Adaptive object tracking for improved gaze estimation based on fusion of starburst algorithm and natural features tracking

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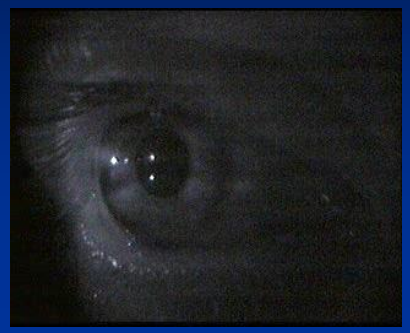
Problem statement

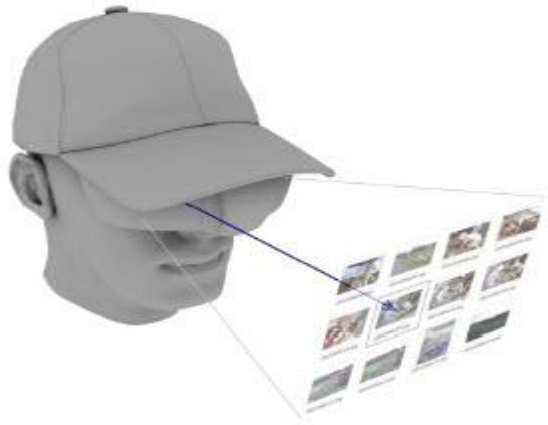
Object detection:
- Pupil detection
- Corneal reflection detection
- Tracking
- Gaze estimation

Outdoor environment:
- non uniform ambient lighting
- eyes variation
- eye activity like twinking and partial occlusion

