Drowsiness Detection using Contactless Heart Rate Monitoring and Eye Tracking

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- Motivation: Driving while fatigued is very dangerous and leads to 10-30% of road deaths (Rios-Aguilar et al). Biometric indicators can be used to detect drowsiness in drivers.
- Ocular indicators of drowsiness include blink rate, blink duration, and percentage of eye closure (Ftouni et al).
- Heart rate variability is another useful indicator, which can be measured by analyzing changes in RGB components of images of the face (Rios-Aguilar et al).

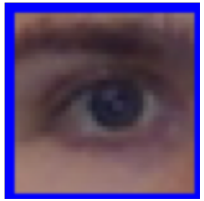
Eye Detection- Training for fisher image

Data Collection

- OpenCV to segment a bounding box around the eyes
- (1) 100 images of open and closed eyes taken at 5 different illuminations

Training

- (2) Global histogram equalization
- (4) Alignment to “good” image and crop
  - Subsequent alignment to (3) meaneye
- Top 100 eigenimages
- (5) Fisherimage



(1)

(2)

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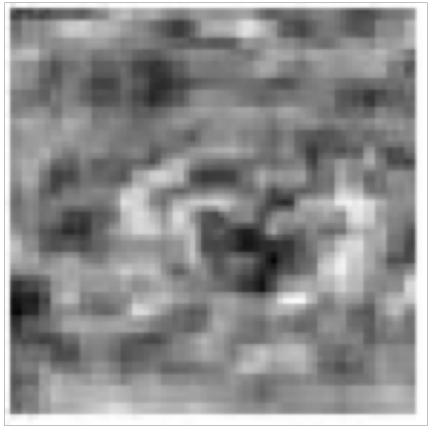


(5)

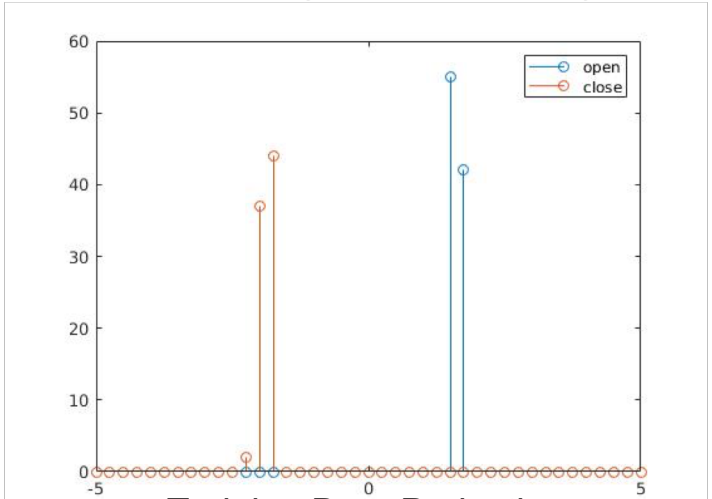
Eye Detection- Testing

Data Collection

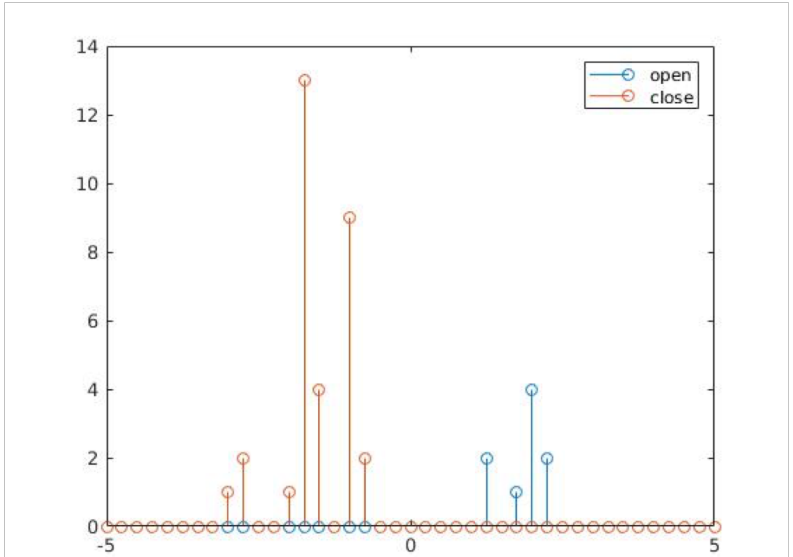
- (1) 100 total images of open and closed eyes

