An Approach Towards Real-time Evaluation of Eyeblink and Gaze Direction using SVM, Viola-Jones Alg. and Hough Transform

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Abstract

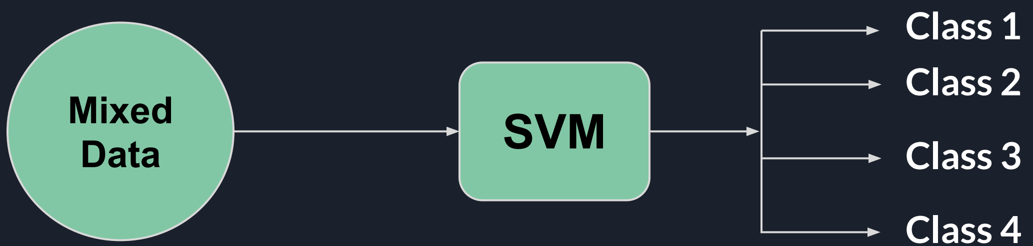
- Classification based eyeblink detection.
- Histogram of Oriented Gradient (HOG) is used as feature descriptor.
- Eigen features are detected in the Region of Interest (ROI).
- Support vector machine is used as classifier to classify closed and opened eyes as they are binary classes.
- Viola-Jones algorithm is used for eye-image extraction from detected face.
- Hough transform is used to detect pupil shape which has been used further for evaluate eye gaze.
- Matric distance is used to decide eye gaze direction.

Motivation

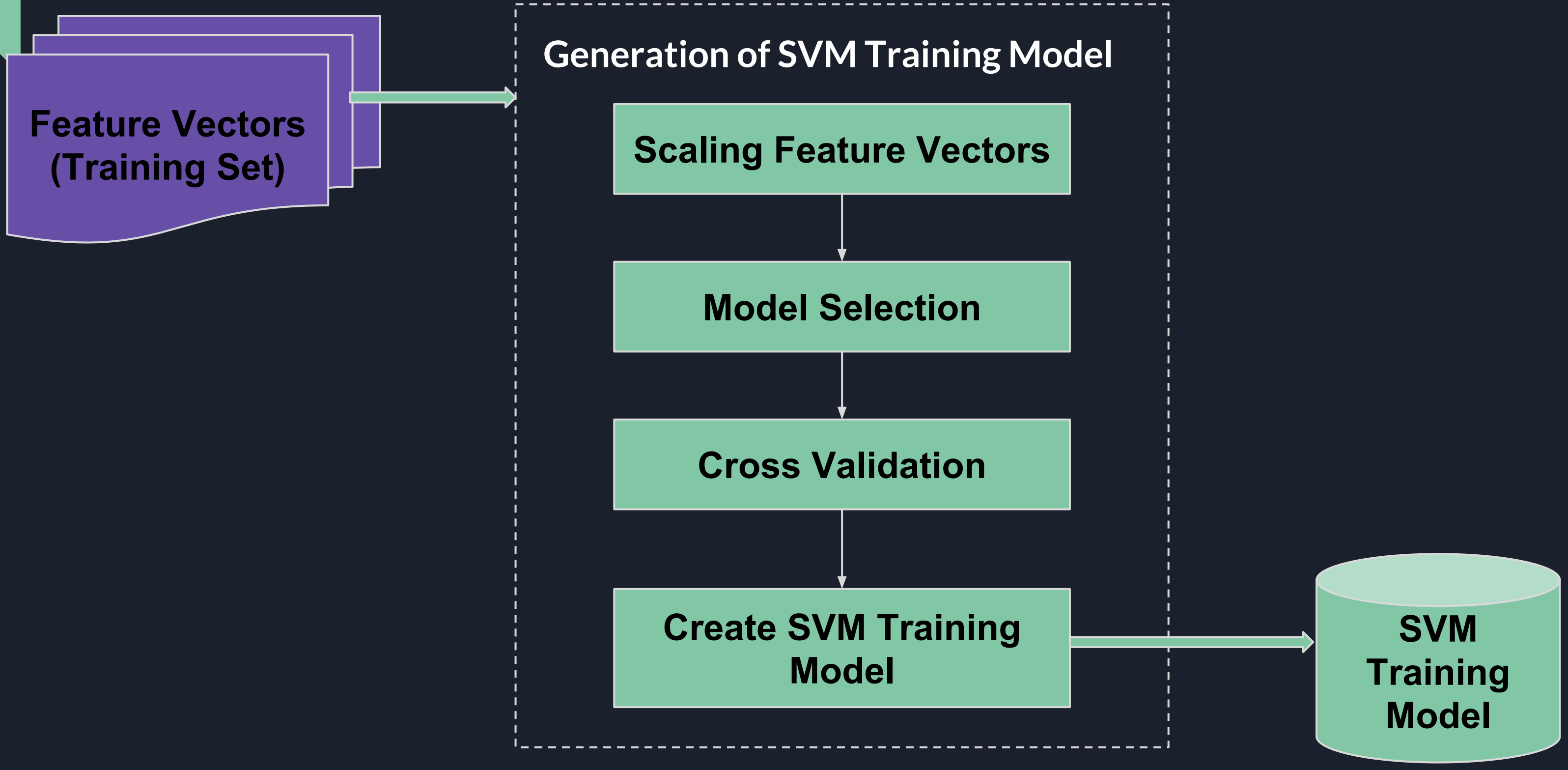
- Automated eyeblink detection through image processing, classification techniques.
- Human eyeblink differs from person to person in terms of speed of closing and opening, degree of squeezing, duration of blink etc.
- Each eyeblink lasts approximately 100-400 ms. Difficult to measure the time duration between opening and closing of eyes.
- A person’s visual attention can be arbitrarily evaluated through eye gaze direction.
- Both eyeblink and gaze direction can be used to evaluate human behavior.
- Applications such as human concentration evaluation, driver gaze direction, vehicle automation, children attention measurement etc.
- HOG, SVM, Viola-Jones algorithm, Hough transform for feature extraction and classification.

