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Advanced accident prevention helmet with smart vehicle protection system

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ABSTRACT

Breath-based alcohol detection system detects alcohol content in motor vehicle drivers breath and localizes drink and drive situation. This alcohol detection system needs to be low cost and highly effective to be widely deployed. A simple alcohol detection scheme is employed to detect the quantity of alcohol in the human body through a breath-based system and accordingly, the relay module is operated depending upon the alcohol content recognized in the rider's breath. Post alcohol detection there is relay operation which brings the vehicle to zero motion state in a case where the driver is drunk; this particular part is attached to the motor vehicle key ignition system. Relay module is attached to the key switch and battery connection so that in case of any fault in the system the system can neutralize for a short span of time. The high-speed wireless network is used to for fast response and accurate data transfer. We use the query based system for data transfer which captures the data and transfers it one by one depending upon the delay set by the user this device can be easily installed in any vehicles with ease. It can also be installed in the existing vehicles by making few minor changes which will not affect the performance of the vehicle but will help to decrease the risk of deaths due to accidents.

Keywords: *Alcohol detection, Breath-based system, Relay module, Wireless network.*

1. INTRODUCTION

According to a thorough analysis of data shared by transport ministry of India through state accident records in 2016, 28 motor vehicle riders die on a daily basis on Indian roads by not wearing helmets. The year 2017 was the deadliest recording 31 people dying in every 100 road accidents. This figure has steadily increased from 21.6 deaths per 100 accidents in 2005 to 29.1 in 2015. This is for the first time that police and transport departments in states have captured data on deaths caused due to non-wearing of the helmet. States have reported that one of every five bike riders who died in crashes was not wearing a helmet and their total number was 10,135.

Most of the present technology available uses a technology needing a very sophisticated environment making it difficult for regular use and high cost. A new breath alcohol detector for a driver has been developed. A mouthpiece is not required for the detection because driver's breath sample is captured by an electric suction fan of the detector[1].An innovative system was designed in which alcohol in the human body was analysed through breath based analyzer placed on the steering wheel. An infrared cell is used which directs the infrared energy through the sample and any of the unabsorbed energy at the other part is detected[2]. Another one is laser alcohol analyzer (LAA), which eliminates the drawbacks of sobriety checking points and allows screening cars or work place for drivers and workers under the influence. The technique uses type 111-V distributed feedback tunable diode laser to observe alcohol absorption in the 1.392 pm range[3]. T Chau presented a program which will be installed on the mobile phones that will compute accelerations based on installed sensor readings, and then it will compare them with drunk driving patterns extracted from real driving tests algorithms. Once there is any hint of drunk driving is present, the mobile phone is used to alert the driver or call the police for necessary action well in advance before the accident actually occurs[4]. The most advanced research in this field is an

infrared alcohol testing system based on differential absorption technique, The technique is based on the fact that the breath alcohol gas has a unique and a well-defined absorption characteristic within the infrared region of electromagnetic spectrum[5].

However, the previous technologies have two major limitations. First, the previous system uses highly sensitive and complex design sensors. This can be used to detect alcohol but need a quite environment for proper functioning, this makes it quite difficult for regular use. Also, the design pattern demands lots of skills making it a costly entity. Therefore, a practical method for regular use and reducing cost is needed. Second, even after the alcohol detection this system just show analytical data. Most of the systems in inform the rider and police station but no action is taken to bring the motor vehicle in zero motion phase.

This paper proposes more practical and cost-effective method for breach based alcohol detection and vehicle tracking system using a highly accurate MQ3 sensor and fast response wireless communication network. The rider wears the helmet which has a limiting switch mounted on the top used to supply power to the alcohol sensor. If the power is not supplied to the alcohol sensor vehicle will receive a low value due to motor vehicle won't turn on, this method makes wearing of helmet mandatory to ride vehicle. Once the power is being provided to the sensor the sensor check for the alcohol content in the breath of the raider. Based on the value received by the alcohol sensor the microcontroller unit (MCU) sends the appropriate signal via HC12 module to the receiver end(motor vehicle system) whether to start the vehicle or not. On receiving a positive response the vehicle turns on else the vehicle continuous to remain in off position. Once a negative response is received the MCU operates the relay module which brings the relay in open position causing the motor vehicle to remain in off state. While in case of any accident occurring the vibration sensor gets activated which inturn activates vehicle protection system. This system involves a GPS module which gets the location of the vehicle in the area, this location data is shared with the police control room to localize the casualties.

