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Wireless Safety Helmet for Electrical Site Workers

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***Abstract* - The Wireless Safety Helmet for Electrical Site Workers is a smart protective system designed to enhance safety and communication in hazardous electrical environments. Traditional helmets offer only physical protection, but this system integrates wireless communication and sensor-based monitoring to provide real-time safety alerts. The helmet is equipped with sensors to detect high voltage proximity, temperature rise, toxic gas presence, and accidental impacts or falls. These sensors continuously collect data, which is processed by a microcontroller and transmitted wirelessly using communication modules such as 433MHz RF module. When abnormal or dangerous conditions are detected, the system automatically triggers alerts or warning messages to the control unit or supervisor, enabling immediate response.**

Keywords: Wireless Safety System, Smart Helmet, Electrical Safety, Worker Protection, Wearable Technology, IoT-Based Safety, Embedded Systems, Sensor Integration.

I. INTRODUCTION

In the field of electrical engineering and construction, worker safety is a major concern. Electrical site workers are often exposed to hazardous environments that include high-voltage areas, falling objects, and limited communication. To address these challenges, the Wireless Safety Helmet has been developed as an intelligent protective device that enhances worker safety through real-time monitoring and communication.

A wireless safety helmet integrates sensors, microcontrollers, and wireless communication modules to continuously monitor the worker's environment and health conditions. The system can detect critical parameters such as temperature, voltage proximity, gas leakage, and impact (shock or fall detection). The data collected is transmitted wirelessly to a control station or supervisor's device using modules like MPU-6050, 433MHz RF module, NEO-6M module or Wi-Fi allowing immediate alerts in case of danger.

The helmet not only ensures personal protection but also enables real-time communication and tracking, helping supervisors monitor workers in remote or hazardous locations. If an abnormal condition is detected such as high voltage nearby, toxic gases, or a worker's fall an alarm or emergency message is automatically sent to prevent accidents and ensure quick rescue operations.

By combining traditional safety gear with modern wireless technology, the wireless safety helmet represents an important step toward smart industrial safety systems, improving the overall security, efficiency, and reliability of electrical work environments.

II. PROBLEM STATEMENT

Electrical site workers are frequently exposed to hazardous conditions such as high-voltage equipment, gas leaks, excessive heat, and accidental falls. Traditional safety helmets provide only mechanical protection against head injuries but fail to detect or communicate environmental hazards in real time. As a result, workers remain vulnerable to electric shocks, toxic gas exposure, and other accidents, which can lead to serious injuries or fatalities.

Furthermore, supervisors lack real-time information about workers' safety status or location, making it difficult to provide timely assistance during emergencies. There is a pressing need for a smart, wireless monitoring system that can continuously track environmental conditions, detect unsafe situations, and instantly alert both the worker and the control room.

Hence, the problem addressed in this project is the development of a wireless safety helmet.

III. OBJECTIVE OF PROJECT

The main objective of this project is to design and develop a smart wireless safety helmet that ensures the protection and real-time monitoring of electrical site workers operating in hazardous environments.

This helmet aims to detect electrical hazards, gas leaks, high temperatures, and accidental falls, and to transmit alerts wirelessly to a control room or supervisor for quick response.

By integrating sensor technology with wireless communication modules such as 433MHz RF module. The system enhances worker safety, accident prevention, and emergency communication in electrical worksites

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IV. BLOCK DIAGRAM

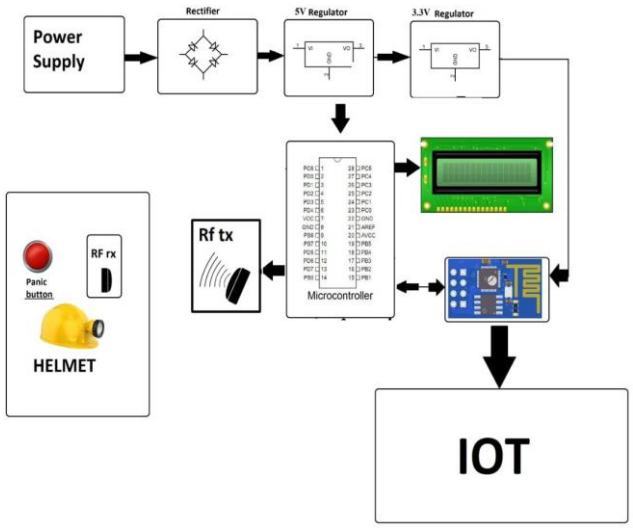


Figure 1: Block diagram

V. CIRCUIT DIAGRAM

This circuit is built around an Arduino Uno, which acts as the central controller. It receives input from multiple sensors, processes the data, and controls different output devices like a display, buzzer, LED, and relay.