Classification Technique

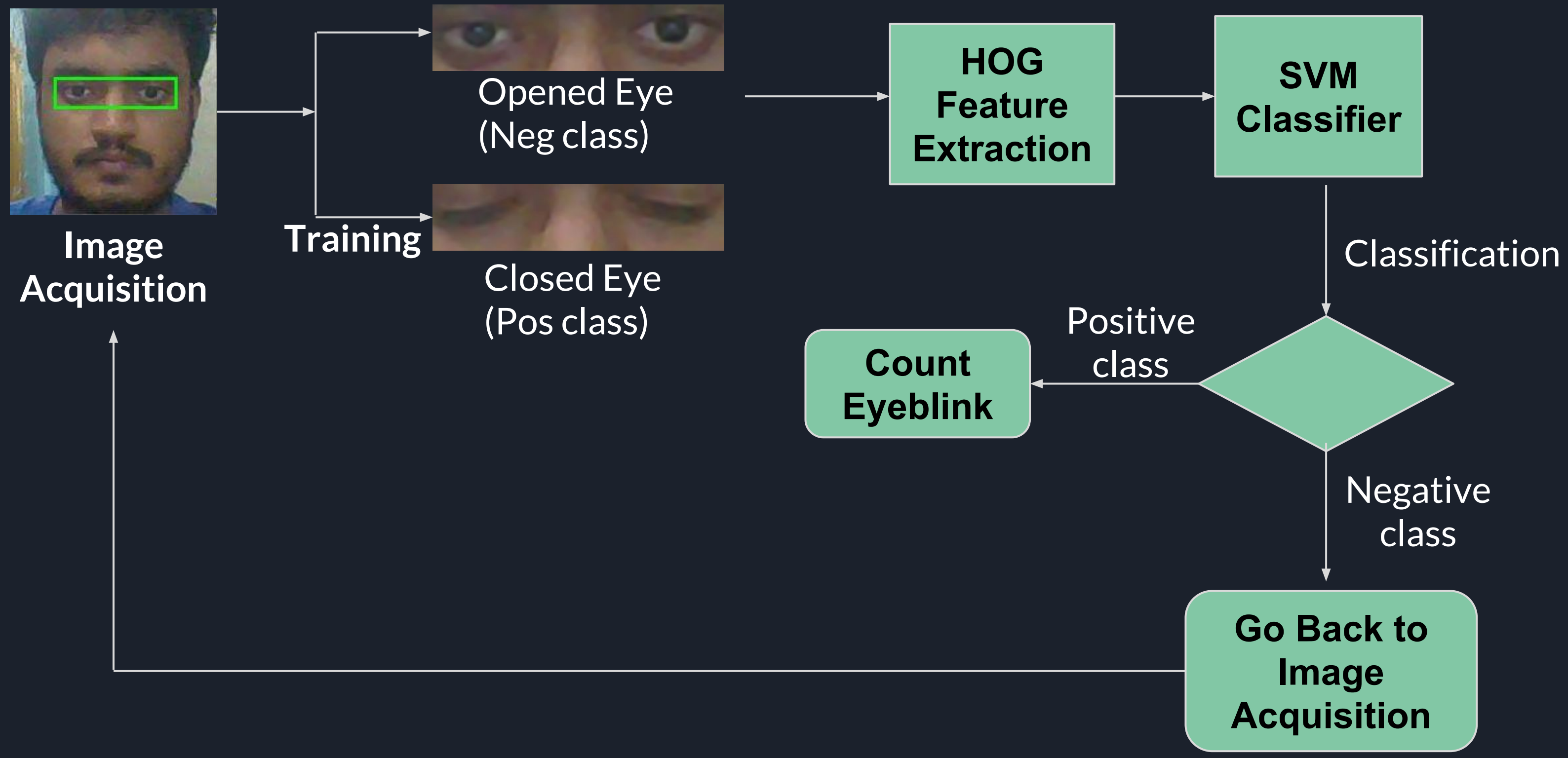
- Given a training dataset of η points of $(\vec{x}_1, y_1), \ldots, (\vec{x}_n, y_n)$ where y_j are either 1 or -1, each indicating the class to which the point x_j belong.
- "Maximum margin hyperplane" with a minimum support vector should be acquired through SVM.
- $\vec{\omega} . \vec{x} - b = 0$, this hyperplane classifies the training data.
  - $\vec{\omega} . \vec{x} - b = 1$, anything on or above this will be in class one with label 1.
  - $\vec{\omega} . \vec{x} - b = -1$, anything on or below this will be in the other class with label -1.



