Arduino Based Integrated Connectivity Helmet

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Abstract **- The Arduino Based Integrated Connectivity Helmet is a versatile project thatallows users to ride their motorbikes with better and advance safety features. This project uses an Arduino Mega 2560 microcontroller and multiple sensors, including the Ultrasonic Distance Sensor Module (HC SR04), Bluetooth module (HC-05) and a Collision Detection Sensor (YL-99) that would sense any sort of collision or accident of the user and send an emergency message to other contacts through Bluetooth interfaced with an application in the user's mobile phone. The data collected by the sensors is to be displayed on an Arduino 128x64 OLED display. Overall, the project demonstrates the potential of modern technology that could improve the safety of the bike riders.**

I. INTRODUCTION

Ensuring safety in a variety of activities and environments is crucial in the fast-paced world of today. In personal protective equipment (PPE), helmets have long been a mainstay since they offer essential protection against head injuries in a variety of settings, such as construction, motorcycling, cycling, and extreme sports. Classic helmets are becoming more intelligent by inclusion of a range of sensors, communication tools, and intelligent features to monitor the surrounding environment, identify possible risks, and give users immediate feedback.

A major turning point in the development of PPE has been reached with the introduction of smart helmet technology. Smart helmets provide a comprehensive approach to safety management by utilizing state-of-the-art technologies to address both the emergency response and preventive actions. In addition to offering physical protection, these cutting-edge helmets provide their wearers with insightful knowledge and situational awareness, reducing risks and enhancing overall safety [1].

J.F. Riya et al. [2] created a smart helmet that runs on renewable energy to protect bikers. Global System for Mobile Communication (GSM) is used for phone calls, for tracking the Global Positioning System (GPS) is used, and an Arduino microprocessor are all included in the helmet. Moreover, the speed sensors will alert the user if they go over the average speed limit. In an emergency, the rider can activate the emergency switch to call for assistance. The bike will not start if the rider is not wearing the helmet. The entire prototype is powered through solar energy.

An extremely efficient and technologically advanced method of using the Internet of Things (IoT) with Smart Helmets to prevent safety issues has been presented in [3]. The microcontroller Arduino NANO and Arduino Mega-2560 are in charge of all the system's components. For communication, two 2.4 GHZ nRF24L01s serve as sender and receiver. The use of a single MQ-3 gas sensor allows for the detection of alcoholism in bike riders. The MQ-3 sensor detects alcoholism in bike riders, and the entire system trips if it finds out.

In [4], a newly developed system called "Aagaahi - A Smart Helmet" has been proposed which suggest an affordable and user-friendly safety protection alternative for the riders. Only when sober and wearing a helmet will the rider be permitted to operate his two-wheeler. Its primary goal is to lessen the harm that two-wheeler riders sustain in traffic accidents and to quickly deliver assistance and medical care.

R. Vashisth et al. [5], proposed a helmet with two modules that operate in unison on the bike and the helmet. Between the bike circuit and the helmet, a wireless communication is facilitated by a radio frequency module. Drink and drive situations are avoided with the help of the ALCHO-LOCK function. Accelerometers are used to detect accidents and GSM module give information about mishappening with the rider to a concerned authority.

H. Chauhan et al [6], improved helmet comfort and feature content to entice users to put it on. This project has a display screen, an alcohol detection sensor and a cooling feature inside the helmet for the rider. It also connects the helmet to the network.

In [7], the authors developed a helmet detection system to prevent accidents. They suggested a module to identify if the rider has put on the helmet. The bike will have an additional accident-avoidance detection module installed.

A smart helmet is developed with the main goal of enhancing two-wheeler riders' safety through the use of the IOT in [8]. Potholes, speed breakers, fall detection modules, and sophisticated alcohol sensing are all embedded in the suggested smart helmet system. The circuit is designed in a way that prevents the bike from starting, preventing the rider from riding if they have had more alcohol than is recommended.

II. COMPONENT DESCRIPTION

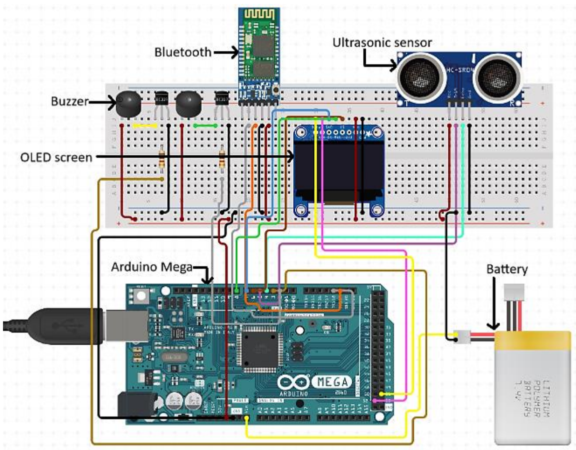

Figure 1: Circuit configurations of Smart Helmet

A. *Ultrasonic sensor (HC-SR04)*

An Ultrasonic sensor is a device that is used to measures the distance of a target by emitting ultrasonic waves. It measures the distance of the object by emitting these ultrasonic waves and converts the reflected waves into electrical signals [9]. Speed of these sound waves are higher than that of sound audible to human ears.

