Natural User Interfaces for Cars

Gaze Tracking

Overview

- History and Basics
- FreeGaze
- Example for Gaze Tracking in Education
- Practical use in our Project

History of Gaze Tracking

- 1800's → studies through observation
- In 1879 observation about eye's pause on words while reading
- 1931 The Eyes movement was recorded

History of Gaze Tracking

- 1980's Eye-Tracking became relevant in marketing
- 1990 Eye-Tracking throughout a whole Football game (afterwards put cursor on the point where the eyes rested)

- Until now Different Eye-Tracking-Projects

  Especially in Traffic, Advertising, HCI, ...

Eyes and their Output

- Many People in a row
- Same question, many times

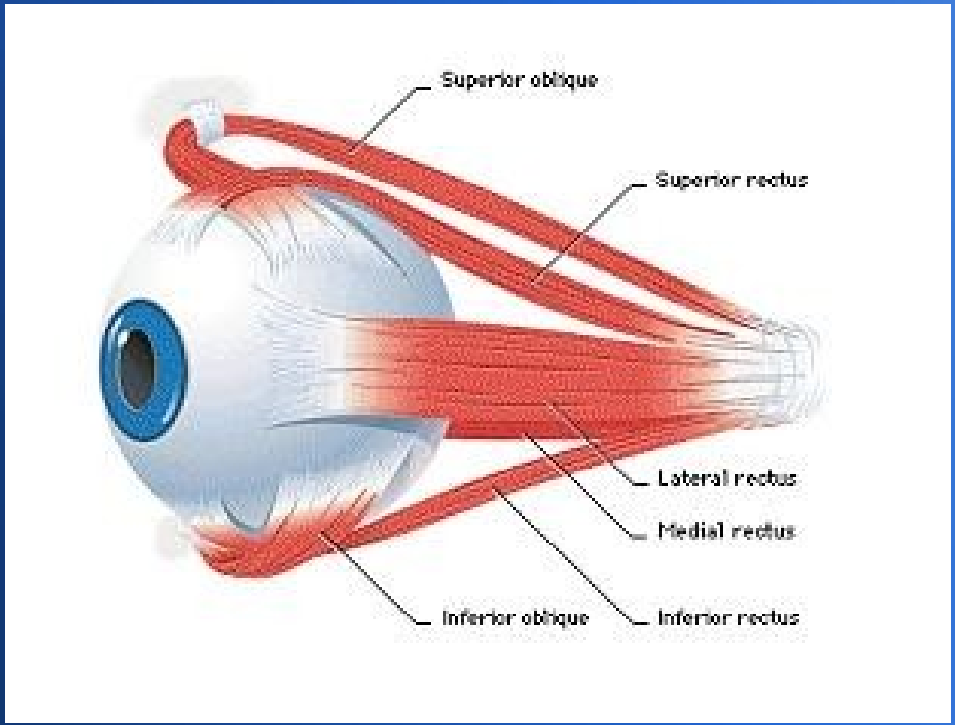
- Who do I talk with?

Anatomy of the Eye

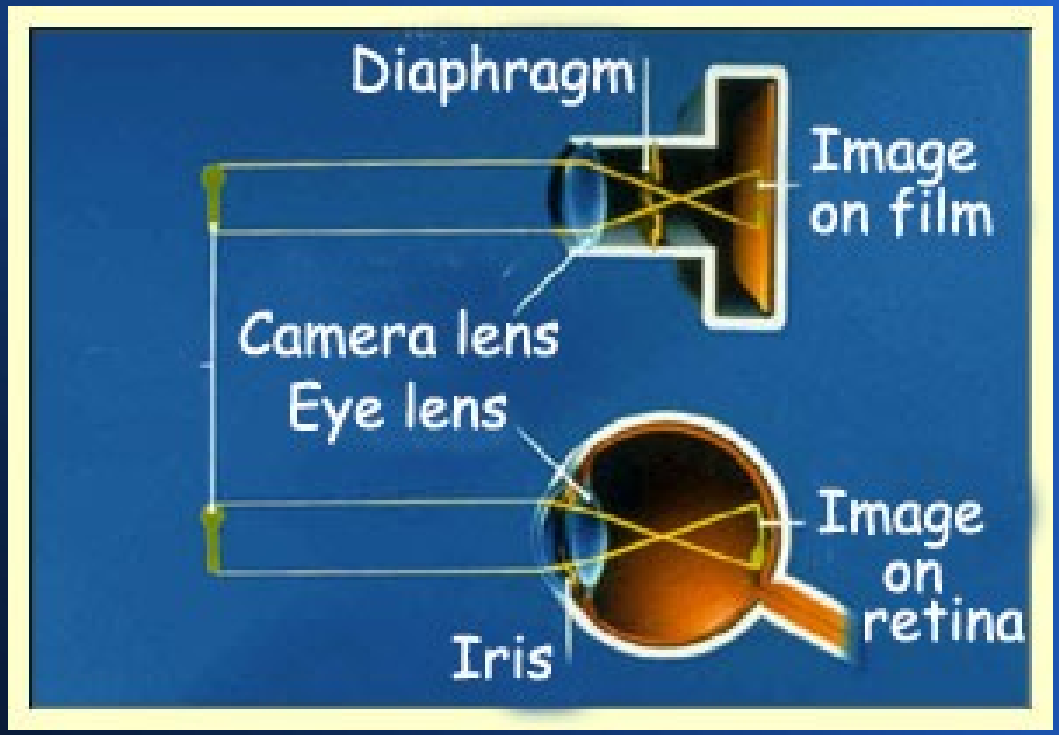
"The eye and its muscles can be seen as a camera with image stabilization"

