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Design and Implementation of Smart Helmet using Internet of Things for Avoidance of Accidents

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Abstract

Accidents are currently a major issue for everyone. Accidents are becoming more common, thus attempts are being undertaken to avoid them and minimize their repercussions. We live in a society where the laws of the road are meaningless to people and are routinely broken. Furthermore, it is human nature to oppose what is placed on them. Hence, from a different angle, we give safety with luxurious and intelligent characteristics by employing a smart helmet. The Smart Helmet is a microcontroller-based project based on the AVR family. It is a helmet with some smart features that will improve your driving experience and make you safer on the road. This smart helmet has three major elements, each with its unique function. For example, the first feature's purpose is to encourage or force the rider to wear a helmet; similarly, the second feature's purpose is to prevent the rider from drinking and driving; and the third feature's purpose is to save as many lives as possible in accidents by ensuring complete head coverage through a servo-controlled helmet door. To ensure that the cyclist is wearing the helmet, two modules, one on the helmet and one on the bike, will work in tandem. The ALCHO-LOCK function is used to prevent drunk driving situations. A vibration sensor detects accidents and is meant to relay the live location to authorized individuals. We can apply this approach to preventing big accidents and avoiding human and financial damages. All components are linked to the Arduino microcontroller. The Arduino ATMEGA328 microcontroller is used to handle input and output using the Arduino IDE with embedded C programming and is powered by a regulated power source that provides 5 volts of DC electricity to all hardware modules.

Keywords: Smart helmet, Accident avoidance, Alcohol sensor, DC motor.

1. Introduction

The Internet of Things is currently being used in a variety of industries, including wearables, home automation, smart appliances, smart agriculture, and others, where devices and people communicate across a network. The IOT devices' job is to sense data and transfer it to a server, where a massive amount of data can be generated. We can make inferences based on the generated data by processing and evaluating the received data. This has the advantage of providing real-time data from the environment. Motorcycle accidents are becoming more common these days, and many people are dying as a result. This can be avoided by wearing a smart helmet. According to the poll, four individuals die in India every hour because they do not wear helmets. In 2017, more than 48,746 two-wheeler riders were killed in traffic accidents. In addition, 78.3% did not wear a helmet. There are two crucial requirements that need be checked before the bike starts with the smart helmet to go through or fix this. The first criterion is that we verify that the cyclist is actually wearing the helmet and not merely keeping it. Second, sensors can be used to determine whether or not the user has consumed an alcoholic substance based on his breath. Road traffic accidents were the leading source of injuries in less developed countries, ranking twelfth among the leading causes of lost years of healthy life.

Widening the route is not an option under the Indian road system for avoiding traffic in such cities. There are numerous solutions to the challenges with state drunk driving control programs. A helmet is a type of protective equipment that is worn to protect the head from injury. A helmet, in particular, assists the skull in protecting the human brain in the event of an accident. The project's goal is to give bike riders with complete safety. Many accidents are caused by carelessness or drunk driving. The traffic authorities issue several directives to vehicle operators. But, many of them do not follow the regulations. Helmets have recently been mandatory, but many individuals continue to drive without them. Despite raising awareness about accidents and the significance of wearing a helmet, many continue to break the law. Traffic cops checking for helmets is not a long-term answer. Because traffic officers cannot be present at all times. As a result, this smart helmet with an accident prevention system was created in order to make the helmet necessary. If the driver wears a helmet and is not under the influence of alcohol, this system will start the vehicle.

