Design & Implementation of IoT Based Smart Helmet for Road Accident Detection

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***Abstract*—It has been observed that an alarming rate of road accidents occur in different countries every year with the increase of bikes and motorcycles. Some countries are one of the densely populated in the world where roads are narrower in comparison to the roads and streets. Although enough rules and regulations are made by the government to avoid road accidents, but the accident rate is increasing day by day. Reasons such as avoiding helmet by the bike rider during their ride as well as riding being drunk are worth mentionable. Motorcycle rider involve them in serious road accidents causing fatality while not wearing helmet and riding motorcycles being drunk. Wearing helmet can however reduce the risk of accidents largely. In this paper a very effective and technological way of Smart Helmet using Internet of Things (IoT) has been introduced by which one can avoid such problems. Arduino NANO and Arduino Mega-2560 are microcontrollers which control the entire components of the system. Two 2.4 GHZ nRF24L01 acts like sender and receiver for communication. One MQ-3 gas sensor is used which can detect whether the bike rider is alcoholic or not. If the bike rider is alcoholic, then the MQ-3 sensor detects it and the whole system goes off. A Sharp IR sensor detects the head of the motorcyclist within the range of 10-80 cm. The Bike rider's engine will start only when the rider will buckle the helmet. GPS & GSM Technology is used for tracking the location of the bike rider and sending text message to the family members of the Bike rider when an accident occurs. Our Smart Helmet is used for Accident Detection and Bike Rider's Safety.**

Keywords— Smart Helmet, Internet of Things (IoT), GPS & GSM Technology, Accident Detection, Bike Rider's Safety

I. INTRODUCTION

Road accident has become a huge concern in our everyday life. Due to this huge amount of population many people are facing very high road accident fatality and official figure indicates 60 deaths per 10,000 motor vehicles [1]. It is estimated that many bike riders die every-day in road accident and due to insufficient information regarding to the accidents those riders cannot be saved as they merely find help after the occurrence of the accident. However, with increasing number of people the motorcycles are also increasing in the roads and streets.

Helmet is one of the most essential and important elements a motorcyclist must wear to avoid any possible road accidents. It ensures safety of the motorcyclist's head from the deadly impact caused by accident and provides guarantee protection to the bike riders and provide hundred percentage user reliability.

The annual fatality rate from street accidents is found to be severe. Various lives could have been spared if crisis clinical help could get mishap data and reach to the scene [3]. More than half all avenue visitor's death is amongst inclined avenue users like pedestrians, motorcyclists, and cyclists [2]. The main purpose of our project is to ensure a safety and build cost-effective system to prevent alcoholic people from riding motorcycle. This project is embedded with sensors modules and microcontroller. MQ-3 sensor is used as a breath analyzer which identifies the presence of alcohol in the user's breath if it is more than the pre -set permissible range, ignition will not start. It will provide the message to the registered number. This project ensures safety of the motorcyclist in two ways. Firstly, whenever a motorcyclist starts the engine it prevents any drunk rider from riding the vehicle and secondly if any accident occurs then the SW420 vibration sensor detects it and an immediate text message is sent to the motorcyclist's relative or any known person of the motorcyclist. However, the first condition of starting the engine is to wear the helmet for riding motorcycle. It successfully deploys the alcohol detection technology that prevents drunk bike riders from roaming around the streets making one's own life and other lives in danger.

There are two various types of microcontrollers which are used in this project. Each of the unit has used a different microcontroller, for bike unit we have used Arduino Mega-2560 and for helmet unit we have used Arduino Nano. The smart helmet will have sharp IR sensor which will be used to detect if the rider has worn the helmet or not. MQ-3 sensor is used for alcohol detection purpose. Signal transmission between the helmet unit and bicycle unit is utilizing a RF idea. nRF24L01 is used as RF module in our smart helmet. It is in the transmitter side and other is used in receiver side. The receiver unit is to be placed on the bike where it will receive data and control the ignition. A DC gear motor as an example to show how the ignition system will work. There is a DC adapter that is connected to the Gear motor. A vibration sensor module which is SW420 has been used to detect road accident. Using the SIM800L (GSM) in the receiver circuit text message is to be sent that an accident has happened. Ublox neo 6M GPS module is used which provides navigation points of the accident location on the given mobile phone number. Also, there is an OLED display which will show all the outputs.