There are 6 muscles:

- 1 pair for horizontal control
- 1 pair for vertical control
- 1pair for rotational movement control



Eye vs. Camera



Eye vs. Camera

Differences:

- The Eye sees 3d (meantime, the camera is also able to make 3d shots)
- Eye is only sharp on fixation point – camera has zones
- In the night the eye needs to adjust itself

  → camera needs more light input
- I read an article where someone praised the camera because it's not so breakable

FreeGaze

- Freegaze tracks eyes through different processes:

  1) Detection of Pupil and Purkinje on Image

  2) Gaze direction determining through images and the eyeball model

  3) Personal calibration

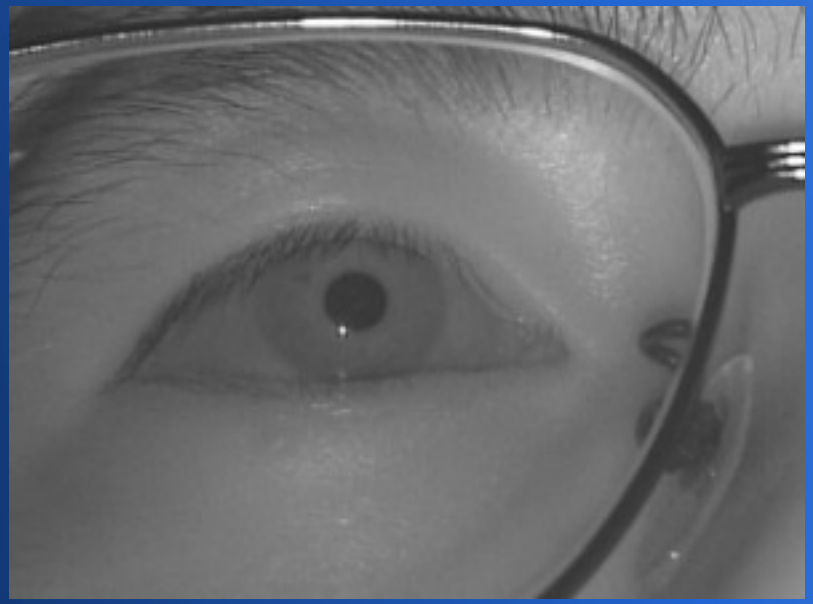
- This part is an aggregation of the article:

  „FreeGaze: A Gaze Tracking System for Everyday Gaze Interaction“

Detection of Pupil and Purkinje

Step 1:

- The Image of the Eye is taken
- To deepen noises in the taken picture, the size is reduced



Detection of Pupil and Purkinje

Step 2: Segmentation of the Image

- Picture is segmented into small regions
- We build grups of Pixels with same values