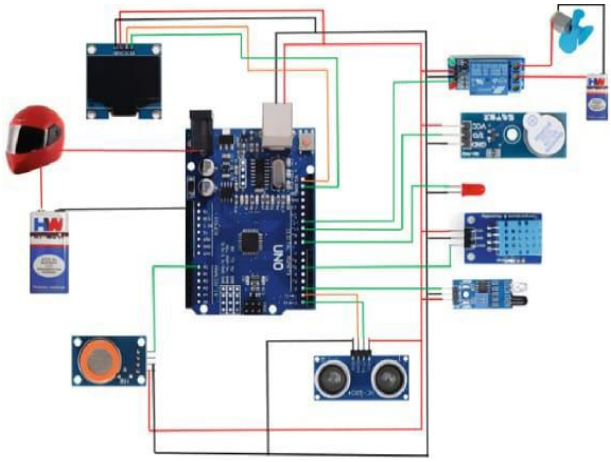


Figure 2: Circuit diagram

The system includes several sensors such as a temperature sensor (lm35), a gas sensor, a flame sensor, a sound sensor, and an ultrasonic sensor. These sensors monitor environmental conditions like heat, air quality, fire presence, noise, and distance.

An OLED display is connected to show real-time readings from the sensors, making it easy to monitor the system's status. The sensors send their data to the Arduino through signal wires, while power is supplied through VCC (red) and ground (black) connections.

For alerts and actions, the circuit uses a buzzer, LED, and a relay module. When any sensor detects abnormal conditions (like gas leakage or fire), the Arduino activates these outputs to warn the user or control external devices.

Overall, this is a multi-purpose safety and monitoring system that can be used in homes or industries to detect hazards and respond automatically.

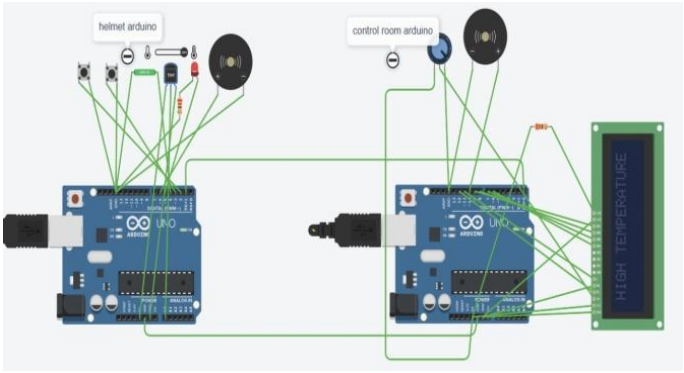
VI. CORE KNOWLEDGE

Tilt Sensors

A tilt sensor detects the angle or orientation of an object and is used in devices like phones and safety systems .A temperature sensor measures heat or cold and converts it into a readable signal. Tilt sensors help detect movement or position, while temperature sensors help control and monitor heat. Both are widely used in electronics, automation, and industrial applications.

GPS Module

The NEO-6M GPS module is a popular, compact, and affordable satellite positioning receiver designed by u-blox for navigation, velocity, and timing applications. It features a UART TTL interface, a built-in ceramic antenna, a backup battery for fast location locking, and supports up to 56 channels with high sensitivity for precise tracking.



433 MHz RF Module

A 433MHz RF module is a low-cost, short-range wireless communication pair consisting of a transmitter (MX-FS-03V) and receiver (MX-05V) operating on the 433MHz ISM band, commonly used with microcontrollers like Arduino. Using ASK (Amplitude Shift Keying), they transmit digital data over distances up to 30-100m, ideal for remote controls, security systems, and IoT sensors.

MPU-6050

The MPU-6050 is a popular 6-DOF (Degrees of Freedom) inertial measurement unit module, combining a 3-

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axis gyroscope and a 3-axis accelerometer on one chip, typically featuring 16-bit analog-to-digital converters and an I2C interface. It is widely used in Arduino, robotics, and drone projects (often named GY-521) for motion tracking, orientation detection, and stabilization.

