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Hybrid Eye Detection Algorithm for Outdoor Environments

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Outline

- Introduction
- Objective
- Method
- Experiments
- Results
- Conclusions

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Introduction

- Goals for Eye Tracking Technology
  - Low cost eye tracking
  - More versatile and simple systems
    - Video games
    - Automotive industry
- Technical Challenges
  - New image processing techniques
  - New methods for gaze estimation

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Introduction

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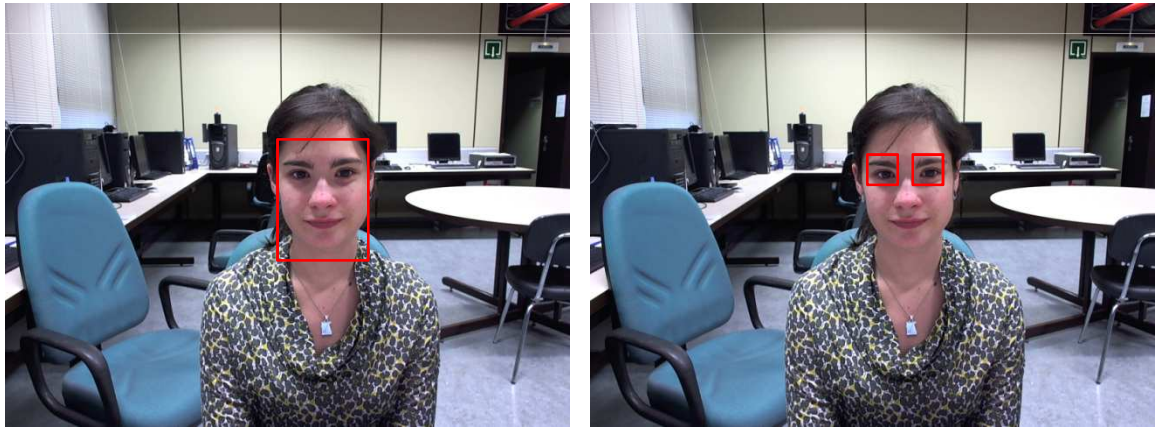
Objective

- To develop an algorithm for eye region detection for a driving scenario using a webcam
  - Fast light variation
  - Fast user movements
  - Occlusions

  - video

Method

- Object Detection➔Viola Jones Detector
  - Facial features detection algorithm
  - Based on a training stage
  - Face is detected and eye regions are segmented using anthropomorphic measures



P. Viola and M. Jones. Robust real-time face detection. International Journal of Computer Vision, 57:137–154, 2004

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Method

- Tracking Algorithm➔Tracking Learning Detection (TLD) Algorithm
  - A tracker and a detector run in parallel
  - An online learning system

Z. Kalal, J. Matas, and K. Mikolajczyk. Tracking learning detection. IEEE Transactions on Pattern Analysis and Machine Intelligence, 2011.

Z. Kalal, K. Mikolajczyk, and J. Matas. Face-TLD: Tracking-Learning-Detection Applied to Faces. International Conference on Image Processing, 2010 .

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Method

- Tracking Learning Detection (TLD) Algorithm
  - A patch is required as input in the first frame
  - The patch is tracked using Lucas-Kanade algorithm and predicts the position of the patch in the next frame
  - The detector is based on 2bitBP features
  - Potential detections are filtered out using information of the tracker
  - The detector is updated online using a random forest procedure

