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An Algorithmic Approach for Detecting Car Accidents using Smartphone

Mitali Bhokare[1], Sumit Kaulkar [2], Anand Khinvasara[3] , Akshay Agrawal [4],Prof. Y. K. Sharma[5]
Department of Computer Science,
Vishwakarma Institute of Information Technology, Pune, India
mitali.bhokare@gmail.com[1],sumitkaulkar@gmail.com[2], anand.khinvasara77@gmail.com[3],
akshagrawal82@gmail.com[4], yogiis_sharma@yahoo.co.in[5].

Abstract- Security in travel is the primary concern for every individual. This paper describes an algorithmic strategy about an accident that is occurred to a vehicle to the family members of travelling persons. The advent of technology has also increased the traffic hazards and the road accident take place frequently which cause huge loss of life and property because of the poor emergency facilities. Our paper will provide an optimum algorithm to this draw back. Various sensors can be used in a car alarm application so that dangerous driving can be detected. With signals from an accelerometer, a severe accident can also be recognized. In this approach, real- time location data are collected by Global Positioning System (GPS) mobile phones to track the vehicles traveling on roads. So, that they can save the injured peoples as soon as possible. Mobile phones and the sensors present in the phone (such as GPS receivers and accelerometers) are favorable platforms for constructing such systems. [1]

Index Term- Accelerometer, Distance, GPS, sensors, Smartphone, sound, Threshold for accident detection, Vehicular speed**.**

I. INTRODUCTION

The widespread adoption of mobile telephony has remarkably improved interpersonal communications in our society. Smartphone-based accident detection applications have both merits and demerits relative to conventional in-vehicle accident detection systems, for example, they are vehicle independent, and provide rich data for accident analysis, including the pictures and videos. It is widely accepted that providing rapid assistance to victims of road accidents is extremely important, especially in critical accidents, in which the victims are not able to call for help [3]. Building a smartphone based accident detection system is difficult, however, because phones can be dropped and also generate false positives as the phone is not directly connected to the vehicle. In contrast, traditional in-vehicle accident detection systems rarely incur the false positive results because they normally depend on sensors, such as accelerometers and airbag sensors, which directly detect damage to the vehicle. This paper shows how the sensors and the processing capabilities of smartphones can be used to overcome the challenges of detecting traffic accidents without direct interaction with a vehicle's onboard sensors. We describe an approach for using smartphones to measure the forces experienced by a vehicle and its occupants to provide a portable "black box" data recorder, accident detection system, and automatic emergency notification mechanism. The approach detailed in this paper uses the sensors on a smartphone to record the G-forces (acceleration) experienced by the vehicle and occupant, the GPS location and speed of the vehicle, and the acoustic signatures, such as air bag deployments or impact noise, during an accident.

Through different experiments that are made in a vehicle testing phase, the most appropriate techniques are used to detect an accident. The elements used for comparison are the accuracy of the acceleration estimation using either: (i) GPS information, (ii) accelerometer information, and (iii) vehicular speed. The total time required to detect an accident, prepare the warning message to be delivered and the actual delivery of such message through different communication channel are also determined. [2]

II. Analysis of Problem

Vehicle manufacturers continue to increase their emphasis on safety. Analysis of external sensors data for vehicle performance is a large area of study. It uses multiple external sensors such as a GPS, accelerometer, and Global System for Mobile communications radio for traffic localization. Pothole Patrol [7] is another system that monitors road conditions using GPS and an external accelerometer for detection.

The device, which is a mobile phone [4]-[5], will contain GPS, various sensors, and an accelerometer offering flexibility in methodology and user implementation. We propose a device that is not only already in abundance but portable enough as well to be one of the most effective multipurpose devices that are able to analyze and advise on safety conditions. In this, we use the accelerometer of an Android-based smartphone, with real-time analysis and auditory alerts of these factors; we can increase a driver's overall awareness to maximize safety [6].

The Figure 1 shows the overview of working of our system. The victim of road accident has its smartphone connected to a central database and Web server. As soon as the accident has taken place a message will be sent to the victim's relative and also the emergency contact if mentioned by the victim. This will reduce the time gap between the accident and when emergency medical facilities are dispatched to the scene.

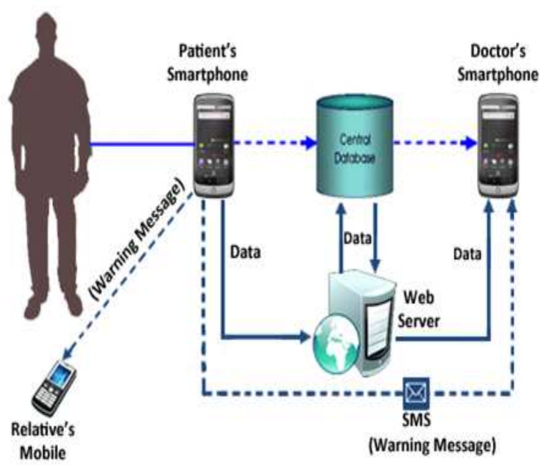

Figure 1: Overview of the system

III. Algorithm

A. The Formal Accident Detection Model

A carefully crafted formal model of accident detection is important to detect traffic accidents accurately. The major challenges faced during detecting the traffic accidents are firstly without the direct measurement of impact data from onboard sensors and secondly examining the false positives, which is a key concern with applications that automatically dispatch police or rescue. To address both challenges, the proposed algorithm uses a soft real-time multi-sensor sampling approach, with threshold-based filtering to predict when an accident occurs.