Specifications:
- Operating voltage- 5V DC
- Operating current- 15 mA
- Operating angle- 15°
- Ranging distance- 2 cm – 4 cm

It consists of 4 pins:
- VCC
- Echo (Receiver)
- Trig (Trigger)
- GND (Ground)

Figure 2: Ultrasonic sensor

B. Bluetooth module

HC-05 is a Bluetooth module that is designed for the wireless communication and it can be operated in a master or slave configuration. This module is used in many applications like a wireless headset, for short range data transfer, wireless mouse, wireless keyboard, and so many other applications [10].

It is having a very short range <100cm which entirely depends upon transmitting and receiving conditions.

Figure 3: HC-05 Bluetooth Module Pin Diagram

It consists of 6 pins in total:

1. **EN:** This pin brings Bluetooth module in AT command mode. The high and low configurations depict command mode and data mode respectively. The baud rate of HC-05 in the command mode is 38400 bps and 9600 bps in the data mode.
HC-05 module operates in two modes.
i. **Data mode**: In this mode, exchange of data takes place between the connected devices.
ii. **Command mode**: In this mode, settings of HC-05 are changed using the AT command. These commands are sent to the module serial using the USART port.
2. **VCC:** 5 V or 3.5 V can be connected to this Pin.
3. **TXD:** It transmits serial data (the data received by Bluetooth module wirelessly is transmitted out on TXD pin serially).
4. **GND:** It is ground pin of Bluetooth module.
5. **RXD:** It receives data serially (received data will be transmitted wirelessly through Bluetooth module).
6. **State:** It shows the state of the module whether it is connected or disconnected.

Figure 4: Bluetooth module pins

C. Arduino Mega 2560

The ATmega2560 serves as the foundation for the Arduino Mega 2560 microcontroller board [11]. It is powered using a battery, an AC-to-DC converter, or a USB cable to link it to a computer.

Microcontroller: The ATmega2560 micro-controller, which is built on the Advanced Virtual RISC (AVR) architecture, is the brains behind the Arduino Mega 2560. It consists 54 digital input/output pins, 15 of which can also be used as PWM outputs, along with a 16 MHz crystal oscillator.

Analog Inputs: The Mega 2560 accepts analog sensor readings via its 16 analog input pins, which are designated A0 through A15.

Clock Speed: With a clock speed of 16 MHz, the board can handle most applications with enough processing power.

Memory: The ATmega2560 microcontroller contains 4 KB of EEPROM for non-volatile data storage, SRAM of 8 KB for variables and runtime data, and Flash memory of 256 KB for program code.

Figure 5: Arduino mega 2560

D. Collision Detection Sensor

The YL-99 collision sensor is employed to identify when an object collides with its surroundings. It has a mechanical switch that, when pressed, gives an output signal. A microcontroller measures the signal voltage, allowing the user to easily determine whether or not the object collides with the surrounding object. It is essentially a digital sensor that, depending on whether your switch is connected to a pull-up resistor or pull-down resistor, will give 5 V when triggered and 0 V otherwise.

Features:

- The sensor operates between 3-12 volts DC.
- It is a vibration-type sensor.

Figure 6: Collision detection sensor

E. I2C OLED display

With an I2C interface, this 0.96-inch OLED monochrome 128x64 dot matrix display module works with an OLED display. It's perfect for a very small display. In comparison to LCD screens, OLED screens are far more competitive due to their features such as large viewing angle, broad temperature range, low power consumption, a high contrast ratio, self-emission, and slim outline [12]. It works with any microcontroller, including Arduino, operating at 3.3V to 5V.

