A PROPOSED SYSTEM TO DETERMINE AND CONTROL CARS' SPEED TO REDUCE ROAD ACCIDENTS USING OBD II AND ARDUINO

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Abstract:

The current research aims to design a proposed system for determining and controlling the speed of cars on different roads, based on Arduino and the standard OBD II communication protocol used in most modern cars, which operate with the electronic Throttle air gate. This is due to the large number of car accidents that killed millions of people around the world, and the research showed the possibility of using the proposed system in school and populated areas, as well as using it in school buses, which maintains students` safety, by controlling the speed of cars and buses in these areas so that drivers cannot exceed the prescribed speeds. The proposed system was designed and tested on different types of cars such as Toyota, Volvo, Peugeot and other cars. A test was conducted for the accuracy of the system in determining speeds and locations, and its accuracy reached more than 98%.

Keywords : Arduino - OBD II - Car Accidents - GSM – GPS

Introduction

The researchers believe in the need to direct scientific research in different disciplines to contribute to solving the problems in society that greatly affect its growth and progress, as about 1.35 million people around the world are killed every year, as a result of road accidents, and the number of injured ranged between 20 to 50 million people, as a result of these accidents [1], and with a review of many studies and reports on the causes of these accidents, it was found that they are the result of two main factors; mainly excessive speed and driving in times of fog, in addition to several

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sub-factors such as the driver's error and the presence of technical malfunctions in the car. So the researchers try in this research to find and propose an appropriate solution by use the proposed system to help in control the speed of cars on different roads, especially in periods of fog and lack of vision, to contribute to reduce the number of daily accidents by relying on some modern technologies and unified OBD II protocol that used in all modern cars as a unified communication language for cars[2][3].

The proposed model of the system has been developed and it is clear that the system relies entirely on internet connectivity in order to follow the movement of cars on different roads. The system has been tested on different types of cars that operate with the electronic throttle body. As well as the regular ones that contain a cruise control, and the system has proven successful in the ability to control the speed of cars by sending signals to them through the OBD II port, so that the car automatically reduces its speed depending on the control of the size of the air intake hole for the engine in the throttle, and the system can also control running and stopping the engines, as this feature can be used in times of fog, as well as in the event of special circumstances as the passage of presidential processions and others.

Research Aims

1- Contribute to the development of solutions to reduce road accidents resulting from excessive speed.

2- Contribute to the development of a mechanism to control the movement of cars in the event of an accident.

3- Control of cars in times of lack of vision and fog.

4- Reducing traffic violations.

Research Importance

1- Reducing expenses of traffic violations.

2- Saving fuel as a result of determining the speed of the car, as the higher speed of the car, the higher rate of fuel consumption[4].

3- Contribute to keep the safety and security of pedestrians and drivers.

System Requirements

1- OBD II Connector Unit connected with internet that`s shown in Fig (1).

2- Roads module for sending and following roads using Arduino Uno. It contains some Arduino parts that are responsible for sending signals and various commands related to stopping the engine, controlling speed, sending text messages to the concerned devices and others that`s shown in Fig (2).

3- Constant Internet connection for both the car and the road via a mobile SIM card in the GSM module.

4- GPS module.

Fig 1 shown OBD II connector

Fig 2 shown roads module

Related work

Several previous studies have dealt with the issue of car accidents and their impact on society, including the following:

Study of Tian entitled (An Automatic Car Accident Detection Method Based on Cooperative Vehicle Infrastructure Systems) which stated that according to the statistics of the world health organization, about 1.35 million people die and from 20 to 50 million suffer injuries as a result of car accidents, and it also confirmed that the presence of a mechanism of

automatic accident detection works to shorten the response time of rescue agencies, which is one of the objectives of the current study. This study relied on image processing by installing imaging devices on both sides of the road so that the images are analyzed and the presence of an accident is detected or not, and report automatically when there is an accident [1].

As confirmed by a study of Murshed entitled (An IOT Based Car Accident Prevention and Detection System with Smart Brake Control) According to the previous study, it determined that the most important causes of accidents are the driver's lack of awareness, as well as the failure to reduce the car's speed when there is a critical distance. This study relied on the technology of using the distance sensor among cars, the front of the car, and any obstacle. As it alerts the driver of danger and sends an e-mail to the concerned authorities when an accident occurs[5].

