A Web based Vehicle Condition Monitoring and Safety Scheme

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***Abstract* - Vehicle accidents are supreme intimidation for human being. This makes people egregiously incapacitate or even takes up to the unnatural death. The automotive industries have made lots of success in abatement of this intimidation. But due to an accident, the potential for harmful effects did not decrease. Extreme speed is a leading fountainhead of road traffic accidents. Another reason is irregular movement of a vehicle. So our purpose is notifying condition about the vehicle to a monitoring cell who can take necessary steps in that situation using a well established system. This system is known as Vehicle Condition Monitoring and Safety Scheme (VCMSS). In addition to the accident detection and notification, VCMSS is able to apprise about various modes and conditions. VCMSS has been developed to notify about reckless driving, safely driving, parking mode and emergency condition. This system operate with different types of sensors and modules, these are accelerometer, gyroscope, magnetometer, GSM, GPS, GPRS and ARDUINO. A specified algorithm has been developed that allows knowing about the different mode of the vehicle. A website has been developed to continuously monitor through GPRS. In case of no GPRS connectivity, GSM system has been used for sending SMS to monitoring cell.**

Index Terms – Vehicle condition monitoring; accelerometer; gyroscope; magnetometer; Website; Emergency contact.

I. INTRODUCTION

In recent years, the automobile industry has shown an extraordinary production growth across the world. So, the numbers of vehicle on the road are exaggerated day by day. Many of motor vehicles owners give to right of their driver to drive that vehicle. So it is quite difficult to monitor their vehicle's condition. Along with these, the accident rates are also getting significantly increased. Because of related people's negligence most of the accidents are taken place. This negligence is reckless driving, lack of good infrastructure etc. After an accident, the instant rescue process is in the intermediate time of life and death. It could be better, if we take any kind of precaution. This also is saved a life from danger.

If owners get time to time data from that vehicle, then owners can knows about vehicle condition. This can restrict some kind of accident. Road traffic injuries are currently estimated to be the ninth leading cause of death across all age groups globally, and are predicted to become the seventh leading cause of death by 2030. Every year the lives of more than 2.5% of injured people are cut short as a result of a road traffic crash without help of any aid. If a system able to detect an accident and also able to take necessary steps to provide medical aid, it will save several human lives.

A vehicle monitoring system is described having an arrangement installed within a Vehicle, wherein the system includes an external data terminal for communication information to a remotely located base station. This system has also Global Position System (GPS) which will receive the co-ordinates from the satellites among other critical information. This can be useful in tracking of the theft vehicle and send the location of accident place. By using GSM and GPRS modem all the data have been transferred to website and monitoring cell. Also use sensor circuit for getting information about vehicle condition.

We have discussed on previous research in section II. In section III we have elucidate the system functionality with technical specification. Afterwards we have shown the implementation result with experimental data and emblematic evaluation of our system. In the end, we have delineated about the challenges and further expansion of our work.

II. LITERATURE REVIEW

VCMSS is not only doing detection of road accident but also it can transmit information about vehicle condition and different mode at any time. But in recent years many researchers had made the project related on accident alarm system. This technology includes: GPS, GSM communication and others. S. M. Tang et al research about road accident detection which is based on nonparametric regression [1]. Different types of application also had been made by different researchers like P. Bellucci et al show speed measurement validation in real traffic condition [2] and Huachun Tan shows Vehicle speed measurement for accident scene investigation [3].

The measurement technologies on vehicle speed mainly apply to simultaneously monitor vehicle speed. The vehicle speed is one of the most important parameters that a traffic monitoring system should provide in a timely manner. It provides traffic management authorities and end users (e.g. drivers) with a rough idea of the current traffic situation, and is also crucial to estimate travel time and traffic flow. Keshav Bahadoor et al. propounded a reporting system for detection of

dangerous driving [4]. Boutheina Maaloul et al. described a video-based algorithm for accident detection on highways [5].

III. System Architecture

In this section the architecture of the VCMSS will be proposed. It comprises with schematic and implementation diagram as well as parameter sensing.

A. Schematic and implementation diagram

In figure1, Schematic diagram of VCMSS is shown. This circuit consists of three different groups. These groups are sensing unit, tracking unit and communication unit. In sensing unit has gyroscope, accelerometer, wheel decoder and a push button switch. For tracking unit a GPS module has been used. Communication unit consist of GSM and GPRS module.

