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Smart Helmet based Accident Detection and Notification

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Abstract: The paper aims to address the increasing rate of accidents by designing and implementing a smart helmet system that integrates sensors and wireless communication to detect accidents in real-time and promptly notify emergency services. An intelligent helmet stands as a crucial safety accessory for riders, emphasizing the utmost importance of their well-being while on the road. Through the incorporation of advanced technologies, it elevates the features of a traditional helmet and transforms a regular bike into a smart vehicle. This groundbreaking headgear seamlessly incorporates features such as alcohol sensing, identifying accidents, tracking location, and detecting falls, effectively operating as a hands-free device.

Keywords: Smart helmet, notification, accident, Arduino, location tracking.

I. INTRODUCTION

This paper represents a significant leap forward in the realm of road safety technology. This pioneering initiative endeavours to create an intelligent helmet system capable of promptly detecting accidents and initiating immediate notifications to emergency services. By integrating state-of-the-art sensors, GPS technology, and wireless communication, this system aims to revolutionize the traditional concept of motorcycle helmets, transforming them into life-saving devices that proactively safeguard riders. In recent years, the surge in vehicular traffic, coupled with the evolving dynamics of urbanization, has ushered in a new era of transportation challenges. Among these challenges, the alarming rate of road accidents. Especially involving motorcyclists, has emerged as a pressing concern globally. Conventional helmets, while serving as indispensable protective gear, have primarily operated within a passive sphere, devoid of mechanisms to detect accidents or trigger immediate assistance. This limitation in responsiveness exacerbates the impact of accidents, contributing to prolonged emergency response times and, subsequently, elevated risks to the lives of riders involved in road mishaps. The glaring need for a more proactive safety infrastructure capable of swiftly detecting accidents and summoning aid has underscored the urgency for innovative solutions. The "Smart Helmet based Accident Detection and Notification" embodies a synthesis of innovation, engineering, and human-centred design principles. By amalgamating state-of-the-art sensor technologies, sophisticated data processing mechanisms, and instantaneous communication interfaces, this project endeavours to transcend the conventional notion of helmets. It aspires to equip these safety staples with intelligence, transforming them into responsive entities that actively monitor for and respond to critical situations. At its essence, this project isn't solely about augmenting helmets with advanced technologies; it symbolizes a profound shift in how society perceives and implements safety measures. It envisions a future where technology seamlessly integrates with daily life, forging a protective shield around individuals engaged in high-risk activities, such as motorcycle riding. By leveraging innovation to augment safety measures, this paper propels the narrative toward a safer and more resilient ecosystem for riders traversing the roads.

Accidents are a major concern in India, with thousands occurring each year due to factors such as intoxicated driving, irresponsible conduct, and overspeeding. Tragically, these accidents often involve innocent people who bear the consequences despite not being at fault. Motorcyclists are particularly vulnerable, drawn to two-wheelers for their affordability and ease of use. However, these riders frequently suffer head injuries in crashes, highlighting the critical need for consistent helmet use. To address this, a system has been proposed that integrates the motorcycle with the rider's helmet. The primary objective is to encourage helmet usage and minimize accident risks. This concept involves a synchronization mechanism that links the helmet to the motorcycle. The vehicle will only start when the helmet is worn properly. Upon wearing the helmet, its internal components align with the motorcycle's system, allowing the engine to activate.

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Furthermore, an MQ-3 alcohol sensor is placed near the rider's mouth to detect the presence of alcohol in their breath. If any trace of alcohol is found, the motorcycle remains non-operational. This feature aims to prevent drunk driving and promote safer riding habits. The vehicle will only start once both helmet detection and alcohol checks are successfully passed, ensuring greater safety for the rider and others on the road.

The proposed system features a vibration sensor on the helmet to detect accidents. When an impact is sensed, the helmet's processor sends the GPS location and an alert message to a registered mobile number, enabling quick assistance for the injured rider. This technology-driven approach can greatly improve road safety in India. By ensuring helmet use, preventing drunk driving through alcohol detection, and enabling timely emergency response, the system aims to reduce motorcycle-related fatalities and promote safer travel.

II. ARDUINO IDE SOFTWARE

A software platform called the Arduino Integrated Development Environment (IDE) is used to programme Arduino microcontrollers. It makes authoring, creating, and uploading code to Arduino boards easier by offering an intuitive user interface. Code editing, syntax highlighting, and programme structure operations like setup() and loop() are all included in the IDE. It works with version control systems like Git, supports code modularization libraries, and has a Board Manager for choosing target boards. Cross-platform and multi-OS compatible, the Arduino IDE receives regular updates and enhancements from the vibrant Arduino community.