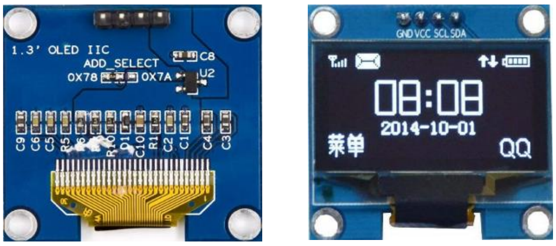

Figure 7: OLED Screen

G. Buzzer

A piezo buzzer is an electronic gadget that sounds an alarm or produces a tone. It typically has a simple design, is lightweight, and is affordable. The applications of piezoelectric vibration plates in small, high-density assemblies are numerous because of their dependability and versatility in producing audible signals, which can range from multi-tones and melodies to monotone buzzes and alarms. Furthermore, they are perfect for many battery-operated devices due to their low power consumption [13].

Figure 8: Buzzer

III. SYSTEM IMPLEMENTATION

A. Implementation

The implementation of Arduino based connectivity helmet involves the following steps:

Setting up hardware components: At first, all the required components such as Arduino mega, Bluetooth module, Collision detection sensor, ultrasonic sensor and the I2C OLED screen are gathered and then connected all together as per circuit diagram.

Writing the code: After setting up of hardware the code for the Arduino mega board using the Arduino IDE software is written. The code consists of setting up the sensors, taking readings from them, sending them to the application through Bluetooth module and receiving the data from the application through the Bluetooth and display the same on the I2C screen.

Uploading the code to the Arduino mega board: Once the code is written, it is uploaded to the Arduino mega board through a USB cable connected to the computer.

Writing the code for application: Then a code is written to create an application of the desired interface and to connect with the Arduino to provide the desired services like GPS and Bluetooth connectivity with the helmet.

Connecting the helmet and the application: The Bluetooth module HC05 is used to connect the helmet and the application for their coordinated working like, displaying the time, date and notifications on the screen and for sending an emergency message to the contacts when a collision signal received

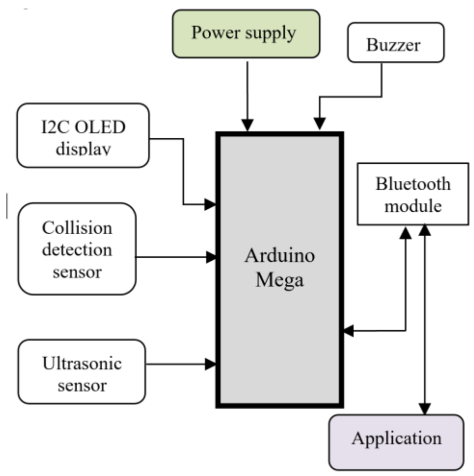

Figure 9: Schematic diagram of Arduino Based Integrated Connectivity Helmet

Displaying the data: The application receives the data that the sensor has collected and the data like date, time, notification alerts are sent to the screen connected with the Arduino mega through the Bluetooth. Additionally, if we start maps on the application then the direction of our destination would be shown and updated regularly on the OLED display

B. Connections

The Arduino based integrated connectivity Helmet is based on Arduino Mega consists of various components that work together to send, receive and display data. The system is implemented as follows:-

Arduino Mega board: The Arduino board is the main microcontroller that is used in the Helmet. It is the brain of the system that receives, processes, and transmits data from the sensors to the application and the screen. The board is connected to a USB cable for power.

Ultrasonic sensor: The RX pin of the ultrasonic sensor is connected to 9^{th} pin and the TX pin of ultrasonic sensor is connected to the 10^{th} pin of Arduino board. It measures the distance to any object in front of it.

Bluetooth module: The RX and TX of Bluetooth is connected to 51^{st} and 52^{nd} pin to Arduino board. It is used to connect the Helmet to the application to send the collision signal and to receive data to display on the I2C screen.

Collision detection sensor: The collision detection sensor is used to detect any type of collision of the helmet at the time of and accident and sends a collision signal to the emergency contacts through the Bluetooth. The OUT pin of this sensor is connected with the 12^{th} pin of the Arduino board.

I2C OLED display: This display is connected with its SDA pin with the 20^{th} pin of the Arduino and its SCL pin with the 21^{st} pin of the Arduino board. The data sent through the application like Time, Date and Notifications of call are displayed on the screen.

IV. SIMULATION RESULTS

A. Testing

The USB cable connects the Arduino Based Integrated Connectivity Helmet to the system, and its readings are observed and analyzed on the Arduino IDE serial monitor. The readings obtained from the Helmet were then verified if they are correct or not. This was done to evaluate the accuracy of the Arduino Based Integrated Connectivity Helmet and to determine its reliability for safety purposes.