The most effective will adhere to certain principles: they will invest authority and responsibility in people and organizations at all levels, from local to national, because drunken driving prevention necessitates action at all levels. They will operate in the public eye, using the media to report on problems and solutions, because ultimate public support is required. They will not promise fast results based on a single activity, but will instead take small steps toward long-term progress. Moreover, rather of trying to apply one-size-fits-all solutions, they will build processes for recognizing and solving problems. As a result, road safety has become a serious concern. As a result, it becomes necessary to employ such a difficult strategy in order to circumvent the basic requirement of wearing a helmet and avoid drunk driving. In this case, we created a system that verifies the two criteria before starting the bike's engine. Our device incorporates an alcohol sensor and a helmet-sensing switch. A switch is used to detect whether or not the biker is wearing a helmet. If the cyclist is drunk, an alcohol sensor detects it and sends the result to the MCU. Both the switch and the alcohol sensor are built inside the helmet. The engine will not start if any of the two prerequisites is not met. The MQ3 alcohol sensor is used to detect the alcohol concentration in the driver's breath. Based on the concentration of alcohol, the sensor produces an analog resistive output. The MCU is the microcontroller unit that controls all of the other blocks in this system. The MCU receives or reads data from the sensors and manipulates this data to operate all of the system's functions. The alcohol sensor is linked to the MCU through an interface circuit, whereas the helmet sensing switch is directly linked to the MCU. The MCU collects data from these sensors and sends digital data to the encoder only if the two requirements are met. Finally, if a person is involved in a collision, the sensor evaluates the person's and bike's conditions and provides location information to a nearby hospital. If the person has no major injuries, the bike's button is pressed, indicating that the person's condition is good.

1.1 Objective

The goals of this project are to create a circuit that can increase motorcycle safety and to create a smart safety helmet for the entire rider. The inspiration for this project comes from the real-world issues we confront on the roads every day. Road accidents are becoming more common, and in countries like India, where bikes are more common, many people die as a result of carelessness induced by not wearing helmets. In today's world, there are numerous examples of mortality caused by two-wheeler road accidents. Despite the fact that helmets are widely available, most people do not use them. In the event of a road accident, the message is transmitted to the emergency contact through GSM.

2. Literature survey

Jesudoos [1] presented a system that employs sensors such as infrared sensors, vibration sensors, and gas sensors. The gas sensor checks the breath of a person wearing the helmet to determine how much booze he has ingested. MEMS is in charge of the vehicle's bar control. A vibration sensor detects an accident. The load checker determines the vehicle's load. The sensors are linked to a PIC microprocessor. If a user has consumed alcohol, the gas sensor will detect it and display it on the LED display. If an accident occurs, the vibration sensor will detect it and send information to the hospital through GPS. If the rider drives recklessly, the MEME sensor identifies the amount in the person's bank account. An IR sensor is utilized to determine whether or not the cyclist is wearing a helmet. The exactness and accuracy of this system are high, and ambulances are booked automatically based on ten locations. The smart helmet approach, suggested by Shabbeer [2], identifies and reports accidents. In this method, a microcontroller is linked to an accelerometer and a GSM module. The cloud infrastructure is used to enable accident notification and reporting. If the acceleration level exceeds the threshold or if an accident happens, the information is transferred to the emergency authority server, which subsequently sends the message to the nominated emergency contact through the GPS module. This method was able to recognize incidents 94.82% of the time and send the right coordinates 96.72% of the time.

P. Roja [3] presented a system made up of six components: a remover sensor, an Infrared sensor, an air quality sensor, an Arduino UNO microprocessor, GPRS, and GSM. This helmet warns employees about dangerous chemicals in mining locations and also sends information to the server if the helmet is removed. This data communication is carried out via IOT technology in this case. Bher et al. [4] presented a smart mining helmet detection system that identifies three sorts of hazards: toxic gases, helmet removal, and impacts. Several sensors are used here, including infrared sensors, gas sensors, and accelerometers. Chandran et al. [5] has proposed Konnect, a smart helmet system. To detect and prevent accidents, they deploy an integrated network of sensors, WIFI enabled processors, and cloud computing infrastructures. If the speed exceeds the threshold level, the information is also sent to the provided contact by text message. Aatif et al. [6] devised a method that used an Arduino Nano, a Bluetooth module, a push button, and a 9-volt battery. If an emergency occurs, the smart helmet with Bluetooth is connected to the cell phones, and a push button is employed. Archana et al. [7] devised a solution to reduce accidents; the system comprises of a sensor that detects human touch when the bike key is inserted. When he puts on the helmet, the sensor automatically locks it, and he can only remove it when the bike is stopped.