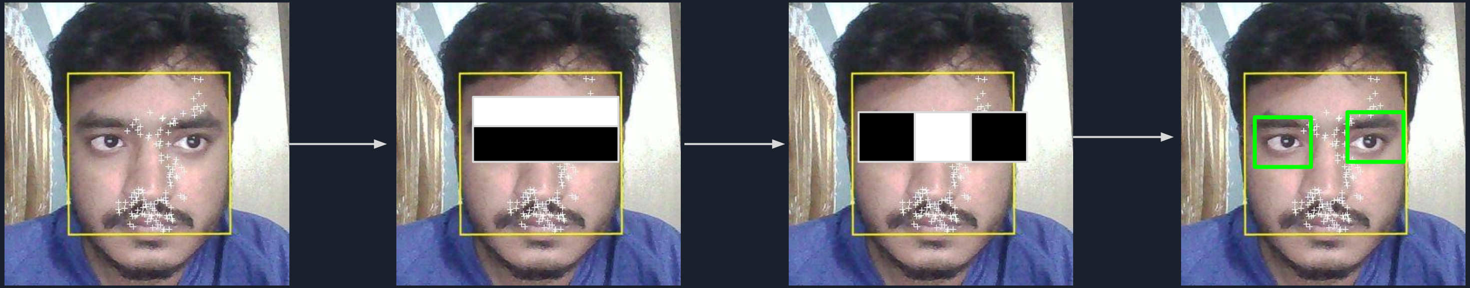
Support Vector Machine (SVM) Classifier



Classification for Eyeblink Detection



Viola-Jones Algorithm one eye detection

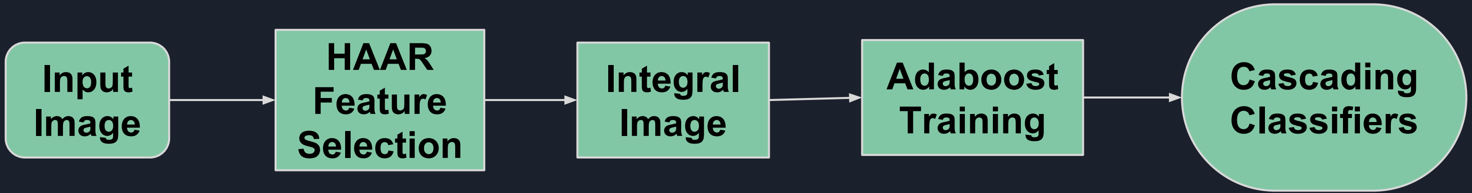


Input Image

HAAR Feature Selection

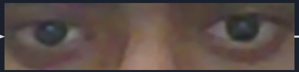
Cascading Classification

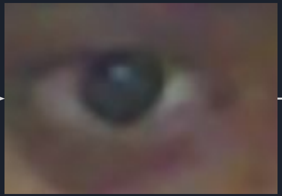
<u>Flow Diagram:</u>

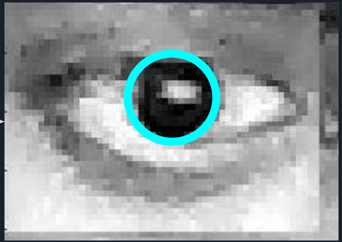


Hough Transform for pupil shape detection

Input Image





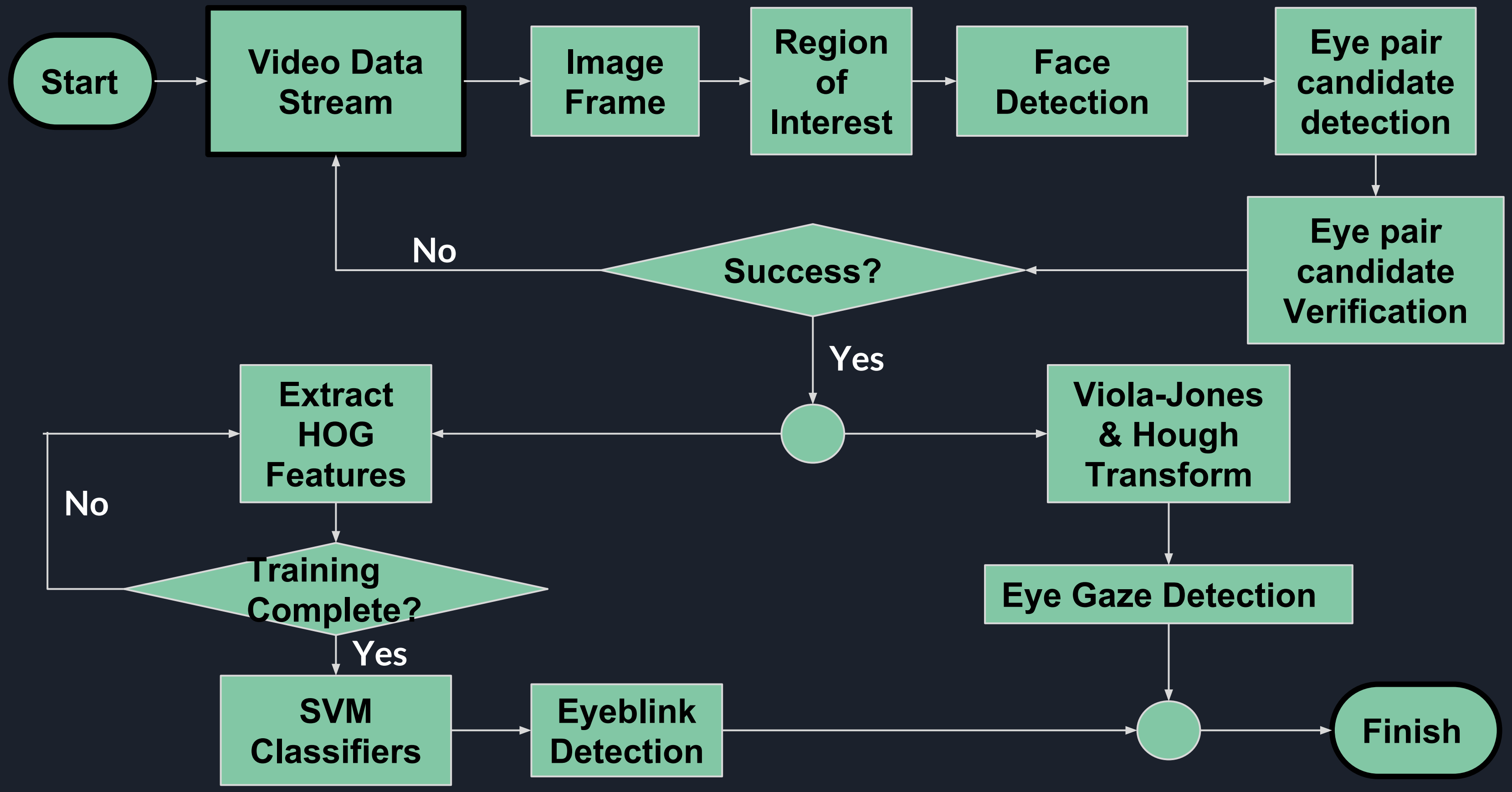


Edge Detection

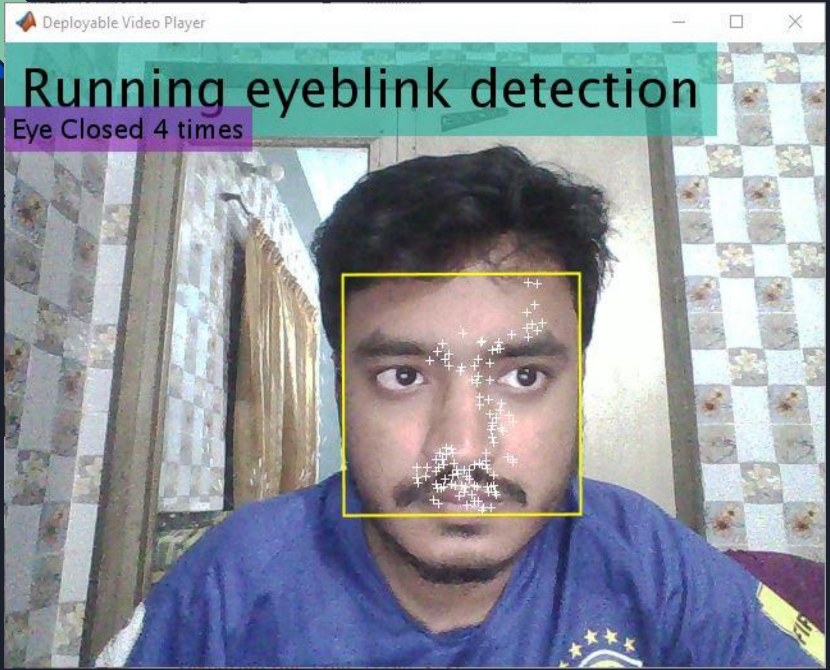
<u>Flow Diagram:</u>

Input Image → Edge Detection → Compact Hough Transform → Smoothing → Peak Finding → Center Finding → Boundary Searching → Radius Map →

Methodology



Results