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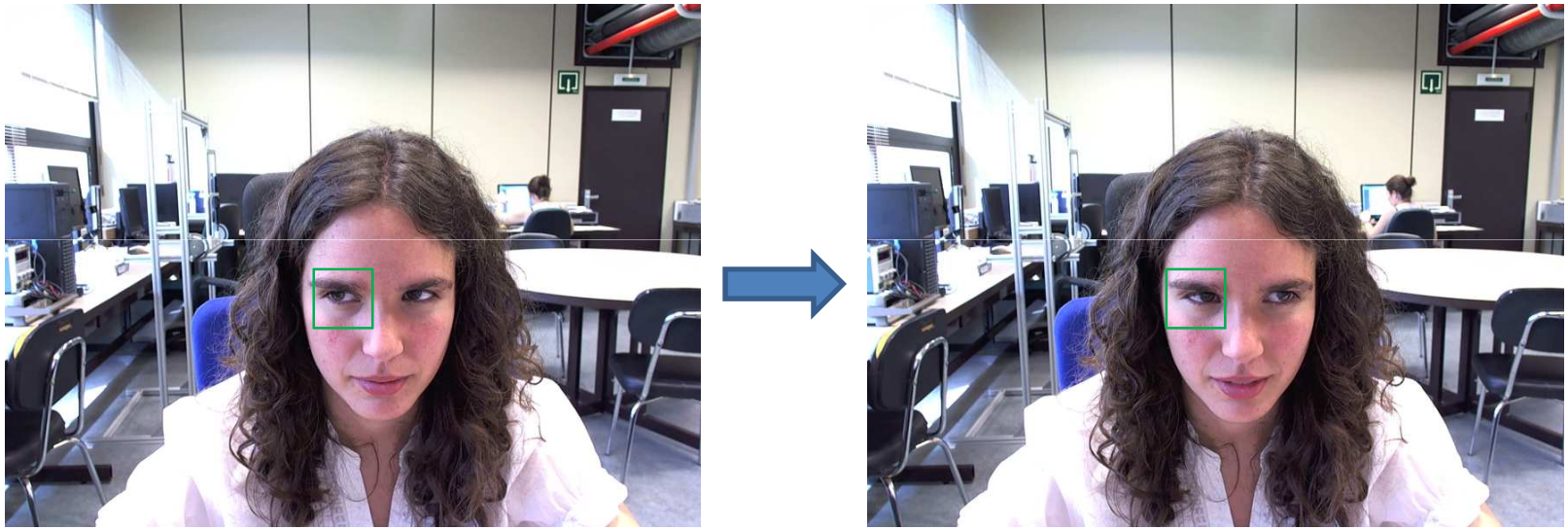
Method

-TLD



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Method

- Viola Jones-Pros and Cons
  - It is very robust, i.e. low False Positive rate
  - It fails when head is rotated
  - It fails in presence of strong light

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Method

- TLD-Pros and Cons
  - It can learn new instances
  - It fails when fast variations occur, light variations or head movements

  - It can get attached to other elements

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Method

- New hybrid approach
  - Tries to combine the robustness of the VJ approach with the updating ability of TLD algorithm.
  - TLD intervenes only when VJ fails