To provide workers with safety, Lee et al. [8] presented a system based on three sensors: an acceleration sensor, an ultrasonic sensor, and a carbon monoxide sensor, as well as an Arduino MCU (Micro Controller Unit) with a Bluetooth module. Budiman et al. [9] designed a system of smart helmets with several features. If a rider is not wearing a helmet, is in risky conditions, or the helmet is not properly locked to offer safety to the rider, a warning notification is issued. A warning to the rider is generated in the form of a notification in this system to advise him of the risky condition. There is a 100% success rate in four smart helmet features in the functioning test and a 98.3% success rate in the communication test between the two modules. Tapadar et al. [10] also developed a prototype that uses an IOT module and sensors to identify the rate of alcohol consumption by the rider as well as accidents. They are attempting to use support vector machines to forecast whether or not the sensor values correspond to an accident by training the device using real-time simulation. This system produces acceptable outcomes. The precision and accuracy are likewise quite excellent.

Ahuja et al. [11] presented a smart helmet system that makes use of GSM and GPRS modules. Because we all know that the ambulance may arrive late at the scene, this prototype assists in informing the appropriate person about the accident so that he may take the necessary procedures. This system has features such as high accuracy, cost effectiveness, and providing accident information within a minute. To avoid mishaps, Jeong et al. [12] presented a system that includes sensors such as a thermal camera, a visible light camera, a drone camera, an oxygen remaining sensor, an inertia sensor, a smartwatch, an HMD, and a command center system. This framework enables the easy integration, effective management, and real-time notification of IOT services. Kurkute et al. [13] presented a system that included a Raspberry Pi module, a Pi camera, a pressure sensor, built-in Wi-Fi, and GPS. To capture the biker's face, image processing technologies are applied. It may be employed in any type of vehicle, is cost-effective, and can be administered in real time.

Kabilan M. [14] presented a vibration sensor-based system. When the rider wears the helmet, which contains a vibrator sensor with a frequency, the message is delivered to the emergency response using the GPS module if the frequency exceeds the threshold. This device can save lives by detecting and reporting accidents. Reddy et al. [15] presented a two-part scheme, the helmet section and the bike section. There is an alcohol gas sensor in the helmet portion to determine if a person is drunk, as well as an IR sensor, an alcohol sensor, and an LCD display to display the information. A vibration sensor in the bike part detects an accident and transmits the data via the GSM network and GPS module. Mhatre et al. [16] proposed a system that includes a helmet as well as a bike module. It is made up of infrared, MQS alcohol, vibration, a GSM module, a GPS module, an Arduino, and an intercom system. The system's workflow is as follows: When the bike starts, if the user has drunk alcohol, the bike will not start; otherwise, it will start, and if the vibration sensor limit is larger than the threshold, a message about the accident is sent to the registered phone. This technology is less expensive and provides more security for the rider.

3. Existing system

The current project uses wireless communications and is linked to a smart phone. This prototype employs sensors to detect a crash or accident, and communication hardware is employed to automatically summon a predetermined emergency contact. GSM and GPS helmet for accident detection and reporting. It was created to promote rider safety. The goal of this project is to examine and comprehend the concept of an RF transmitter and RF receiver circuit. The project makes use of ARM7, GSM, and GPS components. A buzzer is also used to signal the project. Whenever an accident occurs, the location of the accident will be recorded, and information will be transmitted to the registered cell phone number. The main disadvantage of this project is that no display device is used to display the current condition. A helmet's price remains high because it serves only one purpose.

The other existing mechanism controls the biker's speed. The helmet is equipped with all of the components and sensors that read the speed of the bike and direct the rider to lower or raise the speed dependent on the obstacles ahead. The main disadvantage here is that the rider does not wear a helmet in areas where traffic checks are not performed. In large countries like India, testing the alcohol concentration of each individual rider's blood is unfeasible. Difficulties in enforcing traffic laws by traffic cops.

Another existing system is the konnect smart helmet. In this case, they deploy an integrated network of sensors to identify and avoid accidents. If the speed exceeds the threshold, the system will send a text message to the supplied contact.

4. Proposed system

The rider must wear the helmet since there is a switch in it. When the switch is pressed, the ignition starts. The helmet also checks if the rider is drunk and driving. If the rider is drunk, then the ignition of the bike is avoided, hence not letting the rider ride the bike. In this system, we use an Arduino microcontroller interfaced with an alcohol sensor, which is used to monitor the user's breath and constantly send signals to the microcontroller. The microcontroller encounters an alcohol signal from the sensor and sends the data to the motor using UART communication, which stops the DC motor to demonstrate engine locking. If alcohol is detected, the system locks the engine. It also uses a Vibration Sensor to detect an accident and the system also sends a message to a server by displaying the status of the helmet switch, alcohol level, and vibration of the rider's behavior, including the latitude and longitude location of the incident using GPS.