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II. LITERATURE REVIEW

A. Background

There is a gradual increase in the number of motorcycles daily. The motorcycles that are recently manufactured has all the attributes in terms of mileage and performance. It is also priority for the manufactures to take the safety factor into consideration as well. The common people are buying motorcycles which are faster and powerful. In accordance with the increasing number of motorcycles the factor of safety also rises. There are a large number of road accidents those are occurring every day on the roads. There are a lot of causes behind it. The main reasons are responsible for it such as careless behavior of the driver, horrible road condition and mistake from another person on road. Head injury is one of the most severe cases that lead to body paralysis and sometimes death.

There are three major factors which motivate us for designing our project. The initial step is to determine whether the user is wearing the helmet or not. If the user worms the helmet, then the system will automatically initiate ignition of the motorcycle otherwise it will stay off until helmet is put on by the user. To fulfil these tasks, we have used sharp IR sensor. The second step is the detection of alcohol levels. It will provide the message to registered number. This is done with aid of MQ-3 sensor. When these two prerequisites are fulfilled then ignition will start. The third primary concern is in case of accidents, the arrival of medical assistance may be late. This is may turn out to be a matter of life or death. As after accident occurs, the longer it takes to receive medical aid, the lower the chances of the rider's survival. We have found different levels of Alcohol after changing the IR sensor value in our Transmitter circuit. Different levels of Alcohol with respect to IR distance is given below in a table:

TABLE I. DIFFERENT LEVELS OF ALCOHOL WITH IR DISTANCE

IR Distance	Value (cm)	Alcohol Level	Value (%)
IR Distance	14	Alcohol Level	8.0
IR Distance	15	Alcohol Level	8.1
IR Distance	16	Alcohol Level	8.2
IR Distance	17	Alcohol Level	8.3
IR Distance	18	Alcohol Level	8.4
IR Distance	19	Alcohol Level	8.5
IR Distance	20	Alcohol Level	8.6

The receiver unit is to be placed on the bike where it will receive data and control the ignition. We have used a DC gear motor as an example to show how the ignition system will work. We have tried to keep the receiver circuit as compact as possible. We have used a breadboard power supply module to get regulated voltage rail. There is a DC adapter that is connected to the Gear motor. Using the SIM800L in the receiver circuit we are sending SMS that an accident has happened [4]. Using the Ublox neo 6M GPS module we are providing navigation points of the accident location on the given cell phone number. Also, there is an OLED display which will show all the outputs.

B. Related Work

We have tried to construct a smart helmet with a very novel approach. Although the smart helmet has been implemented in many countries, but the idea has not been introduced in South Asian countries where accident occurs frequently in every day. As our smart helmet is a bit different from conventional helmets, Bike riders will not want to use it if it is uncomfortable. So, we tried to keep it as familiar as possible for the users. We have placed all our circuits inside the helmet fabric so that they do not contact the head. Given below is a picture of our smart helmet. There is a receiver circuit unit which is to be placed on the bike. We have tried our best to keep the receiver circuit as compact as possible. A picture of the helmet and receiver circuit is given below:

Fig. 1. Helmet with Receiver circuit

The size of the helmet is just like any other helmet and it is very comfortable to wear. We are calling the entire helmet the transmitter circuit which will transmit data to the bike's receiver unit. The data will be sent via radio frequency communication and for that we have used the nRF24L01 module. Various papers have managed the transmission of accident data [3], [5]. We have placed the MQ-3 alcohol sensor in-front of the rider's mouth keeping a safe distance so that it can analyze the driver's breath and check if he/she is drunk or not. Then there is the Sharp IR sensor which verifies if the helmet is worn or not. There are given conditions for both sensors. If these conditions are met, then the data will be transmitted through communication. All these sensors are connected using an Arduino nano.

III. METHODOLOGY

Sharp Infrared Proximity IR sensor structure is shown in Fig. 2 which is placed in inside of the helmet to detect the head of the motorcyclist and ensures that the wearer is wearing the helmet [18]. This sensor detects the head of the motorcyclist between 10 cm and 80 cm away. So, it is a sensor which can measure distance with integrated signal processing and analogue voltage output. The analogue output vs. distance to reflect object is shown in Figure No 2. The sharp IR has three ports: digital signal, GND and VCC (+5V). The sharp IR has a range of up to 80cm and its typical response time is 39m.

It is a special sensor that not only detects light but also gives the measure of how far any object is.