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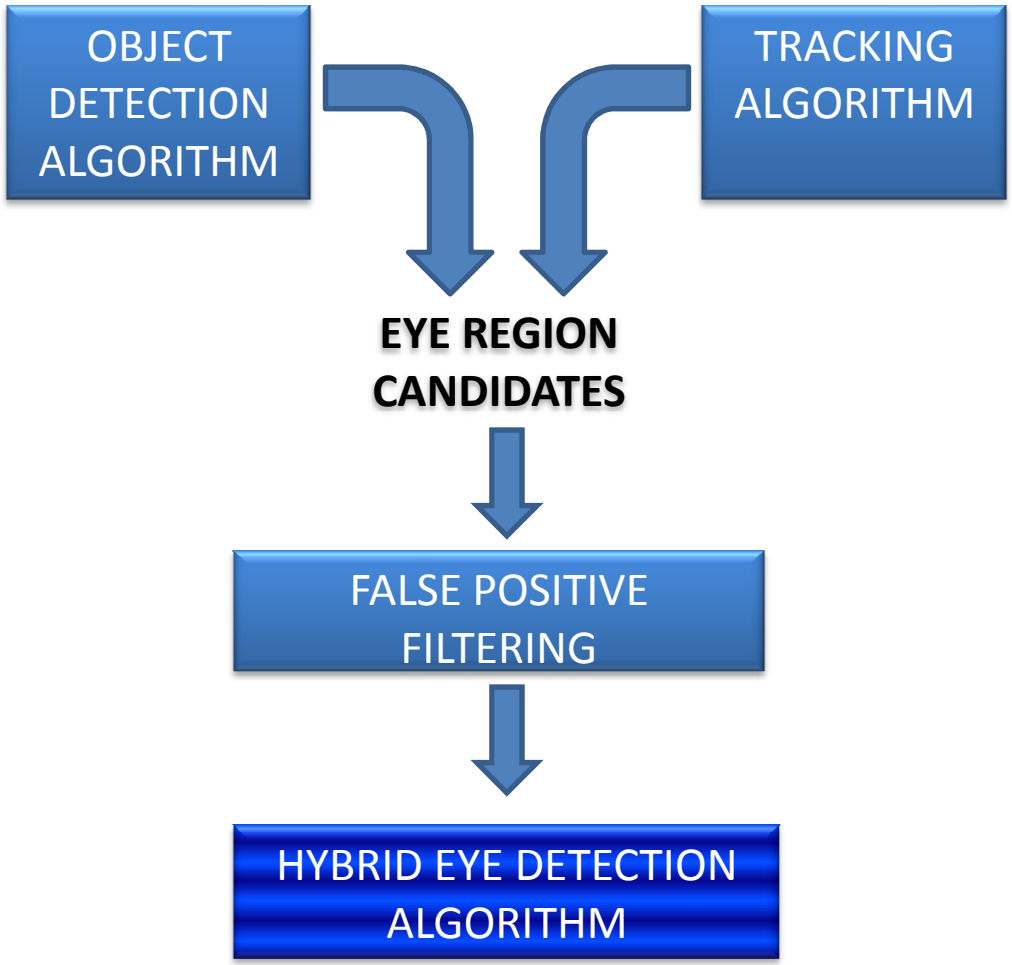
Method


OBJECT DETECTION ALGORITHM
TRACKING ALGORITHM
EYE REGION CANDIDATES
FALSE POSITIVE FILTERING
HYBRID EYE DETECTION ALGORITHM