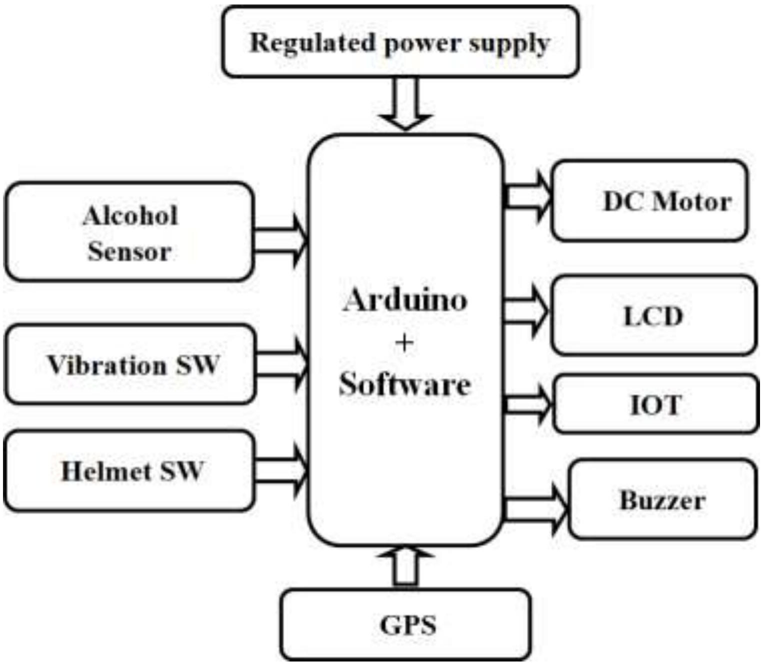


Figure 1: Proposed smart helmet block diagram.

Working operation

The system uses an RPS module to convert the 230 AC volts into 5V DC, which is the power supply for all the components. The inputs of the system include a Helmet switch, Alcohol sensor, Vibration sensor, and GPS module. The Helmet switch is used to detect whether the rider is wearing a helmet or not. The Alcohol sensor measures and detects the alcohol content in the rider's breath. The Vibration sensor detects vibrations caused by the bike's movement, such as a fall or accident. The GPS module determines the location of the bike and rider. The system has several output components, including a DC Motor (used as the bike's engine), an LCD (Liquid Crystal Display) that displays various information such as the status of the inputs, a Buzzer that generates warnings to the rider, and an IoT module. The IoT module connects the helmet to the internet and allows data to be transmitted to a website or mobile app.

The Arduino microcontroller contains the software programming code in Embedded C. It controls the data flow and processing in the system. When the kit is switched on and the mobile hotspot is set, the system waits until it receives GPS data. Once the data is received, the LCD displays the status of the helmet switch, alcohol sensor, and vibration sensor. The system checks if the helmet switch is ON (indicating the rider is wearing a helmet). If the helmet switch is ON and the alcohol sensor is OFF (indicating no alcohol consumption), the DC motor runs, starting or stopping the bike's engine. If the rider doesn't wear a helmet or has consumed alcohol (alcohol sensor is ON), the DC motor stops running, and the buzzer emits a warning sound. The system continuously monitors the vibration sensor. If the sensor detects sudden impacts or an accident, it generates an alert using the buzzer and

LCD. The GPS module helps determine the location of the bike and rider, which can be used to alert emergency services in case of accidents. The IoT technology is utilized to transmit sensor data, such as location, alcohol status, helmet status, and vibration sensor status, to a website or mobile app through a Wi-Fi module. By connecting to the hotspot and logging in, users can easily check the updates and status of each input module on the website or app.

