System for Communicating a Vehicle Position and Speed during Accident

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ABSTRACT
In this paper, this paper seeks an answer to the question: can a vehicle automatically report to the emergency units its position and speed when an accident is occurred? It presents an approach that relates to an accident detection and prevention system. It is particularly related to a system that sends a message to designated parties (such as vehicle owner and emergency helpers) when a certain speed has been detected and when an accident has been detected with a resulting speed below a certain threshold. The proposed system includes a microcontroller, modem, nock sensor, and speed selection box is used to send messages when a certain speed has been exceeded and when an accident has occurred and the resulting speed of the vehicle is less than a predetermined threshold. The message sent can be a text message sent over a GSM modem.

Keywords
Vehicle accident, vehicle position, GSM, safety, and PIC microcontroller.

1. INTRODUCTION
One of the considerable dilemmas in Gulf countries, specifically in Saudi Arabia, is vehicle accidents. This is due to the drivers' recklessness driving their cars. Moreover, the late medical assistance at the accident scenes is another major reason that stands behind the high number of death and disabilities resulting from accidents. This was the cause to raise the social awareness to reduce the effect of vehicle accidents. Therefore, both car producers and research groups have been working to have the streets and cars safer. Implementing this can cost a great deal of time and can also be costly. Therefore, it has been recommended that the use of schemes like fall detection or incident detection with the various types of vehicles can be the solution by quickly alerting the people in-charge.

Road fatalities and the number of vehicle accidents increases every year [1, 2]. The accidents are due to any number of factors, including, but not limited to: vehicle malfunction, road maintenance, and human error. Since the reasons for an accident vary to such a large extent, the community has found it difficult to develop a standard system to reduce or prevent all forms of accidents. Worth to mention, human errors and violations of traffic rules are account for the vast majority of accidents.

Therefore, it would be better to develop ways to reduce or prevent such errors. Nevertheless, human error can be classified in two forms. The first form involves errors that occur before driving. Such errors include negligence, poor maintenance, and lack of driving skills. The second form of human error involves errors that occur during driving. These errors include, but are not limited to, not wearing seat belts, speeding, inattention, alcohol, drugs, and utilizing mobile devices. The human errors from the second category often results in more damaging accidents.

To reduce large number of traffic accidents, we should improve safety; introduce highly reliable traffic control systems, and prompt reporting and evacuation process of accidents' injuries and victims.

The rest of the paper is organized as follows. Section 2 discusses the relevant works that carried by several researchers. While section 3 describes paper research methodology through which the proposed solution is implemented. The experimental and simulated results were clearly stated in section 4. Finally section 5 concludes this paper.

2. Literature Review and Motivations
This section reflects what has been done in order to solve the above mentioned problem. In other words, this section will discuss relevant works that carried by several researches. Both contributions and shortcomings will mainly be discussed. Furthermore, motivations for such work as well will be explained.

2.1 Relevant Works
There have been some attempts to develop systems which help solving the above mentioned problem, though they have numerous shortcomings. Among such attempts the author will discussed Okada and Montague attempts.

Okada [3] in 2000 develops an Emergency assistance system for automobile accidents. The system claims to provide an injured person with first aid or life prolonging treatment and prolong life by detecting the degree of injury.

Despite the claimed contributions, the system amends several drawbacks; among them: (i) the system assumes there is will be a surrounding Vehicles or pedestrians within the accident area and victim car alarms will notified them, (ii) again the local broadcasting equipment will inform nearby vehicles and pedestrians that there is an injured person needs help. Obviously, the whole proposed system is fully relying on the assumption that there will be a surrounding vehicles and pedestrians all the time. Therefore, in 2004 Albert Montague [4] proposed a system that titled as the usage of an automatic system that communicates between an emergency vehicle and people in need for emergency services. He claimed that it provides an interactive communication that use mobile to communicate with the nearest vehicle and GPS to locate the position of the accident car. Despite above-mention claims, the system has several drawbacks; among them, the system is fully dependent on the mobile cell services that provided within the accident vehicle zone. In other words, the system will not be able to recognize accidents that often occurs in remote regions where there are no people/vehicles to witness, hear, or receive local signals. Despite the above mentioned claims by both researchers; still their systems fail in the remote accident zones.

