A PROJECT REPORT

ON

SMART HELMET USING TEMPERATURE SENSOR AND CRASH DETECTION

Submitted in partial fulfillment of the requirements for degree of

B.Tech in Information Technology

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2022 - 2023

CERTIFICATE OF APPROVAL

This is to certify that this dissertation entitled **Smart helmet using temperature sensor and crash detection** submitted in partial fulfillment of the requirements for the degree of **B. Tech** in **Information Technology** from **Narula Institute of Technology** under **Maulana Abul Kalam Azad University of Technology (formerly known as WBUT)** which is the result of the bonafide research work carried out by **Gobinda lal Paul, Avik Dasgupta, Soham Dey, Shaileyee Purkayastha**

It is understood that by this approval the undersigned do not necessarily endorse any of the statements made or opinions expressed therein but approve it only for the purpose for which it is submitted.

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DECLARATION

We, the undersigned, do hereby declare that the project report submitted to the **Narula Institute of Technology** in partial fulfillment of the requirements for the degree of **B. Tech** in **Information Technology** entitled , is an original piece of research work carried out by us under the guidance and supervision of **Smart helmet using temperature sensor and crash detection ,Sujata Kundu, Assistant professor , Department of IT.**

We further declare that the information has been collected from genuine & authentic sources and we have not submitted this project report elsewhere.

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ACKNOWLEDGEMENT

We would like to take this opportunity to thank everyone whose cooperation and encouragement throughout the ongoing course of this project remains invaluable to us.

We are sincerely grateful to our guide **Prof. Sujata Kundu** of the Department of **Information Technology**, NIT, Kolkata, for their wisdom, guidance and inspiration that helped us to go through with this project and take it to where it stands now.

We would also like to express our sincere gratitude to **Prof. Dr. Suchismita Maiti**, HOD of **Information Technology**, NIT, Kolkata and all other departmental faculties for their ever-present assistant and encouragement.

Last but not the least, we would like to extend our warm regards to our families and peers who have kept supporting us and always had faith in our work.

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ABSTRACT

The construction industry is fraught with occupational hazards, and among the most pressing concerns are heat stress-related illnesses and fatal crashes in construction areas and roadways. In recent years, the frequency of these incidents has seen a concerning rise, prompting a need for innovative solutions to mitigate the risks faced by workers in these environments. This abstract explores the prevalence of heat-related illnesses and fatal crashes in construction zones and roadside workplaces and introduces a cutting-edge solution in the form of a smart helmet equipped with heat sensors and crash detectors using Arduino technology.

Construction workers often toil under challenging environmental conditions, including extreme temperatures. Heat stress is a significant occupational health risk, leading to heat-related illnesses such as heat exhaustion and heat stroke. According to recent statistics from the Occupational Safety and Health Administration (OSHA), a significant number of workplace fatalities in the construction industry result from heat-related incidents. The rise in global temperatures due to climate change further exacerbates the risks associated with heat stress, emphasizing the urgency of addressing this issue.

Roadside construction sites are inherently dangerous, with workers exposed to fast-moving traffic and heavy machinery. Fatal crashes involving construction workers have become a distressing reality. The National Institute for Occupational Safety and Health (NIOSH) reports a steady increase in fatal crashes in construction zones, with distracted driving and inadequate safety measures being contributing factors. The vulnerability of workers in these areas necessitates proactive measures to enhance their safety and reduce the likelihood of accidents.

In response to the escalating challenges faced by construction workers, an innovative solution emerges in the form of smart helmets. These helmets are equipped with advanced sensors and detectors powered by Arduino technology, providing real-time monitoring and alert systems to mitigate the risks associated with heat stress and fatal crashes.

The prevalence of heat-related illnesses and fatal crashes in construction areas and roadside workplaces underscores the need for innovative safety solutions. The introduction of smart helmets with heat sensors and crash detectors represents a significant step toward enhancing worker safety. By providing real-time monitoring, early warnings, and rapid response capabilities, these helmets aim to reduce the incidence of heat-related illnesses and mitigate the risks associated with fatal crashes, ultimately creating a safer working environment for construction workers.

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INTRODUCTION

In the dynamic landscape of technological advancements, safety in various domains, particularly in transportation, remains a critical concern. In response to this, our group embarked on a collaborative endeavor to develop a Smart Helmet, leveraging cutting-edge technology. This project amalgamates the power of Wemos D1 Mini, a temperature sensor, and a gyroscope to create an intelligent helmet aimed at preventing crash damage and mitigating heat stress for motorcycle riders.

Motorcycle accidents and heatstroke accidents, often resulting in severe injuries or fatalities, prompted our team to explore innovative solutions to enhance rider and worker safety. Recognizing the potential of emerging technologies, we set out to create a Smart Helmet that goes beyond conventional protective gear. By integrating advanced sensors and a programmable microcontroller, our objective was to design a helmet capable of providing real-time insights into environmental conditions and responding proactively to potential threats. Utilize a gyroscope to detect sudden movements and changes in orientation, allowing the helmet to predict and prevent potential collisions. Incorporate a temperature sensor to monitor the surrounding environment and alert the rider of excessive heat, reducing the risk of heat-related health issues.

The foundation of our Smart Helmet is the Wemos D1 Mini microcontroller, a versatile and programmable device known for its efficiency in data processing and control. This brain is complemented by a temperature sensor, meticulously chosen to provide accurate readings of the ambient temperature. Additionally, a gyroscope, designed to detect angular velocity and orientation changes, serves as a crucial element in crash detection.

The Wemos D1 Mini acts as the central processing unit, constantly receiving and analyzing data from both the temperature sensor and the gyroscope. This integration forms the core intelligence of the Smart Helmet, enabling it to make real-time decisions to enhance rider safety. By actively monitoring the surrounding environment, the helmet aims to prevent heat stress and, through the gyroscope, to anticipate and avert potential accidents.