Database Variation





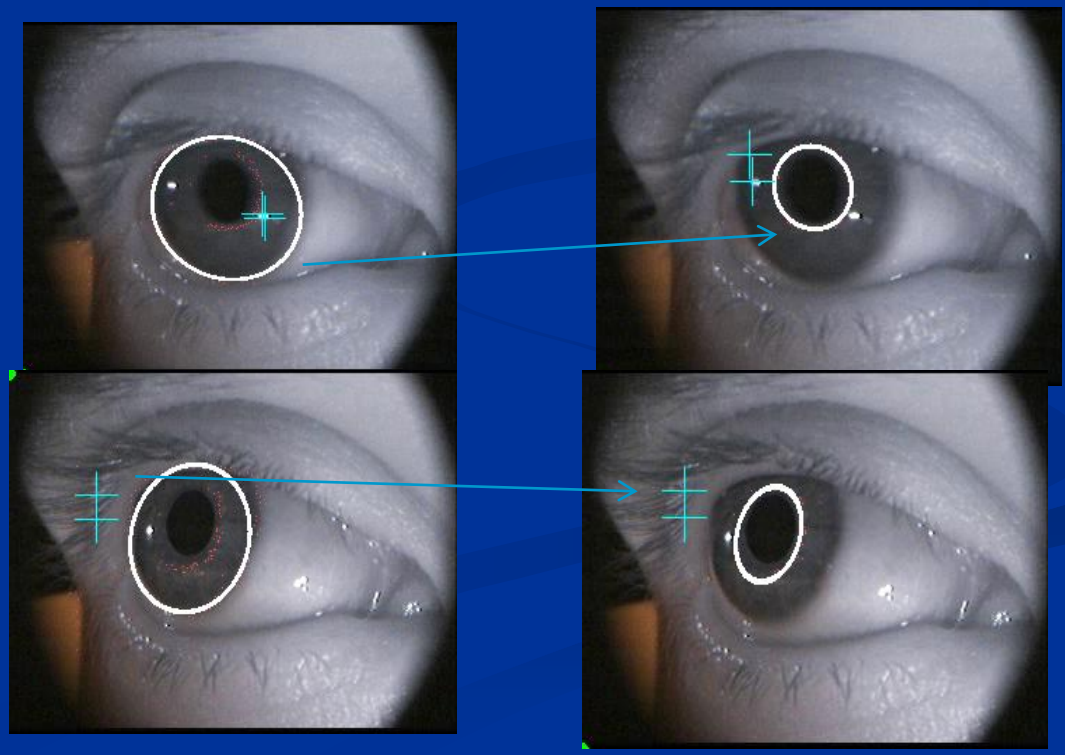



Metrics for quality and accuracy estimation on DB

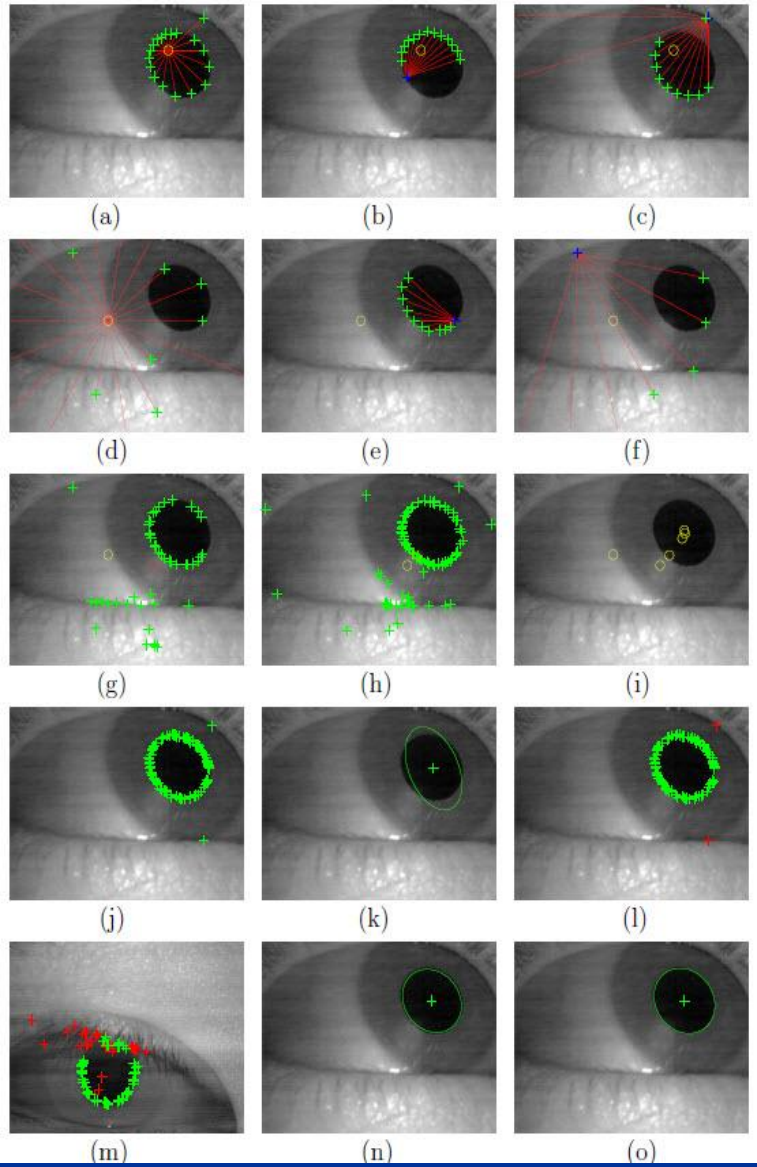
- IRIS contour fitting and major points accuracy estimation
- Strong Criterion less than 10 pixels
- Weak Criterion less than 20 pixels

$$Accuracy = \frac{1}{eyedist}(\sigma_{eyeleftX}, \sigma_{eyeleftY}, \sigma_{eyerightX}, \sigma_{everightY})$$