The formal accident prediction framework is based on the following 11-tuple model of the phone state, which is used to extrapolate the state of the vehicle. The 11-tuple model consists of 11 factors that we have considered in an algorithm during the detection of accident.

B. Algorithm Planned: 11 tuple

$\gamma = < x, T_x, y, T_y, z, \alpha, S_x, S_y, S_z, M_x, M_y, M_z, M_\alpha >$

Where:

S_x: is the span of time after an acceleration event sets a certain value for the variable 'x' before the variable is reset.

x: is an acceleration variable that indicates the maximum acceleration that is experienced in any direction by the phone. The maximum acceleration value is reset after S_x milliseconds have elapsed.

S_y: is the span of time after a sound event with a sound pressure level that is greater than M_y dBs that the sound event variable, y, will remain set to 1.

y: is a binary sound event variable that indicates whether a sound event greater than M_y dBs has occurred. The variable has a value 1 if a sound event of M_y dBs or more was experienced by the phone and 0 otherwise.

From experimentation and a literature review on air bag deployment it has been observed that 140dBs is a good value for M_y.

S_z: is the span of time after the phone is no longer traveling for at least M_z mph that the speed threshold variable, z, will remain set to 1.

z: is a speed threshold variable with value 1 if the phone has been traveling at greater than M_z mph.

α: is the distance traveled since the last time the variable 'z' switched from value 1 to 0.

M_x: is the minimum acceleration required for an acceleration event alone to trigger accident detection.

M_y: is the minimum decibel required for an acoustic event to trigger the sound event variable.

M_z: is the minimum speed in miles per hour that the device must be traveling in order to activate the accident detection system when it is inactive.

M_α: is the max distance in feet that the device is permitted to move at a speed lower than the speed threshold, M_z, before the accident detection system is deactivated.

In the list of the various elements mentioned the three basic and important variables are: variable 'x' is used for acceleration detection, the variable 'y' is used for detecting the sound factor during the accident and the variable 'z' gives the speed of the vehicle.

The accident detection function:

$$Ev : \gamma \rightarrow \{0,1\}$$

evaluates to 1 if an accident is detected and 0 otherwise.

An accident detection can be triggered by one of two situations:
(1) a high acceleration event and a high decibel sound event are recorded while the vehicle is moving above the threshold speed, M_z or (2) the distance moved since the last time the speed threshold M_z was exceeded is less than M_y feet and an acceleration and sound event occur. More formally, we define these two accident detection conditions as:
Two accident detection conditions

$$Ev(\gamma) = \begin{cases} 1 \text{ if } (x/ M_x + \alpha y \geq M_{Tr})\wedge(z == 1) \\ 1 \text{ if } (\alpha < M_\alpha)\wedge(x/ x + \alpha y \geq M_{Tr}) \\ 0 \text{ otherwise} \end{cases}$$

where:
– **M_{Tr}** is the threshold for accident detection.

The first accident detection scenario is triggered when the smartphone is travelling above a threshold speed associated with being inside a car. In this situation, an accident is detected if the smartphone experiences a violent acceleration event, indicating a probable collision, followed by a high-decibel acoustic event, such as air bag deployment, a horn, or an impact noise. It is also possible to detect an accident solely from an acceleration event, without a sound event, where the acceleration value alone is so large that it exceeds the accident detection threshold.

$$\mathbf{(x/ Mx) \geq M_{Tr}}$$

The second scene for accident detection occurs when the smartphone that is traveling inside of a vehicle stops at an intersection, traffic light, or other location. In this situation, the algorithm attempts to detect if the user has left the car or is merely waiting for a light or traffic condition to change. The accident detection algorithm uses the M_y distance threshold to keep the detection process active below the threshold speed. As long as the smartphone does not travel more than M_y feet from the last location the speed threshold was surpassed, the detection algorithm assumes that the user is still inside the car. This extra condition allows the algorithm to detect accidents that occur when the user's car is hit by another vehicle while stopped.

IV. ALGORITHMIC STRATEGY: BRANCH AND BOUND STRATEGY

We will be having various possibilities to check for detection of accident. By combining the possibilities of different parameters the corresponding bounding function is expanded. As Branch and Bound strategy that finds optimal solutions to the problems and throws large parts of the search space by using previous estimates which in our system are known as threshold values. The use of threshold values optimizes the system. The bounding function then expands based on respective threshold values. On getting all the conditions satisfied, a solution node of space tree is obtained. On obtaining the solution node then the system will be triggered. This system is having comparing equation as the main part which will take maximum time. So considering it, time complexity is dependent on three comparison parameters i.e. acceleration , sound , velocity . Therefore time complexity is O(n^3) where n is no of comparisons for each parameter.

V. CONCLUSION

Using a mobile phone, we can demonstrate some innovative applications that are unified inside an automobile to analyze a vehicle's condition. By using a device as an android based phone, it relatively makes easy to obtain data to be thoroughly assessed. Current research efforts aim at developing solutions to enable a future where the networked vehicle plays a central role in our lives, offering numerous possibilities in sectors such as security, publicity, entertainment and commerce. In this paper we propose to integrate the existing vehicles with smartphones through GPS interfaces and other mobile sensors to achieve a solution that allows examining the vehicle and trigger automated warning procedures in case an accident is detected. We consider that such technology allows accelerating the provision of medical services to injured people on the road through an instant emergency call, as well as pinpointing the exact position of the vehicle and offering an estimation of the seriousness of the impact through deceleration estimation. We developed a prototype for the Android platform to validate our approach, and proposed an algorithmic approach for the application in a real vehicle while moving.

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