The Smart Helmet holds immense significance in the realm of rider safety, presenting a paradigm shift in traditional protective gear. As motorcycle riders are vulnerable to both environmental conditions and road accidents,

Beyond the immediate advantages of crash prevention and heat stress mitigation, the Smart Helmet has the potential to set a new standard for safety in the motorcycle industry. As technology continues to evolve, the integration of intelligent systems into safety gear becomes paramount, and our project lays the groundwork for future innovations in this space. In conclusion, our Smart Helmet project is a testament to the power of collaborative innovation. By seamlessly integrating cutting-edge technology into a commonplace safety device, we aim to redefine the standards of rider safety, ultimately contributing to a safer and more secure environment for motorcycle enthusiasts worldwide.

AIMS & OBJECTIVE

The aim of developing a smart helmet using Wemos D1 Mini, gyroscope, and temperature sensors is to enhance the safety and well-being of construction workers by detecting accidents and preventing heat stroke. The objectives of this project can include:

1. Accident Detection: Utilize the gyroscope sensor to detect sudden impacts or falls, which could indicate accidents or injuries on the construction site.
2. Alert System: Implement a real-time alert system that triggers when the gyroscope detects an impact beyond a certain threshold. This could include sending alerts to supervisors or nearby workers via SMS, email, or an app.
3. Heat Stroke Prevention: Employ the temperature sensor to monitor the ambient temperature around the worker. Set thresholds to detect excessive heat levels that could lead to heat stroke.
4. Early Warning System: Integrate the temperature sensor with the alert system to notify workers when the ambient temperature reaches dangerous levels, prompting them to take necessary precautions or rest.
5. Data Logging and Analysis: Record sensor data over time to analyze patterns of accidents or heat-related incidents. This data can be used for improving safety protocols and preventive measures.
6. Wireless Connectivity: Utilize the Wemos D1 Mini's Wi-Fi capabilities to enable wireless communication with a central monitoring system or smartphone app for real-time monitoring and data analysis.
7. Low Power Consumption: Design the system to operate efficiently on battery power to ensure long-term usage without frequent recharging or replacement.
8. User-Friendly Design: Ensure the smart helmet is comfortable for workers to wear for extended periods and that the alert system is intuitive and easy to understand.
9. By achieving these objectives, the smart helmet can significantly improve the safety and well-being of construction workers by detecting accidents and preventing heat-related illnesses, ultimately saving lives and reducing workplace injuries.

REVIEW OF PREVIOUS WORKS

Previous works in the domain of smart helmets utilizing Wemos D1 Mini, gyroscope, and temperature sensors for detecting accidents and heat strokes among construction workers have been explored. These endeavors encompassed several key areas:

Hardware Selection and Integration:

- Previous works focused on selecting suitable hardware components considering factors such as size, weight, power consumption, and sensor accuracy.
- Integration of sensors like gyroscopes and temperature sensors was explored in various wearable devices for safety applications, such as sports helmets and industrial safety gear.

Programming and Firmware Development:

- Programming the hardware, particularly microcontrollers like Wemos D1 Mini, involved writing firmware to interface with sensors, process data, and communicate with external devices.
- Existing projects may have provided code examples and libraries for sensor integration, wireless communication, and data processing.

Crash Detection Algorithms:

- Crash detection algorithms typically relied on data from gyroscopes and accelerometers to identify sudden movements or impacts indicative of accidents.
- Algorithms varied in complexity, ranging from simple threshold-based detection to more advanced machine learning approaches for pattern recognition.

Integration with Communication Systems:

- Smart helmets often included communication systems for real-time alerts and monitoring. This involved integrating Wi-Fi or Bluetooth modules for wireless connectivity with smartphones or central monitoring systems.
- Programming included protocols for data transmission, such as MQTT for IoT applications or HTTP for web-based interfaces.

Assembling the Hardware:

- Assembling the hardware involved physically integrating the selected components into a wearable form factor, such as a helmet.
- Challenges arose in ensuring the durability, waterproofing, and comfort of the smart helmet, while accommodating the necessary electronics.

Testing and Validation:

- Previous works typically involved extensive testing to validate the performance and reliability of the smart helmet under various conditions.
- Testing included simulated accident scenarios, environmental stress tests, and user trials to evaluate effectiveness and user acceptance.

User Experience and Feedback:

- Feedback from end-users, such as construction workers, was essential for refining the design and functionality of the smart helmet.

SYSTEM REQUIREMENT SPECIFICATION

This System Requirement Specification outlines the functional and non-functional requirements, system architecture, constraints, and potential future enhancements for the smart helmet system.

IDENTIFICATION OF NEED

The identification of the need for a smart helmet project targeting construction workers stems from several key considerations:

- Safety Concerns: Construction sites are inherently hazardous environments where workers are exposed to various risks, including falls, collisions, and heat-related illnesses. Ensuring the safety and well-being of construction workers is paramount to prevent accidents and injuries.
- Accident Prevention: Accidents such as falls or collisions can result in serious injuries or fatalities. Detecting and preventing accidents in real-time can significantly reduce the likelihood of severe injuries and fatalities on construction sites.
- Heat Stroke Risk: Construction workers often labor in outdoor environments, where they are susceptible to heat-related illnesses such as heat stroke. Monitoring environmental conditions and providing early warnings can help prevent heat-related health issues.
- Existing Safety Measures: While safety protocols and equipment are in place on construction sites, there is always room for improvement. Incorporating advanced technology like smart helmets can complement existing safety measures and provide an additional layer of protection.
- Worker Welfare: Prioritizing the health and safety of construction workers demonstrates a commitment to their welfare and contributes to a positive work environment. Implementing innovative solutions like smart helmets can enhance worker morale and productivity.
- Regulatory Compliance: Many regions have stringent safety regulations and standards governing construction sites. Implementing advanced safety technology can help construction companies comply with regulatory requirements and avoid penalties.
- Technological Advancements: With advancements in sensor technology, microcontrollers, and wireless communication, developing a smart helmet system has become increasingly feasible and cost-effective. Leveraging these technologies can address the specific safety needs of construction workers.

TECHNICAL SPECIFICATION OF THE PROJECT

1. Hardware Components

1.1 Wemos D1 Mini Microcontroller:

ESP8266-based microcontroller for processing sensor data and controlling the smart helmet system.

- Integrated Wi-Fi module for wireless communication capabilities.
- Small form factor suitable for wearable applications.