Study of Nie entitled (A Study of Fatality Risk and Head Dynamic Response of Cyclist and Pedestrian Based on Passenger Car Accident Data Analysis and Simulations), which confirmed that the risk of death in accidents is directly related to speed, as the higher the speed at the time of the accident, the higher the risk of death. This study relied on an in-depth analysis of car accidents in China, and a statistical measurement of the risk of death was carried out and the extent to which it was related to the speed of cars was determined[6].

Study of Seelam entitled (An Arduino based embedded system in passenger car for road safety), which emphasized the need for a system to control the speed of cars in specific areas, and from those areas (residential - schools), where the study also stated that nearly one million children die around the world as a result of road accidents. This study relied on sensors that detects alcohol so that alcohol sensor prevents the ignition from working if the driver breathes into it and a significant amount of alcohol is detected[7].

Study of Sim entitled (OBD-II standard car engine diagnostic software development), which showed that OBD II is a unified standard in

all modern cars through which the car and its various parts can be controlled, as well as the appropriate diagnosis of many malfunctions[8].

Study of Rimpas entitled (OBD-II sensor diagnostics for monitoring vehicle operation and consumption), which confirmed that the rate of fuel consumption is closely related to the speed of the car, and that the driving style of the car user is the main factor that affects the fuel consumption of a particular model[4].

Study of Bhumkar entitled (Intelligent Car System for Accident Prevention Using ARM-7) developed a system to control the car in case the driver was drunk or stressed, depending on a set of sensors inside the car that send short messages via the phone and turn off the car engine in case of a decrease in the number of times the eye blinks (sleep). The driver in cases of danger or accidents in order to reduce the response time of the concerned authorities. The system can also operate the cruise control system and fully control the airbags system, anti-lock brakes and other vehicle systems, in order to reduce the possibility of accidents[9].

The study of Jiaqi Xue, which confirmed that speed control for electric and hybrid vehicles leads to improved fuel economy[10].

Study of Yuqing Sun entitled (An extended car-following model considering driver's memory and average speed of preceding vehicles with control strategy), which aimed to record the speed of cars on the road to provide real-time traffic information, and this contributes to improving traffic stability and suppressing traffic congestion through the development of different models to follow different cars on the road[11].

Study of Min Chen entitled (Realization of Future Car Sharing Speed Safety System Based on Internet of Vehicles) that proposed a system for linking cars to a wireless communication network that allows them to exchange information about their speed and then issue alerts to drivers of the approaching distance between them and other cars to be able to reduce their speed[12].

Study of Gozdecki entitled (Communication system for Intelligent Road Signs network)that aimed to provide the road with smart signs

equipped with sensors that monitor road conditions in terms of weather and road traffic jam to provide drivers with accurate information about the safe maximum speed limit as well as notify them of traffic congestion and icy surfaces several kilometers ahead[13].

Study of Young entitled (Use of manual speed alerting and cruise control devices by car drivers), which aimed to develop a number of technologies inside the car to reduce the incidence and severity of speed-related collisions through warnings to the driver and to rely on cruise control in an attempt to reduce speed-related car accidents in general[14].

Study of Hamid entitled (Car Accident Detection and Notification System Using Smartphone) , which confirmed the death of a large proportion of people daily worldwide as a result of road accident injuries, and indicated that one of the effective ways to reduce deaths caused by traffic accidents is to build an automated system to detect traffic accidents, as well as reducing the time between the moment of the accident and the notification of the concerned authorities[15], as confirmed by the study of Sharma[16].

By reviewing, reading and analyzing these studies, their agreement with the current research was found in the following: -

1- A large percentage of accidents are caused by excessive speed of cars.
2- Reducing the speed of the car reduces a large proportion of the loss of life, as the risk of death is linked to speed.
3- The community needs a means to help control the speed of cars, especially in pedestrian crossings, schools and residential areas.
4- Reducing the speed of the car helps in saving the spent fuel.
5- Most of the car components, especially the engine, can be controlled by the OBD II port.
6- Automatic detection of accidents contributes to limiting their damage.

While the current research differed from them in the addition of the new one, which is full control of the speed of cars according to the condition

of the road, as well as the possibility of controlling running or stopping the engine in the event of mist or fog, by controlling the car and its components through the OBD II port and the proposed devices to be installed on the roads, In order to achieve the safety and security of road users, which in turn leads to reducing the rate of accidents, especially those resulting from excessive speed and fog.