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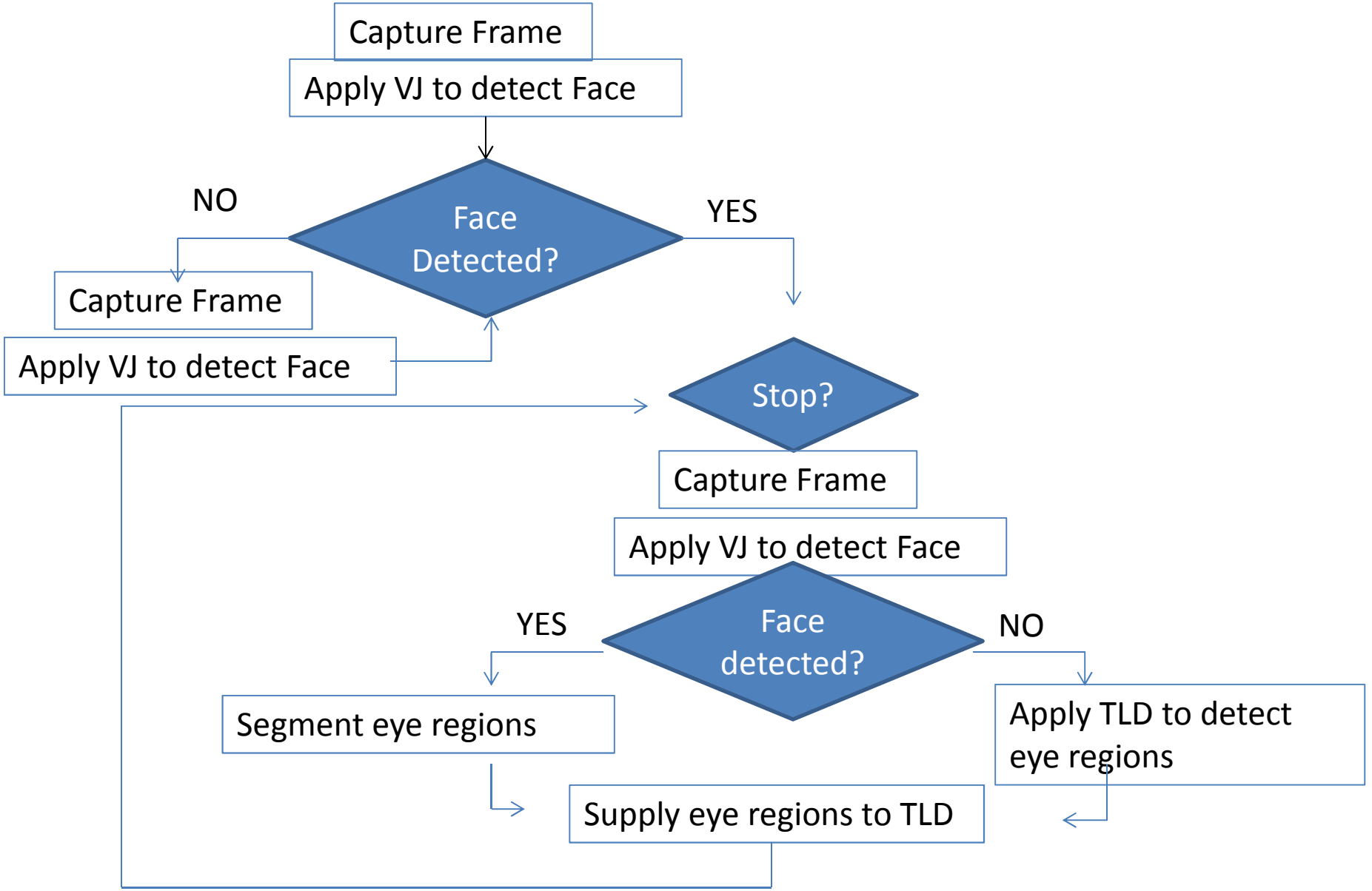
Capture Frame
Apply VJ to detect Face
Face Detected?
NO
YES
Capture Frame
Apply VJ to detect Face
Stop?
Capture Frame
Apply VJ to detect Face
Face detected?
YES
NO
Segment eye regions
Apply TLD to detect eye regions
Supply eye regions to TLD

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Method

- False Positive Filtering
  - The difference between the sizes of the eye region bounding boxes must be less than 60%.
  - The distance between the eye region bounding boxes must be less than twice the bounding box average width horizontally and half of the bounding box average height vertically.
  - The overlap between the bounding boxes must be less than 33%.
  - Both eyes must be detected.

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Experiments

- 12 videos of four people in standard driving conditions (2-3 min)
- Videos recorded in different day times
- Logitech c920 HD ProWeb Cam (24 fps 240x320 pixels)