1) Correct Detection Rate
2) False alarm
3) Accuracy
4) Speed

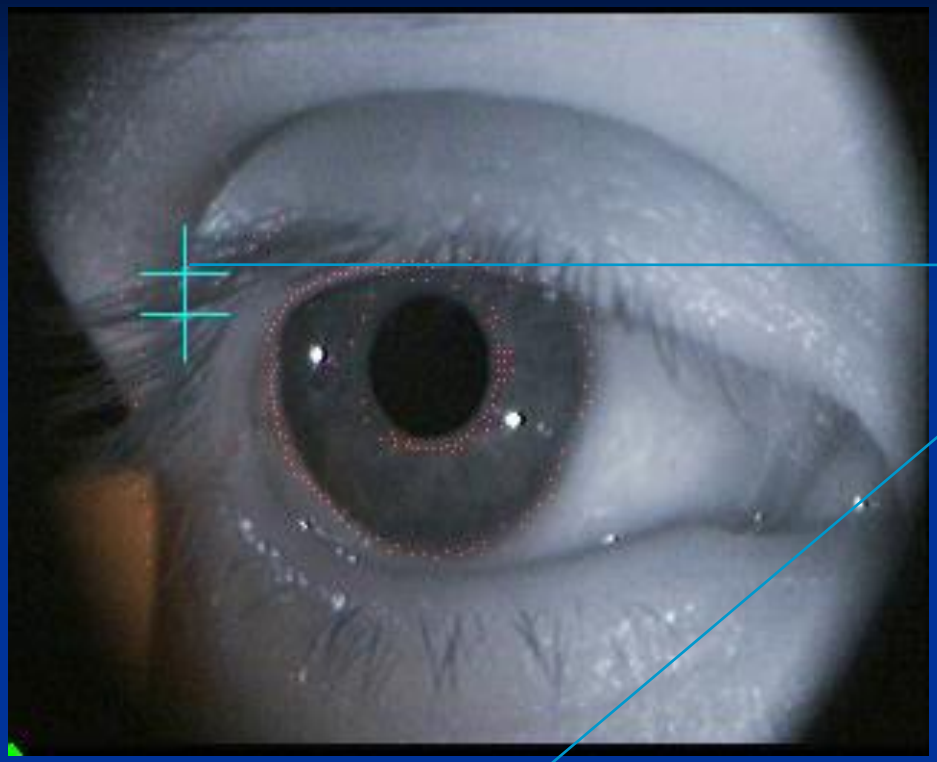


Starburst algorithm steps



1 **Input**: Eye image, Scene image
2 **Output**: Point of gaze
3 **Procedure:**
4 Detect the corneal reflection
5 Localize the corneal reflection
6 Remove the corneal reflection
7 Iterative detection of candidate feature points
8 Apply RANSAC to find feature point consensus set
9 Determine best-fitting ellipse using consensus set
10 Model-based optimization of ellipse parameters
11 Apply calibration to estimate point of gaze