Research Problem

The huge development in the car industry and the development of roads led to an increase in the speed of cars and the failure of many drivers to adhere to the prescribed speeds, as well as boys driving cars recklessly, which led to a significant increase in car accidents and claimed the lives of millions of people worldwide annually, as well as the increase in the number of violations traffic resulting from speeding and traffic officers' preoccupation with following up the main roads and setting up (temporary) ambushes to hold violators accountable lives, reduce the number of traffic violations, and disrupt the movement of cars at times when it is impossible to see due to fog and other weather factors.

Proposed System

In 1996, the OBD II protocol was standardized for all cars, which is a port in the car, through which the user or the maintenance technician can connect many devices to achieve a connection with the control unit of the car, through which it is possible to control all parts of the electric parts of the car and its accessories, especially those related to the engine and transmission. The OBD II link was programmed to connect to the Internet based on the Internet of Things, as well as a signal transmitter (suggested to be installed on the roads) and it is also connected to the Internet, through which the signals sent to cars are controlled by determining the top speed limit that the car can reach according to the road condition. Through controlling the throttle body, as it has been programmed, where a command can be issued to stop the engine or turn on the parking lights in the car automatically in times of fog or accidents on the road, which requires reducing the speed of cars coming on the road, where the speed of cars is measured, and the locations of accidents are determined through GPS, and all units shown in Fig (3) are connected together through the Internet and their data is stored in

the database. Which in turn sends alerts to ambulances or police when needed.

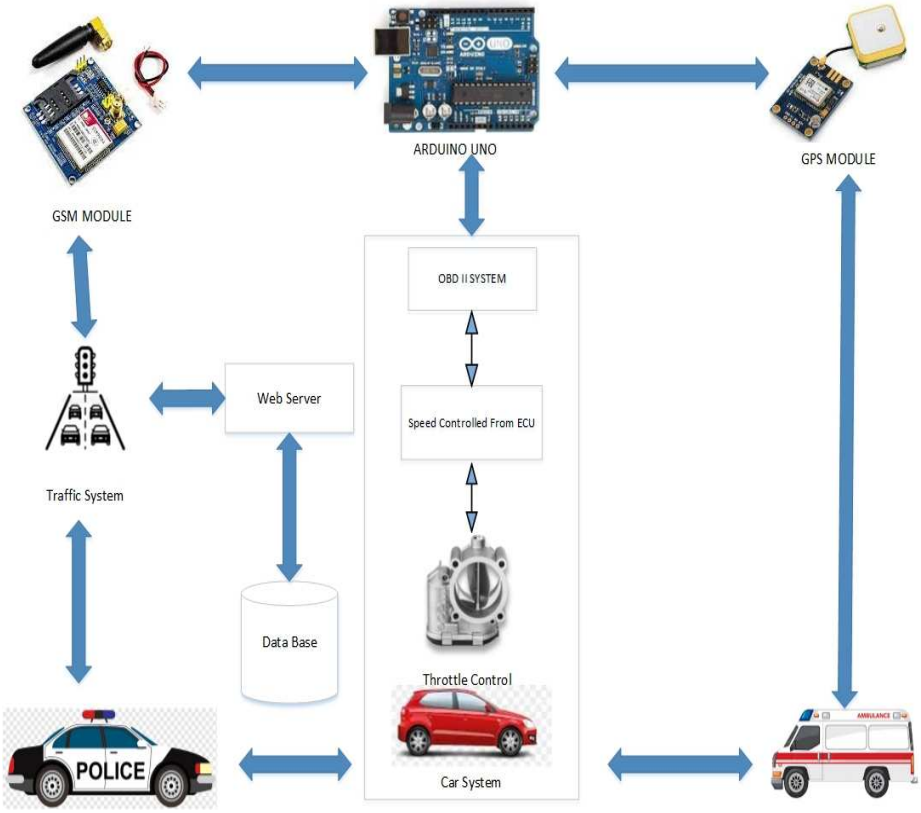

Fig (3) shown diagram of the proposed system and its components

Proposed System Components Communication

Components of proposed system are connected with each other as shown in Fig(4) OBD II piece is connected to the car via OBDII port, and all connected via the internet.

