A Proposed System for Automatic Vehicle Monitoring and Accident Detection in Bangladesh

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Abstract—Now a days, the alarming rise of road accidents has become one of the major concerns in Bangladesh. Unawareness and disrespect towards traffic rules, reckless driving, rapid growth of vehicles etc can be identified as factors leading to this issue. The distress of the accident victims can be reduced if the detection of accidents can be done in no time. Often emergency supports can not be provided immediately due to unawareness of the accident to the concerned persons. On the other hand, vehicle theft has also become a common issue which everyone faces in insecure parking places. In this paper, an automated system has been proposed to deal with these two interrelated affairs. Our proposed system will help the wretched victims by notifying the nearest necessary emergency supports. The system also have two levels of security, password protection for the vehicle, speed control mechanism and remote ignition cut-off mechanism to make vehicle theft almost impossible. Therefore, our cost effective proposed system will be efficacious for a developing country like Bangladesh to diminish the distress of the people.

Keywords—Accident Detection, Emergency Services, Speed Control, Vehicle Tracking, Vehicle Theft Detection.

I. Introduction

As the world population is growing, a large number of vehicles is the demand of time. With the increase rate of transportation, every year road accidents claim exceedingly high number of lives. According to a report of the WHO (World Health Organization), approximately 3000 people die in road accidents every year, while millions are injured or disabled each year [1]. The high demand of automobiles has also increased the traffic hazards and the road accidents. Road accident of Bangladesh also depicts the same scenario. Daily star said that, over the past few years there has been an alarming rise in road accidents, significantly highway accidents in Bangladesh [2]. A study has been conducted by the Accident Research Centre (ARC) of BUET on this issue and it has found that road accidents claim on average 12,000 lives annually and lead to about 35,000 injuries [2]. World Bank statistics says that annual fatality rate from road accidents are found to be 85.6 fatalities per 10,000 vehicles [2]. According to BRTA statistics, 2009 to 2016 (upto July) 19,450 accidents occurred in Bangladesh by which 18,510 died and 14,442 injured [3].

Traffic hazards and road accidents have increased the sufferings of people. One of the main reasons is the lack of emergency facilities available in our country. In most of the cases, when an accident occurs, relatives of that injured person get the news of his/her accident not in time and the emergency rescue teams reach late on the accident spot and the traffic in between accident spot and hospital sometimes increase the chances of death of the victim. Tracing the accident spot is the major issue faced by emergency unit. The guardian reported in 2016 that thirty five patients had died in the past five years due to the late arrival of the ambulance [4]. Besides, it is impossible to rescue a human who is drowning in water by stuck in the car if the concerned persons are not notified immediately. We are dealing with another rising problem of our country, Vehicle Theft. Most of the vehicles susceptible to being stolen are the ones those are parked in areas which are not specifically assigned for parking. There are many reasons behind vehicle theft and one of the main reasons is to sell the stolen cars and their different parts or equipment. In that case, our proposed system will provide advantage to stop a vehicle from being theft. Therefore, the aim of this paper is to propose an automated system which detects road accidents as well as accidents occurred in water medium, notify the location of the accident and the state of the victim to nearby emergency services and relatives through an automated SMS system and also proposed a conceptual model to stop vehicle theft.

The rest of the paper is organized as follows. Section II explores the literature review of our work. In Section III, we discuss about the conceptual design. The implementation and evaluation of the system is discussed in Section IV. The discussion, implications and idea for future work are presented in the section V. Finally section VI concludes the paper.

II. Related Works

The high demand of automobiles has increased the traffic hazards as well as the occurrence of accident. The objective of this scheme is to detect the road accidents, minimizing the delay caused by traffic congestion and to provide the smooth flow of emergency supports. Automatic accident detection system is fruitful in recognizing the location of the accident and to reach the accident spot easily. Amin et al. discussed about a system which is useful in detecting the accident precisely by means of both vibration sensor and Micro Electro Mechanical System (MEMS) or accelerometer. An accelerometer has been used in a car alarm application so that dangerous driving can be detected [5]. According to the system of Prabha et al., when a vehicle meets with an accident Micro Electro Mechanical System (MEMS) sensor immediately detects the signal and an alarm is generated right away [6]. Micro-controller sends the alert message through the GSM modem so the police can

immediately trace the location after receiving the information. They have used GPS for tracking the position of the vehicle and GSM for sending the message. It would be easier if the location can be tracked using mobile phone. Sonika et al. developed a system which provides the shortest distance to the accident spot from the source. This system sends the accident alert to the nearest ambulance from the accident place and always tracks the ambulance to give the right direction [7].

