Detecting Drowsy Driving

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Abstract: Drowsy driving is a serious problem. Although the problem is well-studied, few devices that measure drowsy driving (such as EEG or pulse-measuring devices) are easily accessible and comfortable for the layperson. We developed an Android application that employs pupil tracking and machine learning to determine when drowsiness sets in, at which point the driver may be alerted. The application can be positioned with a common GPS phone stand. We hypothesized that pupil movement differentiates drowsy driving from attentive driving. The application employs a Random Forest machine learning algorithm. For our experiment, we supplied seven hour-long videos of participants navigating a driving simulator in an environment conducive to drowsiness. After merging the data from all of the videos, the algorithm achieved an accuracy of 81.8% for a 2/3 training-testing split.

Previous Research

- 3,154 people died in crashes involving distracted drivers in 2013 [1]
- The best predictor of crashes is the duration of the glance immediately preceding the crash [2]
- “Proxies of crash risk include... failure to scan for potential hazards in the driving environment” [3]
- Although EEGs detect drowsiness accurately [4,5], most drivers don’t carry EEG-measuring devices around
- EEGs physically discomfort the driver
- Pulse-measuring devices can also detect drowsiness [6]; however, most drivers don’t carry pulse-measuring devices
- Blink detection has been used to detect distracted driving [7, 8]

No evidence of successful mass-market solutions

Experimental Design

- Seven hour-long videos of participants driving in drowsy conditions were received
- Four males & three females; age range 23 to 37
- The videos were manually annotated; every thirty seconds, the research recorded whether the subject was drowsy or not

Our algorithm:

- Processed the videos
- Stored pupil movement distances for thirty seconds
- Associated the interval’s eye movements with the provided label (drowsy / not-drowsy)
- Used a Random Forest machine learning classifier to classify each thirty-second interval of movement distances as attentive or drowsy

The experiment tested whether our algorithm, given well-labeled data, differentiates between attentive and drowsy driving using pupil movements.

Methodology

- Face detection: A Haar-cascade classifier from the OpenCV library detects the driver’s face [9]
- Eye detection: Facial geometry is used to estimate the eye locations
- Pupil detection: Tristan Humé’s gradient descent algorithm [11] detects pupil centers within the detected eye regions

- The pupil distance traveled between each pair of frames is stored as a feature

Visualisation

We plotted the positions of one pupil from one of the participants. As seen to the right, our eyes wander when we become drowsy – literally!

Future Directions

1. Application optimization
   - Increase framerate and allow more powerful devices to run the application
2. Further experimentation
   - Test distracted driving with distractor tasks, such as talking on the phone and using Siri

Our algorithm can be found at:
- https://github.com/parejadan/eyeLikeTest (Desktop)
- https://github.com/parejadan/lifeSaver (Android)

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References