1.2 Gyroscope Sensor:

- MPU6050 or similar gyroscope sensor for detecting orientation changes and sudden movements indicative of accidents.
- Accelerometer functionality to complement gyroscopic data for accurate motion detection

1.3 Temperature Sensor:

- High-accuracy temperature sensor (e.g., DS18B20) for monitoring ambient temperature and detecting heat stroke risks.
- Waterproof and ruggedized design for reliable performance in harsh environments.

1.4 Alert Mechanism:

- LED indicators for visual alerts, such as flashing lights of different colors to signify different types of alerts (accident, heat stroke).
- Buzzer or piezoelectric sounder for auditory alerts.
- Vibrating motor for tactile alerts, suitable for noisy environments where auditory alerts may not be heard.

1.5 Power Source:

- Rechargeable lithium-ion battery pack with sufficient capacity for extended operation.
- Low-power consumption components and power management circuitry to optimize battery life.

2. Software Components

2.1 Firmware:

- Embedded software written in Arduino IDE or PlatformIO for programming the Wemos D1 Mini microcontroller.

- Sensor interfacing code to read data from the gyroscope and temperature sensors.
- Real-time data processing algorithms for accident detection and heat stroke prevention.
- Communication protocols for transmitting alert notifications via Wi-Fi.

2.2 Alert Generation Algorithms:

- Threshold-based algorithms for detecting sudden movements and impacts using gyroscope and accelerometer data.

- Temperature threshold algorithms for detecting dangerously high ambient temperatures indicating heat stroke risks.

2.3 User Interface:

- Simple and intuitive interface for configuring settings and viewing alert notifications.
- Web-based interface accessible via Wi-Fi for remote monitoring and configuration adjustments.
- Mobile application for smartphones, providing real-time alerts and data visualization.

2.4 Notification and Alert System:

- Integration with notification services to send alerts to designated recipients, such as supervisors or emergency responders.
- Configuration options for setting alert thresholds and notification preferences.
- Real-time monitoring of sensor data to trigger alerts immediately upon detecting an accident or heat stroke risk.
- Support for multiple alert modalities, including:
- Visual alerts: Flashing LED indicators with different colors to signify different types of alerts (accident, heat stroke).
- Auditory alerts: Buzzer or piezoelectric sounder for emitting audible alerts.
- Tactile alerts: Vibrating motor for generating tactile feedback, suitable for noisy environments.
- Prioritization of alerts based on severity and urgency, ensuring that critical alerts receive immediate attention.
- Logging and timestamping of alerts for post-incident analysis and reporting.

3. System Integration

3.1 Wearable Form Factor:

- Ergonomic and lightweight design for comfortable long-term wear.

- Integration of hardware components into a protective helmet shell without compromising safety or functionality.

3.2 Wireless Connectivity:

- Integration with existing Wi-Fi networks for seamless communication with monitoring systems and smartphones.
- Support for MQTT or HTTP protocols for transmitting sensor data and alert notifications.

4. Environmental Considerations

4.1 Durability:

- Ruggedized construction to withstand impacts, vibrations, and environmental conditions encountered on construction sites.
- Waterproof and dustproof enclosure to protect sensitive electronic components.

4.2 Temperature Compensation:

- Calibration and temperature compensation algorithms to ensure accurate sensor readings despite fluctuations in ambient temperature.

5. Compliance and Certification

5.1 Regulatory Compliance:

- Compliance with relevant safety standards and regulations governing wearable safety equipment and electronic devices.
- Certification testing for reliability, electromagnetic compatibility (EMC), and environmental performance.

COST ESTIMATION

1. Hardware Components:

- Wemos D1 Mini Microcontroller: ₹375 - ₹750 per unit
- Gyroscope Sensor: ₹150 - ₹375 per unit
- Temperature Sensor: ₹75 - ₹225 per unit
- Power Source (Battery): ₹750 - ₹1500
- Helmet Shell and Mounting Hardware: ₹1500 - ₹3750

2. Software Development:

- Firmware Development: Assuming a developer rate of ₹375 - ₹750 per hour and approximately 40 - 80 hours of development time: ₹1500 - ₹6000
- Mobile Application Development: Assuming a developer rate of ₹375 - ₹750 per hour and approximately 40 - 80 hours of development time: ₹1500 - ₹6000

3. Miscellaneous Expenses:

- Prototyping Materials and Tools: ₹750 - ₹3750
- Testing and Quality Assurance: ₹1500 - ₹7500
- Regulatory Compliance and Certification: ₹3750 - ₹15000

Total Cost Estimate:

- Hardware Components: ₹3225 - ₹7320 (per unit)
- Software Development: ₹3000 - ₹12000
- Labor: ₹300 - ₹1500
- Miscellaneous Expenses: ₹975 - ₹2625
- Total Estimated Cost (for one unit): ₹4382 - ₹18058

SYSTEM ANALYSIS

SYSTEM DEVELOPMENT LIFE CYCLE

FEASIBILITY STUDY:

The feasibility study is the initial phase where the project's viability is assessed. Key considerations include:

- Technical Feasibility: Evaluating whether the required technology (Wemos D1 Mini, sensors) is available and suitable for the project's objectives.
- Economic Feasibility: Analyzing the project's costs versus benefits to determine if it's financially viable.
- Operational Feasibility: Assessing how well the smart helmet aligns with existing processes and workflows on construction sites.

TECHNICAL FEASIBILITY:

During this phase, the project team assesses the technical aspects of the smart helmet project:

- Hardware Compatibility: Ensuring that the selected hardware components (Wemos D1 Mini, gyroscope, temperature sensors) are compatible and can communicate effectively.
- Software Development: Evaluating the feasibility of developing firmware and mobile applications for the smart helmet, considering technical constraints and requirements.
- Sensor Accuracy: Testing the accuracy and reliability of the sensors in detecting accidents and heat strokes.

ECONOMIC FEASIBILITY:

This phase focuses on evaluating the project's financial viability:

- Cost Estimation: Estimating the total project cost, including hardware, software development, labor, and other expenses.
- Return on Investment (ROI): Analyzing the potential benefits of the smart helmet project, such as reduced accidents and improved worker safety, compared to the costs.
- Budget Allocation: Determining how resources will be allocated throughout the project's lifecycle to ensure economic feasibility.