2.2 Research Motivations and objectives

Normally when a vehicle is involved in an accident, emergency services are not automatically notified about the accident. Such delay in notification might cause more fatalities. This might be considered among reasons that quantify as the core of the research motivation.

The role and objective of this system is to inform the emergency medical services, police vehicles, and the vehicle owner of an accident or an over speed that might cause an accident.

The system is designed to install in the vehicle and functions to communicate data such as the current position of the car, and speed of the car by using wireless network. Furthermore, the project aims to build a system that is capable of detecting a car crash/accident position and report the location and speed of vehicle during accident to an emergency service provider. Namely the system will fulfil the following objectives; but not limited to:

1. To sense whether there is an accident or not.
2. To measure the speed of a vehicle during an accident and report if the vehicle is over speed.
3. To locate the position of the accident car.
4. To communicate with the nearest emergency medical service provider or police vehicles that might help in reducing number of fatalities.
5. To report both the speed and position to the nearest emergency medical service provider or police station.
6. To prevent accidents from occurrences by sending a SMS to the vehicle owner informing about high speed.

3. Proposed Research Methodology

The paper has been proposed to develop an approach that overcomes the shortcomings of above-mentioned existing systems, and explores the potential of integrating the speed of the vehicle and position whether there is a committed accident or over speed that might lead to an accident.

In one aspect, a vehicle notification and prevention device is provided , the device comprising a microcontroller, a nock sensor electrically connected to the microcontroller, a speed selection box electrically connected to the microcontroller, a modem electrically connected to the microcontroller, and a system reset button electrically connected to the microcontroller as well. The speed selection box assists in determining the speed of the vehicle. The speed can be measured by means such as GPS or engine pulses. A GPS may also be added to provide positioning information. The system may further comprise an alarm, such as a LED.

In another aspect, a method is implemented using the above device. A modem, such as a GSM modem, is initialized. The speed of the vehicle is also measured when accident takes place during the method. If an accident has occurred, then a message will be sent. If an accident has occurred and a message was sent, then the system will wait for rest. The system may also send a message if a certain predetermined speed is exceeded.

In yet another aspect, a GSM modem is initialized. A speed measurement is taken to determine if the vehicle exceeds a third predefined. A determination is made to discover the presence of an accident. If an accident has occurred, the speed needs to be re-measured. If the speed is above a certain limit or threshold, then a message is sent and the system waits for rest. If the speed is below a certain limit, a message will be sent and an alarm will be activated as well. The system will then wait for reset.

In cooperation with the attached drawings, the technical contents and detailed description of the present research proposal are described thereinafter according to a preferable embodiment, being not used to limit its executing scope.

Figure 1 depicts an embodiment of the circuit employed in the current system. The circuit further includes a PIC microcontroller 10, MAX233 20, and GSM modem 30. The circuit further includes resistors R, capacitors C, diodes D, and various integrated circuits IC. Electrically connected to the PIC microcontroller 10 and speed selection box 50 is a nock sensor 40. In this embodiment the PIC microcontroller 10 is a PIC16F84A. The nock sensor 40 is a sensor that detects when the vehicle has been stuck, thereby indicating an accident. The nock 40 may be any sensor, such as a crush sensor, but is preferably a predefined, handmade crush sensor. The crush sensor can be a handmade sensor. The crush sensor can be build out of a spring, ring, and rod. The sensitivity of such a sensor would depend on such factors as the size of the ring and the spring constant. In addition to the crush sensor, a nock sensor can be added. The number of sensors can be increased or decreased depending on such factors as economics for desired safety. For convenience, the nock sensor 40 is depicted as a switch. This is not to be taken as limiting the nock sensor 40 to a switch.

