Smart collision avoidance and detection system

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Abstract. There are many factors due to which accident occur on roads. It has been proved that for fatal road accidents, driving under the alcohol influence is one of the major causes. This methodology of detection system can be a answer for this issue. This system senses whether the driver consumed alcohol or not with the help of MQ3 sensor. If driver has consumed alcohol an immediate SMS alert goes to a related person conveying that the driver is intoxicated and the vehicle slows down and stops after some time giving sufficient time to the driver to park the vehicle or stop it to the side of the road as the buzzer makes a sound until the vehicle is stopped. Also, the location of the person is sent by GSM module which connects it to Google maps. Sometimes it is possible that the person driving the car may undergo sudden stress, distraction or a seizure or cardiac arrest or ill where the person becomes unable to drive. This may prove fatal not only to the person experiencing this but also to the people on road. To avoid this, a pulse sensor is placed where in these can be detected by recording the change in pulse rates. When a drastic change in pulse rate is detected a message is sent to the relevant person that the person needs help and also the position of the effected person is sent. The system also slows down and stops the car to minimize the damage to people on road.

Keywords: Microcontroller, GSM module, Sensor.

1. Introduction

A report on Road Accidents in India by the Indian government stated that nearly 5 lakh accidents have occurred and 1.5 lakh people nearly have been passed away in road accidents and leaving about 5 lakh people injured. Alcohol was found to result to 6755 deaths annually, which are more than 18 deaths daily across the country. A study has found that vision, braking behavior and vigilance are affected greatly even with low consumption of alcohol. The methodology was developed by keeping in mind that an intoxicated person shouldn’t be able to drive a car. The system uses a MQ3 sensor to detect if the person is intoxicated with alcohol [1-4]. The analogue pin value of the MQ3 sensor is increased to decrease the sensitivity to alcohol, so that wrongful detections like detecting a drunken passenger while the driver is not under the influence of alcohol can be avoided. The buzzer also gets activated which alerts the driver to pull over and take a cab. The system also sends a message to the concerned regarding the condition of the driver and his location.
The various problems have let us to think a way in which we can ensure the health of driver and safety of nearby passing vehicles, pedestrians. This research is on the driver’s heart rate by using an infrared heart-rate sensor or pulse sensor [5-7]. This system consists of such an optical pulse sensor and is proposed that it is placed under the steering wheel. Whenever an appreciable change is observed in the driver’s pulse rate, an automatic message is generated along with the location to the person whose details are already saved in the system, so that the driver can get a medical care as early as possible [8-11]. Along with this, it can be integrated with the system of E-vehicles to control the voltage of the motors so that eventually the speed of the vehicles can be reduced, which if connected to the parking lights, other drivers will get conscious about the problem; hence avoiding road accident. Heart beat goes down in case of dizziness, which can be linked to an alarm, thus the driver will get a cautionary alert.

Due to delayed communication and it is shown that phone-based protocols and notifications have been proved helpful. Inspired by this fact, this project provides with an accident detection system which detects accidents and reports it to the concerned person with location so that the help reaches the person on time. The accident detection system consists of a vibration sensor and an accelerometer. The accelerometer also consists of a gyroscope [12-15]. This gyroscope detects the change in orientation of the vehicle, giving information about sudden over turning of the vehicle. Also, the system consists of a 3-vibration sensor which detects force that the vehicle undergoes during the crash. These two sensors work together to detect the accidents and avoid false detection. The communication in this methodology done by a GSM module.

2. Methodology

Microcontroller board based Arduino Uno is on the series of ATmega328. It contains output/input pins are fourteen. The pin diagram of microcontroller as shown in Figure 1

![Figure 1. Pin diagram of microcontroller AT mega 328](image)

Detecting for Benzine, methene, hexane, LPG, Alcohol and CO through MQ-3 module. SnO₂ material is the MQ-3 gas sensor. It contains conductivity is lower with air. The existing of alcohol gas, sensor’s conductivity is higher along with the rising of concentration of gas. High sensitivity of MQ-3 gas sensor to alcohol, and has resistance in good to disturb of gasoline, vapour and smoke.

The H bridge circuit is used to study the motion of motors in this system. In Robotics systems also used these circuits, Figure 2 represents H bridge circuit.
Development software and drivers such as Arduino IDE and Windows Operating System are installation in this system. The block diagram of the smart collision avoidance and detection system as shown in Figure 3.

