

Safe and Secure Driving Using Android Smartphone

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Abstract—Past few years, almost the whole world has seen a tremendous growth in the accidents occurring on roads. Developed and developing countries all around the world and mainly India has experienced increasing number of injuries and deaths due to unawareness of road conditions, unhealthy driving behaviours and increasing traffic. We cannot ignore the important contribution of science made in road safety by introducing advanced driver-assistance systems (ADAS), warning systems, in-vehicle information systems (IVIS) and other such safety systems for minimizing occurring road hazards. Yet existing and new innovations feel the need of more improvements for tackling the road anomalies. Mobile devices or say mobile phones are found to be one of the reasons for road accidents, but in this paper we wish to present a multi-purpose Smartphone as an innovative remedy for preventing road accidents. Most of the safety systems that have been developed are formed by studying different accidental situations after they have occurred. By using a Smartphone mobile device, working on android, we try to provide a pictorial representation of road conditions with different road anomalies on routes shown by Google map. By implementing such an idea we try to make the vehicle operator aware of safe driving behaviours and different road problems on routes to be travelled.

Keywords—Accelerometer, Driving behaviours, Mobile phones, Road anomalies, Sensors

I. INTRODUCTION

In today's fast-paced world, on one hand everyone wants quick results in whatever they do, and on the other hand they continue to forget the dangerous complications they develop around themselves. Any individual wants to reach their desired destination on or before time in a well-equipped vehicle but with these they also want to experience almost no hurdles on the roads they travel through. Driver's inattention to certain preventive details leads to serious injuries, fatal deaths and also harms the other environmental factors.

If we observe the Global Status Report on road safety issued in 2013 [6], it shows the major countries with growing road accident cases and sadly India is one of those countries. Accidental scenarios can be prevented to a good extent using newly developed driver assistance systems. Such kinds of

systems have been included long back by the vehicle manufacturers and they continue to bring innovations in them. These individual systems embedded in cars make use of heavy sensors and other utilities for driver safety like seatbelts, anti-lock brakes, airbags, etc. But such preventive measures are too expensive for all vehicle owners and are limited to mostly four-wheelers vehicle type. With accidents there are other problems caused due to road anomalies. Fixing roads increases the financial and resource problems of the government. Bad road surfaces affect the physical and mental health of people travelling through it. It also causes serious damages to the vehicles. The different road anomalies slow down the travelling experience and leads to wastage of time, fuel and money. Travelling such roads becomes more dangerous at night time.

Some systems used by the government to detect road surfaces are bulky and slow. The road side sensors initiated cannot accurately cover all anomalies of that respective road. Such sensors face too much of human and environmental interference. Intelligent Transportation System (ITS) introduced an important component of advanced driver-assistance systems (ADAS) in the transport field. But it is also experienced that vehicles manufactured with these important ADAS packages increases the vehicle load and financial issues.

Here we will discuss some prior main systems which proved to carry effective work in the transport and automobile field. The system Pothole Patrol (P²) [1] makes use of accelerometer from mobile device along with Global Positioning System (GPS) sensor to gather and process the data that gives information of problems on road surfaces. The Nericell [2] system whose name is derived from Tamil word 'Nerisal' which means congestion focuses widely on traffic conditions, also generates data regarding road surfaces. Nericell makes use of mobile sensors and external sensors. In a mobile phone based drunk driving detection system [4] there is a comparison made between normal driving activity and drunk driving activity, such combined data is recognized and for this an alert system is provided by using a mobile phone.

The lane changing factors are well discussed in a real-time hand held Lane Departure Warning System (LDWS) [3] that can be used easily on any four-wheeler vehicle to improve driving habit at lane departure situations. The system named MotoSafe [5] is another active safety system which mainly concentrates on driving manoeuvres of two-wheeler riders and generates effective warning system using an android platform Smartphone. When we studied the above systems then their techniques used and their drawbacks, motivated us to introduce much easy and innovative method for dealing with different road challenges.

Mobiles especially smart phone devices are equipped with so many features and facilities. Usage of Smartphone cannot be limited to only calling and multimedia, but they can also be used as an important tool to monitor routes. Android operating system takes these devices to new heights. Taking this multipurpose device, running on android, we wish to present it as an overall device that detects and collects data of various road anomalies like potholes, bumps, rough and uneven roads, using an internal sensor known as accelerometer. Further this data is generated on a Google map with different colour markers used to differentiate these road anomalies.