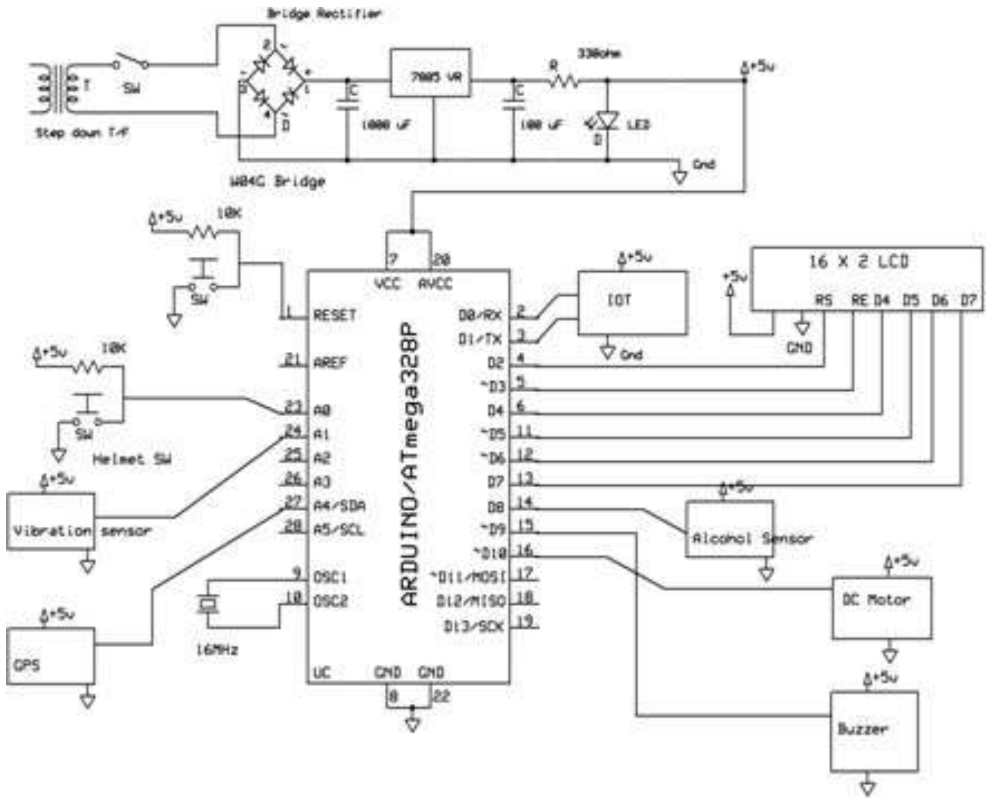
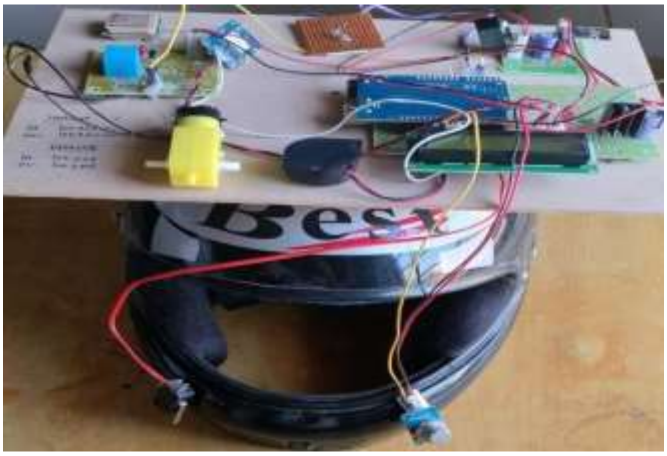


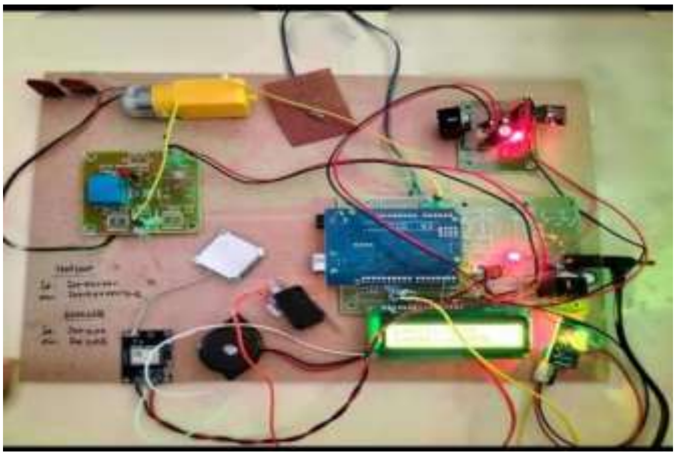
Figure 2: Schematic diagram of proposed smart helmet.

