ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2016

Automotive Mobile Control System to Monitor Teen Driving Behaviour

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ABSTRACT: A big percentage of accidents happen on the roads daily due to young drivers not knowing the consequences of over speeding. However, we can prevent that by developing a technology that can communicate with parents and alert them when their teenagers are over speeding. The functionality of this technology will allow parents to receive a text message on their smart phone as an alert when a car goes over a speed limit that parents have set previously. A big portion of the engine information can be collected in the car using On-board diagnostics (OBD) port. Moreover, the collected information can be passed to a microcontroller for further process and then a decision will be made based on the results. One of the microcontrollers that can be used is the Arduino UNO. Furthermore, there are many gadgets (shields) that can be used to develop this technology for example: Global System for Mobile (GSM) and Bluetooth shields. This technology will avoid many accidents on the roads and will allow the parents to prevent their minors form a mistake that they might regret for the rest of their lives.

KEYWORDS: Teenager safety, Automotive, Arduino, On-Board Diagnostic System, OBD II, GSM.

I. INTRODUCTION

In the United States of America the teenagers are allowed to drive at the age of sixteen. They do not realize that attaining a license to drive comes with certain responsibilities. Most of the teen accidents are caused by speeding. A study that was conducted shows that 30 percent of teens were dying due to car accident in 2000 and that number increased to 33 percent in 2011 [1]. Number of teens dying because of car accident is still increasing due to many factors and also it is hard to make teens listen and do what their parents asks them to do. Teens consider the posted speed limit as the minimum limit they should be driving at and often end up driving at least 10 or 15 mph over the posted limit. As we all know the braking distance increases with speed. The higher the speed you are driving at, the more time and distance you require to brake. For example, if a vehicle is travelling 67 miles per hour and slams on the brake it will continue d travelling roughly about 25 miles per hour compared to a same car that is travailing at 60 miles per hour and comes to a complete stop [2].

In such conditions, it is very difficult to avoid collisions and results in major accidents. There are many consequences of driving 15mps over the speed limit in a neighbourhood where there are kids on the street or on curvy roads in the night. Ford is coming up with a technology and many people think it is a very intelligent idea that will keep people drive on the posted speed limit. The technology will work as follows, a sensor will read the road's speed limit and it will slow the car automatically to the posted speed limit if it is over speeding [3,4]. Moreover, teenagers will over speed because most of the time the parents are not aware of such situations and teens continue to do so until they experience a fatal accident. But this will be too late. Fortunately, people are coming up with a lot of techniques to prevent such fatal crashes. There are a few car companies that make certain models of vehicle that comes equipped with a technology that will alert that driver when over speeding. The most effective way might be if parents are able to monitor their children's driving and prevent them from driving recklessly. This method will allow the parents to have an idea about how their teens are driving on the roads and monitor them remotely.

II. RELATED WORK

Many people have conducted a significant amount of research in the past to find out a way that will prevent teens from over speeding while driving. The number of teens dying in a car accident is increasing rapidly which is a huge issue. Cars are getting faster and faster every year which can put teens in a grader risk than usual. Many people having taken this situation seriously and working with bigger companies to figure out a way that will prevent teens from driving

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ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

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recklessly. One approach was studied and proposed by an auto insurance company which was speeding alert. The study looked at a technology called intelligent speed adaptation (ISA), which uses GPS to locate a car and collect speed limit data for the surrounding area and then notify the driver using variety of techniques if they exceed the speed limit. Moreover, they observed that having a device like that in the car will reduce the speeding at which teen's travels at [5]. White, in [6] authors projected another method which was creating a mobile app that will allow parents to track their teen while they drive. This app will allow the parents to know all the activities that their teens do while driving when they should be really focusing on driving only. The app can alert the parents when their son or daughter is texting or using Facebook. Moreover, it can also set to send an alert when a designated maximum speed is exceeded and the app can be set up to provide daily and weekly reports. However, the app has some glitches that need to be fixed and it does not provide accurate data sometimes. In addition, the app has to be running in the back ground of the teen's phone to work and record the proper information otherwise it will not do anything. In [7] authors recommended that the parents and teens must be educated regarding the frequency of and the potential effects of distractions. Additional enforcement may be necessary if Graduated Driver Licensing (GDL) programs are to be effective. Systems that alert distracted teens could also be especially helpful in reducing rear-end collisions. In [8] authors proposed that the electronic monitoring of teenage drivers can reduce the incidence of risky behaviour, especially seat belt non-use. More complicated behavior is more difficult to change, however, Impact on Parent participation is key to successful behavioural modification, but it is yet to be determined how best to encourage such participation. In this research a newer idea will introduce to monitor teens driving speed remotely without informing them. However, this idea is still not implemented in any of the current car models which we have on the road today. This idea can save teens as well as other innocent lives.

