Sensor-Based Safety Helmets: IoT Innovations for Crash Prevention and Rider Protection

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Abstract: The purpose of this project is to improve motorcycle safety through state-of-the-art IoT integrated smart helmets. Drivers must wear helmets to enable security features. As soon as an accident occurs, the system immediately recognizes the effect and sends an emergency response. SOS services, nearby emergency vehicles and up to 5 registered trustworthy people will be automatically alerted. The helmet provides security before unauthorized use, as it is not permitted to start the engine when the vehicle carries it. The application forces the helmet to counter the occurrence of a fatal injury. This security solution promotes proactive protection and ensures a rapid rescue process. Individual drivers benefit a lot as they ensure that someone is on the way to save themselves, even without a bystander to provide help.

1 INTRODUCTION

Motorcycle accidents, which account for a majority of serious injuries and deaths worldwide, are typically caused by slow emergency response and a lack of protective gear. In view of all these issues, this work will design smart helmets (Jesu doss A. et al. 2019. integrated with IoT for driver's safety. The helmet has sensors that react instantaneously to accidents and trigger automatic emergency responses. Immediately send alerts to SOS services, ambulances surrounding the setting of the collision, and up to five registered contacts of the victim to ensure instant access to medical assistance in an event of a road traffic accident. Such automated response systems can help mitigate injury and enhance survival odds. Another intelligent helmet capable of accident detection that does more than accident detection it's also management in the parts helmet and will not start the motorcycle machine. Due to its simplicity and efficiency, Yolo model is generally used for real-time object detection tasks. Unlike other methods that use complex pipelines or multiple machining stages, Yolo predicts class probabilities and bounding boxes directly from the entire image in a single forward pass through the network. Besides reducing computing efforts, this mode drives deeper real-time proficiencies. With each new publication.

This helps maintain that security protocols are provided 24/7 and reduces the risk of head injuries that can prove fatal. The GPS prosecution also gives responders the ability to pinpoint accurate scenes of the accident, resulting in even more efficient rescues. This system is particularly beneficial for individual drivers as it guarantees instant assistance even for the viewers. This smart helmet provides predictive security solutions to make your motorcycle trip safer by incorporating IoT technology.

2 LITERATURE STUDY

In the last few years the generation of smart IoT-based helmets has been an area of main attention in research. Jesu Doss et al. Smart Helmet to Avoid Accident (2019) that suggested using real-time monitoring systems to protect riders. Likewise, Mehata et al. developed an automated IoT-based helmet for monitoring safety and health for workers that included a data logging algorithm to monitor safety parameters at the site. In the field of transportation, Divyasudha et al. (IEEE) devised a smart IoT-enabled low-cost helmet that prevents accidents and increases emergency response. Due to various other innovations in smart helmet technology, Uniyal et al. researched and proposed an

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IoT-based system with a data logging mechanism where it can log the activities of the rider and environmental conditions.

Shabbeer and Meleet (2017) proposed smart helmet based on which the system can detect the accident and gives the alert message for providing help in emergencies. Roja and Srihari (2018) brought smart helmet applications to the mining industry by developing a helmet that monitors air quality, preventing exposure of workers to hazardous conditions. Similarly, Behr et al. (2016), focused on detecting hazardous events in mines to provide real time alerts to improve the safety of a worker. In addition to accident prevention and environmental surveillance, Chandran et al. revolves around Konnect, an IoT-enabled smart helmet specifically designed to sense and inform accidents so as to generate auto-alerts towards emergency services. Aree buddin and Manoj (2017) have also extended the smart helmets concept to beyond a single sensor for the safety of riders (Divyasudha N et al.) and real-time observation. Finally, Archana et al. engineered an overall safety comfort system integrating various cutting-edge elements to promote riders' full security. Collectively, these studies highlight the role of IoT technology in smart helmet design and provide solutions that enhance user safety through immediate emergency response, environmental awareness, and accident prevention.

3 METHODOLOGY

The methodology used to develop the IoT-integrated smart helmet system involves a thorough requirement analysis and planning stage that defines all the functional and non-functional requirements of the system from surveys, stakeholder consultations, and existing technology analysis. This is followed by the system design, which defines high-level requirements for hardware and software components. Hardware design focuses on the selection of (Divyasudha N et al.) sensors, including accelerometer, gyroscope and GPS, (Manish Uniyal et al.) integration of a microcontroller for processing data, (Shoeb Ahmed Shabbeer et al.) and implementation of a communication module (GSM or Bluetooth).