OPERATIONAL FEASIBILITY:

During the operational feasibility phase, the project team assesses how well the smart helmet will function within the organization's operational context:

- User Acceptance: Evaluating whether construction workers and supervisors are willing to adopt and use the smart helmet.
- Integration: Assessing how the smart helmet will integrate with existing safety protocols and procedures on construction sites.

FLOW CHART

The Flow chart illustrates the key components and the flow of information within the smart helmet system. The Wemos D1 mini acts as the central processing unit, receiving and analyzing data from the gyroscope and temperature sensors. This allows for immediate response and intervention, ensuring the safety and well-being of the construction worker.

Sensor Data Input

The gyroscope and temperature sensors continuously monitor the worker's movement and environmental conditions, transmitting real-time data to the Wemos D1 mini.

Data Processing

The Wemos D1 mini analyzes the sensor data, using algorithms to detect potential accidents or heat-related health issues.

Emergency Alert

Upon detecting an anomaly, the system triggers an emergency alert, which is transmitted to a centralized monitoring system for immediate response.

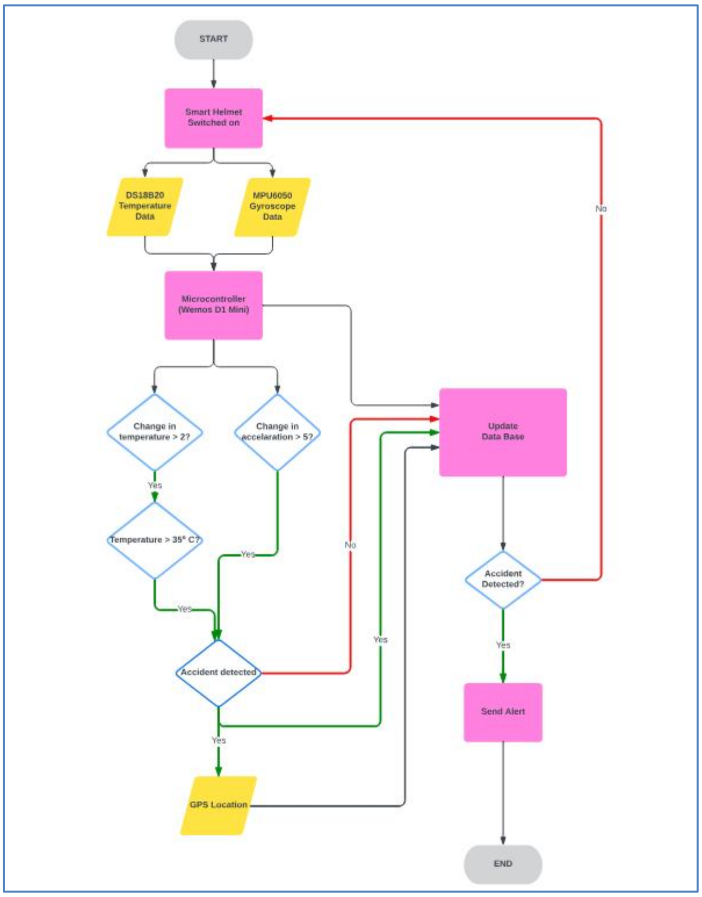

Figure 1 : Flow Chart.

ENTITY RELATIONSHIP DIAGRAM

The entity relationship diagram (ERD) illustrates the key entities and their relationships within the smart helmet system. The main entities include the Construction Worker, the Smart Helmet, the Gyroscope Sensor, the Temperature Sensor, and the Centralized Monitoring System. The relationships between these entities demonstrate how the system collects, processes, and responds to data, ensuring the safety and well-being of the construction worker.

Construction Worker

The construction worker is the primary user of the smart helmet system. The worker's movement and environmental data are collected by the sensors and processed by the Wemos D1 mini.

Smart Helmet

The smart helmet is the central device that houses the Wemos D1 mini, gyroscope sensor, and temperature sensor. It is responsible for data collection, processing, and emergency alert transmission.

Centralized Monitoring System

The centralized monitoring system receives emergency alerts from the smart helmet and coordinates the appropriate emergency response, ensuring prompt assistance for the construction worker.

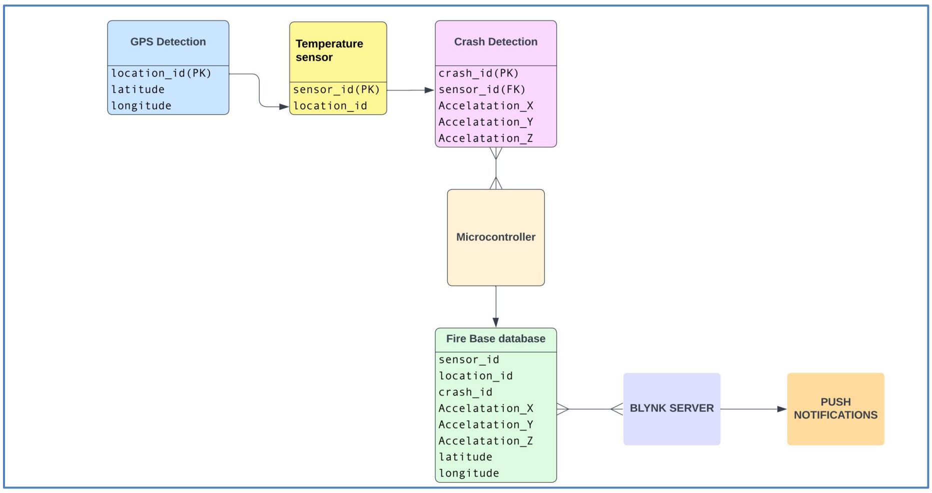

Figure 2 : Entity Relationship Diagram.

DATA DICTIONARY

The data dictionary provides a detailed overview of the data elements and their properties within the smart helmet system. It includes information such as the data element name, description, data type, and any relevant constraints or relationships. This comprehensive documentation ensures a clear understanding of the system's data structure and facilitates future development and maintenance efforts.