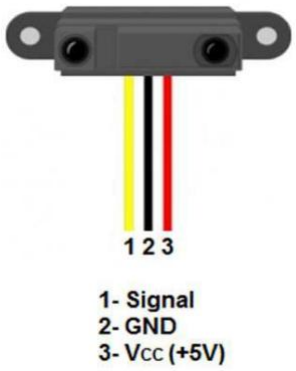

Fig. 2.IR Sensor

The structure of MQ-3 gas sensor which detects the alcohol availability is shown in Fig. 3. This gas sensor module is very useful for leakage of alcohol. Because of its very high sensitivity and quick response time, measurements can be taken in as soon as possible. This sensor gives an output which is analogue resistive based on alcohol concentration. The voltage of the output from the MQ-3 sensor raises when the concentration of gas increases. The gas sensor MQ-3 uses SnO2 which has very low conductivity rate in the atmosphere and this SnO2 material is used as a gas sensing material. In our atmospheric condition where alcohol gas is present, the conductivity of the gas sensor MQ-3 increases along with the concentration of the alcohol gas raises. So, this MQ3 gas sensor is alcohol sensor which can be able to identify the alcohol concentration on anyone's breath. When the alcohol gas presents in the air, the full sensor's conductivity provides greater value along with the increasing value of gas concentration.

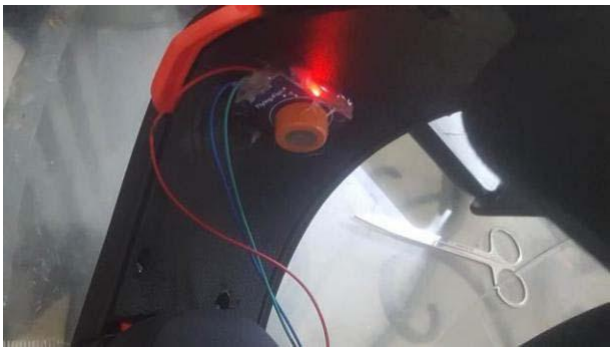

Fig. 3. MQ-3 Alcohol Sensor

SIM800L is a small circuit board. It is set it up with Arduino to send simple text messages. The essential structure of this module is shown in the Fig.4. Pin D8 of Arduino is connected with pin 1(TX) and Pin D9 of Arduino is connected with pin 0(RX) of the SIM800L. One 3.6 Volts Battery is connected between GND of the Arduino and VCC of the SIM800L.The GND and VCC are connected accordingly shown in the Fig. 4.

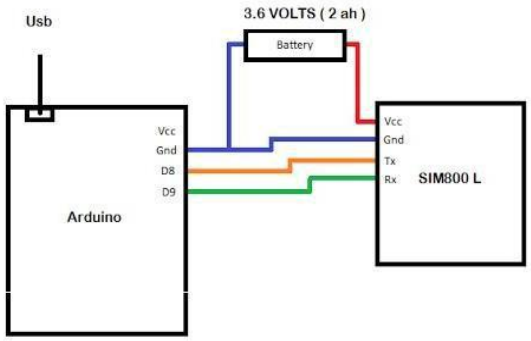

Fig. 4. Connection between Arduino and SIM800L

The IoT is formed of smart machines that imparting and connecting with different machines, articles, situations, and frameworks [17]. The large volume of information hence created, is prepared into valuable activities that will "order and control" things, to shape our carries on with a lot simpler and more secure [6]. This project aims to build an Internet of Things (IoT) application that leverages on ubiquitous connectivity, sensing and data analytics that are the basis of IoT applications [7], [12]. Data will be transmitted from Helmet unit (Transmitter Circuit) to the bike's receiver unit (Receiver Circuit) by nRF24L01 module. This module builds a network between the transmitter circuit and the receiver circuit and it creates a medium for transferring data easily without human to human interaction or human to computer interaction.

IV. PROPOSED SCHEME

This paper describes the design and implementation of Smart Helmet using IoT. Internet of Things (IoT) and calamity management are two areas in which fast progress is being made. White et al. focused regarding using the smartphone because calamity discovery or notification [8]. Zhao [9] outlines the implications regarding region focus of cellular devices or making use of this because of smarter casualty monitoring systems within cars. There are two various kinds of microcontrollers are used in this project. Arduino Mega-2560 is used in bike unit and for helmet unit we have used Arduino Nano. The smart helmet will have sharp IR sensor which will be used to identify if the rider has worn the helmet or not [16]. MQ-3 sensor is used for alcohol detection purpose. Signal transmission between the helmet unit and bicycle unit is utilizing a RF idea. nRF24L01 is used as RF module in our smart helmet. It is in the transmitter side and other is used in receiver side. The fundamental block diagram of the Transmitter circuit is shown in the Fig.5 [11].