III. STATISTICS

According to [9], 28 percent of teen motor vehicle crashes were caused by speeding in the year of 2014. Since 2005, 30 percent of motor vehicle crashes were also due to speeding. Many of the drivers in the crashes were known to have previous speeding citations or racing. The proposed method of alerting parents of their teen driving will help in decreasing the number of motor vehicle crashes. By receiving alerts, parents are able to speak with their teens and reprimand their driving behaviour. This will entertain better driving behaviour in teens thus reducing distractions that may lead to motor vehicle crashes. Figure below illustrates the number of motor vehicle crash deaths involving speeding between the year of 2005 and 2014.

Motor vehicle crash deaths involving speeding as a contributing factor, 2005-2014

	Speeding-related		Not speeding-related		Total
	Number	%	Number	%	Number
2005	13,583	31	29,927	69	43,510
2006	13,609	32	29,099	68	42,708
2007	13,140	32	28,119	68	41,259
2008	11,767	31	25,656	69	37,423
2009	10,664	31	23,219	69	33,883
2010	10,508	32	22,491	68	32,999
2011	10,001	31	22,478	69	32,479
2012	10,329	31	23,453	69	33,782
2013	9,696	29	23,198	71	32,894
2014	9,262	28	23,413	72	32,675

Figure 1: Motor vehicle crash deaths involving speeding, 2005-2014

Additionally [9] states that motor vehicle crash deaths per 100,000 from the year 1975-2014 showed a higher number of deaths in younger drivers. In 2014 drivers between the ages 13 through 19 had a total population of 29,469,473 and 2,623 died from motor vehicle crashes resulting from speeding. However, drivers between the ages 35 through 69 had a total population of 139,374,831 in 2014 and 15,037 died due to motor vehicle crashes. Although, the older drivers had a population larger than teenagers by 109,905,358, more teenagers died in crashes in respect to their population. Therefore, statistics prove that teenagers are more likely to die in motor vehicles due to their driving

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International Journal of Innovative Research in Computer and Communication Engineering

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behaviours. Figure 2 shows the aforementioned statistics and Figure 3 illustrates that the speeding was a factor in more than half of fatal crashes with a teen behind the wheel.

Motor vehicle crash deaths per 100,000 people by age group, 1975-2014

Year	<13 years			13-19 years			20-34 years			35-69 years			70+ years		
	Population	Number	Rate	Population	Number	Rate	Population	Number	Rate	Population	Number	Rate	Population	Number	Rate
2005	52,149,395	1,529	2.9	29,589,854	5,300	17.9	61,180,772	13,023	21.3	126,831,714	18,491	14.6	26,658,669	5,047	18.9
2006	52,306,908	1,430	2.7	29,772,198	5,159	17.3	61,527,219	13,142	21.4	128,907,361	18,233	14.1	26,884,798	4,636	17.2
2007	52,585,809	1,269	2.4	29,775,943	4,981	16.7	61,623,322	12,531	20.3	130,500,566	17,725	13.6	27,135,517	4,631	17.1
2008	52,929,779	1,047	2.0	29,710,307	4,070	13.7	61,990,546	11,406	18.4	131,908,058	16,538	12.5	27,521,034	4,291	15.6
2009	53,753,412	1,066	2.0	29,667,279	3,480	11.7	63,105,881	9,940	15.8	132,693,708	15,340	11.6	27,786,270	3,995	14.4
2010	52,943,218	962	1.8	30,324,338	3,121	10.3	62,649,947	9,684	15.5	134,995,314	15,015	11.1	27,832,721	4,171	15.0
2011	52,950,108	908	1.7	29,895,041	3,033	10.1	63,944,330	9,633	15.1	136,282,085	14,782	10.8	28,520,353	4,071	14.3
2012	52,872,572	958	1.8	29,632,228	2,837	9.6	64,892,524	10,210	15.7	137,348,713	15,614	11.4	29,168,003	4,113	14.1
2013	52,723,720	940	1.8	29,524,367	2,543	8.6	65,640,025	9,908	15.1	138,145,370	15,298	11.1	30,095,357	4,150	13.8
2014	52,666,129	872	1.7	29,469,473	2,623	8.9	66,428,678	9,864	14.8	139,374,831	15,037	10.8	30,917,945	4,192	13.6