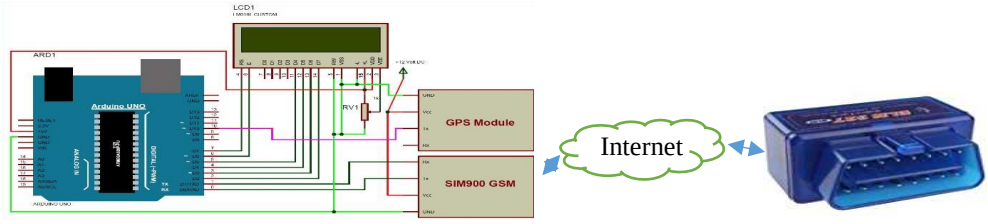

Fig (4) shown communication between components of the proposed system

The driver can disconnect the piece connected to the OBD II port in his car to get out of the system, taking into account the circumstances or emergency situations such as an ambulance, a sick condition and others, and in this case the traffic system records a violation on the car, and the driver can later present an excuse to the Traffic Department affiliated with it to remove the violation if he deserves it or the excuse is accepted by the Traffic Department. The following is an illustration of how the communication between the car and the devices proposed to be installed on the roads, and the system works in a flexible manner so that it can be added new features or removal from it.

GPS Module

GPS stands for Global Positioning System makes use of signals sent by satellites in space and ground stations on Earth to accurately determine its position on Earth.

The **NEO-6M GPS receiver module** uses USART communication to communicate with PC terminal and others. It receives information like latitude, longitude, **for measuring the distances**, etc. from the satellites in the form of NMEA string[17].

Arduino UNO Module

The Arduino UNO board is one of the most popular Arduino boards, which is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button[18].

GSM Module

The Arduino GSM shield allows an Arduino board to connect to the internet, send and receive SMS, and make voice calls using the GSM library[19].

OBD II

OBD stands for On-board diagnostics it is the standard protocol used across most light-duty vehicles to retrieve vehicle diagnostic information

and to control it or reprogrammed it. Information is generated by Engine Control Units (ECUs or Engine Control Modules) within a vehicle. They are like the vehicle's brain or computers[20].

On using our proposed system, car speed is pre-automatically controlled so that the driver couldn't exceed speed limit and avoid accidents caused by emergency conditions (fog, mist, presidential processions, etc) by stopping engines via the proposed system; Which proves the results reached.

The Mobile Application was built depending on:

- The application of the proposed system is designed by Android Studio.
- The Arduino chip was programmed by uploading the code to it by Arduino IDE 2.0.3.
- Arduino- OBD II libraries was used for connection between Arduino and OBD II connector.

The Interface of the proposed system shown in Fig (5), some cases of the proposed system shown in Fig (6)

Fig (5) shown the interface of the proposed system

Fig (6) shown some cases of the proposed system

Accuracy test in determining coordinates

This test included measuring the accuracy of the coordinates determined by the GPS unit in different surrounding conditions such as periods of fog, high buildings and open places. Different distances were recorded and the difference in distances was measured using the tools provided by google maps **(Actual coordinates are obtained using Google Maps and Cars coordinates are obtained using GPS module)**.

The GPS unit (neo-6m GPS) used has an accuracy of about 0.5 meters, and the accuracy of the coordinates was calculated using the following formula[21].

$$\text{Position Accuracy} = 100\% - \frac{Actual\ Variation - Stated\ Variation}{Actual\ Variation} X\ 100\%$$

Table (1) shows the obtained results

Position	Actual Coordinates (Latitude,Longitude)	GPS Module Coordinates (Latitude,Longitude)	Variation in Distance (m)	Accuracy Percentage
1	31.189150, 29.920447	31.189155, 29.920433	0.51	98.03
2	31.186710, 29.924799	31.186715, 29.924788	0.56	89.29
3	31.183009, 29.919808	31.182999, 29.919808	0.52	96.15
4	31.163414, 29.883074	31.163411, 29.883070	0.54	92.59
5	31.159975, 29.879342	31.159971, 29.879338	0.59	84.75

Proposed system accuracy test

To verify the accuracy of the proposed system, the speeds set by the proposed system were compared to the actual speeds (**Speedo meter speed**) of the cars on which it was tested. Table (2) shows these speeds, error percentage, and accuracy.