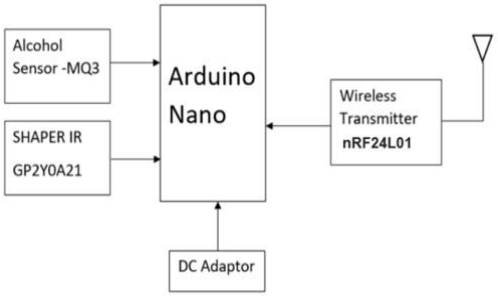

Fig. 5. Block diagram of Transmitter circuit

Motor Driver L298 is a dual motor controller and it can support 12V power supply as Source Voltage. In Receiver circuit, we have used Arduino Mega 2560 as a microcontroller [13]. DC Gear motor is used for L298.

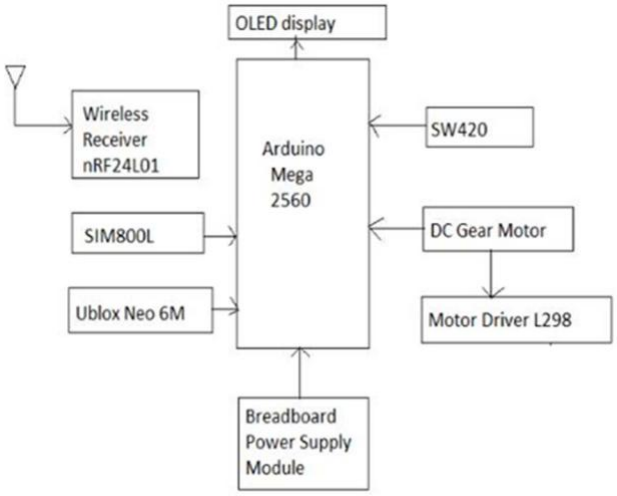

Fig. 6. Block Diagram of Receiver circuit

We have also provided a working diagram of the entire system which is presented below [11]:

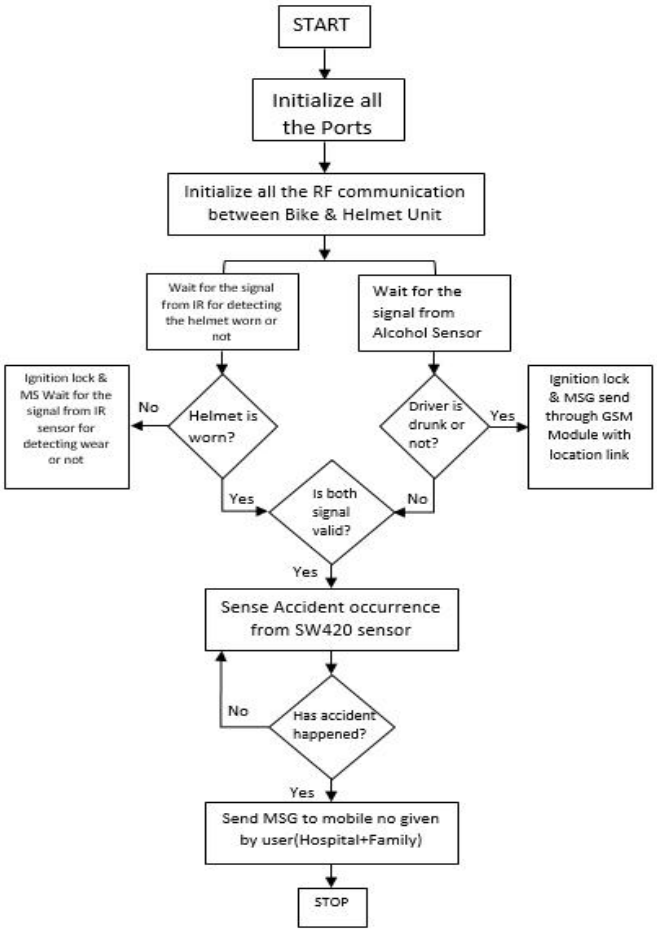

Fig. 7. Flow Chart of the Entire System

V. RESULTS

The smart helmet is developed and tested for various conditions to find out how effectively it operates. There are mainly 4 different conditions the smart helmet is tested for. When the user is drunk and he is not wearing any helmet, the bike will not start. The proximity IR sensor will detect no helmet and the MQ-3 Alcohol sensor will detect alcohol and disable the ignition of the bike. When the user is wearing helmet the proximity IR sensor will give positive signal but since the user is drunk the MQ-3 sensor will give negative reading and as a result the bike will not be able to start. When Driver is drunk, "BE SOBER AND WEAR HELMET" is shown in the OLED Display.