The software design includes algorithms for accident detection, an interface (application in app, web based) to interact with the users, and a cloud-based backend for security. It is also integrated with security features like RFID or biometric authentication to prevent unauthorized use. Then, after assembling the hardware components, writing firmware for the microcontroller, and integrating with the mobile application and cloud backend, a functional prototype is developed. The prototype is subjected to extensive testing and validation in simulated accident scenarios under different environmental conditions to verify performance, accuracy and reliability. The system is deployed when validated for real-world use, including partnerships to integrate it into motorcycle ignition systems and collaboration with emergency services to expedite SOS responses. It also trains users on how to use both the smart helmet and the accompanying app. After the deployment, the system enters an ongoing phase of monitoring and maintenance to handle false alarms, optimization of algorithms, and updates based on users' feedback and technology advancements. Finally, evaluating the impact of the project through data collection on accident detection rates, response times, and user satisfaction, and sharing findings to encourage the widespread adoption of the system (Shoeb Ahmed Shabbeer et al.). This approach is designed to result in a strong, dependable, and easy-to-use solution for preventing motorcycle accidents through preemptive protection and quick emergency response. Figure1 shows Smart Helmet Accident Detection and Alert System Architecture.

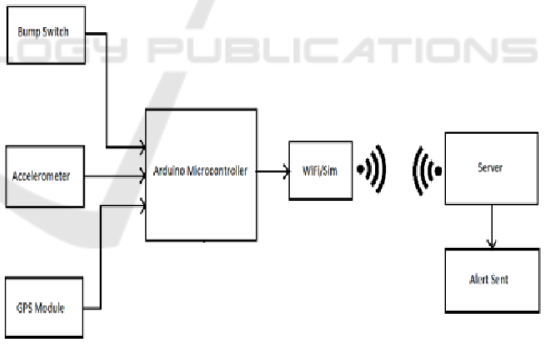

Figure 1: Smart Helmet Accident Detection and Alert System Architecture.

4 SYSTEM IMPLEMENTATIONS

4.1 Hardware Requirements

4.1.1 Arduino Uno – Main controller

Arduino uno is a microcontroller board of Electronics Project. It features 14 digital E/A pencils (6 PWM), 6 analog inputs, and a 16-MHz-ATMEGA328P chip It can use this to drive LEDs,

read sensors, iterate electrical engines, and create IoT devices. MikroC for PIC Microcontroller Programming. (Example: On pin 13, the LED will blink. Power supply through USB (5 V) or external (7°12 V). AT I2C, SPI or daisy-chain sensor to consult. Ideal for novices and experts alike. Figure 2 shows Arduino Uno. It is utilized for robotics, automation, and prototyping. 5- More than 500 mA shall not be drawn from the pin. Starting small projects and moving to complex ones.

Figure 2: Arduino Uno.

4.1.2 FSR

The FSR (force sensing resistor) is used to sense the physical pressure, squeezing. Their power consumption is less. They are used for most touch sensitive applications. They are low cost and less weight. This sensor (figure 3) is configured with the NodeMCU, then the data is being transmitted to the cloud.

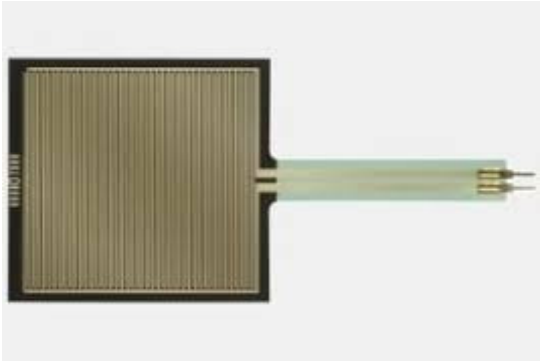

Figure 3: FSR sensor.

4.1.3 Vibrating Sensor

Vibrating sensor: The vibrating sensor (figure 4) is also known as a piezoelectric sensor, when a band of frequency created by the vibrating sensor based on vibration, it measures pressure, temperature, acceleration, force. Particularly it measures force and damped vibration.