Arduino boards have digital pins that can be used for a variety of input and output functions. The output of these pins can be used to toggle between the HIGH (5V) and LOW (0V) states, controlling a variety of devices such motors, relays, and LEDs. Pulse Width Modulation (PWM) capable digital pins make it possible to simulate analogue signals, which makes jobs like dimming LEDs and regulating motor speed easier. In order for the Arduino to react to user inputs or changes in the environment, digital pins on the input side are essential for reading the states of switches, buttons, and digital sensors. Digital pins are essential for communication as well; they facilitate protocols like SPI and I2C in addition to serial communication. Furthermore, some digital pins can be set up to handle interrupts, which makes it possible to react quickly to outside events.

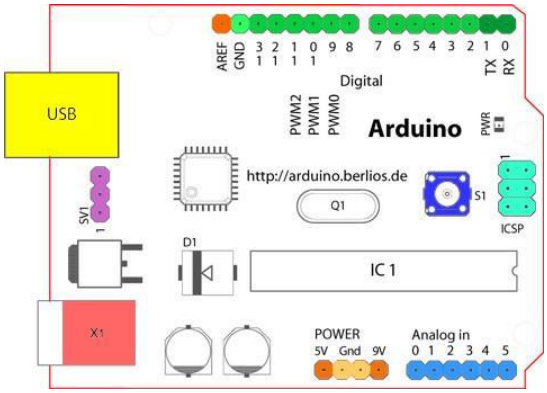

Fig: 1 Arduino board

- Analog Reference pin (orange)
- Digital Ground (light green)
- Digital Pins 0-1/Serial In/Out - TX/RX (dark green) - If serial communication (such as Serial.begin) is simultaneously being used, these pins cannot be used for digital i/o (digitalRead and digitalWrite).
- Digital Pins 2-13 (green).
- S1 is the reset button (dark blue)
- Blue-green In-circuit Serial Programmer
- Light blue analogue in pins 0 through 5.
- Ground and Power Pins (light orange for the grounds, orange for power)
- 9–12 VDC External Power Supply In - X1 in pink
- Adjusts USB and External Power (switch the jumper between the two pins that are nearest to the desired supply). - SV1 in purple
- USB (which may be used to charge the board and is used to upload sketches to the board and communicate serially with computers).

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III. A7672S SIMCOM 4G LTE MODEM 42

The A7672S is an LTE CAT 1 module that enables wireless communication across LTE-FDD, GSM, GPRS, and EDGE networks. It offers peak data rates of up to 10 Mbps for downloads and 5 Mbps for uploads. Featuring an LCC+LGA package, it maintains hardware compatibility with the SIM7000/SIM7070 series and 2G modules like SIM800A and SIM800F.

This module includes support for a wide range of network protocols and drivers for major operating systems, including USB drivers for Windows, Linux, and Android. Its software features and AT command set are fully aligned with those used in the SIM800 series. Additionally, the A7672S is equipped with BLE and GNSS functionality. Designed as a 4G LTE CAT 1 and 2G-capable modem, it supports automatic fallback to 2G when 4G connectivity is unavailable. It also allows communication via both USB and UART interfaces.

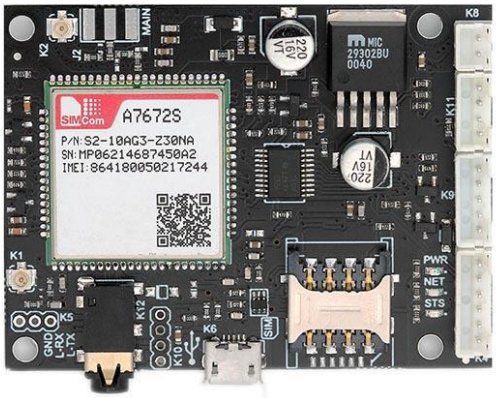

Fig: 2 SIMCOM 4G LTE MODEM

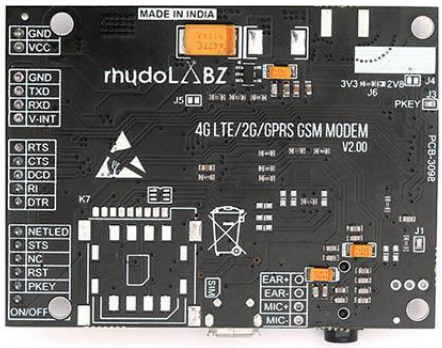

Fig: 3 4G/2G GSM module

The modem offers the option to include a PCB edge-mounted SMA connector for a 4G LTE antenna upon request. Additionally, a UFL connector is available for attaching an external high-gain 4G LTE antenna, if required. These antenna interfaces are designed with precision using RF-optimized PCB layouts and properly tuned impedance matching networks to ensure optimal signal strength and efficient RF power transmission.