Fig.8. OLED Display while Driver is drunk

TABLE II. DIFFERENT USER CONDITION DUE TO MQ-3 SENSOR READING

User Condition	MQ-3 Sensor Reading	Condition of Bike
Drunk and No Helmet	Positive	0
Drunk and Wearing Helmet	Negative	0
Sober and No Helmet	Positive	0
Sober and Wearing Helmet	Positive	1

When the user is sober the MQ-3 sensor will give positive reading but since the user is not wearing any helmet so the proximity IR sensor will send negative signal and the bike will not start. It means Bike condition is 0. There is only one condition where the bike will start which is considered as bit 1. The user is sober so the MQ-3 sensor will send positive signal and the user is wearing the helmet so the proximity sensor will also send positive signal. As a result, the bike can now be started. There are also other components that work together to detect the bike accident and help locating the Bike Rider. The GSM- GPS module is built into the smart helmet system [10]. The GPS part of the system detects the location where the accident has happened and shows its location in the Google maps. The GSM circuit is responsible for sending Text Message to the mobile phone of the bike rider's family member informing that an accident has happened. So, for a scenario where an accident has taken place the bike rider's family member will be notified that an accident has happened at location at xxx.xxxx.xxx coordinates on the Google map. Then it will be easy for the family members of the bike rider to reach the accident spot quickly and save the life of bike rider.

This way the bike rider's life can be saved. A screenshot of Text Message is given in Fig. 8.

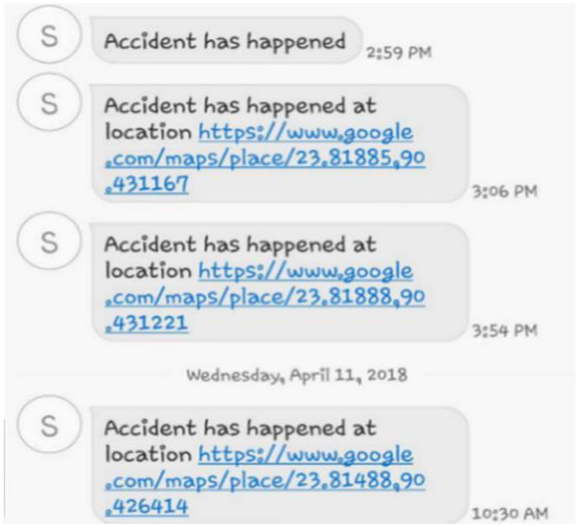

Fig. 8. Screenshot of Text Message

VI. FUTURE WORK

The smart helmet design can be improved by adding additional components which will make this project feasible. We can add a variety of bioelectric sensors to monitor various aspects of the motorcycle such as the level of its battery, tire pressure of the bike and fuel left on its main tank. We can attach a small camera at the front of the motorcycle or the helmet to track various activities of the bike rider and control which route is he/she allowed to go or not to go there. We can add sensors so that a motorcycle can pass a message to another motorcycle about various information regarding traffic congestion in certain area or an accident or just general-purpose communication [3]. We can add solar power for the helmet it can then also be used for charging the mobile phone of the user. For security purposes we can add multiple sensors such as a temperature sensor. The smart helmet is already a very compact technology. Since the helmets inside will be contain the riders head so there is nothing to add there. But the sensors and wires that we add outside the helmet can be made more compact by using smaller IC and shorter length wires. It can be made to look good by painting the IC and using colorful wires, so it becomes presentable. The costs of the project are mainly consisting of cost of equipment, cost of travelling to buy the equipment and the cost for advertisement. The cost can be reduced by verifying the price of a component from multiple shops and then buying. Also doing the work oneself as much as can be done will also reduce the cost. And finally, the advertisement should be done oneself rather than paying others which will reduce the cost. The project will be tested multiple times.

VII. CONCLUSION

Our Smart Helmet is an intelligent system which will aid more secured bike riding. Regarding the poor condition of our roads, large number of accidents, a lot of violations of traffic rules and poor regulation system, there is no alternative to smart helmets for motorcycle rider's safety [14]. Wearing a helmet is imperative while riding a motorcycle because it can save the rider from severe injury to the head in the case of an accident [16]. So, this is where the sharp IR sensor will come into action [15]. Drunk driving is also an important issue to consider nowadays. Because drunk driving can cause more accidents in the case of bikes than cars. So, the alcohol sensor will check if the driver is drunk or not. If we can make our design more full-proof and get a sponsorship, then we will be to mass produce it. A smart helmet maybe a little bit more expensive than a regular helmet but its benefits certainly outweigh the costs.

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