Figure 2: Motor vehicle crash deaths per 100,000 people by age group, 1975-2015

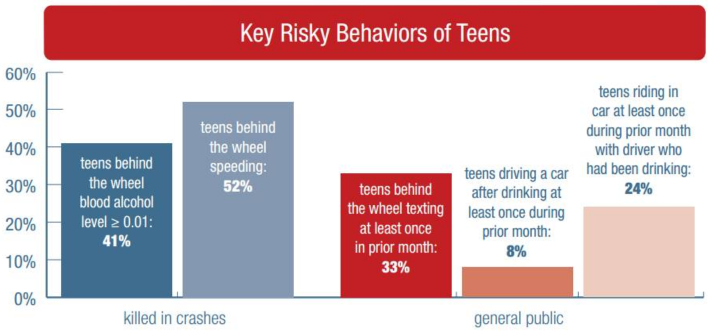

Figure 3: Key Risky Behaviours of Teens

IV. METHODOLOGY

The proposed method of this research is to alert parents of the driving behaviour of their teenagers. The OBD-II grants engine information access to take input and the information is then transferred to the Arduino UNO. The data is then processed within the programmed Arduino UNO and a decision is made according to the input data. If the Arduino UNO recognizes over speeding, the GSM Shield prepares a notification message that is sent as a text message via GPRS (General Packet Radio Service) to the mobile phone of the parents. If no over speeding is recognized, the system is told to do nothing. The system is then refreshed and new data is transmitted which continues to repeat the process infinitely as long as the vehicle engine is running. Figure 4 below shows a detailed schematic of the proposed method.

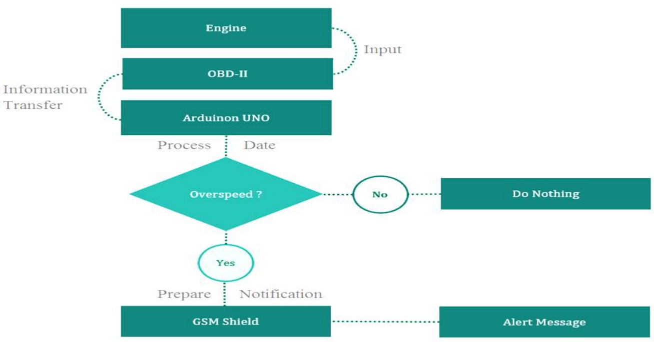

FIGURE 4: SCHEMATIC METHOD

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

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Vol. 4, Issue 5, May 2016

V. INTEGRATED SYSTEM

This type of proposed system requires components that are already integrated into the vehicle in addition to the Arduino UNO that the user connects to the OBD system. It requires the user (parent) to install the programmed Arduino UNO to the present OBD system. The GSM Shield will have a designated network mobile number based on the SIM (subscriber identity module) card installed. The user will then be able to receive alert text messages via the GSM Shield number. As mentioned previously, the OBD is granted access to the engine data which in return transfers the data to be processed in the Arduino UNO. This data is used to decide whether over speeding is detected or not, if so an alert text message is sent to the user to notify them of driving behaviour. The integrated system is illustrated in Figure 5 below.