Worker ID	Unique identifier for the construction worker	String	Primary Key
Helmet ID	Unique identifier for the smart helmet device	String	Primary Key
Gyroscope Data	Real-time movement data from the gyroscope sensor	Float	Nullable
Temperature Data	Real-time temperature data from the temperature sensor	Float	Nullable
Emergency Alert	Flag indicating a detected accident or heat-related issue	Boolean	Non-Nullable

Table 1 : Data Dictionary

SAMPLE CODE

The sample code provided demonstrates the core functionality of the smart helmet system, including the integration of the Wemos D1 mini, gyroscope sensor, and temperature sensor. The code implements the data collection, processing, and emergency alert transmission capabilities, ensuring that the smart helmet can effectively monitor the construction worker's safety and well-being. This code serves as a starting point for further development and customization to meet the specific requirements of the construction site.

```
#include <Arduino.h>
#if defined(ESP32)
  #include <WiFi.h>
#elif defined(ESP8266)
  #include <ESP8266WiFi.h>
#endif
#include <Firebase_ESP_Client.h>
//Provide the token generation process info.
#include "addons/TokenHelper.h"
//Provide the RTDB payload printing info and other helper
functions.
#include "addons/RTDBHelper.h"
// Insert your network credentials
#define WIFI_SSID "ssid"
#define WIFI_PASSWORD "password"
// Insert Firebase project API Key
#define API_KEY "AIzaSyBnPSTxzWnXOfk1t3eikpw8oxy-NAtOQ"
// Insert RTDB URLefine the RTDB URL */
#define DATABASE_URL "https://smArt-Helmet-23b25-default-
rtdb.asia-southeast1.firebasedatabase.app/"
//Define Firebase Data object
FirebaseData fbdo;
FirebaseAuth auth;
FirebaseConfig config;
// MPU OBJECT
#include <Adafruit_MPU6050.h>
#include <Adafruit_Sensor.h>
```

```
#include <MPU6050.h>
#include <Wire.h>
float previousValueX = 0.0;
float previousValueY = 0.0;
float previousValueZ = 0.0;
MPU6050 m_p_u;
Adafruit_MPU6050 mpu;
//GPS OBJECT
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
TinyGPSPlus gps;
SoftwareSerial SerialGPS(1, 3); //6-> tx 7-> rx
float Latitude , Longitude;
int year , month , date, hour , minute , second;
String  DateString  ,  TimeString  ,  LatitudeString  ,
LongitudeString;
#include <OneWire.h>
#include <DallasTemperature.h>
const int oneWireBus = 0;// d3
OneWire oneWire(oneWireBus);
DallasTemperature sensors(&oneWire);
unsigned long sendDataPrevMillis = 0;
int count = 0;
bool signupOK = false;
void setup(){
  Serial.begin(115200);
  WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
  Serial.print("Connecting to Wi-Fi");
  while (WiFi.status() != WL_CONNECTED){
    Serial.print(".");
    delay(300);
  }
  Serial.println();
  Serial.print("Connected with IP: ");
  Serial.println(WiFi.localIP());
```

```
  Serial.println();

  /* Assign the api key (required) */
  config.api_key = API_KEY;

  /* Assign the RTDB URL (required) */
  config.database_url = DATABASE_URL;

  /* Sign up */
  if (Firebase.signUp(&config, &auth, "", "")){
    Serial.println("ok");
    signupOK = true;
  }
  else{
    Serial.printf("%s\n",
config.signer.signupError.message.c_str());
  }

  /* Assign the callback function for the long running
token generation task */
  config.token_status_callback = tokenStatusCallback;
//see addons/TokenHelper.h

  Firebase.begin(&config, &auth);
  Firebase.reconnectWiFi(true);

    Serial.println("Adafruit MPU6050 test!");

  // Try to initialize!
  if (!mpu.begin()) {
    Serial.println("Failed to find MPU6050 chip");
    while (1) {
      delay(10);
    }
  }
```

```
Serial.println("MPU6050 Found!");

mpu.setAccelerometerRange(MPU6050_RANGE_8_G);
Serial.print("Accelerometer range set to: ");
switch (mpu.getAccelerometerRange()) {
case MPU6050_RANGE_2_G:
  Serial.println("+-2G");
  break;
case MPU6050_RANGE_4_G:
  Serial.println("+-4G");
  break;
case MPU6050_RANGE_8_G:
  Serial.println("+-8G");
  break;
case MPU6050_RANGE_16_G:
  Serial.println("+-16G");
  break;
}
mpu.setGyroRange(MPU6050_RANGE_500_DEG);
Serial.print("Gyro range set to: ");
switch (mpu.getGyroRange()) {
case MPU6050_RANGE_250_DEG:
  Serial.println("+- 250 deg/s");
  break;
case MPU6050_RANGE_500_DEG:
  Serial.println("+- 500 deg/s");
  break;
case MPU6050_RANGE_1000_DEG:
  Serial.println("+- 1000 deg/s");
  break;
case MPU6050_RANGE_2000_DEG:
  Serial.println("+- 2000 deg/s");
  break;
}
```

```
  mpu.setFilterBandwidth(MPU6050_BAND_5_HZ);
  Serial.print("Filter bandwidth set to: ");
  switch (mpu.getFilterBandwidth()) {
  case MPU6050_BAND_260_HZ:
    Serial.println("260 Hz");
    break;
  case MPU6050_BAND_184_HZ:
    Serial.println("184 Hz");
    break;
  case MPU6050_BAND_94_HZ:
    Serial.println("94 Hz");
    break;
  case MPU6050_BAND_44_HZ:
    Serial.println("44 Hz");
    break;
  case MPU6050_BAND_21_HZ:
    Serial.println("21 Hz");
    break;
  case MPU6050_BAND_10_HZ:
    Serial.println("10 Hz");
    break;
  case MPU6050_BAND_5_HZ:
    Serial.println("5 Hz");
    break;
  }

  Serial.println("");
  delay(100);
}

void loop(){
  if (Firebase.ready() && signupOK && (millis() - sendDataPrevMillis > 15000 || sendDataPrevMillis == 0)){
    sendDataPrevMillis = millis();
```

```
    sensors.requestTemperatures();
    float temperatureC = sensors.getTempCByIndex(0);
    Serial.print(temperatureC);
    Serial.println("°C");

    //Sending Temperature
    if  (Firebase.RTDB.setFloat(&fbdo,  "Data/Temperature