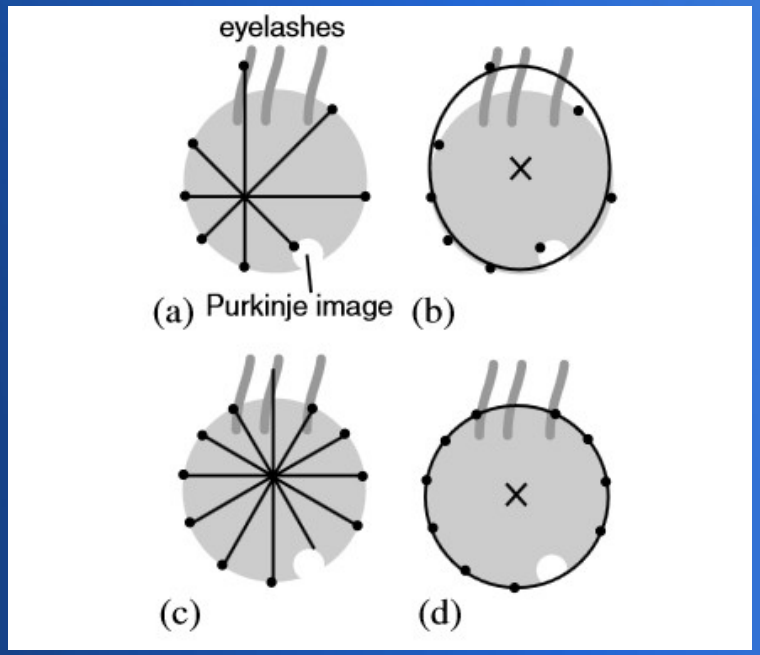
Detection of Pupil and Purkinje

- Step 3: Pupil Detection:
- Forms are calculated, to get possible „pupils“
- Repeat step 2 and 3 till you find the Pupil
- If not found, the program estimates that there is no pupil in the picture

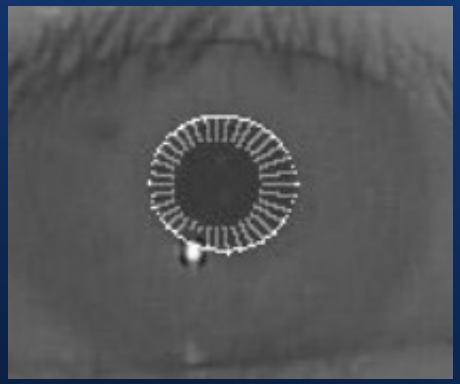
Detection of Pupil and Purkinje

- Step 4 Pupil Detection:
- First edges are defined through edge detection:

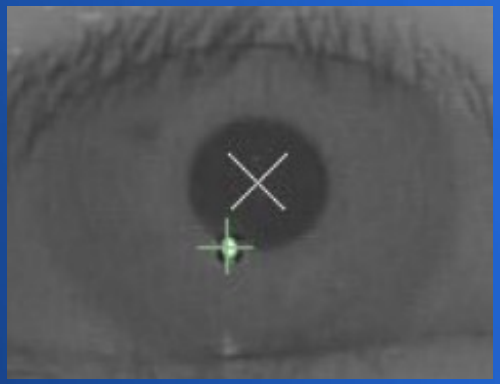
  pixels are scanned, and pixels which are brighter then one edge, are added to the edge
- Then it is formed in a shape
- Next step is detailed edge detection
- And then the ellipse is declared