Accuracy

- 100% accuracy, but...
- More spreading than training case

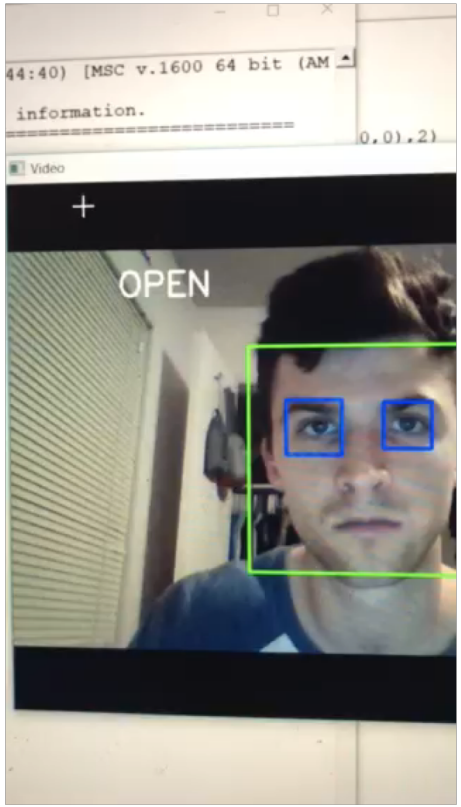


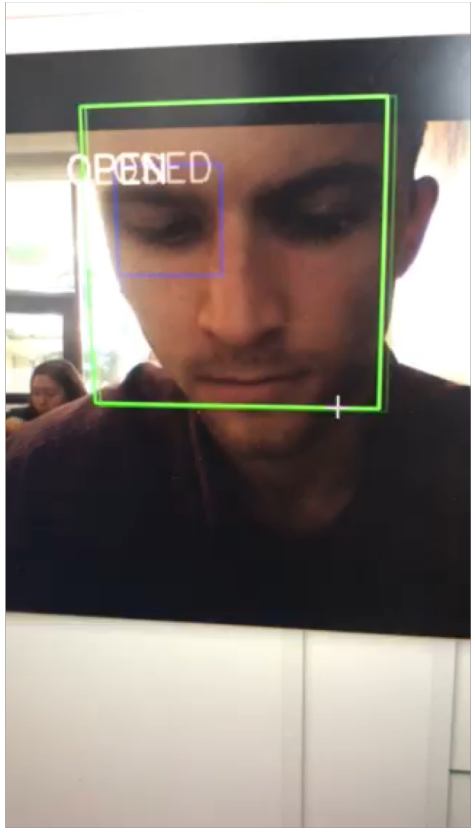
Training Data Projections



Testing Data Projections

Eye Detection- Demonstration





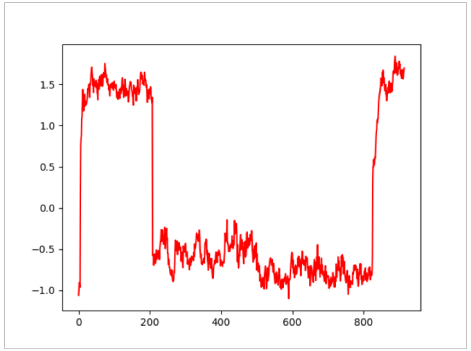
General Heart Rate Procedure

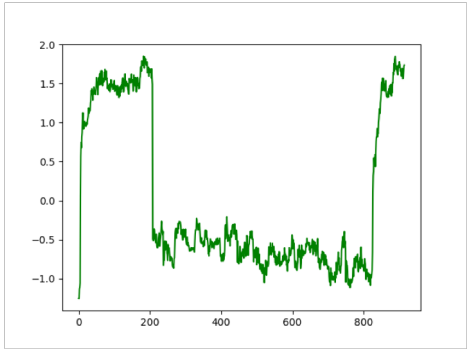
- Detect face using Viola-Jones detector
- Extract cheek area as ROI
  - Currently using dlib's face landmark detector
  - Computationally expensive, will try moving to a simple algorithm using the face bounding box

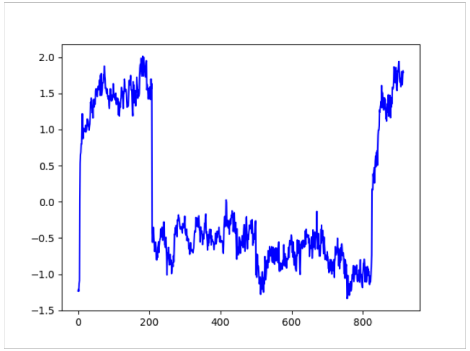
Heart Rate via ICA

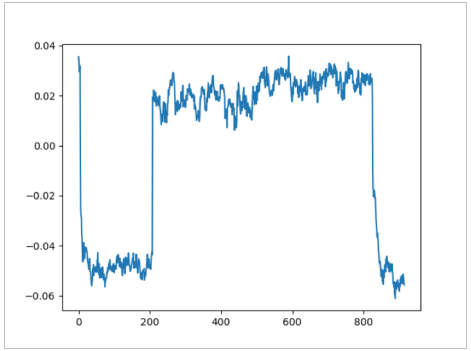
- Separate color channels into independent signals
  - In past experiments one of the signals was BVP
- Take FFT and look at magnitude to determine dominant frequency
- Tried bandpass filtering, looking at specific regions and averaging
- Trained on one video and kept unmixing matrix

