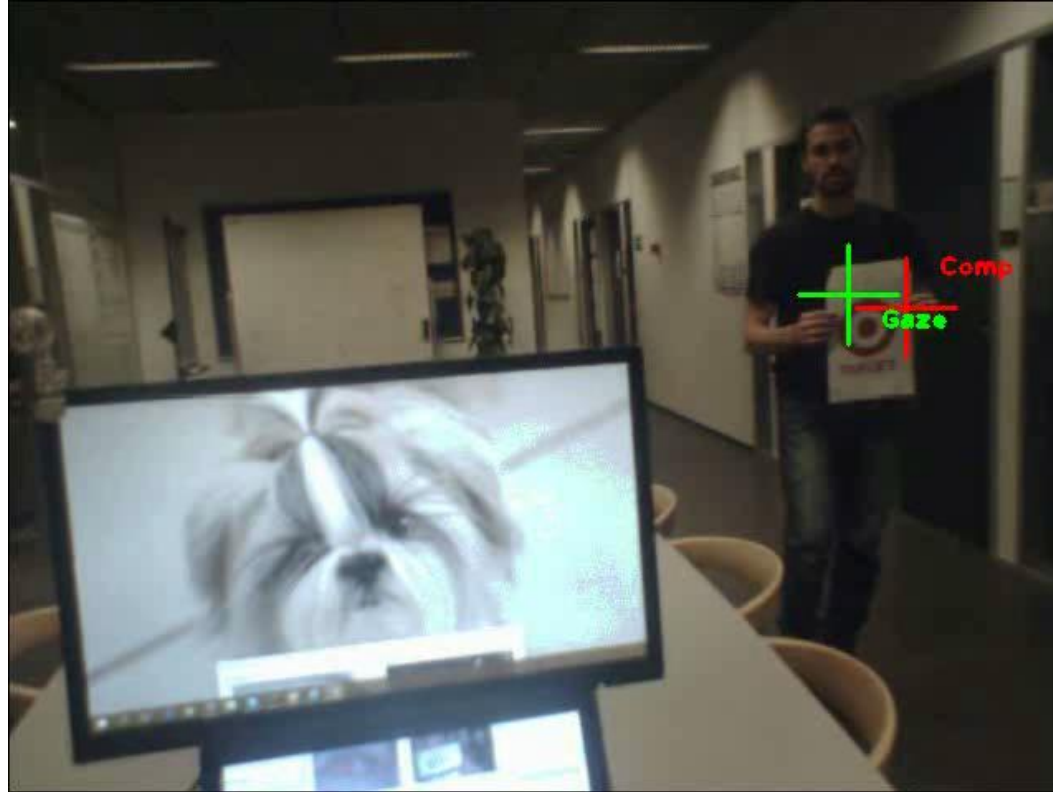
The Influence of Parallax Error with the Proposed Depth Compensation Model



Distance Between the User Position and the Viewed Plane (cm)

# CHANGES IN DEPTH

## Real eye tracking data



## Main contributions of this paper

1. The **gaze estimation method** based on epipolar geometry has presented *high accuracy* gaze estimation
  - ✓ However, this method is *sensitive to noise*
  - ✓ Present problems with head rotations
2. The **depth compensation model** is robust when the *distance* between the user and the target is *a priori known*
  - ✓ For each 10 cm, the parallax error adds a gaze error around  $\pm 0.23^\circ$
  - ✓ The proposed model adjusts the parallax error for  $\pm 0.02^\circ$  (*10 times better*)



# ANY QUESTIONS?

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