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Smart Helmet with A Head-Mounted Display, Solar Panel, and Natural Language Processing

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Abstract: - In order to combat this problem, people don't usually wear helmets when riding a bike. However, in addition to serving as a safety device, helmets can also be used for much more. This will benefit the rider in many ways, including making the most of their time while riding, arriving at their destination efficiently, and riding safely by being aware of the most likely road conditions. The design of the smart helmet presented in this paper aims to achieve the aforementioned characteristics. It will do so by employing an Arduino UNO and HC-05 Bluetooth Module for a direct helmet-to-mobile connection, as well as speech inputs and speech outputs for more convenient communication with the helmet through Natural Language Processing (NLP) and a Heads-Up Display (HUD) for more detailed display output to the rider without diverting their attention from the traffic scene.

Keywords: NLP, Helmet, Arduino, Solar Panel.

I. INTRODUCTION

One safety precaution that many disregard is wearing a helmet. 98 two-wheeler riders perished in 2017 sans helmets, according to a Time of India article [1]. However, the understanding of the requirement for helmet wear is still lacking. Apart from this, cycling long distances between locations might wear out a cyclist.

Imagine a situation in which a rider travels 1-2 hours each day to get to his business, which is far from his residence. He's limited to riding a bike during this period, though. With headphones, a cyclist may listen to music or whatever else while they are riding, but this is not a good use of time. Another situation is when a rider has to go somewhere they are unfamiliar with, and it is quite inconvenient to keep stopping and consulting the map. There's also the additional risk of accidents occurring on a roadway because of other irresponsible drivers. Wearing a basic helmet for safety may be the only purpose for it; however, wearing a helmet that aids riders, amuses riders, and promotes safe time management may be more general uses.

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We have designed a helmet that benefits the rider by acting as both a riding aid and a safety device. The main component of our suggested system is making the most of your riding time. In addition, the helmet may be used to get assistance with road traffic conditions and will aid in route navigation in place of a mobile device. Voice command calling and receiving is one of its functions. Rather, it will also warn of reckless driving around the helmet-wearing cyclist.

Natural Language Processing (NLP) will be employed in conjunction with Speech to Text and Text to Speech for the purpose of carrying out communication between the rider and their helmet. There will be connection between the smartphone and helmet via Bluetooth connectivity. The Smartphone application will process and carry out the work utilizing the CPU of the phone.

II. PROPOSED SYSTEM

The majority of the components, with the exception of the processor, which will carry out the helmet's functions, are found within the smart helmet itself. Initially, an array of microphones will be mounted on the chin guard. This "array of microphones" makes the noise cancellation process extremely effective because, in reality, sounds will always be directed towards the bike rider [2]. The main part is the "Arduino Uno," which is placed inside between the comfort liner and the polystyrene foam liner on the back side [3]. For smartphone connectivity, the Arduino will be fixed with the HC-05 Bluetooth Module [4]. Information including power metres, driver alarms, and navigation instructions are to be displayed on the Scaled-down class of Heads-up Display, which was inspired by [5]. Ultrasonic and infrared sensors will be mounted on the helmet in four different locations: the front, above the visor (face shield); the other two, on the opposite sides from each other; and the rear, on the side facing the sun [6]. Finally, the Solar Panel, which is to be mounted on the upper side of the helmet's hard outer shell, will be utilised to power the whole electronics inside the helmet. To hear the output of the helmet, headphones with speakers will be positioned close to the ear area. As for the smart phone, all you need is a basic smartphone with Bluetooth to connect to the helmet. An application that will interpret and carry out spoken instructions and sensor data that is received over Bluetooth from the helmet [4].