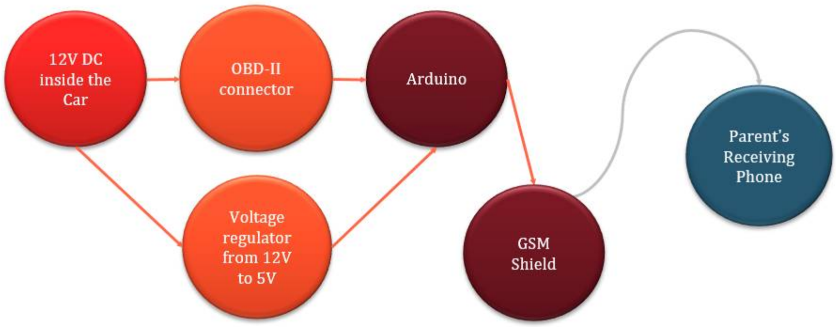

Figure 5: Block diagram of the circuit

V.I SYSTEM CONTROL DEVICE

A microcontroller was used rather than using a footprint mini-computer like Raspberry pi as controlling device between the On-Board Diagnostic system and the GSM shield. The microcontroller that was used was Arduino Uno board, a microcontroller board based on the ATmega328PIt has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button [10]. Arduino UNO is preferred to Raspberry pi because of higher functionality, security, expandability and cost effective features. The system that will be developed will require a better hardware support base, rather than computer-like features; therefore, Arduino is a better choice in terms of functionality. One important aspect that makes the Arduino Uno a better choice, the hardware nodes of an Arduino Uno is more secured than that of Raspberry pi, as in order to change any functionality of the nodes an intruder needs to know the software codes, whereas for Raspberry pi he only need an external SD card and everything will be changed. Moreover, Arduino Uno is open source for everyone to use unlike Raspberry pi which is a closed source. That is the reason why Arduino compatible board is less expensive compared to Raspberry pi. Moreover, Arduino supports a verity of shields that can be at attached to the board to achieve the specific task needed [11]. Figure 6 shows the components of the Arduino UNO.

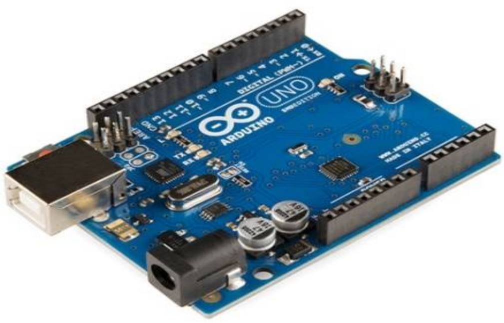

Figure 6: Arduino controller device

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ISSN (Print) : 2320-9798

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V.II On-Board Diagnostic system (OBD-II)

It is a system that is in every cars and light trucks on the road today. During the '70s and early 1980's manufacturers started using electronic means to control engine functions and diagnose engine problems. This was primarily to meet EPA emission standards. Through the years on-board diagnostic systems have become more sophisticated. OBD-II, a new standard introduced in the mid-'90s, provides almost complete engine control and also monitors parts of the chassis, body and accessory devices, as well as the diagnostic control network of the car [12]. This system will allow us to get all the necessary engine information when the vehicle is moving from RPM speed (revolutions per minute), and the speed at which the car is travelling at. Figure 7 illustrates the head connector of the OBD within the vehicle and the pin diagram.

Figure 7: On-Board Diagnostic System (OBD-II)

V.III GSM shield

The Arduino GSM Shield connects the Arduino microcontroller to the internet using the GPRS wireless network. Plug this module onto your Arduino board then plug in a SIM card from an operator offering GPRS coverage and by following a few simple instructions you can control your world through the internet. The GSM Shield allows an Arduino board to make/receive voice calls and send/receive SMS messages. The shield uses a radio modem M10 by Quectel. It is possible to communicate with the board using at commands. The GSM library has a large number of methods for communication with the shield [13]. Figure 8 shows the GSM shield that can be connect to the Arduino UNO.

Figure 8: GSM Shield

V.IV Voltage Regulator

It is any electrical or electronic device that maintains the voltage of a power source within acceptable limits. Voltage regulator is usually needed to keep voltages within the prescribed range that can be tolerated by the electrical equipment using that voltage [14]. Voltage regulators are used in too many applications to control the voltage that enters the specific device. Moreover, voltage regulators act as a transformer, which can step up or a step down the voltage. That concept means that the voltage regulator can increase, or decrease the incoming voltage to make it match the voltage which the device requires. Figure 9 illustrates the voltage regulator that connected to the Arduino.

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International Journal of Innovative Research in Computer and Communication Engineering

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Figure 9: Voltage Regulator

VI. Complete System

These components which were mentioned earlier, will communicate together to do the required task. First the important engine and car information will be available for anyone to use at the OBD-II connector. Moreover, this information then will be passed to an Arduino using a cable which has on one end the OBD-II connector head and on the other end just two wires which will get connected the Arduino. The Arduino start processing the received data from the OBD-II. When the provided data does not have a sign of over speeding, the Arduino will discard this data and will look at a fresh data that was just received from the OBD-II connector. This process will keep repeating until the loop is broken that will happen when the received data have a sign of over speeding. At this point, the Arduino will give a signal to the GSM shield to get ready to send the text message which was prepared earlier to the saved parent's phone number. On the other end, the parents will receive the text message alert on their phone and they can decide on what to do after. The Arduino will need a voltage regulator to work properly. The Voltage regulator will step the voltage down from 12 volt DC to 5V DC. Figure 10 below illustrates the complete system.