II. EXISTING SYSTEMS

A. Pothole Patrol (P²)

This monitoring system deals with sensing, detecting and reporting of road surfaces. Pothole Patrol system mainly collects the data related to potholes and bumps for which it mainly focuses on vehicle mobility, sensors embedded in vehicles and makes use of certain algorithms for accuracy. In this system the time, speed, location and heading these four functioning parameters come under the GPS device and related acceleration vectors are obtained from the three-axis based accelerometer. Here a central server maintains a database of detections and also, all such required detections are uploaded. For elimination of occurring errors and to obtain accuracy this system makes use of a pothole detection algorithm and an algorithm to compute or find clusters of collected pothole detections.

GPS sensors from computers that are embedded in cars, limits the P² usage in case of other vehicles like two-wheelers. No special installation or usage of any other hardware is required for our device. It can be used by two wheeler owners or four wheeler owners. The experimental result of P² system shows only usage of public transport like taxis, postal vehicles, garbage trucks, etc. In our scenario a Smartphone can be operated in any vehicle and the data need not be recorded by the driver only, it can be recorded and observed by any fellow passenger present on vehicle. Pothole Patrol collects the data related to road anomaly effectively but no proper or easy generation of such data is available. We use Google maps to show these road anomalies by which user can see and understand the data easily.

B. Nericell

The sensing functions supported by Nericell system make use of the portable mobile phone device. The pothole data is captured by accelerometer and the honking from traffic areas is detected by the microphone technology present in the device. So both main issues of uneven surfaces and traffic on road are detected by the mobile. Nericell also makes use of

cellular radio or say Global System for Mobile Communication (GSM) as a sensing and alert conveying functionality. But Nericell is not available for detecting other problems related to the road like uneven, rough or smooth surfaces. These complexities are easily differentiated and shown by our system. This system makes use of very complex hardware and software setup which results in the energy saving problem. The experiments carried out in Bangalore, India show use of a virtual reorientation algorithm that works on a Smartphone name HP iPAQ using Windows Mobile 5.0 operating system. It also mainly describes the traffic conditions and gives less focus on road conditions. The sensed data collected by the system is sent for reporting and aggregation first, to a service in the cloud. This system discusses that the information gathered is used to annotate a map that gives details of some road anomalies but they remain unclear of how they show it.

C. MotoSafe

The MotoSafe system differentiates and shows the dangerous driving behaviour of a motorcyclist and also acts as a data recorder for traffic. The system felt the need to focus on this area because mostly two-wheeler operators have bad driving habits and also very less such work is done with respect to a motorcycle. One more new thing that this system made use of was the Smartphone along with cloud computing domain. Mainly three sensing techniques are used here namely magnetometer sensor, GPS and acceleration sensor. All these sensors are present inbuilt in a Smartphone.

System platform for this is the Android which is based on modified version of the Linux Kernel. For proper functioning the system working was differentiated into different modules like pattern matching, sensor listener, user interface, traffic data recorder with notification module. Alerting factor is shown on screen of device which is based on different colours like low risk factor is shown by blue and dangerous condition is shown by green colour. Notification module sends an emergency alert to the police department when any serious accident has occurred. When the stop function is indicated all this information combined by the system is sent on the cloud. So basically MotoSafe acts as a warning system. In this case the focus is on driving behaviour and not road conditions. In short, it gives data about whether the two-wheeler driver is driving properly or not and not about the route the operator is travelling on. Our system focuses on routes to be travelled and also warns driver on proper driving pattern. This MotoSafe was developed using android device technology only for two wheelers. The condition for our system usage is that may it be any type of vehicle only the person in the vehicle should have a multi-purpose Smartphone with android. The most disturbing factor in MotoSafe is that the driver has to see the device while driving, which is equally dangerous. Our device shows road anomalies on maps which can be seen before starting the journey or any other person can see the map and inform the person driving the car.

