Joint Eye Tracking and Head Pose Estimation for Gaze Estimation

CS365 Project

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Motivation

- Human Computer Interaction
- Information about interest of the subject, e.g. advertisement research
- Analyze driver attention
- Device control by disabled people through eye position and head pose.

Past Work

- Eye locations and head pose have been separately used for gaze estimation
- Eye location algorithms are sensitive to head pose
  - Allow limited motion of head
- Head pose estimation often requires multiple cameras
- Head pose estimation alone fails to finely locate the gaze

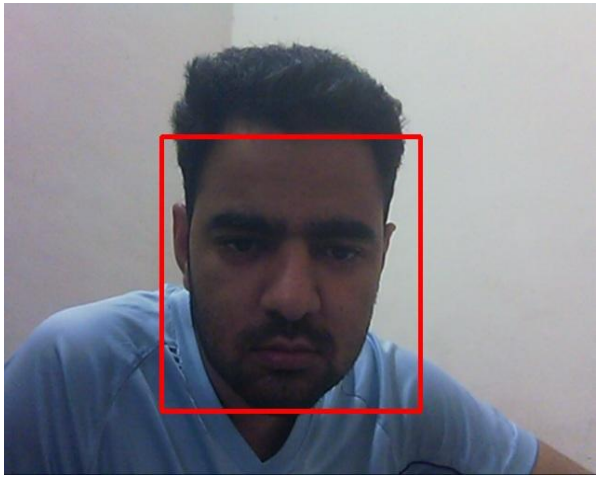
Approach

- Appearance based
- Integration of head tracker and eye location estimation
- Head pose defines the field of view
- Eye locations adjust the gaze estimation

Algorithm

Face Detection

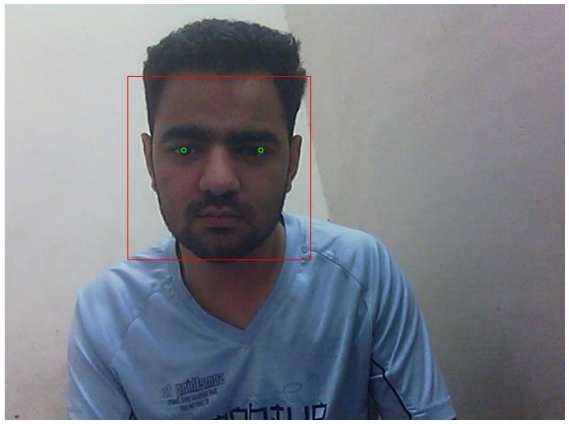
- Haar-like features for face detection
- Viola Jones object detection framework
- Classifier cascades



Algorithm

Face Detection → Eye Location →

- Isophotes – Curves connecting points of equal intensity
- Eyes are characterized by radially symmetric brightness patterns
- Find centres of the curved isophotes in the image



Algorithm

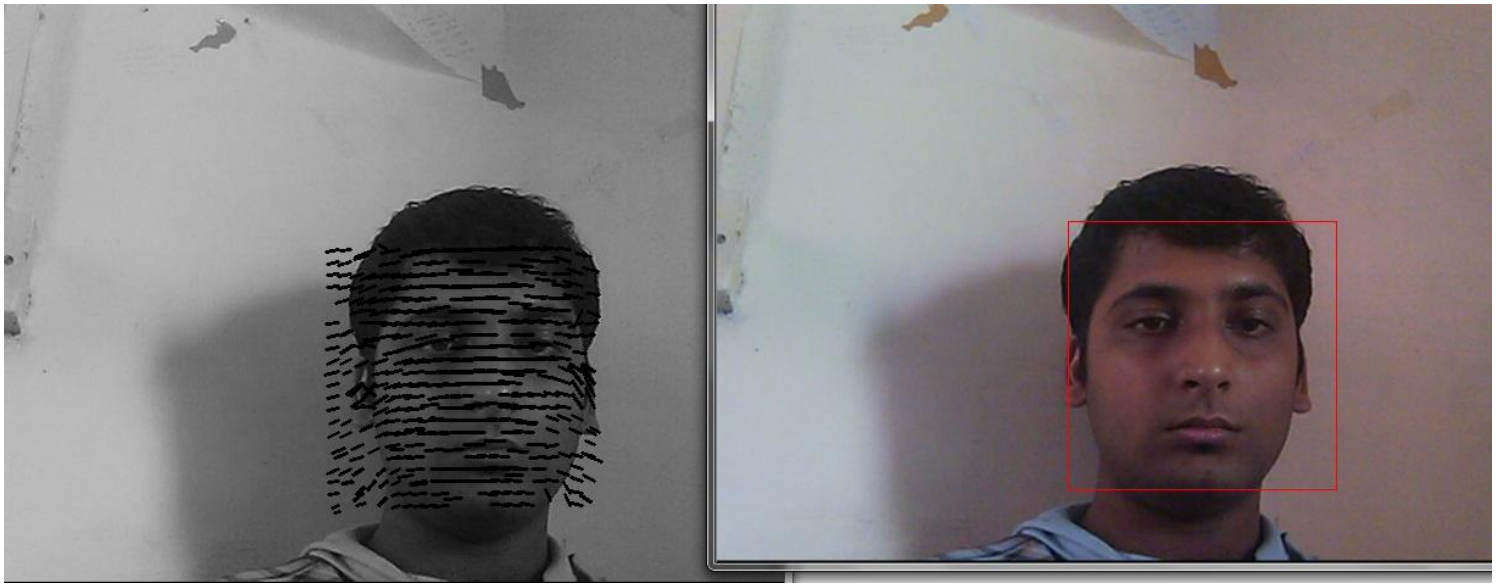
- Cylindrical Head Model
- Pose comprises of rotation parameters and translation parameters
- Tracking is done using the Lucas Kanade Algorithm
- Initial Eye locations used as reference points
- An area is sampled around each reference point and eye detector is applied to these regions
- These eye locations are used to validate the tracking process

