MOBILE PHONE BASED DRUNK DRIVING DETECTION

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Abstract—*Drunk driving, or officially Driving Under the Influence (DUI) of alcohol, is a major cause of traffic accidentsthroughout the world. In this paper, we propose a highly efficientsystem aimed at early detection and alert of dangerous vehiclemaneuvers typically related to drunk driving.The entire solutionrequires only a mobile phone placed in vehicle and withaccelerometer and orientation sensor.A program installed on themobile phone computes accelerations based on sensor readings,and compares them with typical drunk driving patterns extractedfrom real driving tests.The purpose of this system is to advance a system to detect drunk driving based on real time patterns found while driving by the driver and to alert driver's friends or family or both before accident actually happens. The main components of thesystem consist of accelerometer and orientation sensors and softwareinterface with GPS and Google Maps APIs forlocation.*

Keywords—Drunk Driving Detection; Mobile Application;Sensors

1. INTRODUCTION

According to the report of U.S. National Highway Traffic Safety Administration (NHTSA), about 137000 people have died in road accidents in the United States in 2013 and almost 44600 deaths were because of drunk driving. Drinking can seem harmless, but is not when you are going to handle a large vehicle that could take the lives of innocent people when used improperly. In the last two years, 2014 and 2015, 16,041 and 17,773 alcohol-impaired driving fatalities happened, respectively. Blood Alcohol Content (BAC) or Blood Alcohol Concentration (BAC) is concentration of alcohol in blood. It is usually measured as mass per volume. If the Blood Alcohol Concentration (BAC) is about 0.2 % then the loss of judgment is seen in that drunk driver. If it is about 0.5% then it results in reduced co-ordination and reduced ability to track moving objects. If it is about 0.8%, it troubles driver even in controlling speed, for 0.10% the difficulty in staying in lane and breaks are applied when needed as per the driver's sake. If the intake of beer exceeds to 7, i.e. 0.15% then serious difficulty in controlling the car and focusing on driving.

A. Motivation

The causes of accident on the highway in any countries come from vehicle condition, human error, and highway physical conditions. The major cause of highway traffic accidents is from driving behavior such as excessive speeding, improper following, erratic lane changing and making improper turns, which is approximately 75% of total accidents. Hence there is a need of system which will detect/predict accident if the driver's behavior is not good due to alcohol or rush driving.

B. Objective

We have developed a system by which the drivers behavior should get recorded in real-time and which can be monitor remotely by police or relatives.System should be able to detect improper driving behavior in real-time.Alarm system to notify nearest police and driver's friends in real-time.

2. LITERATURE REVIEW

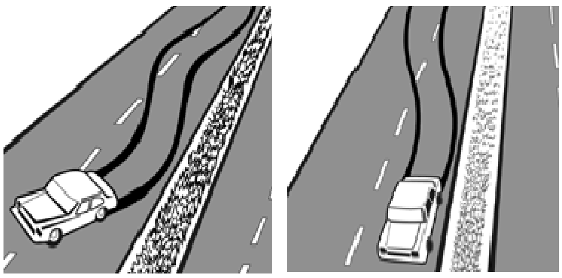
There is some existing research on the development andvalidation of technological tools for driving monitoring. Some of them are known under the name of driver vigilance monitoring, and they focus on monitoring and preventing driver fatigue. In the MIROAD system, they have used two cameras on dashboard to capturethe visual cues of drivers, such as eyelid movement, gazemovement, head movement and facial expression, in order topredict fatigue with a probabilistic model. The limitation of MIROAD systemisimproper working of camera at night& it is costly because of high performance camera is needed.

Some system have only hardware sensor which are deployed in car to monitor driving behavior, Estimating DrivingBehavior. The limitation of this system is No SMS notification mechanism,Hardware failure might occur.

3. PROPOSED WORK

A. Lateral Acceleration and Lane Position Maintenance

Normally, the prime reason of abnormal or irregular curvy movements is the lane position maintenance which causes weaving, drifting, weaving and turning with a wide radius. Result of these all driving behaviours is an extraordinary change on lateral acceleration.