As accident rate is increasing, the smart vehicle system is also developing rapidly. Amin et al. improved an existing system by adding a new feature with it. In this system, the accident can be detected and the current location of the vehicle will be sent to the predefined number through GSM network. But this method has one major drawback. They developed the system in a way that, it will detect the accident occurrence if the speed of the vehicle is below than a predefined range for sometime. So, if the vehicle is stuck in a huge traffic jam, it will send false SMS [8].

Authors of paper [9] had merged the total system and developed a prototype of a smart vehicle. This set up not only detects an accident but also prevents the accident from happening. It has an IR sensor that can detect the obstacle and prevent accident from happening. It also contains the SMS sending subsystem same as the previous systems.

Now a days vehicle theft is a major issue. Ensuring and enhancing vehicle security is also mandatory for a smart vehicle system. Russell et al. proposed a system where a key assembly was used for mounting an electronic component at the head of the key. The electronic component is mounted in either an opening such as a bore or recess formed at the key head, or a carrier connected to the heel end of the key shank. To start the vehicle engine it is necessary to unlock the sterring through this key [10].

To get the exact location of the vehicle Subha Koley and Prasun Ghosal used a GPS device and at the same time they also used Google's geolocation to detect the latitude and longitude of a location in a realtime basis if GPS fails to work properly [11]. Another very important feature of this system is the use of emergency cameras installed in different angles inside the car to make the full interior part visible. They developed the system by using Flocks of Trackers(FoT) which estimates the displacement to measure the motion.

Rajni Sahu et al. developed a project of a security system to protect bike from being stolen by using a password through keypad. A buzzer is used for detecting the wrong password three times and considered it as a theft. A GSM technology and vehicle anti-theft system with ignition controlling technique is used to provide vibration of piezoelectric sensor and notify the owner about theft so that a feedback SMS from the owner can stop the vehicle engine [12].

The drawbacks of this system was solved and developed by Magar et al. [13]. Authors here said that this system consists of a CSM unit which sends SMS containing the information of exact location of vehicle and a password is used for ignition start. If any unauthorized person enters wrong password three times, an identify message is sent to owner and driver to notify

them about the attempt of thieving. This system also provides facility to lock the wheel, stop ignition of vehicle and to set a new password for vehicle.

Password can be stolen by, leaked by the driver or some other way. To solve this problem Julian Eric Lovelock et al. have given a solution which generates temporary access codes [14]. An external server provides the access code to the authorized user and it is used as an input. For additional security the user is asked to enter a pin which is entered through user's device. If the access code and pin are valid, then an access is given to the physical areas by granting the opening of door.

The invention of paper [15] relates to a monitoring, alarm and automatic adjustment system for oxygen and compressed air, specifically to warn users about oxygen and compressed air of low pressure and no supply and automatically adjust the flow of oxygen and compressed air to the optimum rate according to the actual real time monitored condition and physiological needs of the user.

The present invention in paper [16] is directed to a portable oxygen concentrator system adapted to be transported by a user. The portable oxygen concentrator system includes an energy source, an air separation device powered by the energy source and adapted to convert ambient air into concentrated oxygen gas for the user, at least one sensor adapted to sense one or more conditions indicative of the oxygen gas needs of the user and a control unit interrelated with the air separation device and at least one sensor to control the air separation device as to supply an amount of oxygen gas equivalent to the oxygen gas needs of the user based at least in part upon the one or more conditions sensed by the at least one sensor. All these systems are small separated system and do not contain any database. These systems can not be considered as the prototype of the real model because they are mainly small project based solution and they do not have much features altogether to be a solution of a real life problem. We are aiming to propose an integrated system to detect and minimize the vehicle accidents and thievings. Our proposed system will enhance the security of the vehicle with biometric authentication and password protection which is unique and easy to maintain. We'll also use a firm database to store the records of road accidents and stolen or attempt to be stolen vehicles automatically. This system will also help to minimize the devastation of accidents by increasing the availability of the emergency supports. Our developed prototype of the real model will reduce the life loosing rate with it's remarkable features if this system can be implemented in real life.