A speed selection box 50 is electrically connected to the PIC microcontroller 10 and the nock sensor 40. The speed selection box 50 contains a plurality of speed selection units 51, 53, 55. It is preferable that the system contain at least three speed selection units 51, 53, 55. The speed selection units 51, 53, 55 allow a user to select a speed with the system is programmed to monitor the speed. The speed selection units 51, 53, 55 are depicted as switches for convenience and ease of understanding. It should be noted that these speed selection units 51, 53, 55 are not actual switches. They represent the various voltage outputs of the corresponding voltage regulators, described below. The speed selection box operates under Ohm's law. The current of the system depends on the resistance values. As the speed of the vehicle changes, the resistance within the circuit will change.

In Figure 1, there are three speed selection units 51, 53, 55. Each voltage selection unit 51, 53, 55 corresponds to a different vehicle speed. For example, the first voltage selection unit 51 could correspond to a speed of 50 Km/h, the second voltage selection unit 53 to a speed of 100 Km/h, and the third voltage selection unit 55 to a speed of 150 Km/h. Measuring speed is not limited to changes in voltage as the speed of the vehicle can be measured in various ways. An example of the ways the speed can be tested is by use of a tachometer. The speed can also be measured by counting the number of pulses generated by a gear box over a certain period of time. The number of pulses corresponds to the distance. When the distance is divided by time, speed can be obtained.

Figure 1 depicts an embodiment of a system reset switch 60. The system rests switch 60 can be any type of switch that will allow a user to reset the program running within the circuit. After the user activates the system reset switch, the program will start from the beginning.

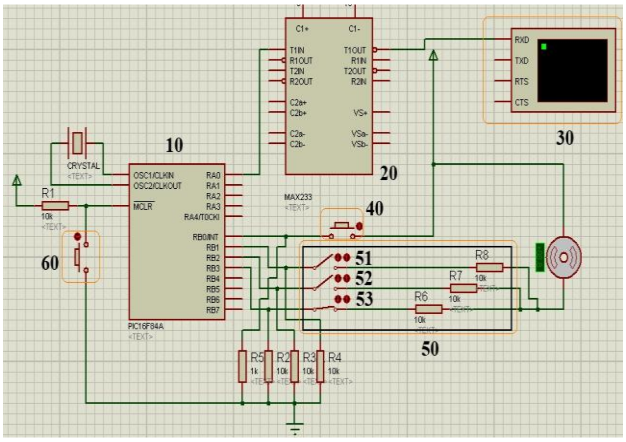


Figure 1: depicts an embodiment of a system reset switch 60

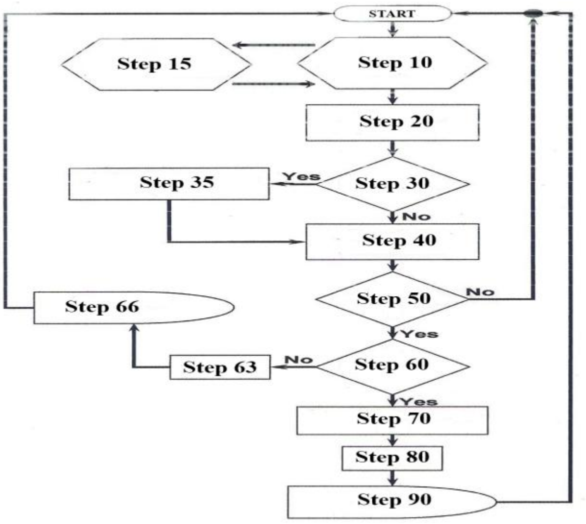


Figure 2: flowchart depicting an accident notifications system

Figure 2 depicts an embodiment of a flowchart depicting an accident notifications system. Step 10 indicated the initialization of a modem. The initialization can be started by a PIC microcontroller 10 (not shown in Figure 2). The modem can be a GSM modem 30 (not depicted in Figure 2). During initialization of the GSM modem, the PIC microcontroller 10 (not depicted in Figure 2) may set up the GSM modem 30 (not depicted in Figure 2) by sending two AT commands. An example of the two AT commands sent are AT+CNMI and AT+CMGF. If these two signals are sent, the values for each signal can be AT+CNMI =2,1,0,0,1 and AT+CMGF=1. Near the time or at the same time of step 10, step 15 may occur. Step 15 is the initialization of a GPS device.