Which was done by the following equation:

$$\textbf{Error Percentage} = \frac{\text{Speedo meter speed (Actual speed)} - \textit{Proposed System Speed}}{\text{Speedo meter speed (Actual speed)}} * 100$$

Accuracy Percentage (%) = 100% - Error Percentage

Table (2) shows error and accuracy percentage

N	Car Model	Speedo meter speed	Proposed System Speed	Error Percentage (%)	Accuracy Percentage (%)
1	Toyota Camry	100 km/h	99.8 km/h	0.2%	99.8%
2	Volvo S40	65 km/h	64.9 km/h	0.15%	99.85%
3	Volks Wagen (Jetta)	80km/h	79.2km/h	1%	99%
4	Geely Emgrand 7	90km/h	89.4km/h	0.67%	99.3%
5	Volvo S80	60km/h	59km/h	1.7%	98.3%
6	Peugeot 508	100km/h	99.9km/h	0.1%	99.9%

After experiencing the use of the proposed system, a survey form was presented to 20 drivers and experts in the field of cars to obtain their opinions about the proposed system. Table (3) shows these opinions and the percentage of each of them.

Table (3) shows opinions of car drivers and experts

Statements	Yes		To some extent		No	
	N	%	N	%	N	%
The proposed system is easy to use and install	17	85%	2	10%	1	5%
The proposed system negatively affects your vehicle	_	_	1	5%	19	95%
You may exceed the speed limit set by the proposed system	_	_	_	_	20	100%
The use of the proposed system leads to a reduction in speeding violations	19	95%	1	5%	_	_
The proposed system helps reduce accidents resulting from excessive speed	18	90%	1	5%	1	5%
I agree to use the proposed system to stop my car's engine at times of mist and fog, for the sake of my safety	16	80%	4	20%	_	_
The proposed system can be used in school districts and populated areas	20	100%	_	_	_	_
The cost of the proposed system is somewhat acceptable compared to its benefits	15	75%	3	15%	2	10%

Benefits of the proposed system in the field of Education

The use of the proposed system can be applied in the populated areas of schools in order to determine and control the speed of all vehicles in these areas so that the driver cannot exceed the speed limits to avoid accidents. The proposed system can also be used in **school buses to ensure the safety of students.**

Results

The proposed system was designed and tested on different types of cars and there was a survey which assure that the proposed system is able to help in the following: -

1- 95% assured that the use of the proposed system leads to a reduction in speeding violations.

2- Everyone in the survey assured that exceed the speed limit set by the proposed system is impossible.

3- 80% of people in survey agreed to use the proposed system to stop their engines in times of fog and mist for their safety.

4- 100% assured that the proposed system can be used in school districts and populated areas for students` and people`s safety.

5- Most people believe that the proposed system is easy to use and install and also not negatively affects their vehicles.

Conclusion

Depending on use of the proposed system in populated areas and school areas, the following can be achieved:

1- Achieving the security and safety of students and residents, as cars will not be able to exceed the speed limit for the road.

2- By using the proposed system in school buses, the system helps to increase the security and safety factors of students, by determining and controlling the speed of those buses.

3- Reducing car accidents resulting from excessive speed.

4- Reducing traffic violations related to speeding, as the vehicle driver will not be able to exceed the prescribed speeds.

Recommendations

1- The current study recommends the necessity of adopting the proposed system and expanding its application to contribute to solving the various problems resulting from excessive speed of cars.

2- The current study recommends car manufacturers to work on integrating the idea of the proposed system into all new cars because of the many benefits that this may be achieved (which was proved by the survey).

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نظام مقترح لتحديد وضبط سرعة السيارات لتقليل حوادث الطرق باستخدام OBD II **و** Arduino

الملخص العربي:

يهدف البحث الحالي إلى تصميم نظام مقترح لتحديد وضبط سرعة السيارات على الطرق المختلفة، يعتمد على Arduino وبروتوكول الاتصال الموحد OBD II المستخدم في معظم السيارات الحديثة ، والتي تعمل ببوابة الهواء الإلكترونية. ويرجع ذلك إلى العدد الكبير من حوادث السيارات التي أودت بحياة ملايين الأشخاص حول العالم، وأوضح البحث إمكانية استخدام النظام المقترح في مناطق المدارس والمأهولة بالسكان، كذلك استخدامه في حافلات نقل التلاميذ مما يحافظ على أمنهم وسلامتهم، وذلك من خلال التحكم في سرعة السيارات والحافلات في تلك المناطق بحيث لا يستطيع السائقين تجاوز السرعات المقررة، وقد تم إجراء اختبار لدقة النظام في تحديد السرعات والأماكن وقد بلغت دقته أكثر من ٩٨٪.