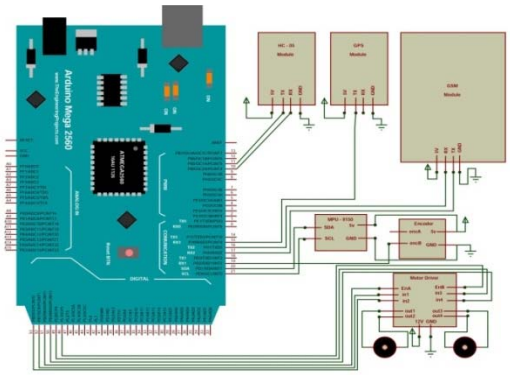

Fig. 1. Schematic diagram of Vehicle condition monitoring and safety scheme.

In figure2, shows the develop model of VCMSS. To check output of VCMSS, a prototype vehicle has been used. The complete model of VCMSS with this prototype model is shown in below.

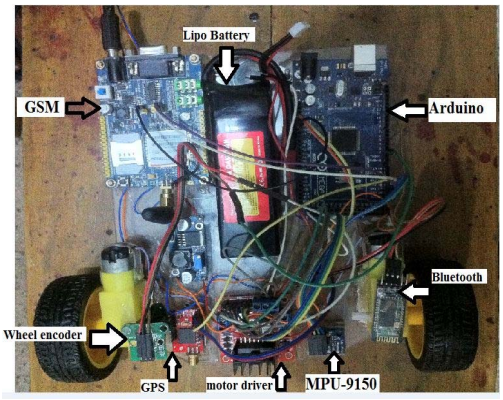

Fig. 2. Developed model of VCMSS with prototype vehicle.

This prototype vehicle runs through a motor drive. MPU-9150 is compact model of 3 axis accelerometer, gyroscope and magnetometer. SIM-900 module has been used for both GSM and GPRS connectivity. Whole system is powered by a 12 volt LIPO battery.

B. Parameter sensing

VCMSS is a device capable of working together different types of task at simultaneous manner. This device can check several types of modes and condition of vehicle. Some parameters of vehicle have been selected for checking those modes and condition. These selected parameters are listed below:

1) Speed of vehicle: Wheel encoder has been used for speed determination of the vehicle. This encoded value has converted into m/s unit. In this system, three types of value are taken to know the vehicle condition. The first of which is zero value of speed. By this we check the parking condition. The second type of the value is threshold value. We have been set a maximum value to determine the reckless driving. Finally the derivative value of speed with respect to time has been taken by using starling formula. The negative slop of that derivative needs to check accident occurrence.

2) *Collision measurement:* To determine the level of collision, a 3axis accelerometer use in the VCMSS. This accelerometer gives value in three different axis. All that value has been observed in different situation. By determination the range of occurred collision, a threshold value of accelerometer has been selected. This value need to check whether a accident occurred or not.

3) *Vibration of engine:* A piezoelectric vibration sensor use to determine the vibration of engine. This sensor set in the engine which only checks the zero value of vibration. It is used to decide parking mode of the vehicle.

4) *Angle between road line and vehicle position:* Gyroscope has been used to measure angle between vehicle and road line. The derivative value of the gyroscope with respect to time has been taken to determine reckless driving mood. Using starling's formula the derivative value have been gotten.

5) Flipped position of vehicle: Magnetometer has been use to know whether the vehicle has been flipped or not. This value of this parameter can only be determined, when it comes to vehicle accidents. By negative value of the magnetometer, system can decide that vehicle has been flipped.

6) Emergency communication: For emergency communication a push button is placed beside the driver sit.

7) Location and data transmission: To track the position of vehicle, a GPS tracker has been connected with the system. SIM-900 module has been used for both GSM and GPRS connectivity. GSM connection is needed for sending SMS to monitoring cell and GPRS connection is needed for sending data to website simultaneously.

IV. System Methodology

To check all the modes and conditions together need a different algorithm. Considering all aspects, some conclusions have been taken, which is shown through a flow chart below:

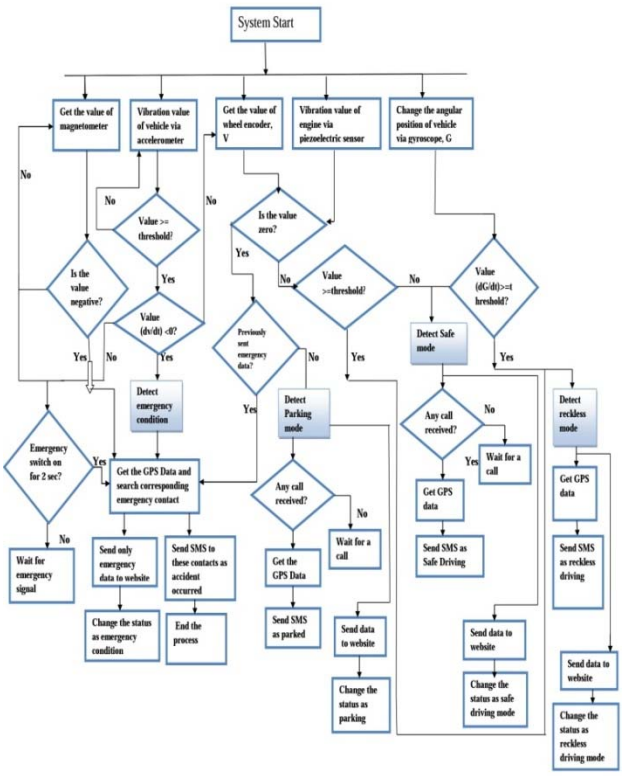

Fig. 3. Flow chart of system algorithm for VCMSS.

A. Detection of accident condition

To know whether a vehicle conformed to road accident or not, VCMSS need to check three sensor values. These are magnetometer value, accelerometer value and wheel encoder value. Firstly, VCMSS cheeks that, is the value of accelerometer greater than the threshold or not. If that value is grater then check slope of speed. If the slope is negative then for some time and finally reach to zero value of speed then that situation would be accident occurring condition. Furthermore, VCMSS also check magnetometer value. If that value is negative, it will be serious accident.

B. Detection of reckless driving condition:

To detect reckless driving condition, VCMSS needs to check gyroscope and wheel encoder values. If the value of wheel encoder is greater than a specific threshold value and the rate of change of gyroscope value with respect to time is greater than threshold value, that situation will be reckless driving. Starling formula has been used to determine the derivative of gyroscope value. If X is the value of time (t) and Y is the value of gyroscope (G), then starling's formula will be:

$$y(x) = y_0 + s\left(\frac{\Delta y_0 + \Delta y_{-1}}{2}\right) + \frac{1}{2}s^2\Delta^2 y_{-1} + \frac{1}{6}(s^3 - s)\left(\frac{\Delta^3 y_{-1} + \Delta^3 y_{-2}}{2}\right) + \frac{1}{24}(4s^3 - 2s)\Delta^4 y_{-2} + \cdots\cdots \quad (1)$$

Where y_0 is the value of gyroscope (G) at which derivative value need to determine and Δy_o is the difference between y_0 and next time interval value of gyroscope. Similarly Δy_{-1} is the previous difference value of Δy_o and so on. When $s = \frac{x - x_o}{h}$ and x_0 is the value of time at which derivative value will be found, h is the time interval between to two gyroscope value.

At $x = x_0$ then $s = 0$ hence the derivative will be

$$y'(x) = \frac{1}{h}\left[\left(\frac{\Delta y_0 + \Delta y_{-1}}{2}\right) - \frac{1}{6}\left(\frac{\Delta^3 y_{-1} + \Delta^3 y_{-2}}{2}\right)\right] \quad (2)$$

Finally we get the value of $\left(\frac{dG}{dt}\right)$ which is shown in above equation as $y'(x)$ at any time instant. If the vehicle goes in without irregular movement then this value will be nearly zero. So we set a threshold value, after reached that value or crossed the value, system can decide about reckless driving condition.

C. Detection of safely driving condition

VCMSS needs to ensure about wheel encoder and gyroscope value for fulfillment of safely driving condition. If the value of wheel encoder less than the threshold value of speed and the derivative value of gyroscope also lower than threshold value of derivative gyroscope, safely driving mode will be confirmed by VCMSS.

D. Detection of parking mode

If the wheel encoder and piezoelectric vibration sensor value is zero, system will automatically detect the vehicle as parking mode.

E. Emergency mode

This feature contain on VCMSS because of sending a helping message in danger situation to monitoring cell. For this purpose, when the push button switch is pressed for continuously two or more seconds, then a message automatically will send to the monitoring cell. Authorized person will take emergency step by knowing all conditions of the vehicle.

F. Website of VCMSS

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When VCMSS determines emergency and accident condition, then the website itself finds the closest number of requests through the means of the GOOGLE API. There are also the benefits of sending an SMS to the numbers received.

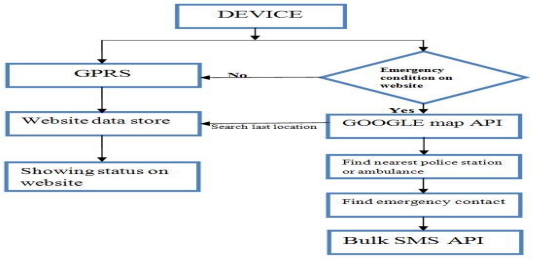

Fig. 4. Flow chart of website algorithm for searching emergency contact and sending bulk SMS to those numbers.