III. Conceptual Design of the System

In this section a conceptual design is described which represents the proposed system to make it easy to understand. It would be helpful if it can detect the speed level of the vehicle and alert the driver if the limit exceed the given limit. Vehicle theft is another reason behind the need of smart vehicle system. Based on these necessary needs, the vehicle system has been designed. The block diagram of our system is given in Figure 1.
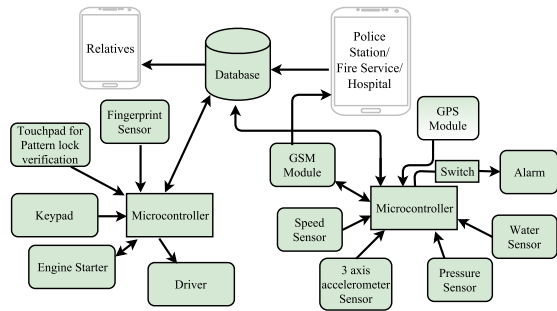
Fig. 1: Block Diagram

Fig. 2: Flowchart of Theft Control Process

The features of this system are described as follows-

1) Registration of the Authorized Person: At first the authorized person has to register in our system using his fingerprint. He also has to provide a specific pattern and password for other persons to ignite the engine except him. During the registration he has to provide his detail information like name, NID, phone number, vehicle registration number, vehicle identification number, relative information for emergency contacts etc. If any accident happens to his vehicle, the system will inform him and also the emergency contacts provided by him. If the vehicle is attempted to be stolen, he will be informed through this provided information.

2) Vehicle Theft Control: In 2006, motor vehicle theft rate was 0.7 per 100,000 population in Bangladesh [17]. Our designed system provides support to reduce the rate of vehicle theft. This subsystem is designed in three ways-

- Using Fingerprint Sensor
- Using Pattern System
- Password through Keypad

People who have already registered themselves using fingerprints, can use their fingerprints to ignite the engine, which will optimize the time complexity and will be more user friendly. In case of pattern system, a specific pattern will be given to start the engine. People who want to drive the vehicle will simply give the pattern to start the engine. For password system, it will be given through keypad. Three chances will be considered in case of pattern and password system. If the pattern or password is correct then the car key will be able to start the engine. If those three chances fail, then the system will alert the owner that someone is trying to start the engine of the car by sending an SMS. The flowchart of the system is given in Figure 2.

3) Accident Detection and Rescue System: One of our major concern is detecting the accident, minimize the risks of the victims and rescue them. We have designed the system in such a way that if any accident has been detected by our system, an alarm will be generated and the system will wait 3 minutes(t) for the person in the vehicle to press a button which will indicate it is a minor accident, no need to contact with anyone for rescuing. But, if the person fails to press the button within the predefined time then the system will detect it as a major accident and will send SMS to the concerned persons, relatives, nearest police station, hospitals etc. so that
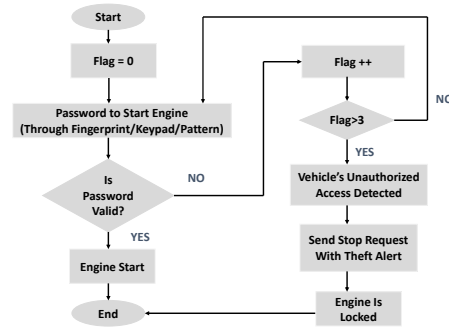
they can take necessary actions as soon as possible to rescue the victim. The flowchart of this feature is given in Figure 3.
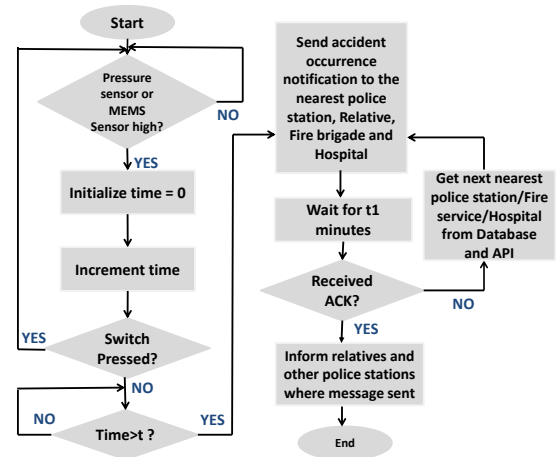

Fig. 3: Flowchart of Accident Detection and Acknowledgement

There will be an acknowledgment module in our mobile application through which police and fire brigade can acknowledge the system that they have received the SMS. If the system will not be acknowledged, then it will send the SMS again after some time(t1).