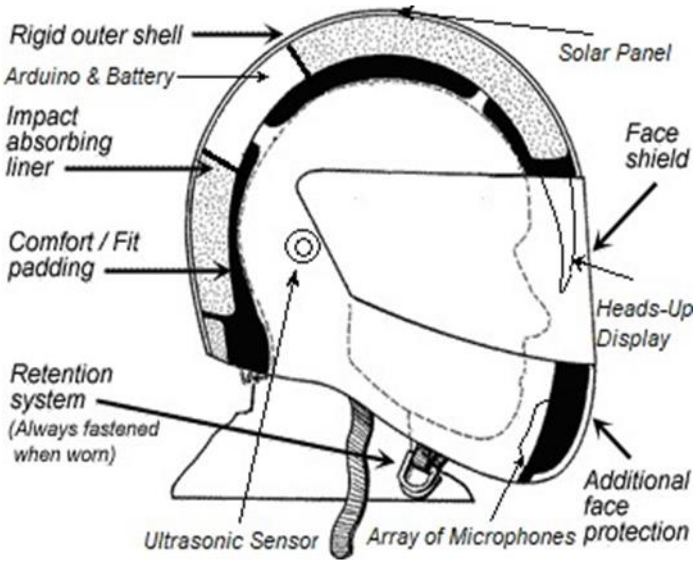

Figure 1: Helmet Structure

III. TECHNICAL STUDIES

A. An Array of Microphones

MEMS microphones offer a sufficient signal-to-noise ratio (SNR), tiny size, and frequency response at an affordable price. Small arrays with a diameter of only a few centimetres may be produced because to these characteristics [7]. Since the microphones may be connected with conventional PCB manufacturing methods and a PCB can be made in the appropriate array shape, these scaled-down arrays are probably going to be mass-produced. Wave propagation is the foundational principle that is applied to process the signals generated by these sensor arrays. They are made up of many microphones arranged such that the three-dimensional audio data may be accurately recorded. An arrayed microphone may simultaneously read a sound signal from several locations when the right processing is used for spatial audio filtering. This implies that a microphone array may be used to select a location in space and selectively filter out sound waves coming from that direction. The capacity to identify a specific voice source is possessed by a microphone array [7].

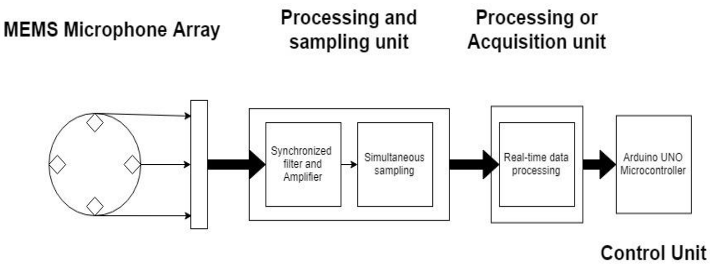

Figure 2: Control Unit

B. Arduino Uno

The Arduino UNO is an open-source, programmable microcontroller board that is inexpensive, versatile, and simple to use. It may be used in a wide range of electronic projects. This board can control relays, LEDs, servos, and motors as an output and can interact with other Arduino boards, Arduino shields, and Raspberry Pi boards.

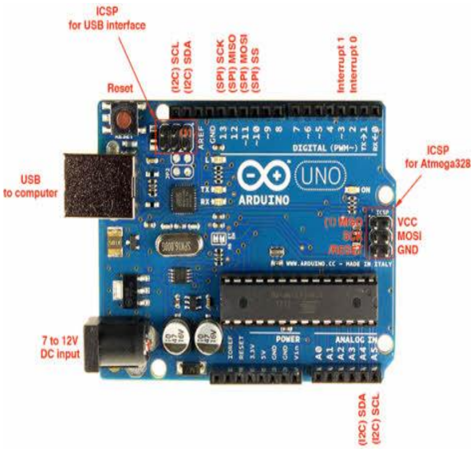

Figure 3: Arduino

C. HC-50 Bluetooth Model

Known as an apparent Bluetooth Serial Port Protocol (SPP) module, the HC-05 module is intended for the establishment of wireless serial connections. With a whole 2.4GHz radio transceiver and baseband, the Bluetooth module's serial interface is fully privileged Bluetooth V2.0+Enhanced Data Rate (EDR) 3Mbps modulation. Using CMOS technology and the Adaptive Frequency Hopping Feature (AFH), it makes use of a CSR Bluecore External single-chip Bluetooth system. Its footprint is just 12.7 mm by 27 mm [4].