Problems in Starburst : ellipse points stability



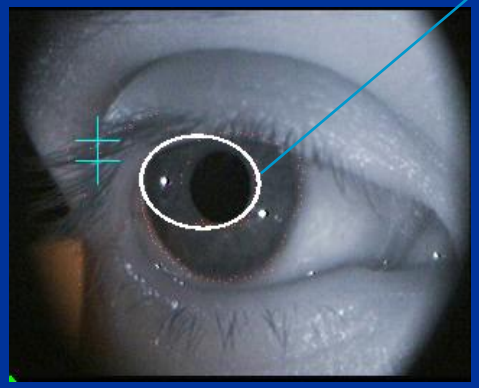


Image enhancement problems

Many edges, points – ransac cannot estimate right ellipse

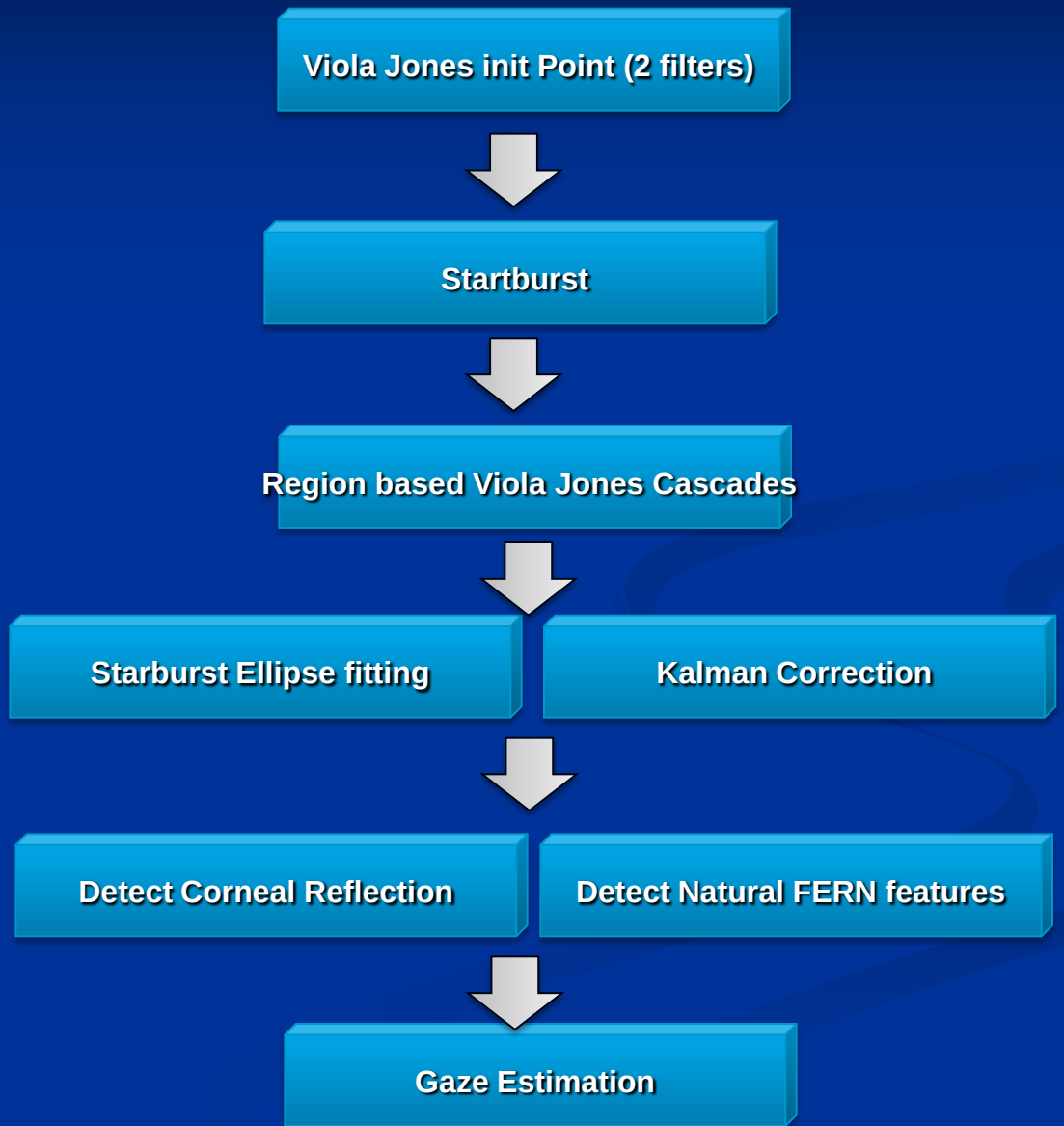
Corneal reflection detection algorithm non stable