In this embodiment, after the initialization step(s), the speed is measured (step 20). The speed will be placed into three categories. The first category is below a first predetermined speed, for example 50 Km/h. The second category is above the first predetermined speed and below a second predetermined speed, for example above 50 Km/h and below 119 Km/h. The third category is above a third predetermined speed, for example 120 Km/h. Step 30 determines if the measured speed falls within the third category. If so, then a message is sent in step 35. The message sent may be a text message sent via a GSM modem. The message contains the information that the speed has exceeded the third predetermined speed.

Step 40 detects if an accident has occurred. Detection means can be any means which may detect that an accident has occurred. For example, a crush sensor may be implemented to show an accident has occurred. During the accident detection step, the system will determine if the speed is outside the first category (step 60) and if the accident occurred (step 50). If no accident is detected, the system is reset. If an accident occurs and the speed falls within the first category, then an alarm will be activated (step 63). An example of the type of alarm that may be used is an LED. A further example of the alarm is a red LED. After the alarm is sent, the system will wait for reset (step 66). Reset can occur automatically or by physical action of a user. If the speed falls within a category other than the first category and an accident is detected, a message will be sent (step 70). The message can be sent via text message over a GSM modem. After sending a message (step 70), an alarm will be activated (step 80). The alarm can be an LED, for example. The message sent in step 70 includes information indicating that an accident has occurred and the speed category at the time of accident.

If a GPS unit has been included within the system, then the message may also contain the coordinates of the accident site. In this embodiment, a PIC microcontroller 10 would detect the accident and send a special AT command to the GPS module. This command would cause a reading of the GPS coordinates and relay it to the PIC microcontroller 10. The PIC would then send include the coordinates in the message and relay them to rescue staff. The GPS module could also be used to determine the speed of the vehicle, which could then be relayed to the rescue staff.

In the last few years, the number of Vehicles has increased rapidly and as consequence the number of vehicle accidents is increased. The accidents are due to many factors; among them, vehicle malfunction (around 3% of car accidents), road maintenance (around 7% of car accidents), and Human error (around 90-95% of car accidents combined with other factors). Since the nature of accidents are varied and hard to have a standard system that capable to reduce or prevent them. The researchers come up with an idea that might reduce the consequence of accidents and save lives. The project focuses on the third reason, which is human error or accidents due to over speed.

The current system provides solution that an overcome the previous mentioned solution and adds some features that neither being consider by previous researcher nor implemented in their applications. The solution composed of hardware and software components. Worth to mention, the system consists of different hardware components; discrete components as resistors, capacitors, diodes, and integrated circuits. The core of the system is the microcontroller, which is connected to other peripherals, and the GSM modem which is used to transfer data over the GSM network, and other sensors to detect speed and accident. While GPS is considered as main core for positioning the accidents vehicle location. Figure 1 illustrates the flowchart of the proposed system.

4. Experimental Design and Procedure

The experimental design consists of various steps and tasks; as shown in Figure 2. The simulation system contains the following important parts:

4.1 Virtual Hyper terminal

This is a virtual screen which represents the system response to the command sent from the PIC microcontroller to the MAX233 then to the GSM modem.

4.2 Nock sensor

This is the predefined handmade crush sensor on which we represent it with a switch in order to show the system response to different cases of car situations.

