CAREER: Secure and Trustworthy Ocular Biometrics

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IDEA

A novel biometric approach uses three fundamentally different traits captured by the same camera sensor:

1) the internal, non-visible, anatomical properties of the human eye, represented by Oculomotor Plant Characteristics (OPC);
2) the visual attention strategies employed by the brain, represented by Complex Eye Movement patterns (CEM);
3) the unique physical structure of the iris.

Eye Movement Biometrics - Advantages

Eye movements are highly counterfeit resistant, as they depend on both brain activity and the physical properties of extraocular muscles.
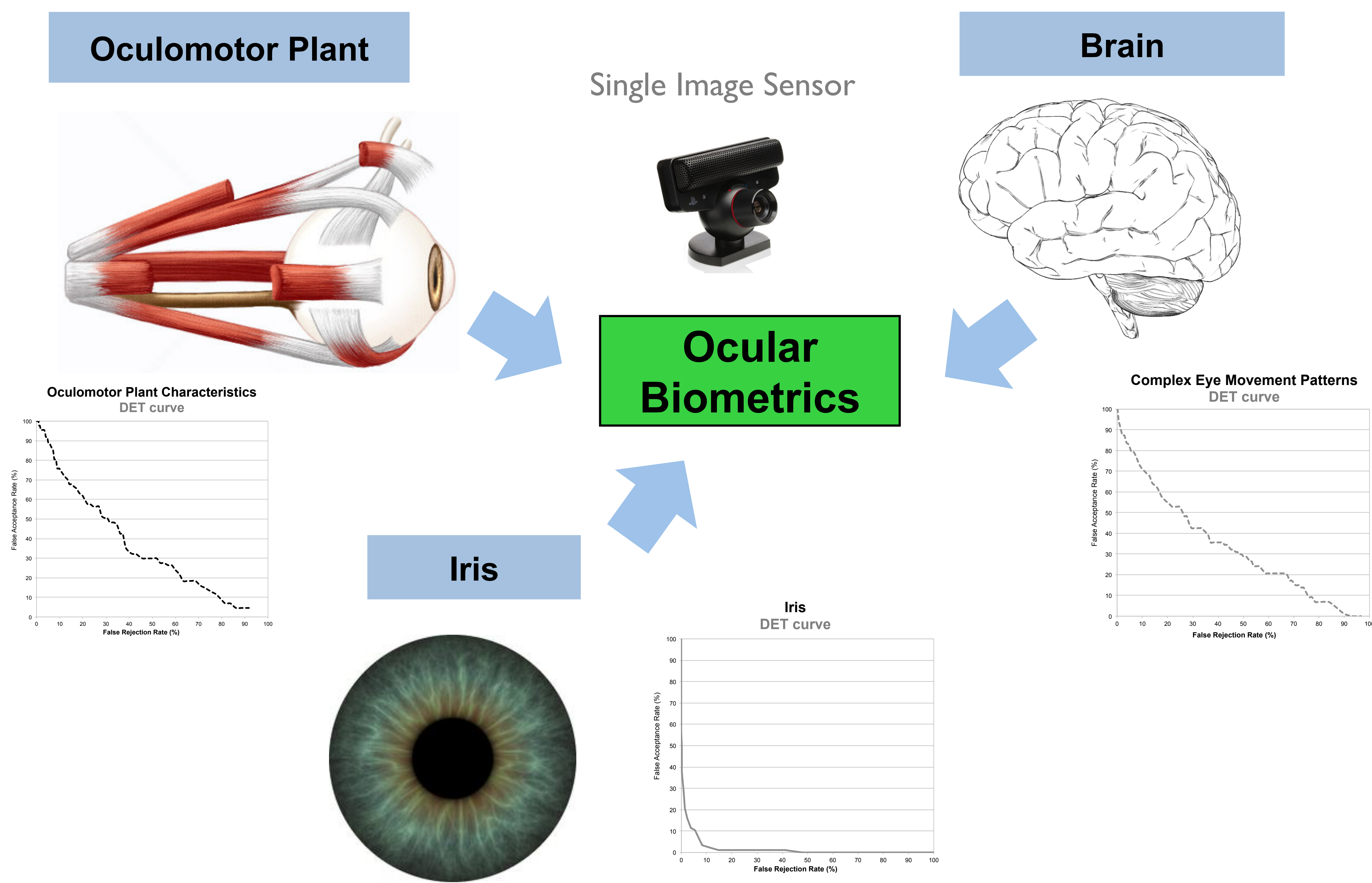
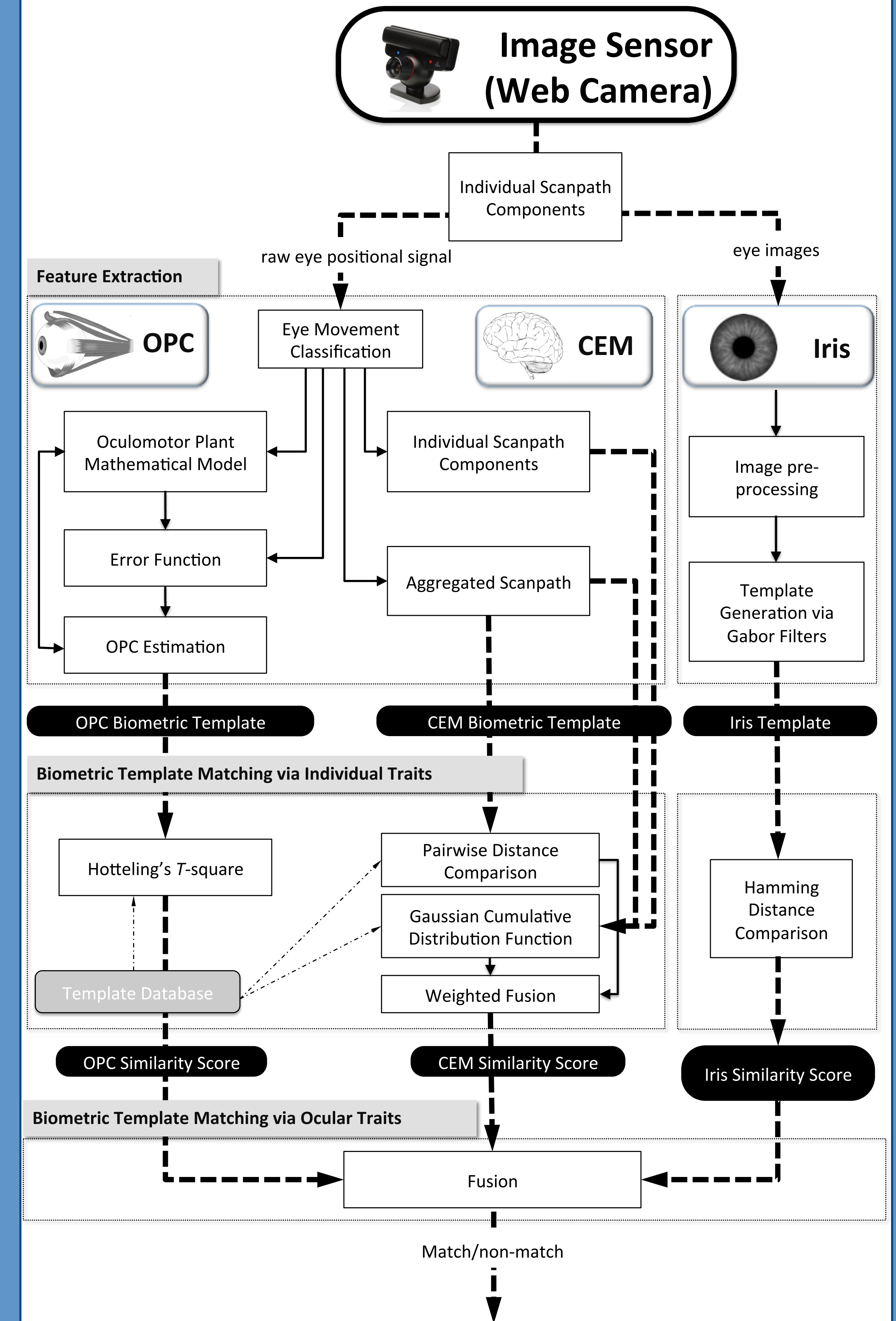## Iris Biometrics - Advantages