No tracking

Pupil detection
Corneal detection

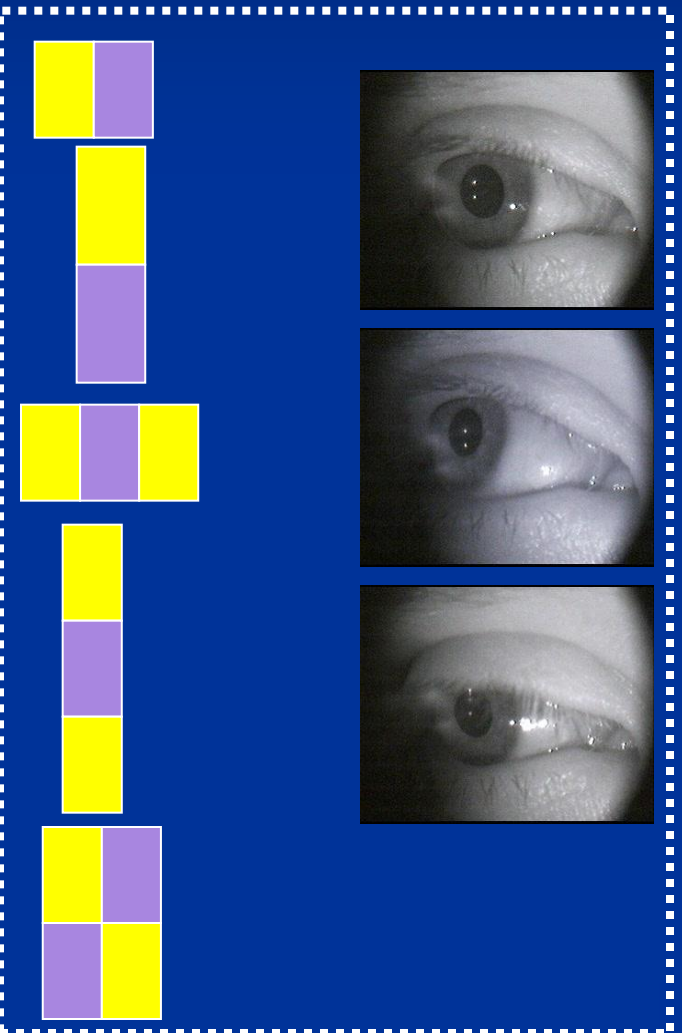
Gaze tracking

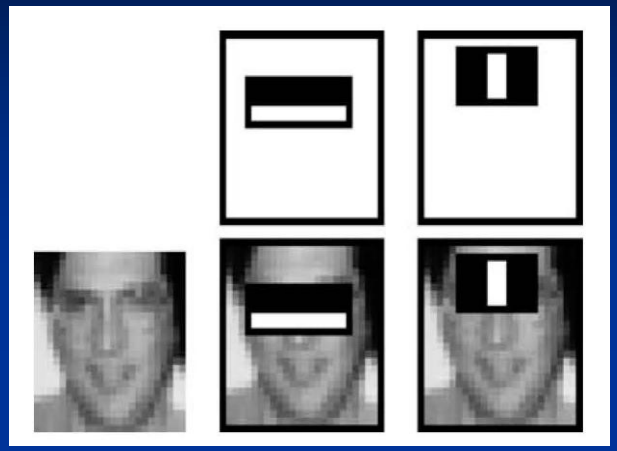
Architecture of proposed gaze estimation algorithm



Viola Jones detector

- Haar wavelets



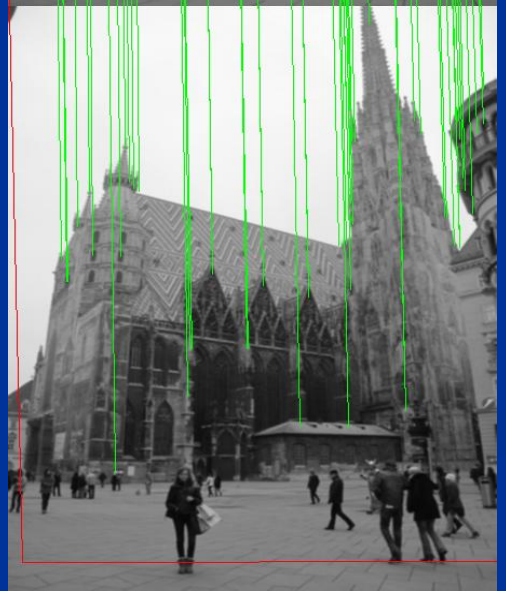


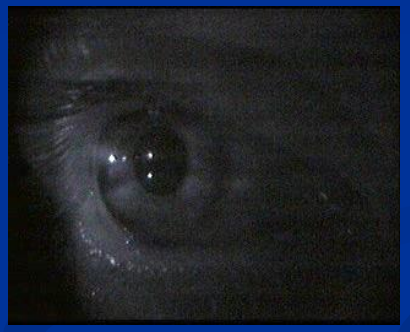
Classifier

$$h(x) = \begin{cases} 1, & if\ f(x) > \theta \\ -1, & if\ f(x) \le \theta \end{cases}$$