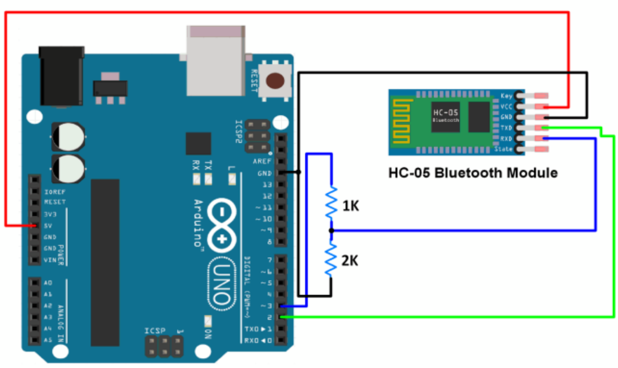

Figure 4: Arduino Blutooth module

D. Heads-up Display

The Head-Up Display (HUD), which is defined as any transparent display that presents data without requiring users to look away from their usual point of view, is one component of the solution for displaying information from systems to the driver because it has been shown to reduce the amount of time and frequency that drivers look away from the traffic scene [10].

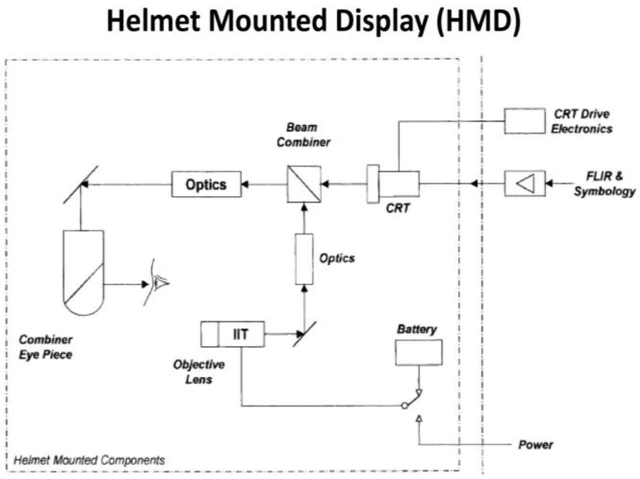

Figure 5: Circuit Diagram

E. HC-SR04 Ultrasonic sensor

Using an accuracy of 3 mm, the HC-SR04 ultrasonic sensor measures distances between 2 and 400 cm. The control circuit, transmitter, and receiver for ultrasonics are all part of the sensor module. The ultrasonic sensor operates as [6] follows:

1. Using Trigger, transmitting high-level impulses for 10 seconds.

2. Eight 40 kHz signals are automatically sent by the module, which then determines whether or not a pulse is received.

3. After reaching the high level, the signal is received. The time interval between transmitting and receiving the signal is known as the period of high length.

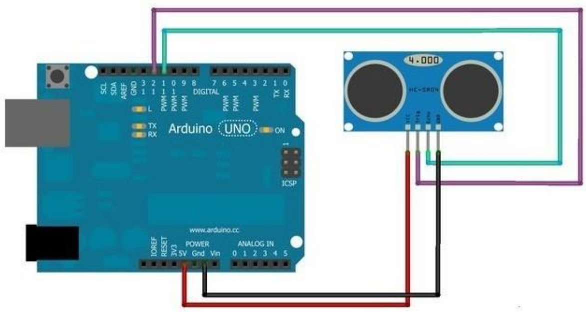

Figure 6: Arduino Sound Connection

F. Solar Panel

Ni-Cd batteries have a bank capacity of up to 4000 Ah and thousands of ampere-hours (up to 48 V) that can be charged by solar chargers. Intelligent charge controllers, which may be linked to a battery to store energy for off-peak use, are typically used in these kinds of solar charger configurations. Depending on the amount of sunlight received, a solar panel can produce a range of charging voltages; thus, a voltage regulator must be incorporated into the charging circuit to prevent overcharging (overvoltage) of a device [12].

Figure 7:Solar Panel

G. Natural Language Processing

Artificial intelligence (AI) uses natural language processing, which is the automatic processing of natural language by software, to enable computers to comprehend human languages. Natural language processing (NLP) is a branch of computer science and artificial intelligence that focuses on how computers and human languages interact, particularly on how to structure computer programmes to handle and evaluate vast volumes of natural language data [14].