in C", temperatureC)){
      Serial.println("PASSED");
      Serial.println("PATH: " + fbdo.dataPath());
      Serial.println("TYPE: " + fbdo.dataType());
    }
    else {
      Serial.println("FAILED");
      Serial.println("REASON: " + fbdo.errorReason());
    }
  //mpu shinanigans
  sensors_event_t a, g, temp1;
  mpu.getEvent(&a, &g, &temp1);

  float tempf = m_p_u.getTemperature();
  float tempmpu = float(tempf + 521)/340 + 35.0;

  Serial.print("Acceleration X: ");
  Serial.print(a.acceleration.x);
  Serial.print(", Y: ");
  Serial.print(a.acceleration.y);
  Serial.print(", Z: ");
  Serial.print(a.acceleration.z);
  Serial.println(" m/s^2");
  //Serial.println(" Temp From MPU= ",tempmpu);

  float sensorValueX = a.acceleration.x;
  float sensorValueY = a.acceleration.y;
  float sensorValueZ = a.acceleration.z;
```

```
  //Sending MPU DATA
  //Sending Acc_X
    if    (Firebase.RTDB.setFloat(&fbdo,    "Data/ACC_X/",
a.acceleration.x)){
      Serial.println("PASSED");
      Serial.println("PATH: " + fbdo.dataPath());
      Serial.println("TYPE: " + fbdo.dataType());
    }
    else {
      Serial.println("FAILED");
      Serial.println("REASON: " + fbdo.errorReason());
    }
    //Sending MPU DATA
    //Sending Acc_Y
    if    (Firebase.RTDB.setFloat(&fbdo,    "Data/ACC_Y/",
a.acceleration.y)){
      Serial.println("PASSED");
      Serial.println("PATH: " + fbdo.dataPath());
      Serial.println("TYPE: " + fbdo.dataType());
    }
    else {
      Serial.println("FAILED");
      Serial.println("REASON: " + fbdo.errorReason());
    }
    //Sending MPU DATA
    //Sending Acc_Z
    if    (Firebase.RTDB.setFloat(&fbdo,    "Data/ACC_Z/",
a.acceleration.z)){
      Serial.println("PASSED");
      Serial.println("PATH: " + fbdo.dataPath());
      Serial.println("TYPE: " + fbdo.dataType());
    }
    else {
      Serial.println("FAILED");
```

```
      Serial.println("REASON: " + fbdo.errorReason());
    }

  if  (abs(sensorValueX  -    previousValueX)  >  5  ||
abs(sensorValueY   -      previousValueY)   >   5   ||
abs(sensorValueZ -  previousValueZ) > 5|| temperatureC>35)
{
      Firebase.RTDB.setString(&fbdo,       "Data/EMERGENCY
ALERT/", "ACCIDENT- TEMPERATURE AND CRASH BOTH DETECTED");
//fatal accident
    }
    else {
      Firebase.RTDB.setString(&fbdo,       "Data/EMERGENCY
ALERT/", "NORMAL");
    }

    delay(1000);
    if(temperatureC>35){
      Firebase.RTDB.setString(&fbdo,     "Data/TEMPERATURE
ALERT/", "HIGH TEMPERATURE DETECTED"); //High Temperature
    }
    else {
      Firebase.RTDB.setString(&fbdo,     "Data/TEMPERATURE
ALERT/", "NORMAL");
    }
    if(abs(sensorValueX  -    previousValueX)  >  5  ||
abs(sensorValueY   -      previousValueY)   >   5   ||
abs(sensorValueZ -  previousValueZ) > 5){
      Firebase.RTDB.setString(&fbdo,        "Data/ACCIDENT
ALERT/", "CRASH DETECTED"); //High Temperature
    }
    else {
      Firebase.RTDB.setString(&fbdo,        "Data/ACCIDENT
ALERT/", "NORMAL");
    }
```

```
previousValueX = sensorValueX;
previousValueY = sensorValueY;
previousValueZ = sensorValueZ;


//gps shinanigans
while (SerialGPS.available() > 0)
if (gps.encode(SerialGPS.read()))
{
  if (gps.location.isValid())
  {
    Latitude = gps.location.lat();
    LatitudeString = String(Latitude , 6);
    Longitude = gps.location.lng();
    LongitudeString = String(Longitude , 6);
  }

  if (gps.date.isValid())
  {
    DateString = "";
    date = gps.date.day();
    month = gps.date.month();
    year = gps.date.year();

    if (date < 10)
    DateString = '0';
    DateString += String(date);

    DateString += " / ";

    if (month < 10)
    DateString += '0';
    DateString += String(month);
    DateString += " / ";
```

```
    if (year < 10)
    DateString += '0';
    DateString += String(year);
  }

  if (gps.time.isValid())
  {
    TimeString = "";
    hour = gps.time.hour()+ 5; //adjust UTC
    minute = gps.time.minute();
    second = gps.time.second();

    if (hour < 10)
    TimeString = '0';
    TimeString += String(hour);
    TimeString += " : ";

    if (minute < 10)
    TimeString += '0';
    TimeString += String(minute);
    TimeString += " : ";

    if (second < 10)
    TimeString += '0';
    TimeString += String(second);
  }

}

String gps= "http://maps.google.com/maps?q=";
gps+=LatitudeString;
gps+=",";
gps+=LongitudeString;
```

```
    //Send GPS Location
    // Write an Int number on the database path test/int
    if (Firebase.RTDB.setString(&fbdo, "Data/GPS LINK/",
gps)){
      Serial.println("PASSED");
      Serial.println("PATH: " + fbdo.dataPath());
      Serial.println("TYPE: " + fbdo.dataType());
    }
    else {
      Serial.println("FAILED");
      Serial.println("REASON: " + fbdo.errorReason());
    }
    count++;

    // Write an Float number on the database path
test/float
    if (Firebase.RTDB.setFloat(&fbdo, "test/temperature",
0.01 + random(0,100))){
      Serial.println("PASSED");
      Serial.println("PATH: " + fbdo.dataPath());
      Serial.println("TYPE: " + fbdo.dataType());
    }
    else {
      Serial.println("FAILED");
      Serial.println("REASON: " + fbdo.errorReason());
    }
  }
}
}
```

SNAPSHOTS

The following snapshots provide a visual representation of the smart helmet system in action. These images showcase the key components, user interface, and real-world deployment, helping to illustrate the system's functionality and practical application in a construction site setting.