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Experiments

- Three methods
  - VJ
  - TLD
  - Hybrid Approach-Our Method

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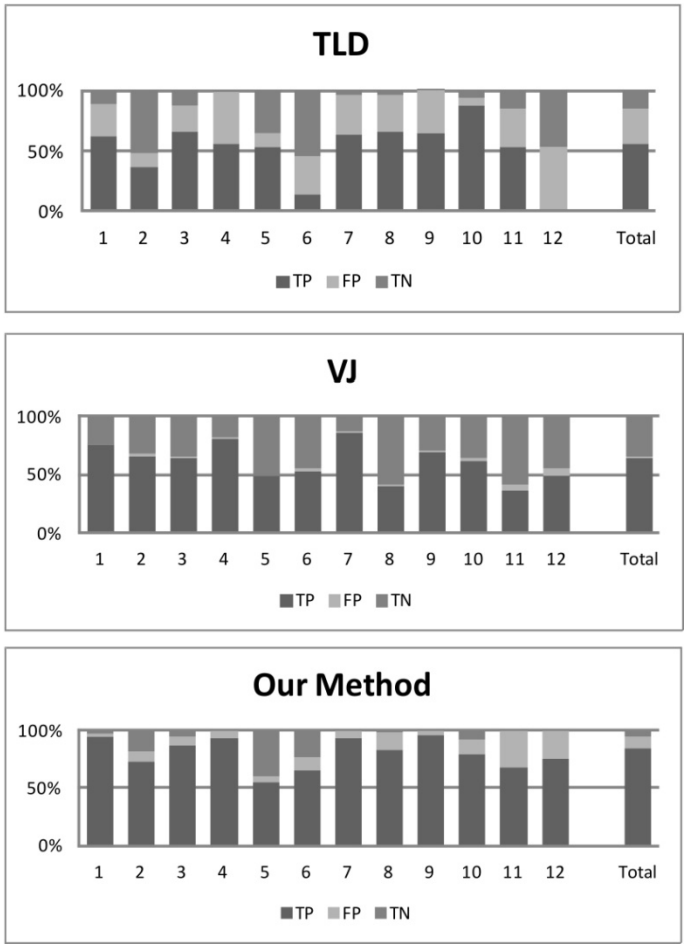
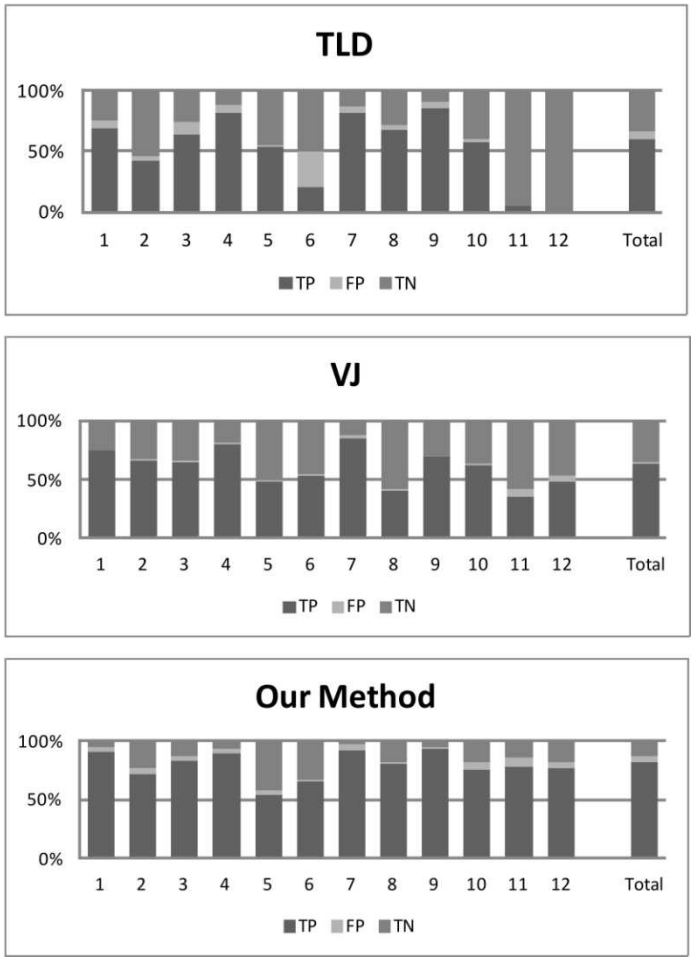
Results



Without FP filtering



With FP filtering

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Results

	TP Rate	FP Rate before filtering
VJ	64%	2%
TLD	56%	29%
Our Method	84%	10%

	TP Rate	FP Rate after filtering
VJ	64%	2%
TLD	60%	7%
Our Method	82%	5%

- video

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Conclusions

- A new method has been presented to track eye regions in outdoor environments
- It combines an online learning tracking method and VJ detector
- The method has an accuracy of 82% while mantaining a low error rate

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ECEM 2013

(Eye Conference on Eye Movements)

Lund (Sweeden)

11/08-16/08 2013

Is hosted by Lund University and co-organized by COGAIN Association

Courses will be organized the week before!!

Call for papers and symposia soon!!