The rest of the paper is organized as follows. Section II describes the architecture of proposed breath-based alcohol detection system . Section III shows the implementation results in the real field. Finally, section IV concludes the paper.

2. BREATH BASED ALCOHOL DETECTION SYSTEM

A. SYSTEM ARCHITECTURE

The system we are implementing involves helmet wear and alcohol detection and further transmitting the processed data wirelessly to the relay connected to the ignition port (key port) of the vehicle through Bluetooth module. For processing the data we implement Arduino uno microprocessor.

Components used are; Push buttons - 4, jumping wires, buzzer (5V) - 1, Arduino UNO - 2, MQ-3 alcohol sensor - 1, relay (12V) - 1, HC-12 wireless communication module.

Fig.1 shows a block diagram of the whole system, where power flow and the sequence of components activation can be understood.

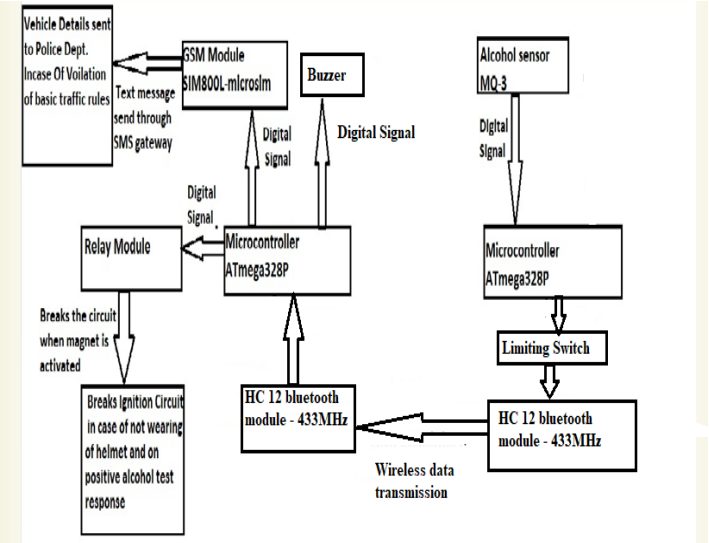


Fig 1:- Block diagram of the system

B. BREATH BASED ALCOHOL DETECTION SYSTEM

Fig 2:- MQ-3 sensor with crash board

Fig.2 shows an MQ3 sensor, the sensitive material of MQ-3 gas sensor is SnO_2, which has lower conductivity in clean air. The MQ-3 gas sensor has high sensitivity to alcohol and has good resistance to the interference of gasoline, smoke, and vapor.

It requires two voltages to operate (1) heater voltage (V_H), (2) test voltage (V_C). V_H used to supply certified working temperature to the sensor, while V_C used to detect voltage (V_{RL}) on load resistance (R_L) who is in series with the sensor. The sensor has light polarity, V_C need DC power. Power of sensitivity body (P_S): $P_S = V_C^2 * R_S / (R_S + R_L)^2$. Resistance of sensor ($R_S$): $R_S = ((V_C/V_{RL}) - 1)*R_L$.

As shown in Fig.3 sensor made by micro AL203 ceramic tube, sensitive layer of Tin dioxide (SnO_2), gold (Au) measuring electrode and heater are fixed into a cover made by plastic and stainless steel netting. The heater provides a necessary working condition for functioning sensitive components. The enwrapped MQ-3 have 6 pins, of which 4 are used for providing heating current.

Sensor's elements and working ranges and limits are:

1M (ohms) $<R_S<$ 8M (ohms),
-10^0C<operating temperature< 50^0C,
0.05 mg/L < detecting concentration< 10 mg/L,
0.5 mW < heating consumption < 750 mW,
Current consumption is 150 mA.

The MQ-3 sensor is capable of producing both analog and digital output. It is placed and attached inside helmet in front of mouth at mouth guard. This sensor is integrated with Arduino Uno to collect the data and is respectively used for further applications.