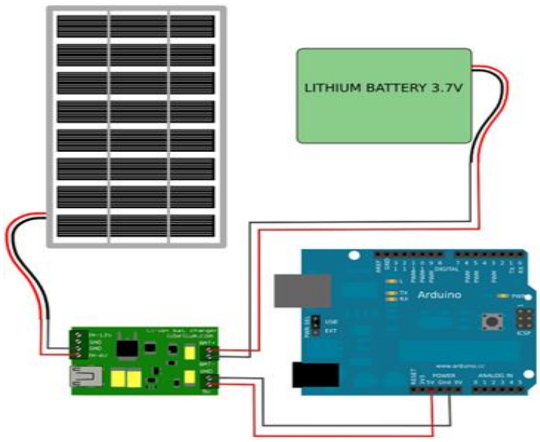

Figure 8:Solar Panel Arduino

IV. SYSTEM WORKFLOW

The features that are included with the helmet determine the complete system process.

A. Basic Circuitry Connections

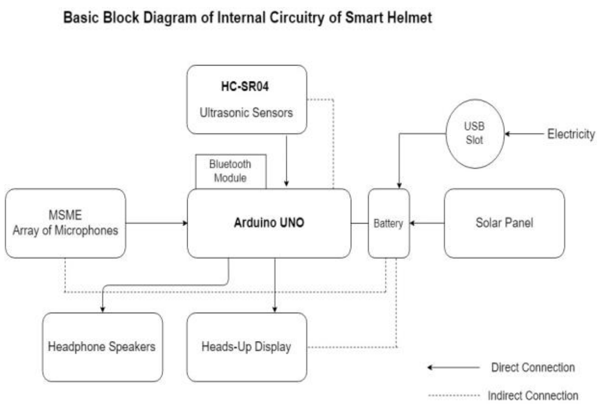

Figure 9: System Workflow

The Arduino Uno, which is the primary component of the Helmet Unit, is indicated by all the connections in the diagram above. The speech input will first be collected by the MSME Array of Microphones, which will also transform and filter the rider's voice input before sending the voice signals to the Arduino Uno Microcontroller. As a result, the perceived data from the HC-SR04 Ultrasonic Sensors—which will be monitoring the rider's distance from other drivers in order to help the rider avoid reckless drivers or other vehicles—will be sent to the microcontroller for additional processing. The Heads-Up show will receive the output data from the Microcontroller and show the necessary information to the rider. All of the circuitry's battery units are to be connected to microcontrollers, which will obliquely supply power to each and every helmet unit component. Without a doubt, sunlight or the USB slot that is attached to it will be used to charge this battery power source. This creates a two-way powered circuit and makes utilising a USB charger simple. The headset speakers are designed to be installed on the rider's ears, on the opposite side of the helmet. They will be used to play music, transmit speech output, and receive calls. Through the usage of a Bluetooth module and microcontroller, all of the signals from the helmet unit will be sent to the smartphone via a wireless link[15].