4) Automatic Phone Call and SMS System: There will be an automatic phone call and SMS system which will call or send SMS to the relative, nearest police station and fire brigade if an accident has occurred. A prerecorded voice will tell them about the accident. For SMS, there will be a predefined message which will contain the accident location, victim's name which are previously saved in the database.

5) Vehicle Tracking System: This system will easily track the vehicle any time, any place. There will be a mobile application through which the owner will be able to track the vehicle whenever he wants to. He has to provide the vehicle identification number for tracking.

6) Speed Control: We have also integrated a speed control feature in our system to alert the driver by generating a buzzer

if the vehicle speed limit exceeds the predefined limit. This will help to minimize the car accidents due to over speed.

7) Ignition Cut-off Remotely: When a vehicle is suspected to be stolen, owner can turn the engine off by pressing the "stop the vehicle button" on the mobile application. This will change the ignition value from high to low in the database. The micro-controller will read the value from the database and slowly stop the vehicle by turning the signal of the transistor to low and thus disconnects the power. This process can stop vehicle theft as the abductor will be unable to drive the car. It can also reduce vehicle accident due to over speed.

IV. IMPLEMENTATION OF THE SYSTEM

A prototype system has been developed to implement these features. For the development of the entire system two sequential steps have been used. 1) Development of the hardware, 2) Development of the mobile application. The model of the prototype system is given in Figure 4.
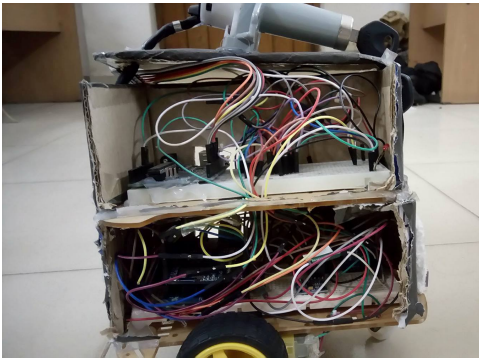

Fig. 4: Prototype Model of the System

For this prototype system we have considered a motor as a vehicle engine. A keypad, fingerprint sensor and a touch-pad are attached to it. To start the motor one needs to give a password through keypad or fingerprint through fingerprint sensor or a pattern password through touch-pad. Three consecutive wrong password or pattern will alert the car owner through the mobile application. Then the micro-controller will start the engine and after that the micro-controller will check for accident detection.

To detect the accident we have used an accelerometer sensor. An accelerometer sensor continuously monitors the acceleration of the vehicle and sends the value to the microcontroller. The microcontroller compares this with the threshold set value and if it is greater then the threshold value it immediately sends message to preset numbers.

Pressure sensor has also been used for accident detection purpose. Pressure sensors work on piezo resistive effect. If any other vehicle sharply pushes the vehicle from back, front, left or right side or if the vehicle collide with a tree this sensor is activated and check if this sensed value is greater than the predefined threshold value, upon on this observation it takes decision that an accident has happened and sends the data to the microcontroller for further process.
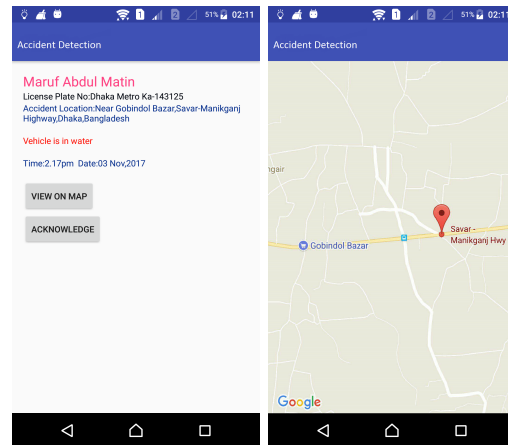
Fig. 5: Screen Shots of Accident Notification and Location Details of User Interface

Water sensor is used to detect the water level inside vehicle if the vehicle is dropped into water due to accident. After detecting water it sends data to micro-controller so that it can release the oxygen mask by activating the motor as a result the passenger can have oxygen until the rescue team arrive that location.