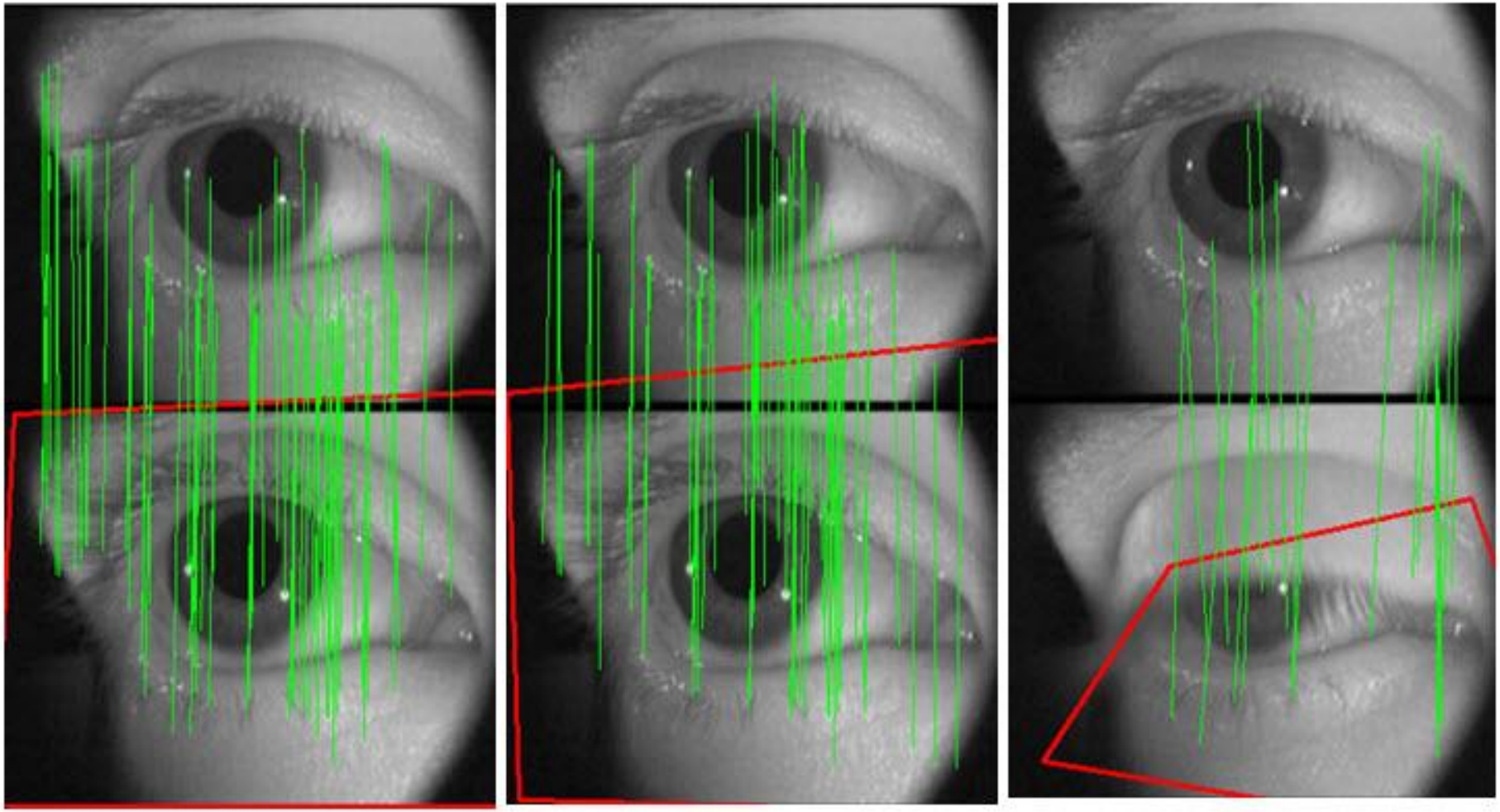
Detection rate 99%
False alarm 10%

Natural Features: FERN against outdoor environment variation

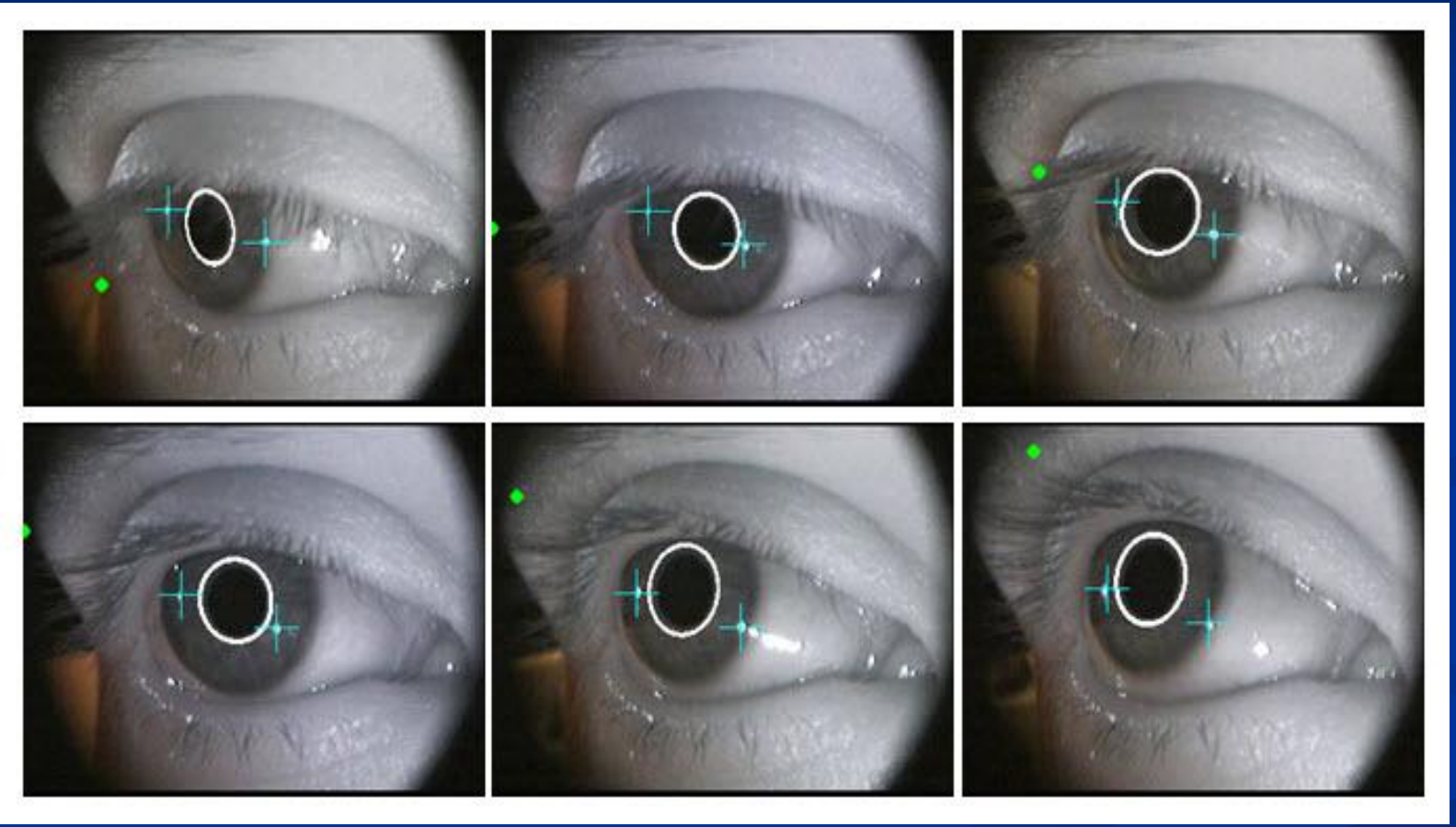




Natural Features: FERN markerless tracking



Results



Experiments on DB with high outdoor variation

Eye Object = 240x140, iris=95x95

Strong Criteria
max difference < 10 pixels

	STARBURST	STARBURST VIOLA JONES	STARBURST VIOLA JONES FERN
Average Performance (fps)	100	30	15
Detection Rate (%)	74,4%	96.6%	98,3%
Eye Coordinate Accuracy Sigma X (pixels)	7.25	5.7	3.4
Eye Coordinate Accuracy Sigma Y (pixels)	7.9	6.1	4.1