Figure 2. Circuit diagram of H-bridge

Figure 3. Block diagram of the smart collision avoidance and detection system

It consists of the following

1. The circuit consist of various sensors connected to the Arduino.
2. The analog output of pulse sensor, MQ-3 sensor and Accelerometer (MPU 6050) are connected to the analog pins provided on the Arduino.
3. The GSM module (SIM800L), vibration sensor (digital output) and H- Bridge (L293D) are attached to the Arduino pins.
4. The H bridge is connected to the stepper motor.
5. The power (Vcc) is provided with 5V and the ground connections are made.

The working model for the system as shown in Figure 4.
Figure 4. Working model of the system

The applications of this system as
1. The system can be implemented in four wheelers and heavy automobiles with little modifications to keep drunken drivers off the roads.
2. The GSM module will help communicate the accident to emergency services with the need of a human to do so.
3. The system will detect and alert the driver when the vehicle is being driven rashly.
4. Undetected or unseen problems that may arise suddenly can be detected and care can be provided immediately.
5. This can help avoid accidents that occur due to illness or other factors due which the driver may lose concentration.
6. The system will keep the concerned people updated about the driver’s condition and his location.

3. Results And Discussion

This system complements the existing government laws for avoiding ‘DRUNK AND DRIVE’ and ensures the safety of the driver as well as co-passers. The system is able to integrate the pulse rate along with alcohol level sensing, which can be used to safely slow down the vehicle and stop it and in case of emergency; the message with location can be sent to the emergency service and to near ones. The module can further be modified using the eye blinker sensor, giving audio visual cautionary alarm for the driver if he / she is drowsy in vehicle. The accelerometer and vibration sensor can sense severe accidents and with the help of Google Maps sends the geo-location to the family and emergency health care can be provided as early as possible on fast track. As E-vehicles are going to be the future mode of transport, this system can smartly ensure the precautionary measures. Implementing this system could bring a drastic change in the statistics of fatal road incidents / accidents. Further to stop the vehicle when the driver is not fit to drive the car, mechanisms can be designed to apply an appropriate force. The force required to be applied on the brake by developed mechanisms can be found by taking a few assumptions about the car speed, pressure in fluid lines etc.,

The mathematical modeling of the system as follows

- Speed of the car = 45 kmph = 12.5 m/s
- Pressure inside the fluid lines = 35-280bar
- Average weight of a compact car = 1300 kgs
- The hydraulic power ratio, mechanical advantage = 30:1
In passenger cars, the hydraulic pressure developed in the brake system in passenger cars will be around 35–45 bar. Severe braking can generate pressures of the order of 70–96 bar. Higher pressures are not likely. The maximum pressure that the caliper can withstand before breakage is in the range of 220–280 bar. It is considered that the pressure to be developed in the fluid lines is to be 96 bars, which is present in manual braking and proceed with our mathematical modelling of system.

The force acted on the rack in order to generate 96 bars of pressure to stop the vehicle:

\[ P = \frac{F}{A} \]

Where,
- \( F \) = Force applied on the piston (Master Cylinder)
- \( P \) = Pressure inside the brake caliper
- \( A \) = Area
- \( D = \) Diameter of piston = 0.0254 m

\[
96 \times 10^5 = \frac{F}{\pi \times 0.024^2}
\]

\[ F = 4.9 \text{ kN} \]

From the above calculations, a force of 4.9 kN is required to be applied on the brake pedal so that the vehicle moving at 45 km/h to come to rest.

4. Conclusions

Mechatronics is a subject which is not only related to industrial automation but a field of science which can be applied in every walk of life. We have used this approach to bring solution to avoid road accidents. It is evident that the use of sensors can bring real time solutions to a lot of challenges we face in our daily life. The use of three sensors could prove to avoid major road accidents and save a lot of lives. The reduced number of intoxicated drivers would make roads a safer place to drive vehicles with reduced threat to the others driving. Accidents occur on roads due to various reasons like stress driving, distracted driving, illness, cardio-vascular failures etc., which may not be completely detected by a pulse sensor but this project makes an attempt to sense or detect such anomalies in the human body through pulse rate detection. Not only the system takes into consideration of stopping the vehicle after giving a time period to pull over the vehicle or slowing it down continuously, the system would send alerts to emergency services and concerned person regarding the condition and location of the person, so that immediate help is provided. The accident detection system would not only help detect accident but also help avoid further damage to the victim due to delayed health care. The system looks at reducing human error that could lead to fatal accidents on roads. By implementing such simple system, we could be looking at saving millions of people yearly throughout the world and reduce the number of accidents that occur. This shows that Mechatronics applied in real time could make a huge impact. The future lies in implementing sensors and converting things into smart objects which could feel, detect and react to overcome the huddles we face in our life.

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