D. Lane Departure Warning System (LDWS)

Lane departure also acts as problem or the reason for accidents in some cases. This danger mainly occurs if the driver is not attentive in his driving activity or say unaware of sudden lane change. For this problem we studied the LDWS system called Lane Departure Warning System. The working of LDWS is ARM based which stands for Advanced RISC

machines. LDWS has its results based on two main scenarios that are firstly when the vehicle operator goes too close to the lane boundary and secondly when the vehicle approaches the boundaries in fast or uncontrolled speed. The sharp tortuous paths or any other such non-flat roads that can be equally dangerous are not taken into consideration by this system and it only tries to focus on lanes. Comparatively our system considers lane changing and makes driver aware of proper driving actions on new roads depending on road anomalies occurring on it.

The LDWS uses Spatial and Temporal mechanism with difficult formulas. Here frame-based day and night time evaluation factor needs the usage and maintenance of hundreds of frames by video clips from Liquid-Crystal Display (LCD) which increases the working and cost of Lane Departure Warning System. LDWS has different core setup or say architecture for its hardware and different input and output modules in software section along with storage and power supply related modules which do not allow the LDWS to remain in portable category. Night time travelling when the alert or warning is required more regarding accurate lane changes; it is at this severe time when performance of LDWS fails due to lack of sufficient illumination.

III. PROPOSED WORK

Smartphone operating on android platform has made its important contribution in almost every field like medical, gaming, multimedia and seeing previous work we again try to bring it in transport sector. We try to deal with dangers occurring on roads and road safety using Smartphone for detection and capturing, GPS and Wireless Fidelity i.e. Wi-Fi for accuracy and connection and Map especially popular Google map for easy generation or view of such combined data. The main factor here in our case is that we wish to make any individual and Government aware of hazardous consequences, before they lead to any accident or severe damage. Also we try to minimize the cost, time and energy wastage, may it be from the Government side or any common man.

A. System Description

Our proposed work introduces such a product or system whose user can be any citizen who has an android device and this application installed on that respective device. The user-interface is very easy to use and the access requires internet only, to view or download the provided data. Once the required route data is downloaded by the user it can be viewed any time as per the individual's need. The inbuilt accelerometer of the device detects any kind of movement and it is further numerically analysed and shown in respective directions. Depending on these values proper location information is further extracted. From historical time any man has used either direction compass or maps to travel any route by any transportation mode. Even today the simplest way to scan a route by human eye is by the source of a map. After getting the road conditions, exact GPS based location can be found out and simultaneously can be mapped on the Google Maps. Our requirement in case of monitoring of roads and communication is at least one mobile of android operating system and one router in case if android handset fails to discover the local ad-hoc network, in such case we need to create actual network. Finally in this way when any person

wants to travel through new routes such easy representation of roads makes the journey more secure and increases driver awareness.

B. Setup Overview

The Smartphone of mobile device category, running on android platform is the heart of our system. Smartphone devices are embedded with so many features like sensors, microphones, audio/video features that make it a useful portable device. These embedded factors help to reduce the cost of infrastructure and working for our system. Moreover these devices are so user friendly, lightweight, portable and hence widely used. For road anomaly detection purpose we use the embedded three-axis based accelerometer of an android device. It is capable of detecting multiple motions triggered by a vehicle. Different driving manoeuvres are found and differentiated by using each individual axis of the accelerometer. Here we try and utilize the accelerometer's x-axis and y-axis values to measure the driver's direct control of the vehicle as they perform steering, acceleration, and braking actions. Accelerometer (x, y, and z) axes can be adjusted in an arbitrary orientation with respect to vehicle it is kept in and its respective (X, Y, and Z) axes. We intake the accelerometer value for an individual GPS recorded value and denote the accelerometer value as a segment of a given particular area. The orientation or say position of the phone is fixed in specific manner. Previous experimental results carried out for this notify that for road condition analysing it must be firmly mounted on to the floor board of the front passenger section. There were 1 to 5 places inside the car on which the phone was tested to measure various driving actions.

The three axes involved in the accelerometer, work for different types of scenario capturing like the x-axis captures all left and right movements which can be used to detect and show the turning and lane changing actions, similarly the y-axis records front and rear directions in the vehicle to detect acceleration and braking actions and the z-axis is given the task of analysing up and down directions to differentiate sharp or sudden vibrations and different road anomalies like potholes, bumps, uneven and rough surfaces on the routes. As we know Java is both a programming language and an environment for executing programs written in Java Language. So we plan to use java seeing its suitability for networked environments which enables secure, robust, programs to be delivered across the networks and runs on a great variety of computers and devices. It is possible to differentiate a pothole from a bump or any such comparison of the different road anomalies; it can be done by setting specific and accurate threshold values for each accelerometer axis. The threshold values will be the type and speed of the vehicle. These android based devices (Smartphone) should have Wi-Fi through which it will connect to server. Along with the accelerometer values the GPS latitude coordinates and longitude coordinates taken are then sent to the respective server.