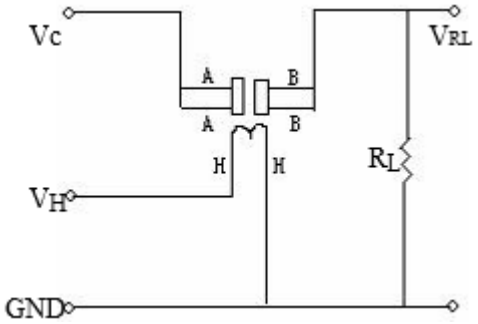


Fig 3:- basic test circuit of the MQ-3 sensor

C. POWER SUPPLY SWITCH FOR BREATH BASED ALCOHOL DETECTION SYSTEM

As observed till now, for the system to work we need to provide some power supply to it, without which the activation of the sensor is a failure and rider cannot operate the ignition port (key port).

This can be used as an advantage to keep in check for rider's helmet wear condition. We incorporate clipped push buttons in helmet and place it in between battery power supply and MQ-3 pannel, which switches in if and only if the rider wears a helmet. Further, the power flow continues and allows for smooth operation of the system. Thus making the wearing helmet a mandatory process for the rider to start the vehicle and while riding the vehicle.

To ensure proper helmet placement on the head, push buttons are effectively arranged in mesh kind design (diamond arrangement) (push buttons used are 4). Which out rules the situation of jerks and ensures smooth functioning of the system.

D. RELAY MODULE

A relay as shown in fig..4 is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. The most important part of the relay is an electromagnet. Many sensors are very sensitive pieces of electronic equipment and produce small electric currents. Usually, we need them to drive bigger pieces of apparatus that use much larger currents. Relays are used to bridge the gap, through which it possible for small currents to activate larger ones. That means relays can work as switches. The relays have three output terminals in general; NO (Normally Open), NC (Normally Closed) and common terminal. We can make connections to these terminals as per our application.

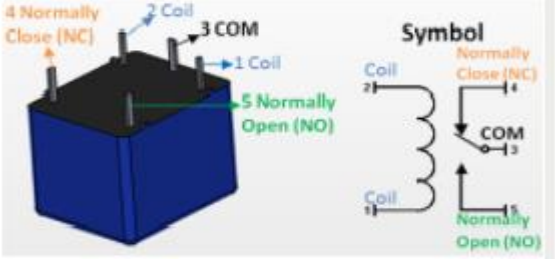
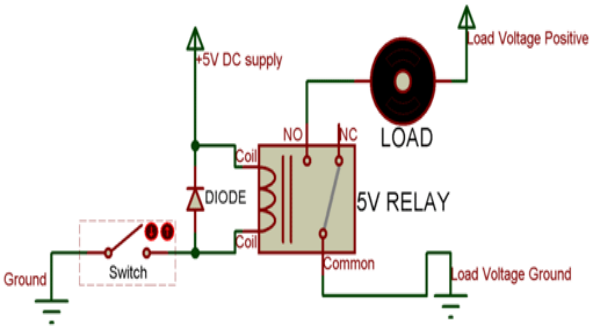


Fig.4:- overview of the relay module



The fig.5 internal circuit relay

The fig.5 shows a basic concept for a relay to operate. Since the relay has a 5V of trigger voltage we have used a +5V DC supply to one end of the coil and the other end to ground via a switch. This switch can be anything from a transistor, microcontroller or microprocessor which can perform switching operation. There is also a diode connected across the coil of the relay, this diode is called the Fly back Diode. The purpose of the flyback diode is to protect the switch from high voltage spike that can produce by the relay coil. As we can see one end of the load can be connected to the Common pin and the other end is either connected to NO or NC. If connected to NO the load remains disconnected before trigger and if connected to NC the load remains connected before trigger.

This particular system is used in our proposed paper to open the ignition circuit and the rider will not be able to turn on the vehicle in case he is not wearing a helmet or if he is riding under the influence of alcohol.

E. WIRELESS COMMUNICATION NETWORK

Wireless networking is simple and less complicated means through which residential homes, telecommunications grids and business and administration installations can avoid the costly and complicated method of introducing cables into a building, or as a connection between various equipment locations. Wireless communications networks are generally executed and monitored using radio communication or Bluetooth. Bluetooth is generally used for short distance communication within a few meters. A basic wireless local area network (WLAN) links two or more devices over a short distance using a wireless communication technique. This is the most suitable technique for our application as the distance between the helmet and the vehicle is less and a Bluetooth module can be used to connect the helmet and the vehicle. Also, the rider must be comfortable and should have sufficient freedom of movement, therefore wireless communication of the helmet and the vehicle is preferred. This also ensures that the vehicle retains its looks by avoiding wires. Also, wireless network is faster than a wired connection. This helps us to transmit and receive real-time data very fast between the helmet and the vehicle to have a very quick response. Having very quick response is crucial in this application. Therefore wireless network is preferred over a wired connection.

