Using Mobile Phone Sensors to Detect Driving Behavior

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ABSTRACT

In India, an increasing number of vehicles on the roads, in recent past, have led to an increase in the number of road accidents. There have been alarming statistics regarding the number of accidents per day in India. At least 1,42,000 people died due to road accidents in India in the year 2011[1]. Bad driving, lax traffic control, and poor road conditions are the main reason for this.

In this work, we present a mobile phone application that uses combination of in-built sensors, GPS, micro-phone and accelerometer, to detect driving behavior along with road and traffic conditions. This application will prove helpful in detecting bad driving as well as road and traffic conditions in order to assist a willing individual to change his or her driving behavior. The law and enforcement agencies may also use this data in analyzing the ground realities for increasing number of road accidents.

Categories and Subject Descriptors

H.3.4 [**Systems and Software**]: User profiles and alert services; H.1.2 [**User/Machine Systems**]: Human information processing

Keywords

Sensors, accelerometer, audio, mobile

1. INTRODUCTION

With dramatic increase in number of personal vehicles in past few years, driving in developing countries, e.g. India, is becoming increasingly difficult and dangerous. Lax traffic control and poor road conditions further add to this menace. With limited resources, the government agencies are finding it increasingly difficult to control the situation. A good road, traffic, and driving monitoring application can be a good enabler for such acts. It will also help a willing individual to analyze his or her personal driving behavior and improve over it.

Previously researchers have tried to monitor road conditions using both embedded sensing platforms [3] and mobile phone sensors [1]. Sen et al. [4] used low-cost audio sensors, deployed on the road-side, to detect traffic conditions on Indian roads. The novelty in our work is about combining inbuilt sensors of mobile phones (accelerometers, GPS, and microphone) to detect driving behavior, thus adding a new dimension in the existing research work [1], [3]. Previously, Lu et al. [2] have used microphones of mobile phones to classify different types of ambient sound. In our work, we are using audio processing to detect how drivers are using horns and indicators in their driving.

Figure 1: Ground Truth Application

2. APPLICATION DESIGN AND ANALYSIS

We have developed our application as a service on Android platform to allow it to run in the background. The application is divided into two parts: data collection and analysis. The application collects data from accelerometers, GPS, and also records sound via the microphone. The combined data is then analyzed to detect rash driving patterns. We have collected data by doing multiple experimental runs in New Delhi, India. For the data analysis, we also needed to collect the ground truth. For this, we developed a second application, see a screen-shot in Figure 1, which was used by a co-passenger to collect ground truth and label the data.

[1] `http://articles.timesofindia.indiatimes.com/2012-06-08/india/32123122_1_road-accidents-road-fatalities-road-deaths`

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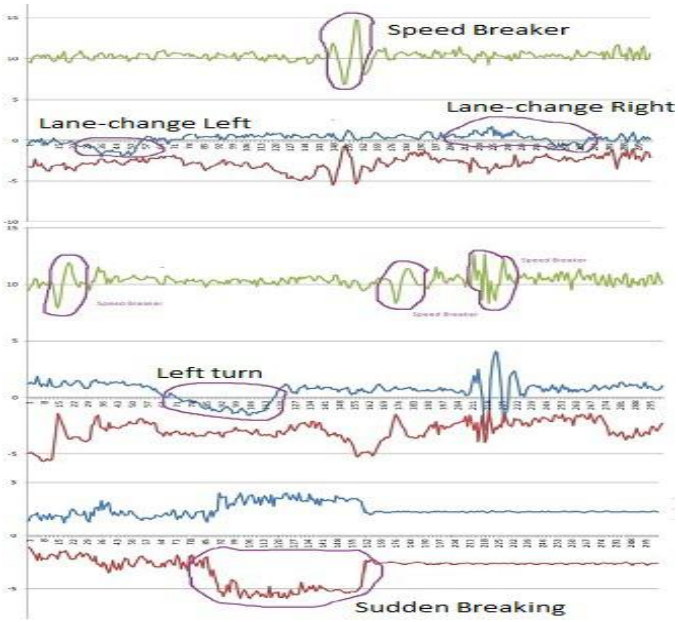

Figure 2: Driving pattern from accelerometer data

From the data, The following patterns were observed and verified using 'Ground Truth' as shown in Figure 2:

- Speed Breaker: Peak in z-axis.
- Left Turn: Sudden decrease in x-axis acceleration towards negative side.
- Right Turn: Sudden decrease in x-axis acceleration towards positive side.
- Left Lane Change: Initial decrease in x-axis acceleration followed by increments.
- Right Lane Change: Initial increase in x-axis acceleration followed by decrements.
- Sudden Braking: Sudden decrease in y-axis acceleration followed by a nearly straight line. The acceleration values of the x and the z axis also experience curves due to a sudden jolt.
- Sudden Acceleration: Sudden increase in y-axis acceleration. The acceleration values of the x and the z axis also experience curves due to a sudden jolt.

With collected audio data, we found two patterns: for horn and for indicators, see Figure 3. We used audio finger printing techniques to find audio patterns in collected audio samples as shown in Figure 4.

While normal user behavior such as number of honks, speeding, and sudden brakes etc. can be detected directly from the data. We can also correlate audio data with accelerometer data to further find new patterns of rash driving. For example, if a turn or lane change is not accompanied with indicator sound, then this also means rash driving. Combining frequent honking with slow speed indicates traffic. Our application can also plot the analyzed pattern on Google maps to help visually see the spots where violations occurred.

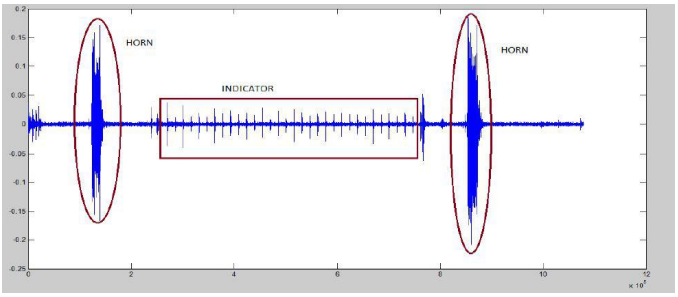

Figure 3: Audio indicator/horn pattern

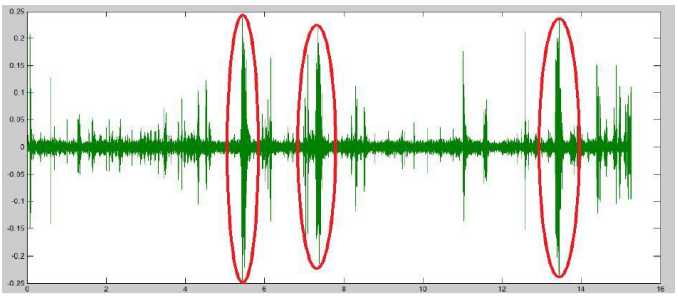

Figure 4: Audio patterns in collected data

3. FUTURE WORK

Our future work is aimed towards using advanced machine learning techniques to find out patterns from the collected data and classify them accordingly. This can be done on a server where data can be uploaded at the end of the journey. We also want to enable crowd-sourcing, to collect mass data and analyze other subtle reasons behind rash driving, e.g., under what conditions - traffic, rush hours etc.- a person drives rashly.

4. REFERENCES

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