Detection of Pupil and Purkinje



Edge detection



Result of Pupil Detection

Eyeball Model

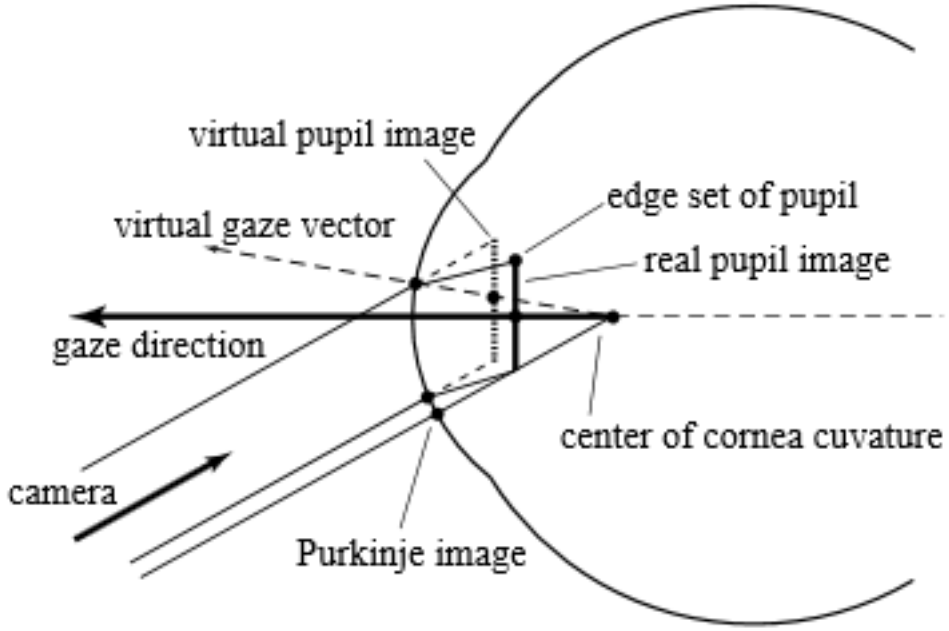


Figure 7: The eyeball model

Eyeball Model

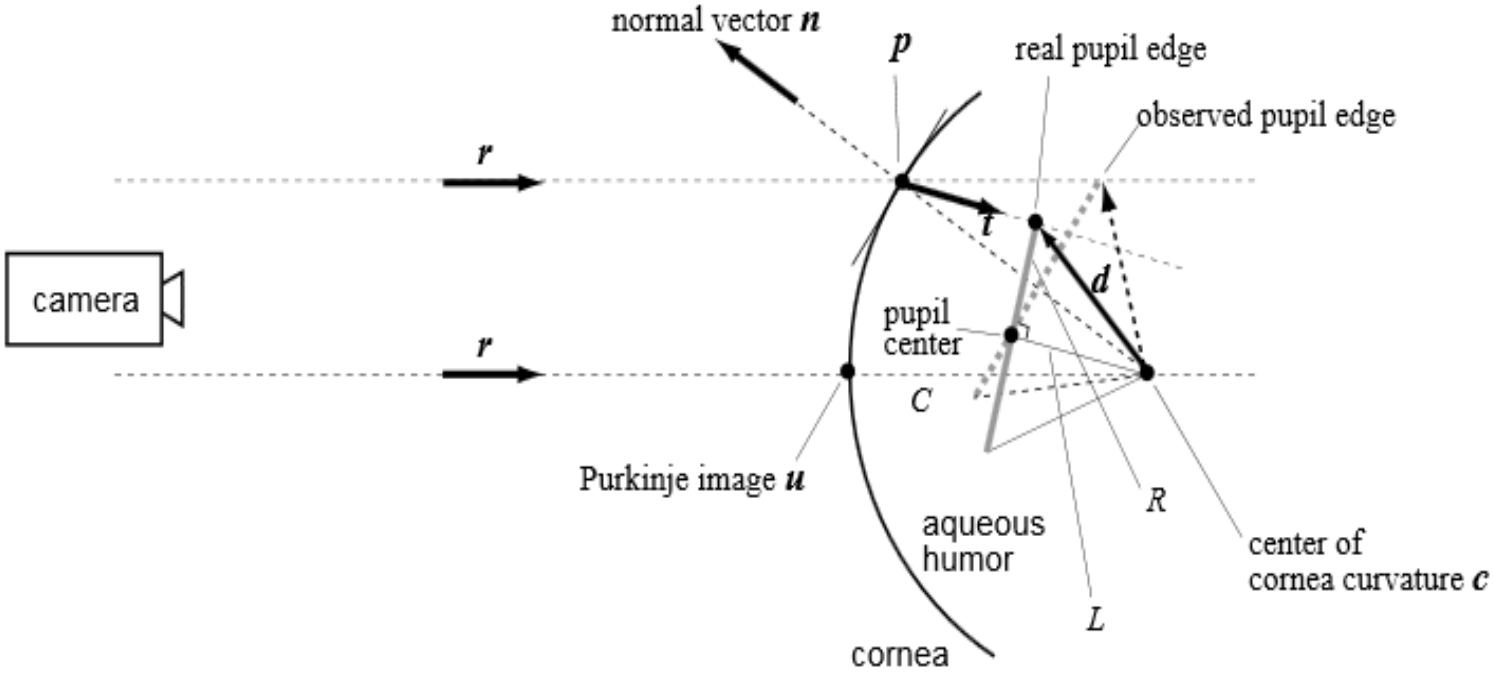
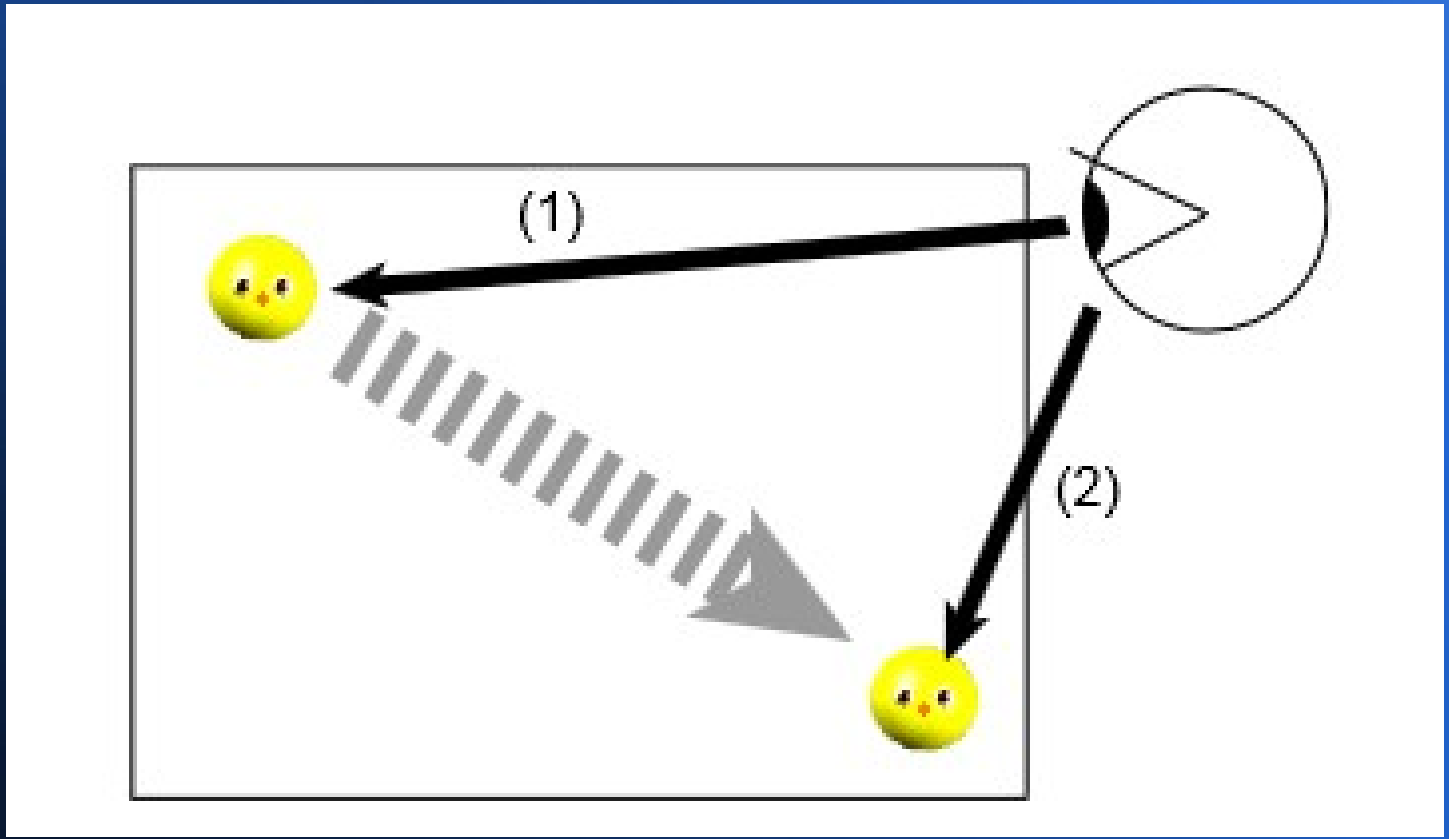


Figure 10: Detection of real pupil center from virtual pupil image.

„Finally, the gaze position g_w is obtained as the intersection of the gaze vector v_w and the screen S.“

Personal Calibration



Move the gaze from one corner to the next

Practical Use in our Project

What are our eyes looking for in a car?

Example: put down the window, start the

Motor?

What happens if we control important parts of the car with our eyes?

Example: The wheel (there I don't want to go)

How can we start a command through the Eyes?

(possibly like Humphry Bogart who said in a film:
"Schau mir in die Augen, Kleines" - Look into my Eyes Baby)

How can we end a command through the Eyes?

(Example: Close the eyes for about 10 seconds?)

Important Links

- Video 1:

  Quick guide through the Gaze Tracker of the University of Copenhagen
- Video 2:

  Control any PC through your eyes with Tobii PCEye
- Homepage of University of Copenhagen

Literature

Most important articles:

- History of Gaze Tracking:
  http://www.uxbooth.com/articles/a-brief-history-of-eye-tracking/
- FreeGaze: A Gaze Tracking System for Everyday Gaze Interaction:
  http://www.brl.ntt.co.jp/people/takehiko/papers/etra2002.pdf