Algorithm

Sampling Points on the Face for Tracking

Algorithm

Face Detection → Eye Location → Head Pose Estimation →



Face Motion Tracking

Algorithm

Face Detection → Eye Location → Head Pose Estimation → Gaze Estimation

- Assumptions - Visual Field of View is defined by the head pose only
- Point of interest is defined by the eyes
- Visual Field of View can be approximated by a pyramid

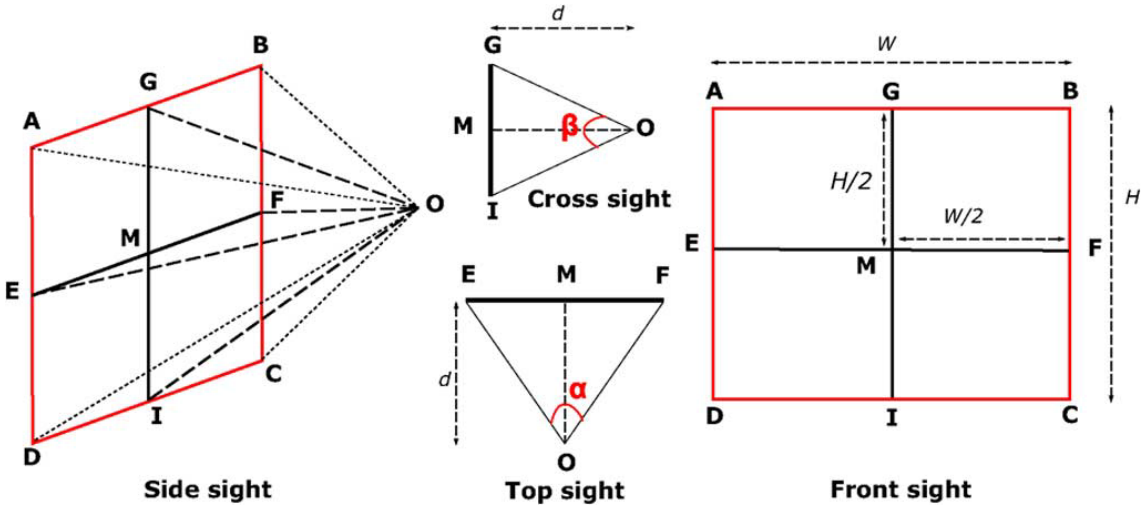


Image from [1]

Tools and Data

- Live data from web camera
- Eye API from [3]
- Boston University Dataset [5]

Work Done

- Face Detection
- Eye Locations
- 2D - Face Tracking

Promised but Not Done

- 3D Head Pose Estimation and Tracking
- Visual Gaze Estimation

References

1. Roberto Valenti, Nicu Sebe, Theo Gevers: Combining Head Pose and Eye Location Information for Gaze Estimation. IEEE Transactions on Image Processing 21(2): 802-815 (2012)
2. Jing Xiao, Takeo Kanade, Jeffrey F. Cohn: Robust Full-Motion Recovery of Head by Dynamic Templates and Re-Registration Techniques. FGR 2002: 163-169
3. Roberto Valenti, Theo Gevers: Accurate eye center location and tracking using isophote curvature. CVPR 2008
4. Roberto Valenti, Zeynep Yücel, Theo Gevers: Robustifying eye center localization by head pose cues. CVPR 2009: 612-618
5. http://csr.bu.edu/headtracking/uniform-light/
6. Jun-Su Jang, Takeo Kanade: Robust 3D Head Tracking by Online Feature Registration. IEEE International Conference on Automatic Face and Gesture Recognition, September, 2008.
7. Paul Viola, Michael Jones: Robust real-time object detection. IJCV, 2001