(a) (b)

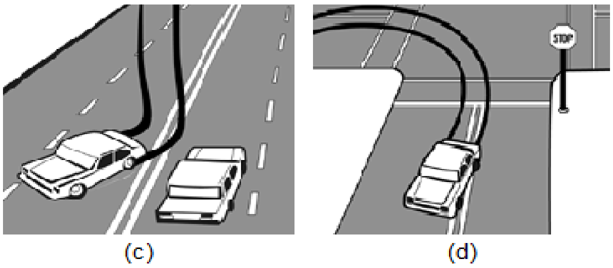


Fig.1. Problems in maintaining the lane position: (a) weaving, (b) drifting, (c) swerving, (d) turning with a wide radius

B. *Longitudinal Acceleration and Speed Maintaining*

Driver who is driving vehicle under the influence of alcohol unable to keep proper speed and so he often experiences difficulty in driving. Sudden acceleration or deceleration, eccentric braking and shaky stop are some strong hints that concludes the driver is an under influence of alcohol. They all cause an inappropriate change in longitudinal acceleration. The longitudinal acceleration is toward the head of the vehicle. So the concise acceleration of vehicle will lead to an extensive increase of longitudinal acceleration i.e. in positive values. The concise deceleration, eccentric braking or shaky stop will cause an immense decrease of longitudinal acceleration i.e. in negative values.

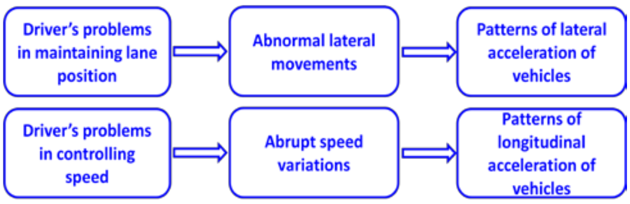


Fig. 2. Lateral and Longitudinal acceleration

C. *System Overview*

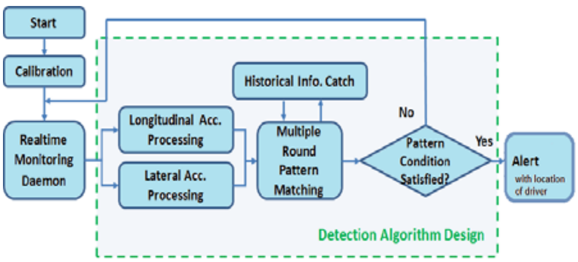


Fig. 3. System Detection Algorithm

The drunk and drive detection system is made up of four components, as presented in Fig. 3. They are (1) monitoring daemon module, (2) calibration module, (3) data processing and pattern matching module and (4) alert module. The third module implements the detection algorithm, as marked by a dashed box. Our design is general, not constrained to any particular brand or type of mobile phone. And our design is also power-aware, as hardware such as the screen is only activated when necessary.

The work flow of our drunken driving detection system is also illustrated in Fig. 3. After the system starts manually, a calibration procedure is conducted when the system detects that the phone is located in a moving vehicle. Then the main program launches, working as a background daemon. The daemon monitors the driving behaviors in real time and collects acceleration information. The collected information includes lateral and longitudinal acceleration. They are processed separately, and used as inputs to the multiple round pattern matching process. At the same time, the historical information will be registered. This information is helpful in the following round pattern matching process. If the pattern condition is satisfied, which means a drunk driving is detected; one signal is transmitted to trigger an alert. The phone may alert to friends and family of driver with an SMS Notification which includes the current location of driver. If the condition is not satisfied, execution returns to the daemon immediately.

D. *Design of the Algorithm*

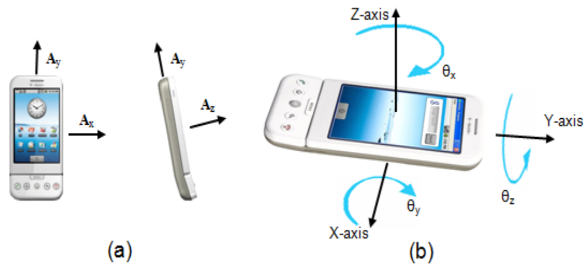


Fig. 4. (a) Acceleration readings in direction of x-, y-, and z-axis with regard to the body of the mobile phone. (b) The posture of mobile phone is decided by yaw (_x), pitch (_y) and roll (_z).

We design the detection algorithm based on accelerations, and apply it to the mobile phones equipped with accelerometer and orientation sensor. The acceleration readings are usually provided by accelerometers in directions of x-, y-, and z-axis, correspondingly represented by A_x; A_y and A_z. For generality, we assume that the directions of x-, y-, and z-axis are decided by the orientation of the phone. As illustrated in Fig. 4, the x-axis has positive direction toward the right side of the device, the y-axis has positive direction toward the top of the device and the z-axis has positive direction toward the front of the device.