GSM is an open, digital cellular technology used for transmitting mobile voice/SMS and data services. We have used GSM module for mobile communication. In our system when the accident has occurred GSM is used for sending SMS to the nearest police station, hospitals, relatives and fire brigades.

For tracking the vehicle GPS module has been used. So when an accident occurs it can track the vehicle position through detecting the latitude and longitude and sends these data to the micro-controller.

Speed sensors are used to detect the speed of an object. A vehicle speed sensor generates a magnetic pulse in the form of a wave proportional to the speed of the vehicle (i.e., imagine a vehicle moving at high speed, the vehicle speed sensor (VSS) will generate a high-frequency signal directly proportional to this). We used this sensor to detect the speed of vehicle and if the speed is very high, this sensor will send the data to the micro-controller and it generates an alarm to alert the driver.

To integrate all the features a code has been designed on Windows platform using Arduino software. A mobile application has also been developed on Android platform through which a message is sent to the nearest police stations and relatives of the victims. Getting a notification about an incident, the police station must acknowledge the system so that the victim and relatives can be assured that help is on the way. A sample of the notification that is sent after an accident to the nearest police station through the mobile application and details of the accident location are given in Figure 5.

The working procedure of this prototype system is described as follows-

To start the engine one needs to give password or fingerprint

or pattern. If the password is correct the motor will start and it rotates the wheels attached to it. If the password is incorrect for three times in a row, this system interprets it as vehicle theft and sends an alert SMS to the owner through mobile application. If the vehicle is exposed to an accident or fallen into water, an buzzer will generate an alarm. The system will wait for 3 minutes for the passenger to press a switch and stop the buzzer. If the passenger is able to stop the buzzer the system will determine it as a minor accident, but if the passenger will not be able to stop the buzzer within the predefined time the system will interpret this as a major accident and will send SMS containing the location of the accident to the concerned persons. These numbers are previously stored in the database during registration. Through the GPS module we will get the latitude and longitude value of the accident place. These values are sent to the reverse geocoding which returns the location name. When police station and fire brigade receive an SMS about the accident they can acknowledge the system that they have received the SMS and they are approaching to help. The system will wait for 5 minutes to get the acknowledgement. If it does not get any acknowledgement within this time it will further send an SMS to the second nearest emergency services. The relatives will also get a notification from the system if any emergency services acknowledge the system, this will reduce the panic of the relatives. This system can also detect the speed of the vehicle. If it exceeds the limit it generates a buzzer to alert the driver. If the driver does not willing to control the speed within a short period of time, a notification will be sent to the owner of the vehicle so that he can cut off the ignition remotely. If it is observed that, for a long period of time no steps has been taken after notifying the owner, the system will notify the nearest traffic control.

V. Discussion and Future Work

In this paper, a noble idea is presented about accident detection in road and immediate rescue of the victims. This paper also contains an important strategy about vehicle theft controlling system. The proposed system will help the vehicle owners to monitor their vehicles through a mobile application and will provide help as soon as possible in case of any major accident. As smart phone has become an essential part in our daily life, we are planning to make this system fully mobile based in future. Now-a-days smart phones have fingerprint sensor and touch screen. The system can use Bluetooth module or wifi module so that smart phone will be connected to the system through this and from the smart phone's fingerprint sensor the fingerprint will be taken to start the engine. Pattern password and keypad password will also be taken from the mobile phone. This process will diminish the cost of this system as no separate fingerprint sensor, touch pad and keypad will be needed as proposed in this system. This is a prototype model for now and it is not implemented for real life use yet. We are desirous to implement this system for real life use in near future.

VI. Conclusion

This automatic vehicle monitoring and accident detection system can be an important aid in constructing smart transport systems in Bangladesh in near future. Random vehicle theft can also be reduced through this system. The main goal of this system is to reduce the accidents by controlling vehicle speed and to reduce death rate by taking the injured persons to hospital through proper actions in shortest possible time. This smart system will make vehicles more secure, trustworthy, and effective to owner and will contribute to save people's life.

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