In this project, we are using an Atmega328p microcontroller. It has a total of 28 pins. With these 28 pins, we are using only 20 pins. D0-D13 are the digital pins (14) and A0-A5 are the analog pins (6). Here, D0 and D1 are connected to the IOT for transmitting and receiving the data. D2-D7 pins are connected to a 16*2 LCD display, and D8 pins are connected to the alcohol sensor, which detects whether alcohol is consumed or not. The D9 pin is connected to the buzzer, which gives a beep sound as a warning to the rider. The D10 pin is connected to the DC motor; it is used to start or stop the bike engine based on the status of the inputs. The A0 pin is connected to the helmet switch, which acts as a toggle switch; if it is pressed, then the bike starts; otherwise, it does not. The A1 pin is connected to the vibration sensor, which detects the sudden impacts or falls of the rider. The A4 pin (serial communication) is connected to the GPS module, which detects the location of the rider. The 230-volt AC is converted into 5 volts of DC, and that is given to the circuit through pin 7. Reset is given to pin 1, which is used to reset the circuit for connecting to the IOT module. The oscillator is connected to pins 9 and 10, and GND is connected to pins 8 and 22.

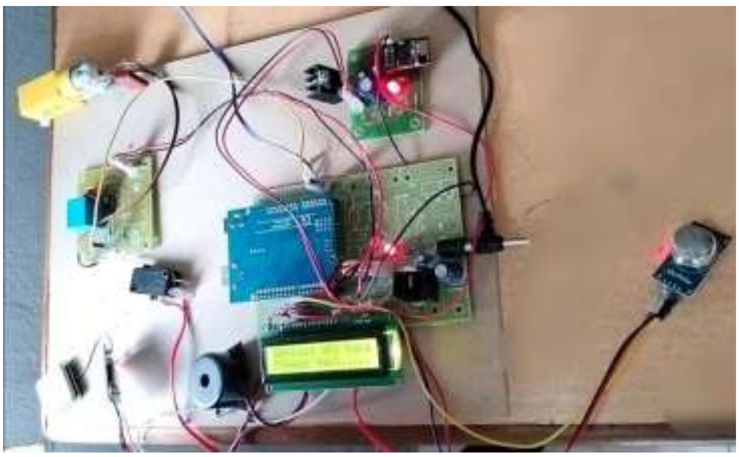
5. Results and discussion

We attempted to build a smart helmet using an innovative approach. Because our smart helmet differs from traditional helmets. All of our circuits have been put outside the helmet fabric for ease, so they do not come into touch with the head. The image above depicts our smart helmet. A receiver circuit device is to be installed on the bike. We made every effort to keep the receiver circuit as small as feasible. The helmet is the same size as any other helmet and is quite comfortable to wear. The entire helmet is referred to as the transmitter circuit since it will communicate data to the bike's reception unit (DC motor). The data will be transmitted using UART communication. We have positioned the MQ-3 alcohol sensor in front of the rider's lips at a safe distance so that it can analyze the driver's breath and determine whether or not he or she is drunk. The helmet switch determines whether or not the helmet is worn. There is a vibration sensor (Mercury Switch) that detects the rider's fall. Sensors must meet specified requirements. If these conditions are met, the data will be sent via communication. An Arduino Uno is used to link all of these sensors.





Here the circuit is turned on by using the regulated power supply of 12 volts, which is then converted to 5 volts of DC current. The LED is the indication for 5 volts of current, so if there is 5 volts of current, then automatically the LED glows. The generated 5 V DC current passes to every hardware component in the circuit.