Deployable Video Player
Running eyeblink detection
Eye Closed 4 times

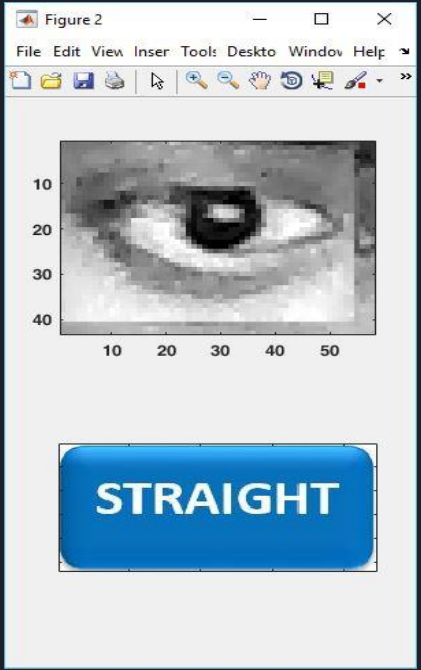


Figure 2
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STRAIGHT

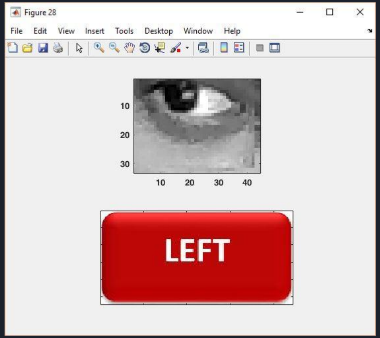
Figure 28
File Edit View Insert Tools Desktop Window Help
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LEFT

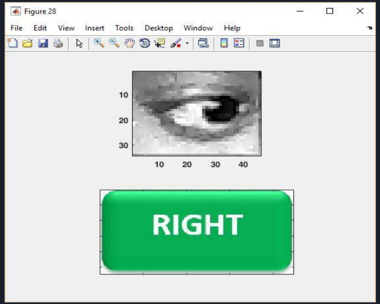
Figure 28
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RIGHT

Future Works and Conclusion

- Gaze region estimation along with head posture will be more precise to estimate human behavior.
- Gaze-based attention system for multi-human multi-robot interaction.
- Along with facial landmarks eyeblink and eye gaze can classify human expressions.
- Semi-automated vehicle intelligent system can be generated.
- Smart braking system along with smart auto-pilot system can be introduced.

Related works

1. Christopher D. McMurrough, Vangelis Metsis, Dimitrios Kosmopoulos, Ilias Maglogiannis, Fillia Makedon . “A Dataset for Point of Gaze Detection using Head Poses and Eye Images”. 2013
2. Tereza Soukupov´a. “Eye-Blink Detection Using Facial Landmarks” . 2016
3. Tereza Soukupova´ and Jan Cˇ ech. “Real-Time Eye Blink Detection using Facial Landmarks”. 2016
4. Lex Fridman, Philipp Langhans, Joonbum Lee and Bryan Reimer. “Driver Gaze Region Estimation Without Using Eye Movement” . 2016
5. Lex Fridman, Joonbum Lee, Bryan Reimer, Trent Victor. “Owl and Lizard: patterns of head pose and eye pose in driver gaze classification”. 2016