B. Voice Command Module

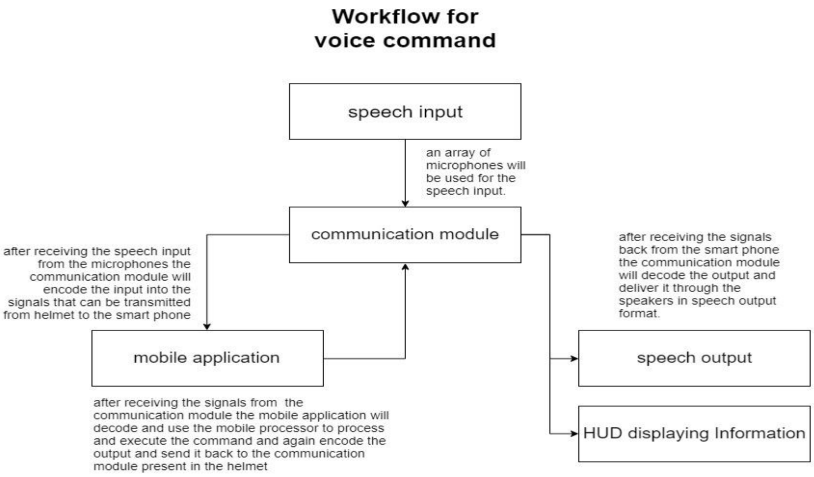

Figure 10: Workflow for Voice Command

An array of microphones will be essential for speech input in order to record the rider's voice, convert it to signals, and send it to the communication module (the Arduino Uno microcontroller and the HC-05 Bluetooth module). At this point, the raw signals will be encoded or converted before being wirelessly transmitted to the smartphone. In order to carry out the operation from the statement, the Smart Phone application will first decode or reconvert the received signal. Next, it will process the speech input using Natural Language Processing (NLP). Finally, it will understand the statement and execute it. The generated output data will then be sent back to the communication module, where it will be displayed to the rider either simultaneously on the Heads-Up display or through headphones, depending on the format.

C. Vehicle and Distance Measurement Module

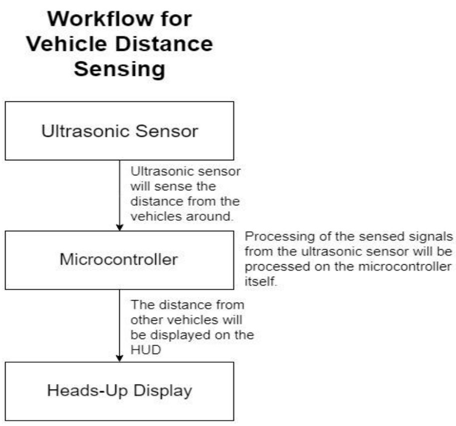

Figure 11:Workflow for Vehical Distance

All four sides of the vehicles will be sensed by the ultrasonic sensors, and all of the signals collected will be sent to the microcontroller. The Arduino Uno will process the signals and produce an output immediately, passing the data it is exhibiting to the Heads-Up Display (HUD), which will show the rider the distance data. This process will be done on the microcontroller itself to save time while displaying the real-time distance data.

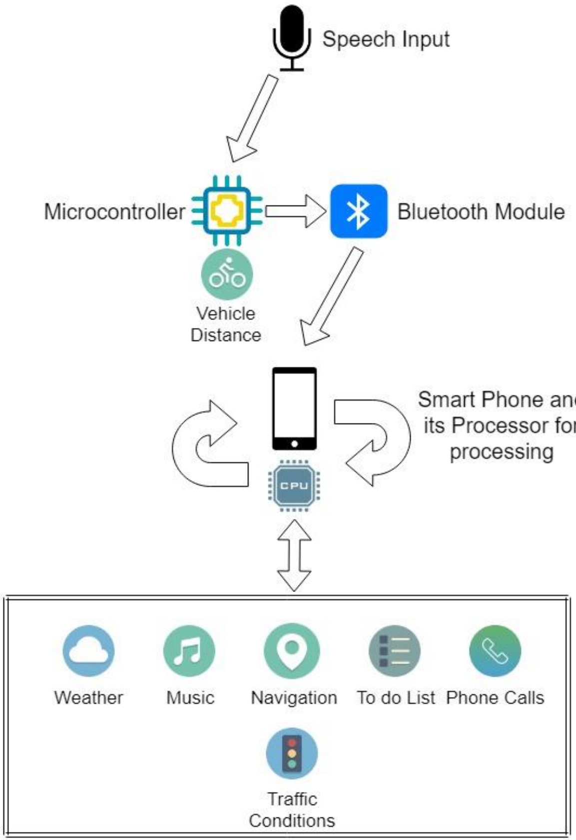

Figure 12: Overall Working of Proposed System

V. CONCLUSION

The number of accidents and subsequent damage will ultimately decrease if this smart helmet is used. Long-distance riding will no longer be a tedious chore thanks to smart helmets, which offer incredibly efficient riding experiences by keeping riders aware of traffic patterns. The bike rider will find it easy to go to the unfamiliar spots.

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