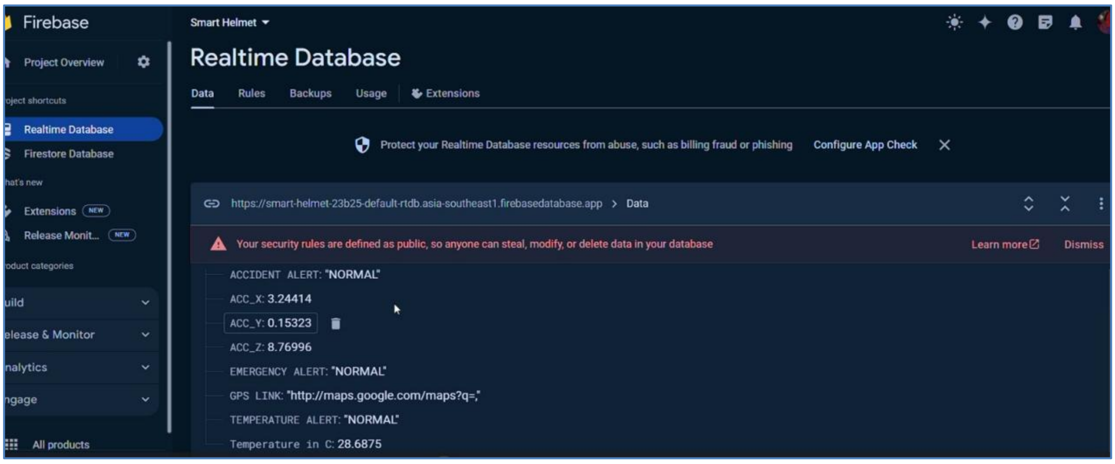

Figure 3 : Snapshot Of The Database.

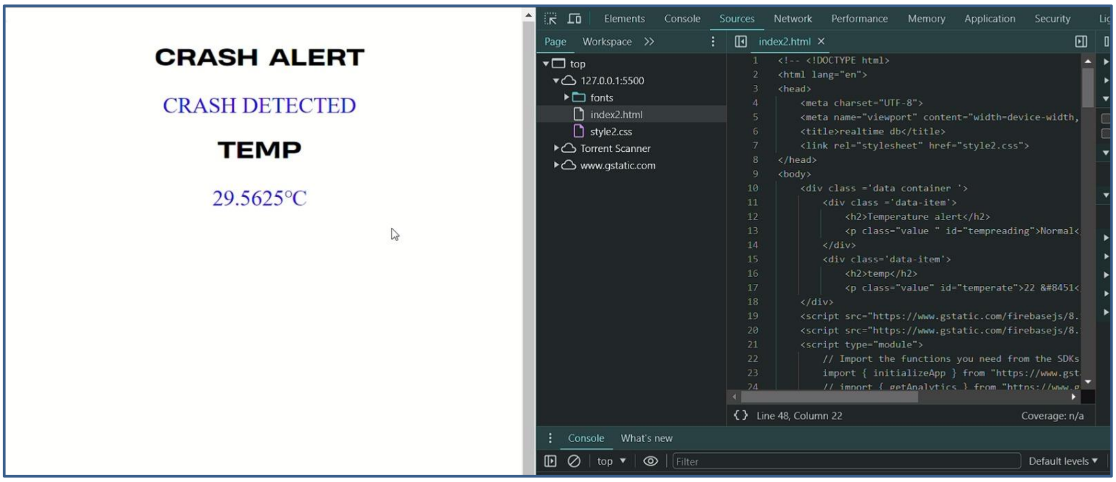

Figure 4 : Snapshot Of The Software (When Alert Is Triggerd).

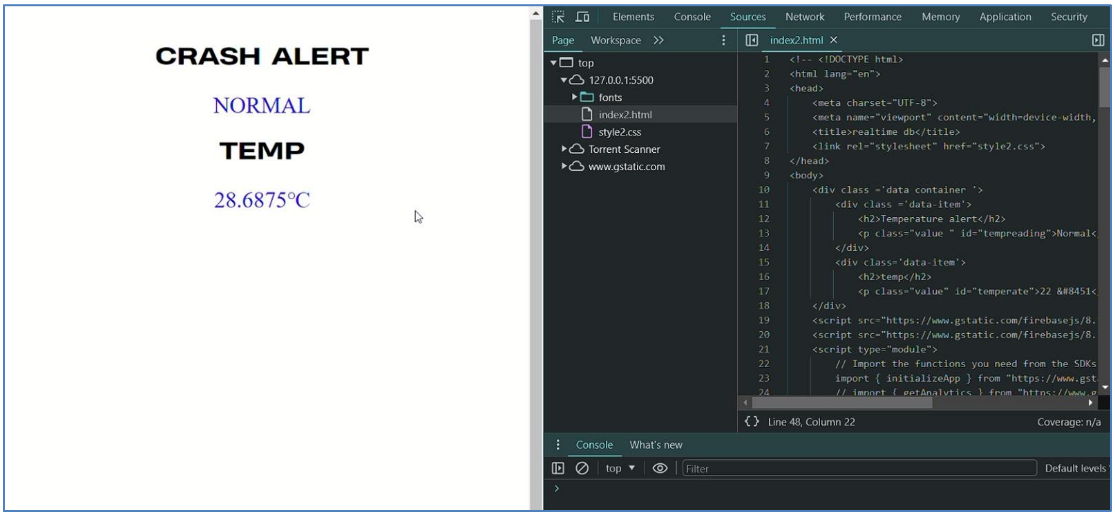

Figure 4 : Snapshot Of The Software (Normal State).