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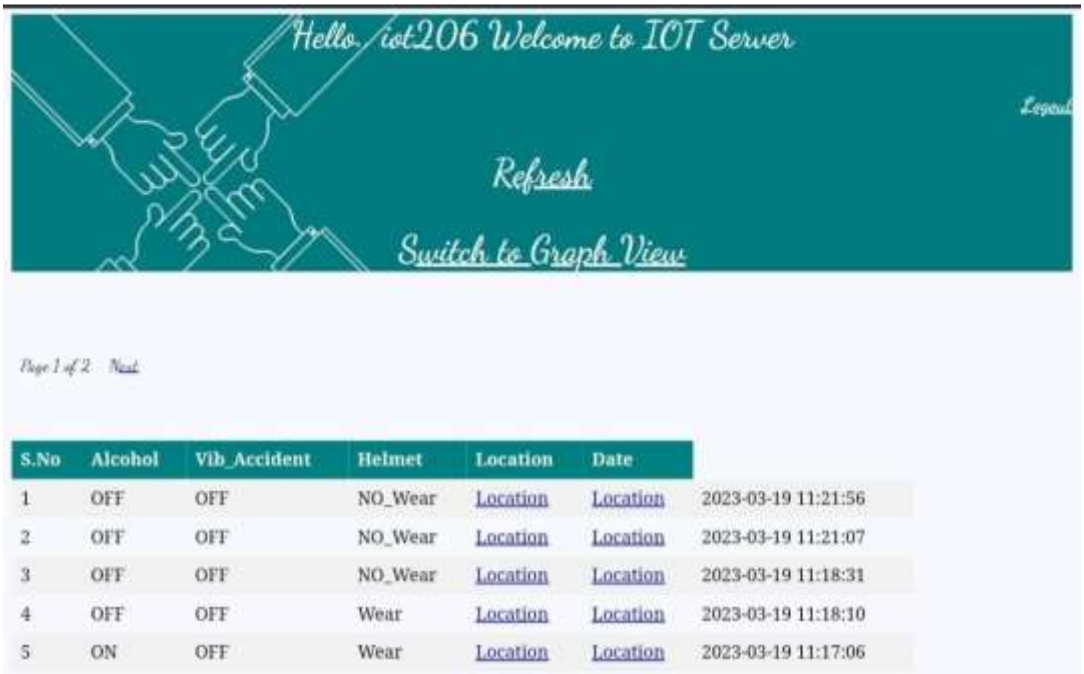
Once power is received by all the components in the kit, wait until it gets the GPS data. It means detecting the location of the rider. After getting GPS data, when we press the reset button, the LCD displays the title "IOT Smart Helmet". The output may be seen in the following image after we have connected the IOT module via a Wi-Fi connection. Here, the LCD displays the output based on the status of the inputs.

The above figure is about detecting the rider's status and displaying it on the LCD. The system is proposed to detect whether the rider wears a helmet or not (on or off) and, based on his consumption of alcohol, whether he is drunk or not (on or off). If he falls down or not (on or off), all these statuses are displayed on the LCD. If the helmet is not worn and alcohol is consumed, if an accident happens (falls), then it displays alert on the LCD (ON) and gives a beep sound through the buzzer.



S.No	Alcohol	Vib_Accident	Helmet	Location	Date	
1	OFF	OFF	NO_Wear	Location	Location	2023-03-19 11:21:56
2	OFF	OFF	NO_Wear	Location	Location	2023-03-19 11:21:07
3	OFF	OFF	NO_Wear	Location	Location	2023-03-19 11:18:31
4	OFF	OFF	Wear	Location	Location	2023-03-19 11:18:10
5	ON	OFF	Wear	Location	Location	2023-03-19 11:17:06

This website shows the status of the rider (whether he or she consumed alcohol or not, wore a helmet or not, had an accident or not), and the location of the rider. Every minute, the information and exact location of the rider are updated on the website with the date and time.

6. Conclusion

The IOT smart helmet to avoid accidents project is a novel solution to the problem of motorcycle accidents caused by drunk driving and a lack of suitable safety equipment. Using the vibration sensor and GPS module, the project ensures that the rider is wearing a helmet, prevents the bike from starting if alcohol is detected, and detects accidents. The inclusion of a Wi-Fi module allows data to be transferred to a server for monitoring and analysis, hence strengthening safety regulations. Finally, the Internet of Things smart helmet project has the potential to increase motorcycle safety and reduce accidents caused by human mistake. The initiative emphasizes the need of combining technology into safety equipment and supports the use of creative solutions to societal problems. The idea may be expanded and scaled out to benefit a bigger community of riders, making it a wonderful example of how technology can be used to make the world a safer place.

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