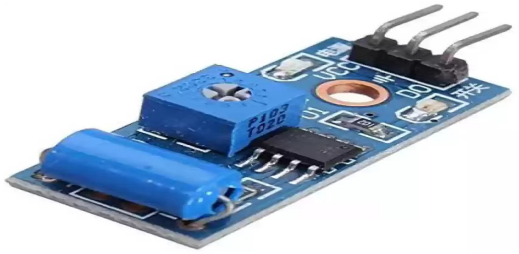

Figure 4: Vibrating Sensor.

4.2 Software Requirements

4.2.1 Arduino IDE

Arduino IDE is a free, open source software that is used to write, compile and upload code to an Arduino board. It is implemented by writing program in C/C++ language. Now we collect the errors and verify the code. Then upload the code to your Arduino board. Or you can also use a serial monitor to spy on the output and debug the program. You will have the option to import libraries to give your code even more functionality. Just select the correct board type and the corresponding port and you are good to go!

4.2.2 GSM Module

A GSM modem is a hardware device that enables you to send and receive data, SMS, and voice calls using a mobile phone connection. Connect GSM modem to your computer/device using a USB cable or serial connected. Install any required drivers and software. Set modem on your mobile network like APN, username, password, etc. Command to Send & Receive SMS, Voice Calls, and Data It also enables you to send and retrieve files, emails, and other data. GSM modems are used in remote monitoring, automation, and IoT projects. Ensure that your modem has an active SIM card and mobile phone signal

5 RESULT

IoT and intelligent helmets in the two-wheel safety system increase the safety of the driver in the event of an accident and avoid injury. Figure 5 shows End Module. The accident is detected by checking the comparison between the helmet binding and

predefined limits. The system sounds an alert or takes a security measure if the tilt corresponds to a fall in the helmet. Its innovative solution is based only on the driving's behavior and becomes a trusted and trusted security mechanism. Figure 6 and figure 7 shows Output interface.

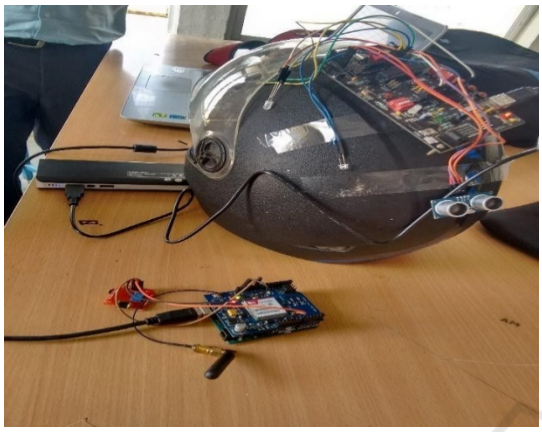

Figure 5: End Module.

Figure 6: Output interface.

Figure 7: Output Interface.

6 CONCLUSION & FUTURE ENHANCEMENT

To sum up, Two Wheel safety system is a remarkable innovation in driver safety project integrated into a smart helmet. The actual time data as well as the tilt value is used to determine if an accident has occurred, based on whether or not the helmet button passes the predefined threshold. You will write this to trigger immediate alerts or actions, so that you are notified quickly. You don't have to worry about carrying it if you are not driving or without using the service. The latest design also aims to minimize bike and motorcycle injuries and overall road safety. With advanced IoT technology along with some functional security features, this intelligent helmet system solution is not only an efficient way to avoid accidents but also acts as a safety net for the riders. This is a hopeful move towards making the streets safer and the risk of travelling on two wheels lower.

Future updates for the smart helmet system include AI analytics either to predict accidents through riders' behavior and which can be read by the helmet, avoiding potential accidents. Low-power sensors providing constant functioning can be motivated by solar charging or enhanced battery efficiency. Voice and gesture commands integration will allow hands-free operation of safety features for improved convenience. A self-locking safety helmet is another solution that can be integrated. When the rider wants to start the bike, this mechanism would be locked with the ignition system of the bike, and to start it, the rider must put on the helmet, enhancing safety and ensuring compliance. These capabilities will make the system more intelligent, more efficient and more user friendly.

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