E. Quarry and emergency message

The reason to keep this feature in VCMSS is that, no information should be dropped. To monitor a vehicle by website needs full time GPRS network. Website data would not update, when there has not any GPRS network. So GSM system has been used for secondary communication.

V. Experimental Result

A. Experimental data

To observe all the conditions, a prototype vehicle has been made. The value of angle between road line and vehicle has been changed by rotating sometimes because of checking the gyroscope value. Speed values by hard break, turning a curve road and slope road also have been cheeked. Changing the pressure value manually by physical force has been in that prototype vehicle because of checking the accelerometer value. Finally that vehicle has been flipped over a sometimes manually to see the magnetometer value. The experimental results of the entire situation are shown in table.

TABLE I. Experimental table for different condition

Experiment No.	Change of speed (m/h)	Change of angle (rad)	Pressure value	Magnetometer value	Vibration value of engine	Satisfied condition
1.	2.3	0.348	89	Positive	23	Safely
2.	4.5	0.523	74	Positive	34	Reckless
3.	3.6	0.436	108	Positive	40	Emergency
4.	4.2	0.785	305	Negative	37	Emergency
5.	0	0	0.55	Positive	0.677	Parking

In exp 1 all value are perfect so status of website has not been changed. In exp 2 changes of speed and angle increased so status of website has been uploaded as reckless driving mode exp 3 shows that whole angle and pressure value has crossed the limit, and then status changes to as emergency condition. Hence website sends SMS automatically via bulk SMS API.

B. Web based Output of VCMSS

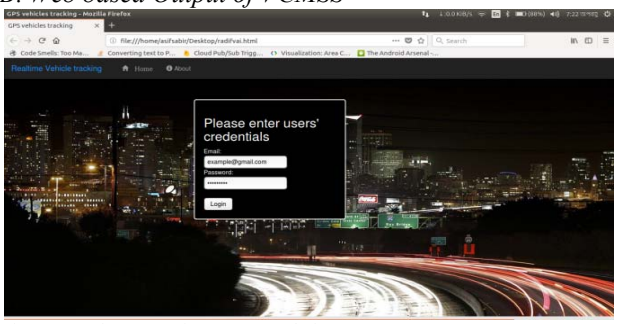

Fig. 5. Log in page of VCMSS website

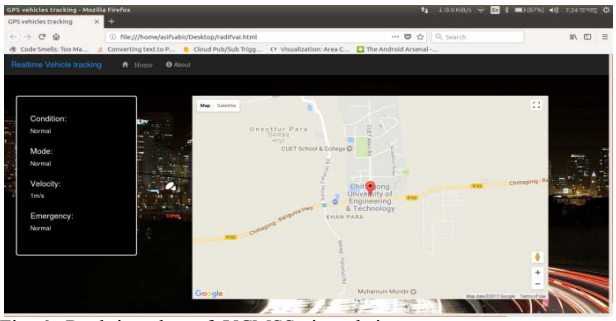

Fig. 6. Real time data of VCMSS via website

C. SMS based output of VCMSS

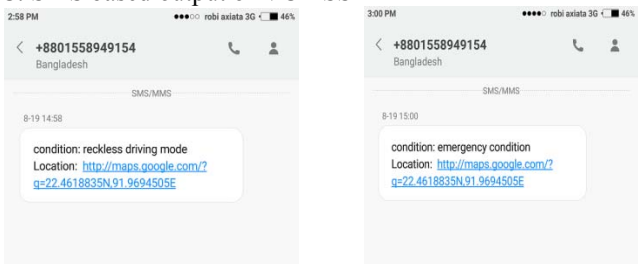

Fig. 7. Query and emergency message

VI. Conclusion

In this paper, we have shown that vehicles can be monitored precisely by using some particular parameters, GSM and a well organised website. This proposed system capable of deciding different condition of vehicle and it can upload data to an allocated account in VCMSS website for a specific vehicle. If any emergency condition is found in the website, it will immediately traces nearest police station as well as hospital and send SMS for seeking help. Though the system requires a continuous Internet connection, but VCMMS can send data to monitoring cell due to unavailability of internet service with help of the GSM. In the future, brake control will be the key parameter for this specialised system, without that more parameter could be considered. Our proposed system can reduce pre and post accident damage in a great extent through continuous vehicle monitoring.

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