The Android Software Development Kit (SDK) provides the tools and APIs necessary to begin developing applications on android platform using the java programming language. Android is known as the most popular, user friendly and inexpensive operating system, mainly for cellular devices, which equally supports many hardware components. Its common hardware components consist of cameras, a Wi-Fi

communication chip, cellular commutation chip, Bluetooth sender and receiver, and a colour touch screen. The Android Application Program Interface (API) contains many functions and classes to control these mobile devices. This functionality is all available in a single device with at least a day worth battery life. The application requires a suitable user-id and route-id that will let user to access required accurate data present on the server. Here we try and use the Wi-Fi network and plan to create our very own communication protocol. Software will also support BASE64 encryption logic while sending data to server. Server will support HTTP protocol for web based access. All these features put the Smartphone in the category of a portable device as well as integrated device.

C. Data Representation

We will be using the Google Maps that is a Google service offering powerful, effective and user-friendly mapping technology. Google Map Handler will help to generate easy view road map for safety purpose. Differentiating of road anomaly data is done by making use of a colour code technique which is assigned to specific interpolated values for certain segments. For example the red colour can be used to represent various bumps, the blue colour to specify any kind of potholes, smooth road surfaces can be indicated by a green colour and so on. A previous experimental result that was successfully carried out shows 85.6% of accuracy for total road anomaly detection and classification by using this system’s method.

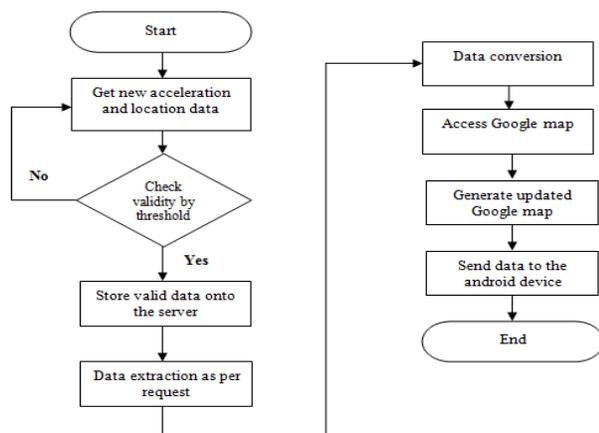


Fig. 1 Flowchart

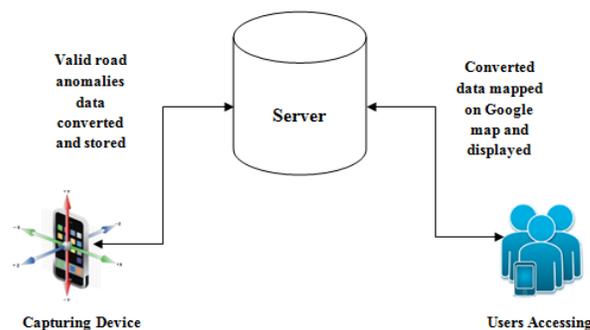


Fig. 2 Data access and generation

IV. CONCLUSION AND FUTURE WORK

Safety and security are the key concerns in any and every field. We observe that any sector may it be education, medical or here transport and automobile field, gains its new meaning and sees much advancement by the integration of technology. Observing and studying both these factors, in this paper we have made use of an embedded sensor that is an accelerometer from a Smartphone to obtain and analyze data regarding different hurdles on roads that are potholes, bumps, uneven and roughness. Along with road surface issues we have also tried to address some safety measures for improving driver’s awareness to enhance their respective driving habits. Our study and work on it, shows the roads as more complex. We also touch the issue of lane changing. The proper visual view after analysis of such data can be shown by Google map technology. This visual information helps any kind of user to understand the routes that are to be newly travelled. In its future scope we try and plan to extend our methodology to auditory or warning alerts of all such road issues and driving actions. The place or route may be any but the only requirement for our system is a Smartphone device working on android platform.

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