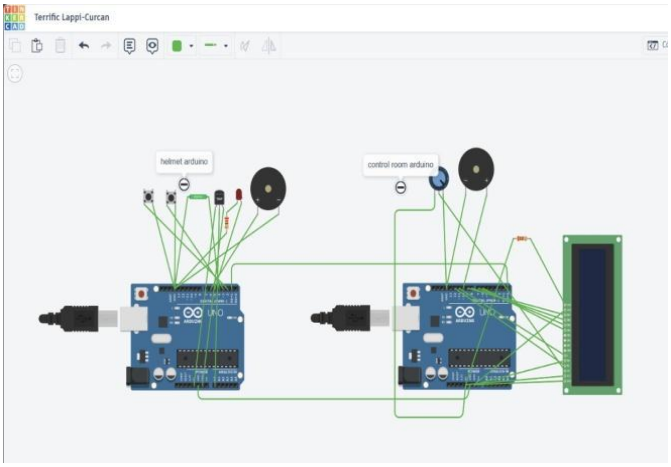
Arduino Uno

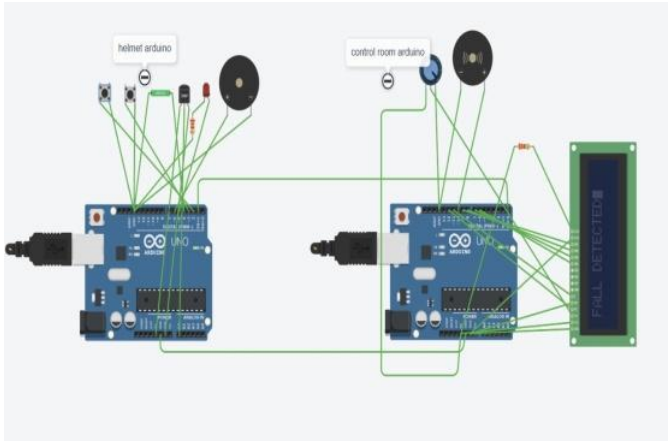
Arduino Uno is a popular microcontroller board designed for beginners in electronics and programming. It uses the Atmega328P chip, running at 16 MHz with 32KB flash memory to hold our code. Key features include 14 digital I/O pins (6 PWM-capable) and 6 analog inputs for connecting sensors and actuators.

VII. SIMULATION RESULTS

The Wireless Safety Helmet for Electrical Site Workers was successfully designed, fabricated, and tested to monitor various hazardous conditions at an electrical worksite.

During testing, the system effectively detected gas leakage, high temperature, voltage proximity, and fall incidents, and provided instant alerts to both the worker and the control unit through buzzer indication and wireless data transmission.





The 433MHz RF module wireless module maintained reliable communication between the helmet and the monitoring system within a range of 100-200 meters. The response time for hazard detection and alert transmission was found to be less than 2 seconds.

The prototype achieved an overall detection accuracy of about 95%, confirming the system's reliability in identifying and reporting unsafe conditions in real time.

Thus, the developed wireless safety helmet proves to be an effective and low-cost safety device that enhances worker protection, reduces accident response time, and enables supervisors to monitor worker safety remotely.

VIII. CONCLUSION

The project "Wireless Safety Helmet for Electrical Site Workers" has been successfully designed and implemented to enhance worker safety in hazardous electrical environments. The developed system effectively integrates multiple sensors for detecting gas leakage, high temperature, voltage proximity, and falls with a wireless communication module to provide real-time monitoring and alerting.

Testing results confirm that the helmet can accurately sense hazardous conditions and instantly transmit alerts to both the worker and the control unit. The average response time was observed to be less than 2 seconds, with an overall detection accuracy of about 95%, ensuring high reliability and timely warning.

The wireless safety helmet offers a cost-effective, portable, and practical solution for accident prevention on electrical sites. By improving situational awareness and reducing response time during emergencies, the system contributes significantly to worker protection and workplace safety management.

In conclusion, the project demonstrates how IoT and sensor-based smart technologies can be effectively utilized to prevent accidents and save lives in electrical and industrial work environments.

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