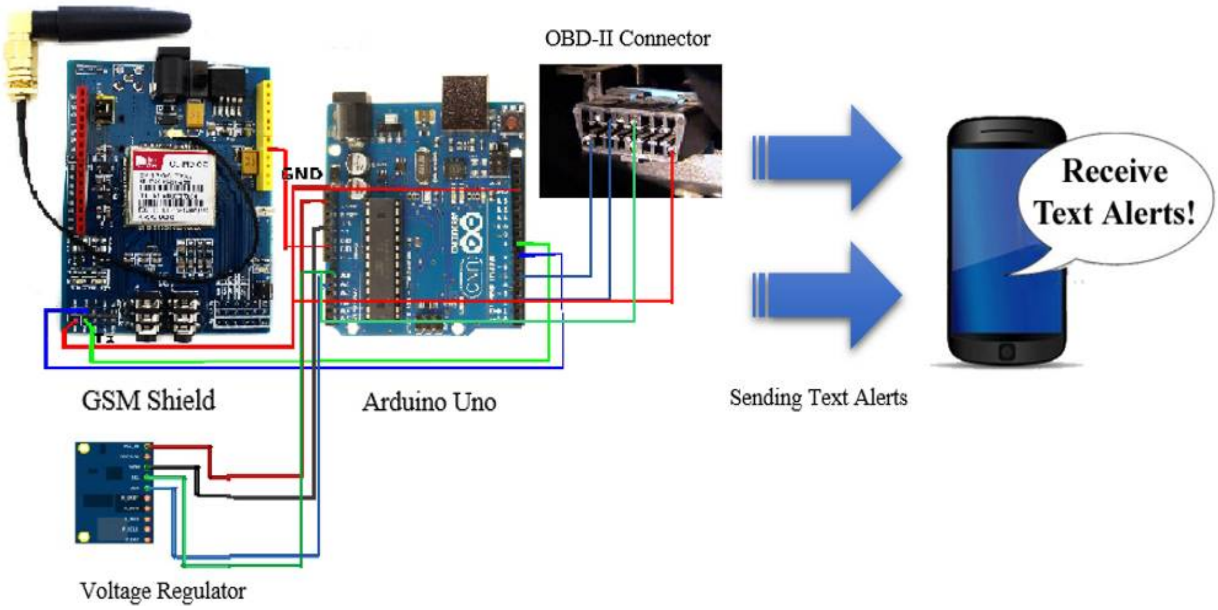

FIGURE 10: COMPLETE SYSTEM.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2016

V.II CONCLUSION

The purpose of this technology is to reduce the number of car accidents that are caused by teen reckless driving. This feature allows parents to monitor the driving behaviour of their teens without their teens knowing. Many fatal accidents are caused by over speeding because many teens don't realize the responsibility and consequences of over speeding. As long as this system is active, the driver will continue to drive on the set speed limit since the system is monitored by the parents.

This feature will work with any car as long as it has OBD-II connector and that should not be an issue since most vehicles made after 1975 will have OBD-II connector available to connect the system to; therefore, it can be stated that the system will work with all cars. Moreover, the system is very easy to install in the car and it does not require any additional tools to connect it. Various studies have shown that having a system like that will decrease the results of accidents that are caused by over speeding; therefore, having a monitoring system especially for new drivers will be one of the necessities that will be required in all new cars.

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BIOGRAPHY

Lubna Alazzawi joined the Department of Electrical and Computer Engineering at Wayne State University, USA as a Faculty on 2013. Prior to joining Wayne State University, She was teaching in the Department of Electrical and Computer Engineering at University of Michigan, Dearborn, USA. She also worked there as a postdoctoral research fellow. Dr. Alazzawi received her doctoral degree from University of Technology and University of Michigan-Dearborn, USA joint program. Her research interests include embedded systems, vehicle automation, high-speed networks reliability and security, wireless sensor networks, smart sensors and FPGA chip design.

Bashar Najjar is an Electrical Engineering student at Wayne State University, Michgan, USA. Has his associate degree in General Science from Oakland Community College, USA. Currently, he is working as Pre Integration test engineer at Harman Becker automotive systems. He recently won an award from Wayne State University on having one of the best three projects in "The Innovation and Design Day". His research interests include vehicle automation and improving safety for modern vehicles.