A mobile phone's orientation can be determined by orientation angles, i.e. yaw, pitch, roll values that are denoted as _x; _y and _z, respectively. The yaw means rotation around the z-axis, while pitch and roll represent the rotation around x-axis and y-axis. They are also shown in Fig. 4. The values of them can be obtained via the orientation sensor. In real detection process, both the lateral acceleration and the longitudinal acceleration should be based on the vehicle movement direction. The acceleration information of the mobile phone, A_x; A_y, should be transformed into the accelerations of the vehicle. In the simplest case, we assume that the mobile phone is laid flat in the vehicle, with the top of phone toward the head of vehicle, so that the accelerations on x-axis and y-axis represent the lateral and longitudinal accelerations of vehicle, respectively. However, the real situations are more complex. The mobile phone may be laid in the vehicle arbitrarily, neither flat nor heading toward the head of the vehicle. Therefore, we set a calibration procedure to help the system determine what direction is longitudinal. The calibration procedure begins to work when the system detects the vehicle starts to move. Its starting movement gives the mobile phone a continuously initial longitudinal acceleration, either forward or backward.

E. Implementation

We develop the prototype of the drunken driving detection system on Android MOBILE phone. The MOBILE phone provides an accelerometer sensor and an orientation sensor. We implement the prototype in Java, with Eclipse and Android SDK. It consists of 6 class files, which include 3 Activities, 1 Service and 1 Resource. They can be divided into five major components: user interface, system configuration, monitoring daemon, data processing and alert notification. The monitoring daemon keeps running in background as a Service in Android, collecting and recording the readings of sensors. These readings are processed and used to detect drunk driving. When drunk driving is detected, the alert notification component alerts friends and family with SMS notification. We compile and build the system project, create and sign the .apk file and install it onto mobile phone. The size of the .apk application file is about 1.4MB.

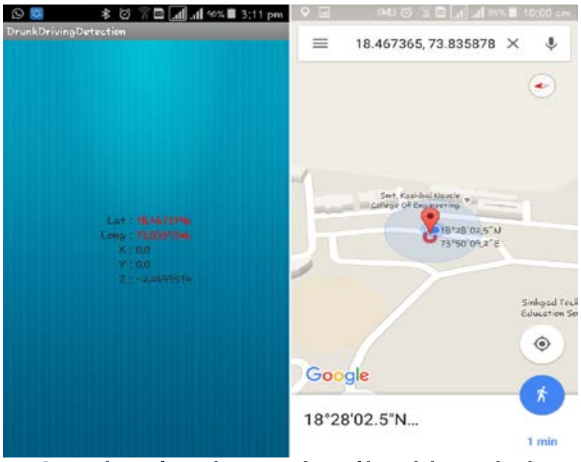


Fig. 5. Screenshots of app showing values of lateral, longitudinal, x, y, z and current location of driver on Google maps

F. Energy Efficiency

To test power consumption of the detection system, we fully charge the mobile phone and then monitor the power states continuously for 7 hours in different scenarios: 1) the mobile phone runs without drunken driving detection; 2) the monitoring daemon of system keeps running, sensing and recording acceleration and orientation, and do the pattern matching on the monitoring results. Fig. 6 illustrates the two curves of battery level states versus time during this time period of 7 hours. If the drunken driving detection system keeps running until the battery power is exhausted, it will last a little more than 15 hours.

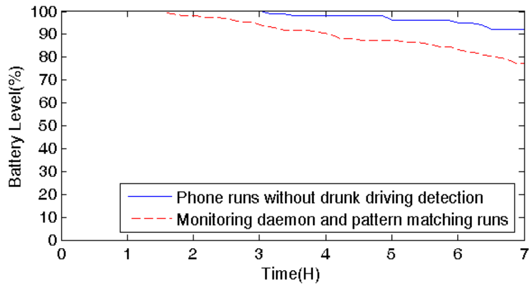


Fig. 6. Power consumption curves in different scenarios

4. Conclusion

In this paper, we present a very efficient android phone based drunk driver detection system. The mobile phone collects and analyses the information from its accelerometer, GPS sensor and orientation sensor to identify any irregular or dangerous driving behaviour typically related to driving under influence of alcohol and alerts friends or family or both through SMS notification with current location of driver, before accident actually takes place.

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