Highly accurate

Ocular Biometrics - Advantages

Counterfeit resistant + accurate

Architecture

OCULAR BIOMETRICS-OVERVIEW

Oculomotor Plant

Single Image Sensor

Brain

Ocular Biometrics

Iris

Oculomotor Plant Characteristics DET curve

Complex Eye Movement Patterns DET curve

Iris DET curve

Results

- Various aspects of the eye movement signal were investigated for their ability to carry person's identifying information. We found that oculomotor characteristics corrective eye movements, and many other features related to the eye movements carry such information. We found that various classes of eye movement features could provide Equal Error Rate (EER) in the range of ~8% to 15%.
- We have considered various approaches of fusing information provided by different eye movement classes. In addition to score fusion we found out that stimuli fusion allowed to increase the effectiveness of the overall schema pushing down the EER to 5.6%.
- We have performed liveness detection experiments and found out that ocular biometrics is extremely resistant to spoofing attacks including print out attacks and attacks by mechanical replicas created from person specific representations of the oculomotor plant.
- Our latest research concentrates on identifying new approaches for the eye movement feature creation that contain more than 1000 features. Such approaches based on the feature reliability are able to push down the EER to 2.6% which is the level which is close to fingerprints.
- Eye movement traits can improve the accuracy of the iris biometrics performance, in certain cases. Largest achieved improvement was 19%.
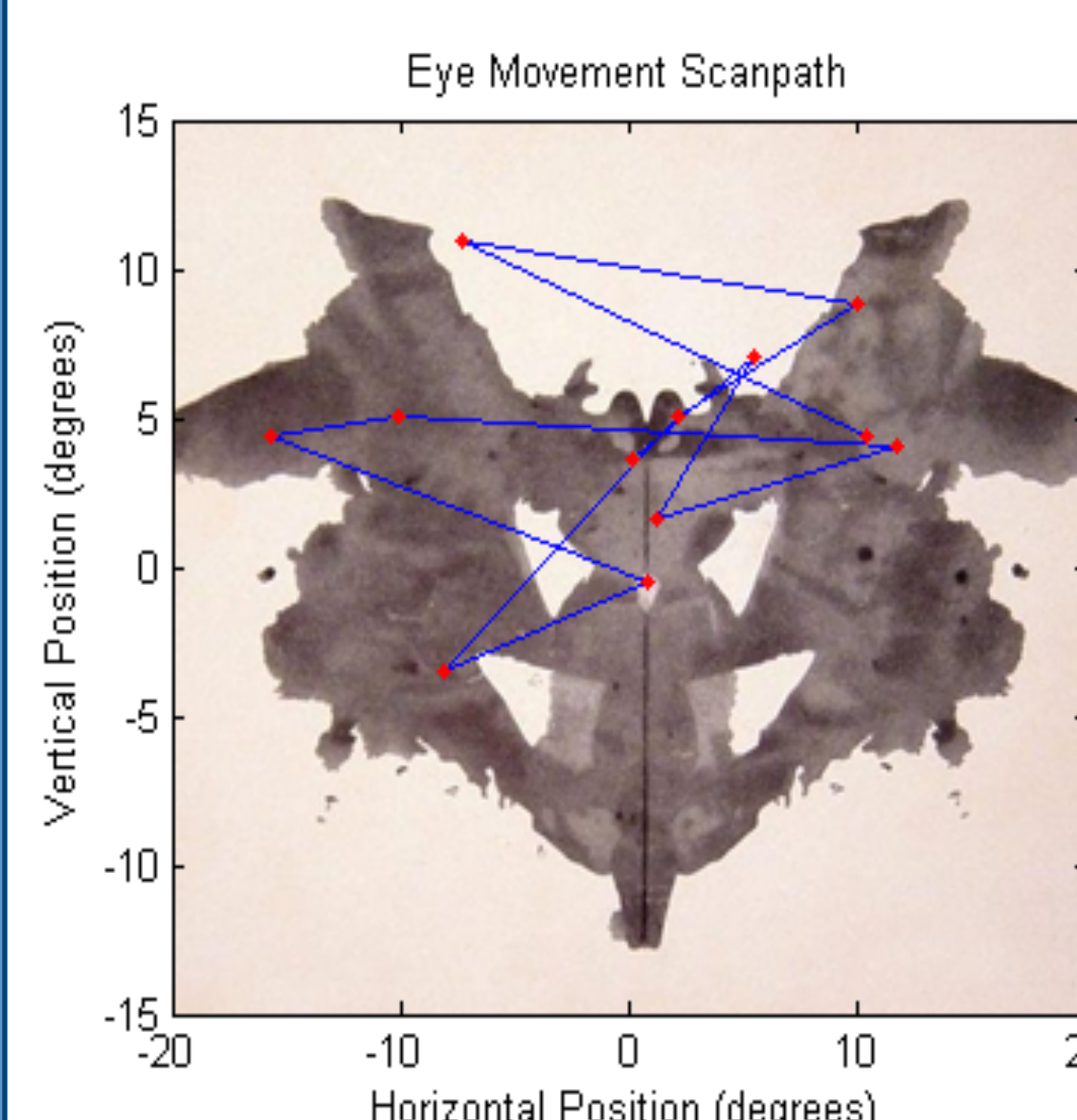
Eye Tracking

- Captures eye images at a distance by an image sensor
- Non intrusive
- Works at a distance

Captured Eye Images

Example of Experiment Setup

Eye Movement Scanpath

Equipment:
- PS3 Eye Cam ($20)
  - resolution 640x480
  - sampling rate 75Hz
  - positional accuracy 1°

Participants:
- 87 subjects
  - ages 18 – 47
- two recording sessions
- 15 min between sessions