What’s on Your Mind?
A Mind-Based Driving Alert System

1. Motivation
According to a report by United States Department of Transportation about 400,000 accidents annually are due to hasty driver decisions. More than 160,000 people find it fatal. In recent years, the enforcement of safety features like seatbelt and reactive automotive technologies like lane assistance system have enabled drivers to drive more safely and effectively. Better safety can be achieved by using proactive technologies to predict driver’s intentions ahead of time and inform surrounding drivers of the course of the current action. This work introduces a novel system to predict driver’s intention based on Electroencephalography (EEG).

![Figure 1: Cars crashing due to a hasty driver decision](image1)

2. Experimental Setup
In our experimental setup an EEG headset (Figure 2) was worn by the subject (driver) guided through a course comprising both of city streets as well as interstate highway during different traffic densities. A video recorder was used to record the driving course and driver’s activity. We used the headset to record the five parameters viz. Engagement, Frustration, Mediation, Instantaneous excitement and Long term excitement.

![Figure 2: Driver wearing the Emotiv Epoc Headset](image2)

As the driver progresses through the designated course, the levels of each of these “Affective Parameters” are continuously monitored and recorded. A change in level of one or more parameters is a characterization of a range of physiological responses including pupil dilation, eye widening and heart rate etc.

Visualizing the driver activity (intention) alongside a change in level of these parameters allows us to infer patterns which are repeated each time the driver makes a driving related decision.

3. Results
We observed that out of various parameters, Instantaneous excitement follows the driver’s intentions most reliably. Instantaneous excitement parameter experienced monotonic increase at the second 17 to second 20 at which the driver actually switches lane (Figure 3). This change was triggered by a thought of switching lanes at which the reading level was 0.3 and persists during the entire process of switching lane with a peak value at 0.7 when the action was taken. The values started to decline immediately after lane change. Note that this three seconds prediction are perfectly enough for the majority of driving response times.

![Figure 3: Change in affective parameter level and Gyrop activity as the driver decides to make a lane change](image3)

We can also observe change in gyro readings as the driver makes up his mind for performing an action (in this case a left lane change). As he scans his mirrors in either direction, the gyro readings swing from positive to negative, indicating a left lane change. For an activity related to a decision on the right hand side, we would observe a swing in readings from negative to positive, thus allowing us to differentiate between left and right directions.

On comparing the parameter levels for two drivers, we observe similar patterns for the same activity. Figure 4 shows the change in excitement and frustration levels of the two drivers as each tries to change lanes.

![Figure 4: Comparing parameter levels for two drivers](image4)

4. Conclusion and Future Work
These preliminary results are very encouraging and motivating, and we plan to integrate EEG system with eye movement and other on-body accelerometer sensors to be able to detect high granularity sub actions (e.g., eye movement) that lead to major actions (e.g., turning left, passing car) with high accuracy.

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