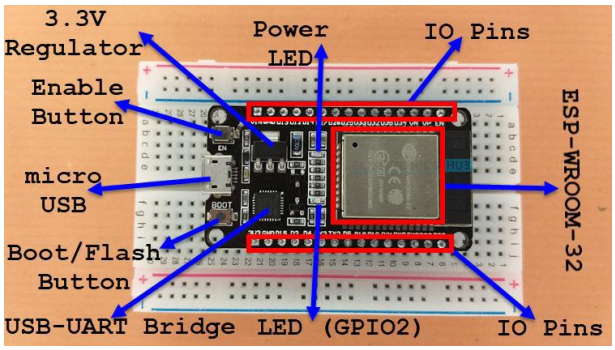

Fig: 4 ESP32 MICROCONTROLLER

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IV. CIRCUIT DIAGRAM AND PROGRAM

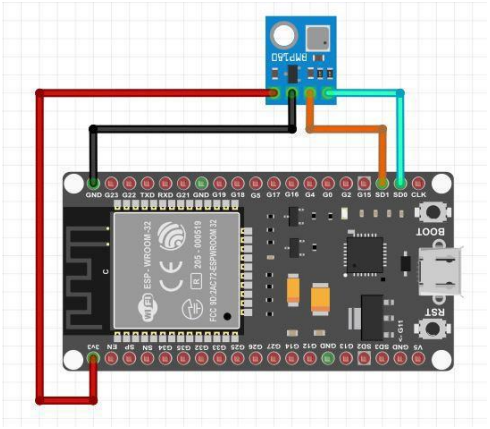

Fig: 5 Circuit Diagram

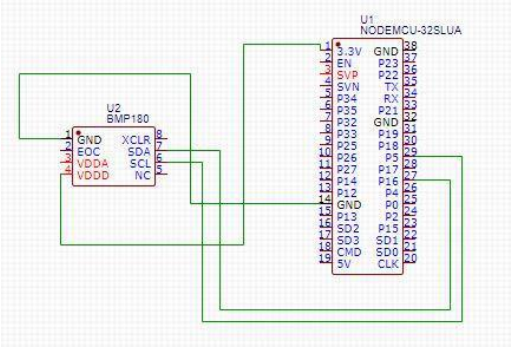

Fig: 6 Connection Diagram

V. HARDWARE MODELLING

There are two devices in this smart helmet project one is transmitter and other is receiver, and both of them transmit the data. A smart helmet is designed using Arduino with transmitter. The IR Sensor and microcontroller sensor are used in the detection of the helmet worn by the rider. The Arduino Nano is used as a microcontroller to control the components on the helmet. The A7672s simcom 4g lte modem, Esp32 microcontroller board and Pressure sensor is been used I this model.

Transmitter module transmit signal to the Arduino and then Arduino receives these signals, therefore Arduino known as Receiver. In transmitter there is an Antenna which is used to receive and send signals. In these, wires are connected between gnd-gnd, rxt-txt, txt-rxt. Arduino is connected to IC sensor and the battery is directly connected positively and negatively to the transmitter. When there is an emergency situation then there is one sim card connected to it. Then it transfers a signal to the sim card which is then connected to the mobile, which is connected to this helmet. It will receive an emergency message or call. And then farther steps will be taken.

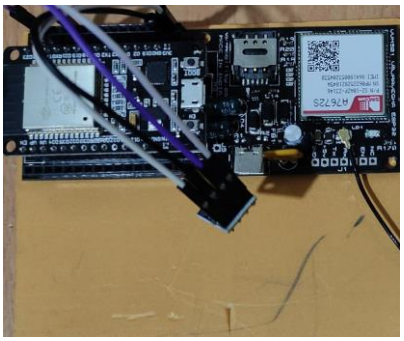

Fig: 7 SIMCOM MODEM

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In this design a A7672S simcom 4g ite modem is being because it is the latest and can run on the new sim cards .it has also been tested in this project with other modules but it is been observed that while other gsm sim module get 5 to 10 minutes to catch signal A7672s takes not more then a few seconds to catch network will send the signal to A767S simcom 4g to send massage to the riders emergency contacts. And the most important thing is pressure sensor because when the collation will occur it is the one which will detect the accident and send the massage to esp32 which will then do its job.

VI. CONCLUSION

The developed system efficiently ensures that the rider is safe throughout the ride. In case of an accident the rider can contact immediate medical help, vehicle theft can be detected and by sending lock message in this project belt we used pressure sensors to detect the pressure of collision

The future scope of smart helmets is promising, with potential applications in various fields. They could enhance safety for cyclists and motorcyclists through features like augmented reality displays, integrated communication systems, and real-time hazard alerts. In industrial settings, smart helmets could improve worker safety by providing vital information and monitoring for potential risks. As technology advances, we can expect further integration of sensors, AI, and connectivity, expanding the capabilities and usefulness of smart helmets in diverse domains.

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BIOGRAPHY

Manish Paul received the Master in Technology in Electrical Engineering from NIT Agartala in 2014 and a Ph.D. degree in Electrical Engineering department from NERIST, Arunachal Pradesh in 2024. He is currently a faculty with the Department of Electrical Engineering, ICFAI University, Tripura, India. His research interests include electric motor drives, wind energy conversion, control of doubly fed machines for variable speed applications, and reluctance machine. He can be contacted at email: manishpaul@iutripura.edu.in

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