4.3 Speed selection box

This box contains a three speed selections on which we allow the user to select the speed while the system is programmed to monitor the speed and to response to different predefined cases the driver may met. These switches are not real; they represent the output voltage of the three voltage regulators. The simulation model contains three switches each one represent a single car speed, the top one represent the 50 Km/H speed selector, the second one represent the 100 Km/H selector and the third represent the 150 Km/h selector. The speed system works under Ohms low on which the current in the circuit depend on the resistance values which means that this current will vary from selection to another which leads us to the face that motor speed will change because of this fact.

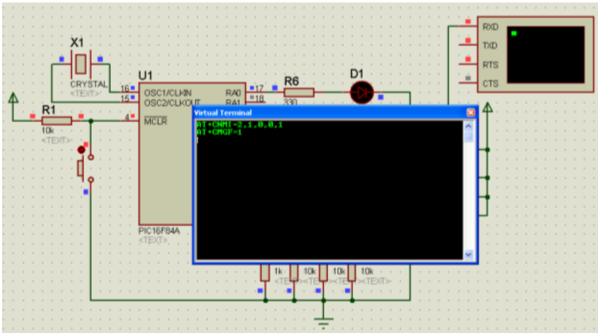
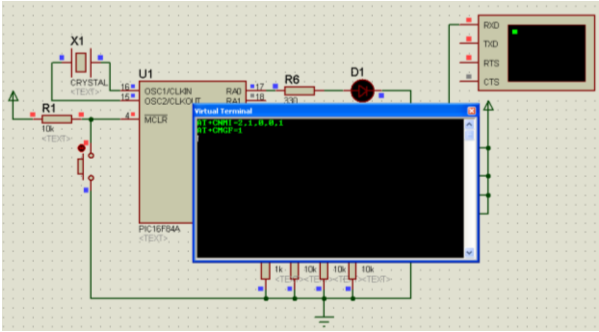


Fig.3: GSM initialization

4.4 System reset bottom

This switch helps the user to reset the system when needed by just clicking on it, so that the program will be started again from the beginning. In real life, resetting the system is similar to switching the car OFF and ON. At the beginning, PIC16F84A will setup the GSM modem to the needed requirements by sending the two AT commands.

Setting the speed to (1), and by pressing the bush button, which represents an accident, only the alarm will be enabled – Figure 3 – and no message is sent. If speed is increased to speed 2, by closing the second switch, and an accident happens, the system will send a message to the mobile number "e.g. +966554449065" as in Figure 4.



Now if speed exceeds speed 2 by closing the third switch, the system will send a report to the mobile phone – Figure 5 – and if an accident occurs, it will send another message; as shown in Figure 6 and 7, and then enables the alarm.