HC-12 is a new-generation multichannel embedded wireless data transmission module. It is also easy to setup a connection between the transmitter and receiver module. Therefore HC-12 is a perfect match for this application. Its wireless working frequency bandwidth is from 433.4 to 473.0MHz, in which multiple channels can be set, with the stepping of 400 KHz, and there are totally 100 channels. The maximum transmitting power of this module is around 100mW, bearing receiving sensitivity of -117dBm at a baud rate of 5,000bps in the air, and having a communication distance is 1,000m in open area.The signal from the switch mesh and the MQ3 sensor is transmitted through HC-12 transmitter module present on the helmet. This signal is received by the HC-12 receiver module present in the vehicle. This signal is processed by the Arduino present on the vehicle and takes necessary action based on the received signal i.e., if the rider is drunk the relay must remain off and the vehicle will not be able to turn on, but if the rider is not under the influence of alcohol then the relay must turn on and the vehicle will be able to start. The HC-12 module makes it very easy for the transfer of this signal. The connection of HC-12 with Arduino is as shown in the fig.6

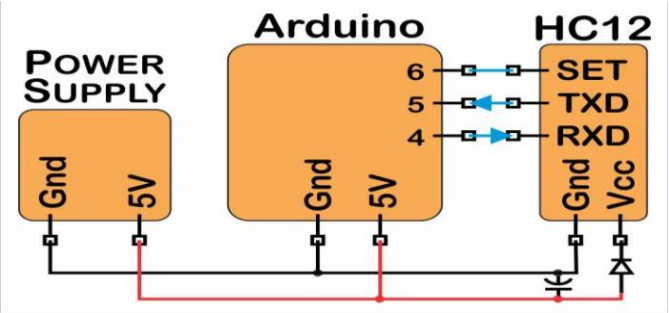


Fig. 6:- HC-12 connected to Arduino

3. IMPLEMENTATION

A. HELMET OPERATION

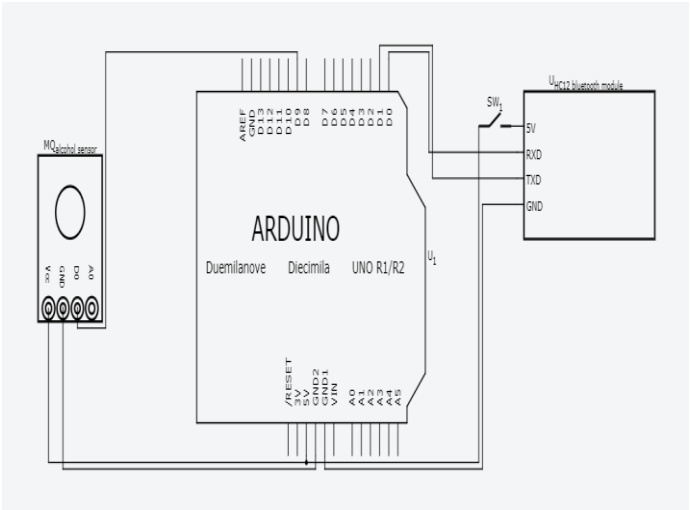


Fig.7:- Helmet Circuit connection

The major objectives of our project are to make helmet compulsory and to prevent drink and drive cases. The vehicle is normally in off condition and will turn on only when the rider wears his/her helmet and is not drunk. The helmet consists of five components; Switch mesh, an MQ3 alcohol sensor, Arduino microcontroller, HC12 Bluetooth transmitter module and a battery as shown in fig.7. At first, all the components in the helmet are in off state. All the components are turned on only when the rider wears the helmet. As soon as the switch mesh is triggered or turned on, the MQ3 sensor checks the breath of the rider to check if the rider is drunk. If the MQ3 sensor detects alcohol content in the breath of the rider, it immediately sends a negative digital signal to the Arduino microcontroller. If alcohol content is not detected then the MQ3 alcohol sensor sends a positive digital signal to the Arduino microcontroller. The Microcontroller has to take in two inputs and give out one output. The first input is to check if the rider is wearing a helmet and the second input is to check if the rider is under the influence of alcohol.Only if both the conditions are satisfied the Arduino sends a signal to the Bluetooth transmitter module. The HC12 transmitter module works with 5V DC and receives the output signal of the Arduino and sends the same signal to the vehicle using Bluetooth.