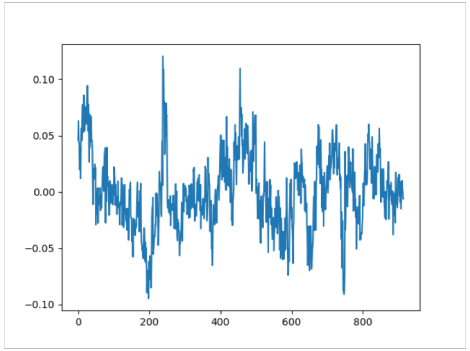
Heart Rate via ICA

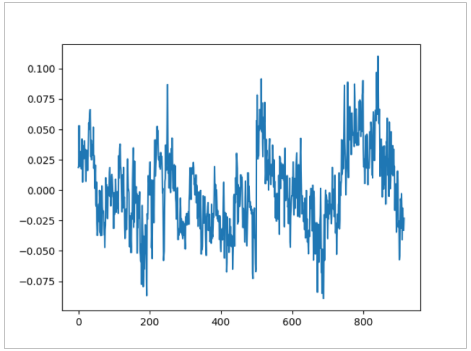






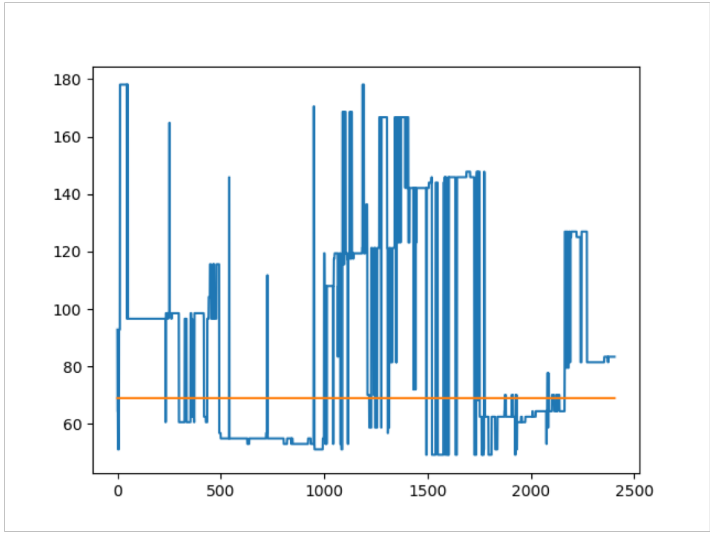


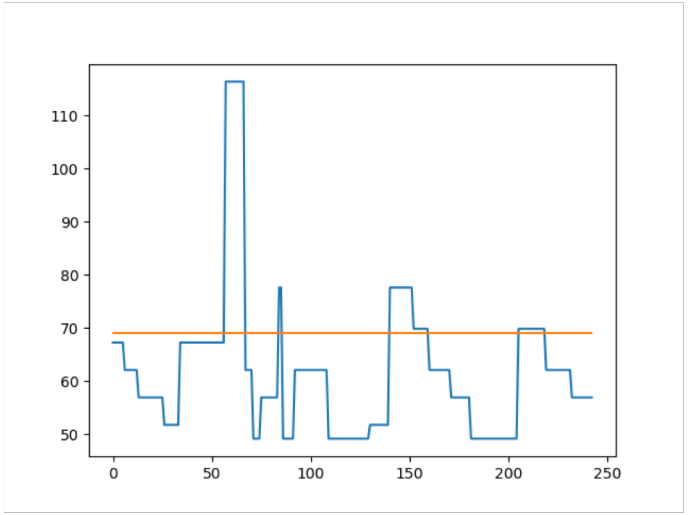




Heart Rate via ICA Results

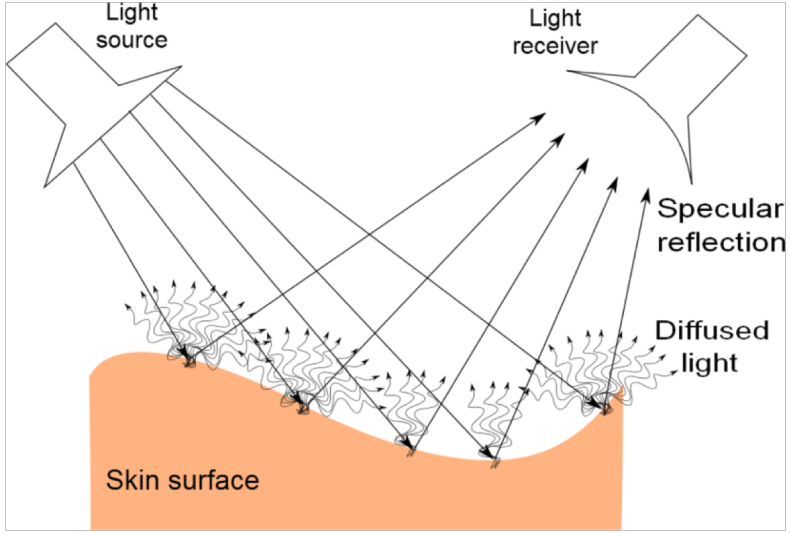
- Very imprecise
  - Measurement varies significantly for a steady video
  - Standard deviation around 11 bpm for database videos and around 40 bpm for webcam





Heart Rate via CHROM

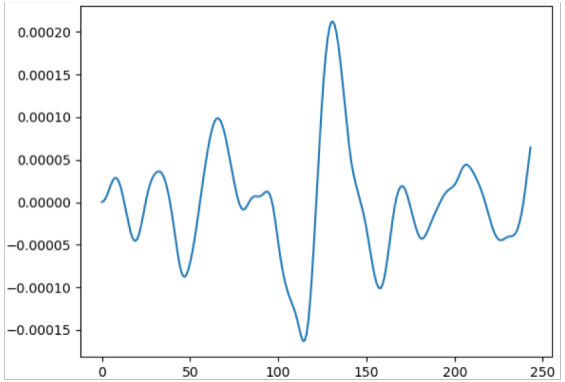
- Temporally normalize RGB signals
- Assume a standardized skin-tone and project into plane without specular reflection component
- Signal is defined as difference of chrominance signals



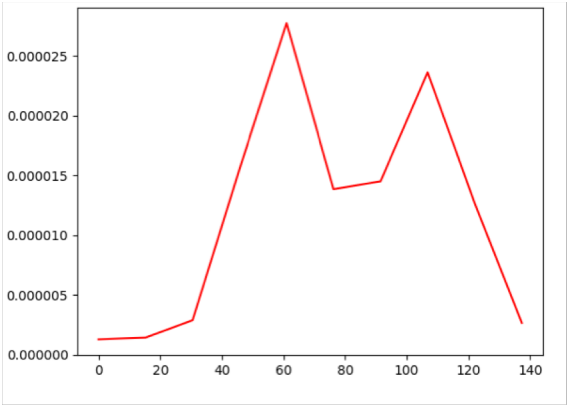