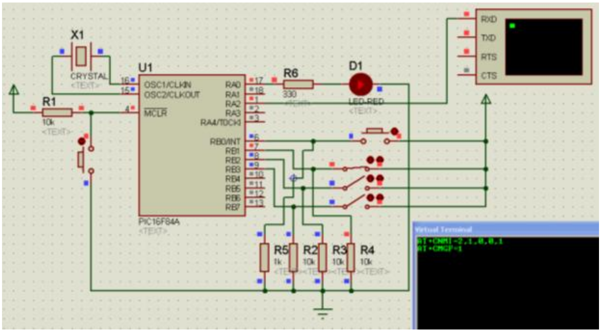


Fig.4: Accident at speed

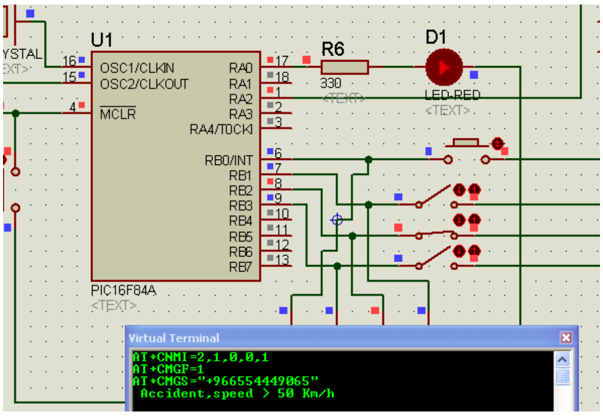


Fig.5: Accident at speed 2

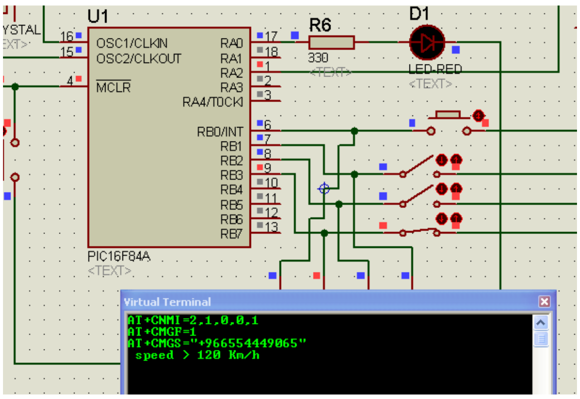


Fig.6: Speed exceeds 120 Km/hr

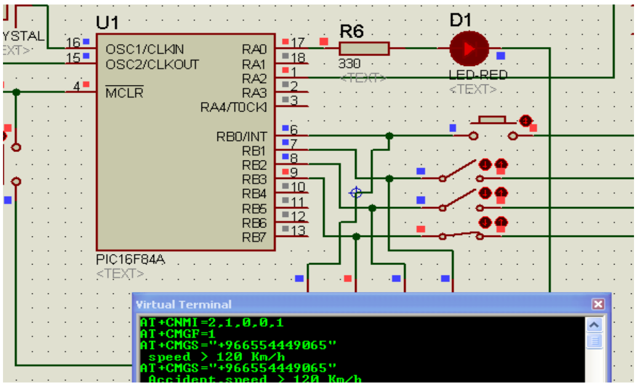


Fig.7: Accident at speed 3

5. Conclusion and Future works

From the system described it is obvious that we met our goals by designing a suitable safety car system in which we can monitor the speed of the car and any crushes may occurs during driving, the run of the system shows how the system is reliable and can be trusted in different cases.

The run of the system was on both simulation and a real circuit to insure the functionality of the system; the results met the level we want.

The system contains two subsystems one to measure the motor speed and the other to detect any crush occurs during driving to ensure a safety driving which leads to avoid accident (minimize them), the first subsystem is the crush sensor which is a handmade sensor, built from a spring, a ring and a rode, this sensor sensitivity depend on many factors such as: the ring size and the spring constant. While the second subsystem contains a speed monitoring criteria on which it detect three different ranges of speed, all the subsystems is grouped together and connected to the PIC microcontroller in different ways to ensure that the data is transferred correctly between them.

As we discussed, the system is built on a small toy car which gives us a sense on how this system will work in real life applications, the only different will be that we have to replace the toy car with a real car, add more sensors to the system to ensure more safety drive, such as nock sensor, furthermore we have to modify the speed monitoring system to be more reliable with real Vehicles so this means the need to use a tachometer to measure the speed and send this values to the PIC in a suitable way in order to respond to it.

In real Vehicles, the speed is measured by counting the number of pulses generated from the gear box, during time interval. Number of pulses is corresponding to the distance, and by dividing distance by time, we get the speed. So we can develop our system to count these pulses, and only we need to modify the software by adding the pulses factor (pulses per meter) which depends on the car manufacturer and model.

Also, the system can be more reliable by adding GPS "Global Positioning System", to the circuit. This can be added simply by connecting it to the PIC microcontroller, and modify the PIC code, to read the car coordination at request. This can be added to any other pin on the PIC, and at accident the PIC will send special AT command to the GPS module, to read coordination, and then PIC will send them via the GSM to the rescue staffs, telling them the speed of the car when crush and its position.

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