B. RELAY OPERATION

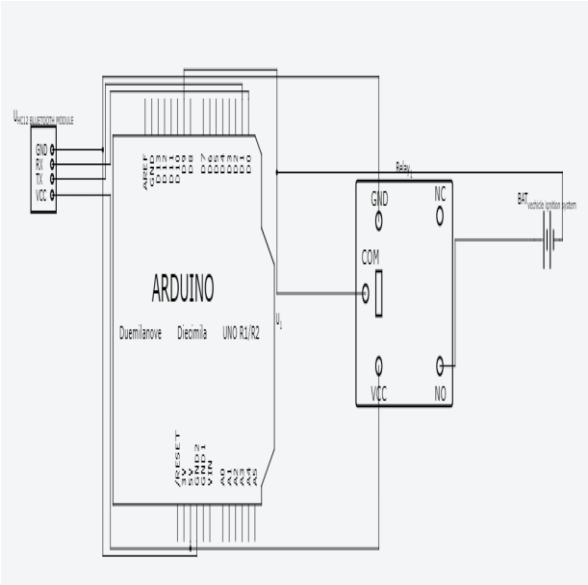


Fig.8:- Circuit connection vehicle part

For our application the relay module is generally in off condition i.e., the vehicle cannot be turned on in this state. The relay module works according to the two received signals i.e., one from the switch mesh and another from the MQ3 sensor. The signal from the switch mesh is positive only when the rider is wearing a his\her helmet. This signal triggers the MQ3 sensor to turn on and check whether the rider is under the influence of alcohol. If the rider is drunk the MQ3 sensor sends a negative signal to the Arduino present on the helmet which inturn sends a negative signal to the relay module through a Bluetooth module meaning the rider is drunk. This signal is processed by the Arduino present in the vehicle which does not turn on the relay.When the relay is OFF the rider will be unable to start the vehicle. If the rider is not drunk the MQ3 sensor sends a positive signal to the relay through the bluetooth module and the relay is activated meaning the vehicle can be turned ON. The vehicle will turn on only if the relay gets activated and the relay is activated only when the rider is wearing his/her helmet and should not be under the influence of alcohol. The relay helps us to make sure that the ignition of the vehicle is turned off if the rider is drunk.

The vehicle consists of four components; HC12 Bluetooth receiver, Arduino microcontroller, Relay and a battery as shown in fig.8. When the relay is off, the vehicle is in off condition. The vehicle will turn on only when the relay is on. The HC12 receiver module receives a signal only when both the conditions i.e., the rider is wearing a helmet and is not drunk is satisfied. So when the HC12 receives a signal that means both the above conditions are satisfied and this signal is passed on to the Arduino microcontroller. The Arduino then gives a signal to the relay to turn on so that the vehicle can be started now. But if the rider is not wearing a helmet or is drunk, the Arduino in the helmet sends no signal to the vehicle and the relay is in off condition and therefore the vehicle cannot be turned on. The relay is connected in normally off condition and is turned on only by receiving a signal from the helmet. The relay is connected to the ignition wires so that incase the conditions are not satisfied the sparkplug of the vehicle cannot work and the vehicle will not turn on. All the components of the vehicle are powered by a battery.

4. CONCLUSION

This paper proposes a more practical and cost-effective model for breath-based alcohol detection system. The proposed breath-based alcohol detection system is used to sense the alcohol in the human body and further prevents the rider from driving a vehicle under the influence of alcohol. The limiting switch provided between microcontroller and Bluetooth module ensures that wearing a helmet is mandatory while driving vehicle, as the data is continuosly send over the wireless network if rider removes the helmet vehicle will stop instanly. Vehicle contains a wireless network and a relay module attached to a microcontroller, vehicle part and helmet part are connected via wireless network. Once the data is send over the wireless network microcontroller installed in the vehicle compares it with the government specified alcohol limit, incase the limit is higher than the specified point relay comes in open position and vehicle could not be turned on. This breath based system is installed and tested in the real field; it found alcohol in the breath of drunk person and further prevented the vehicle from starting. The proposed alcohol detection system can be installed easily in any vehicle and its wide use can prevent lots of drink and driving cases around the world.

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