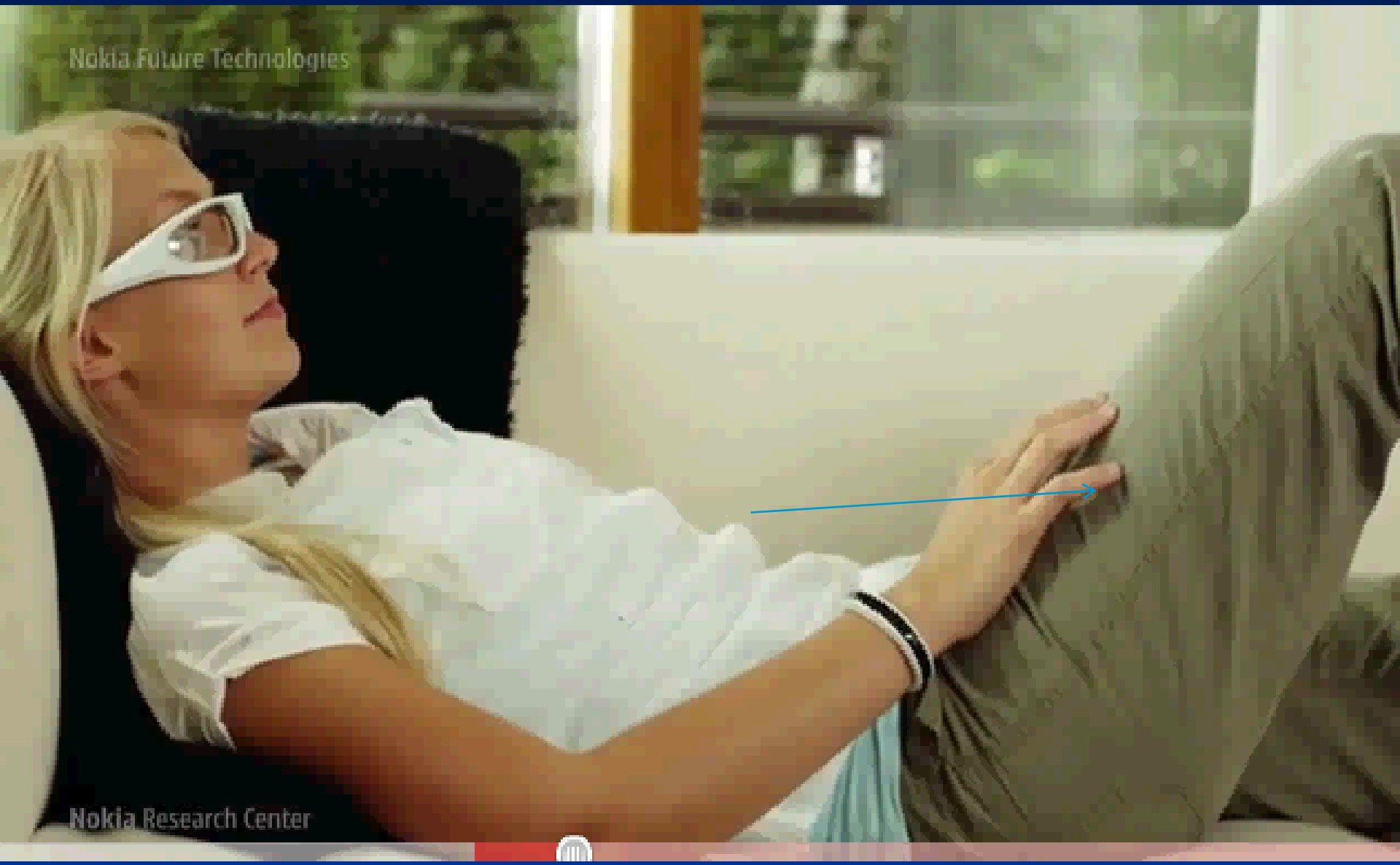
Conclusions

- STARBURST: speed , only localization, not so accurate, problems with adaptation for the natural environment

- STARBURST VIOLA JONES : speed, robustness in accuracy

- STARBURST VIOLA JONES FERN : high robustness in accuracy, adaptation to natural outdoor scenes

Applications



Interaction via Gaze

Thank you