G. Haan, V. Jeanne, “Robust Pulse Rate From Chrominance-Based rPPG”

Heart Rate via CHROM Results

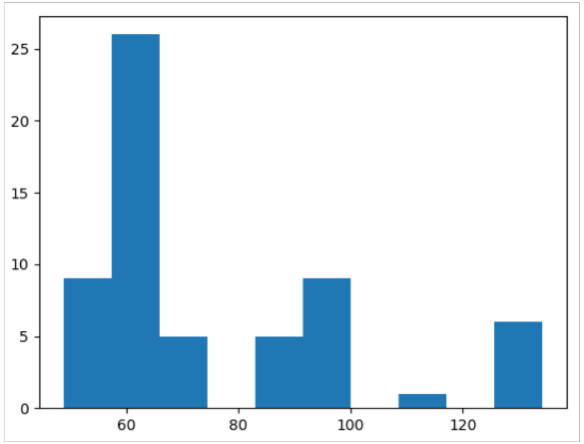
Ground Truth: 70bpm



Time Domain



Frequency Domain



Histogram of BPM

Relatively decent results for both dataset and webcam, within 10bpm

Conclusions

- Much more difficult than initially thought
- Originally planned for Android but canceled
- Despite many similar implementations heart rate was very difficult
  - Current implementation cannot determine heart rate variability
- Eye detection effective but limited
  - Requires training for individual users
- A good first step toward a drowsiness detector
  - Goal was not to make a detector but to provide tools for it