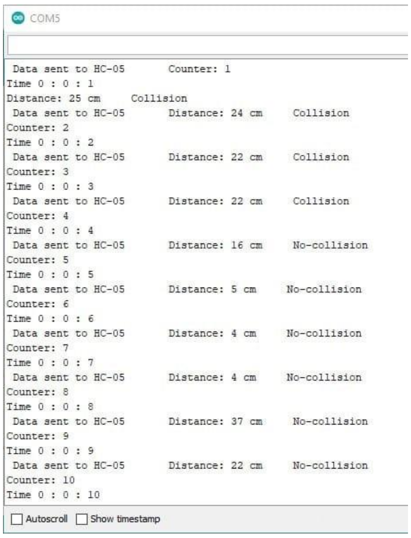

Figure 10: Test samples in Arduino IDE serial monitor

Figure 12: Result on OLED display

B. Result

The Arduino based Integrated Connectivity Helmet built using the Arduino Mega provides various smart and safety features that would be very helpful for the riders. It alerts the user through a buzzer if there is any vehicle within the specified range of the rider using the ultrasonic sensor and on account of any type of accident it will send an emergency message along with the live location of the user to the contacts saved. This all would be done with the help of an application. Additionally, the data from the application like the date, time, incoming call notification, and if we have started a map in the app then directions to our destination would be shown on I2C OLED display. The data displayed on the screen is in a simple format that would be easily understandable by the user.

The inclusion of snapshots of the hardware model of the 'Arduino based Integrated Connectivity Helmet' in a research paper offers a visual depiction of the parts and connections of the system.

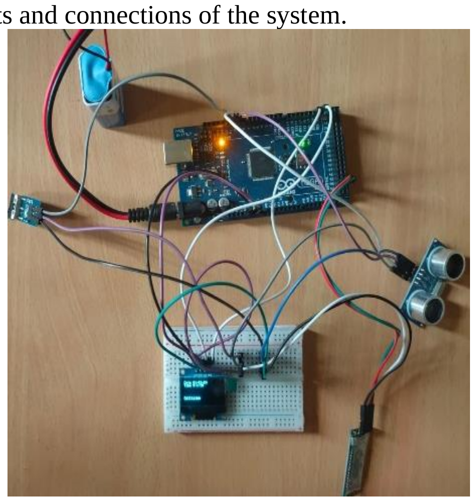

Figure 11: Snapshot of internal circuit

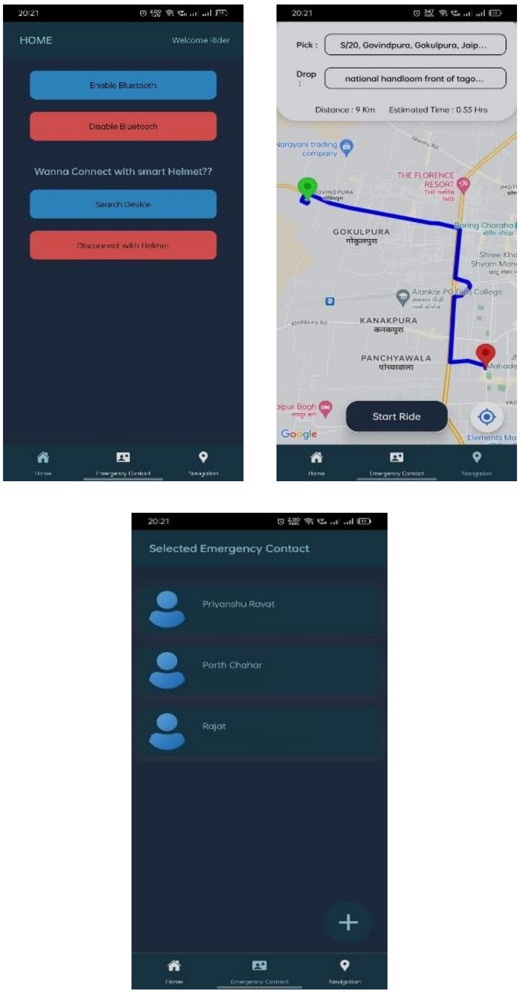

Figure 13: Snapshot of Application interface

Figure 14: Snapshot of Hardware Model

V. CONCLUSION

This project 'Arduino Based Integrated Connectivity Helmet' has the potential to provide better safety and comfort for bike riders. The project offers useful insights about the components and working of the helmet. Using an OLED screen and a variety of sensors, including HC SR04, HC 05, and YL 99 which detect the distance, provide Bluetooth connectivity and detects the collision of helmet in the occurrence of an accident. With above features, it also sends an emergency message with the live location of the helmet user to the contacts saved by the user in the application on account of an accident. The data like date, time, and call notification are fetched from the user's phone and are displayed on the OLED screen with the help of Bluetooth module.

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