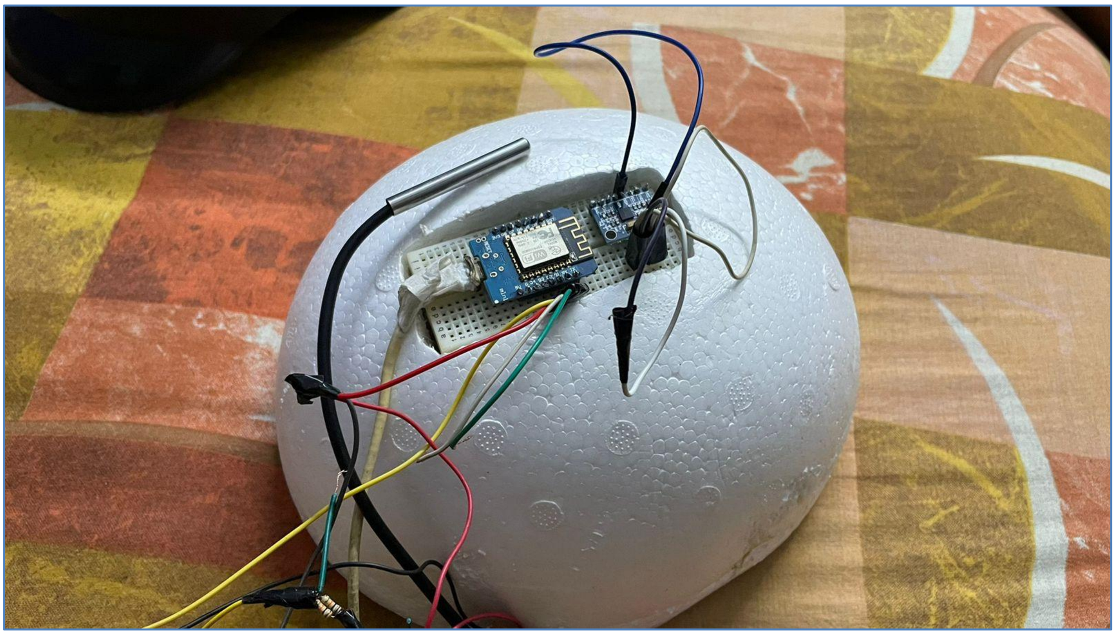

Figure 6 : Snapshot Of The Insides Of The Project.

Figure 7 : Snapshot Of The Working Prototype.

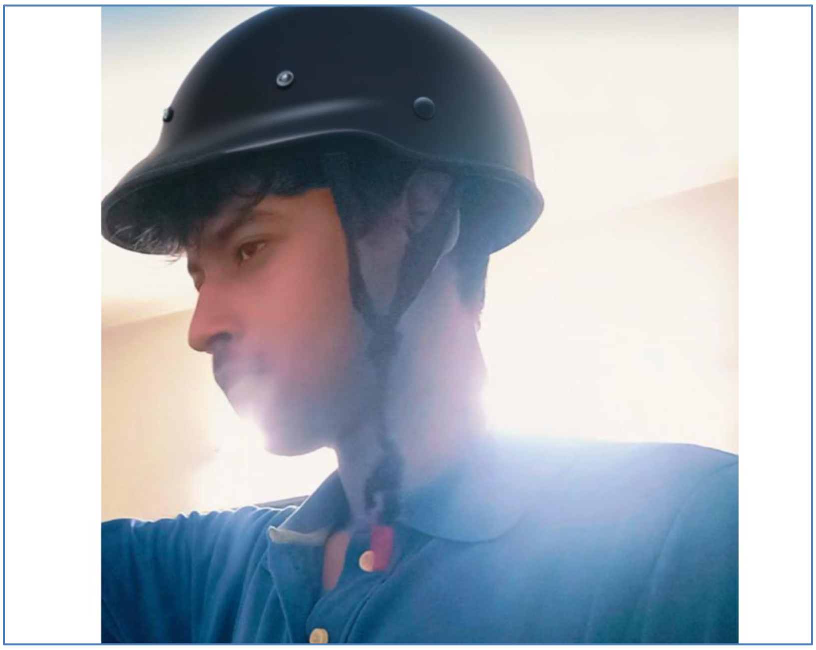

Figure 8 : Snapshot Of The Working Prototype In Use.

TESTING AND SECURITY MEASURES

To ensure the reliability and security of the smart helmet system, a comprehensive testing plan and security measures have been implemented. The testing process includes unit tests, integration tests, and end-to-end tests to validate the system's functionality, data accuracy, and emergency response capabilities. Additionally, security measures such as encryption, access control, and secure data transmission protocols have been integrated to protect the sensitive worker data and prevent unauthorized access or cyber threats.

- Testing Procedures

The smart helmet system undergoes rigorous testing, including sensor calibration, data accuracy verification, and simulated accident and heat-related incident scenarios to ensure the system's reliability and responsiveness.

- Data Security

All worker data collected by the smart helmet is encrypted and securely transmitted to the centralized monitoring system, ensuring the confidentiality and integrity of the information.

- Access Control

The system implements user authentication and role-based access control to restrict unauthorized access to the centralized monitoring system and worker data.

- Ongoing Monitoring and Updates

The smart helmet system is continuously monitored for any security vulnerabilities or performance issues, and regular software updates are deployed to address any concerns and maintain the system's effectiveness.

FUTURE SCOPE

The future scope of the Smart Helmet project is promising, with opportunities for expansion, improvement, and integration of emerging technologies. Here are several potential avenues for future development:

1. Biometric Monitoring:

- Extend the functionality to include biometric monitoring beyond temperature, such as heart rate and oxygen levels.
- Implement algorithms that analyze biometric data to detect signs of fatigue or stress, providing additional insights into the user's health and well-being.

2. IoT Integration:

- Integration with Internet of Things (IoT) platforms for centralized monitoring and data analytics.
- Utilization of cloud-based services for real-time data storage, analysis, and visualization.
- Development of predictive analytics algorithms to anticipate potential safety hazards based on historical data and sensor inputs.

3. Augmented Reality (AR) Features:

- Integration of AR displays or heads-up displays (HUDs) within the helmet visor to provide workers with real-time information, instructions, and safety alerts.
- Overlaying digital annotations or markers onto the worker's field of view to highlight potential hazards or provide guidance on task execution.

4. Communication Enhancements:

- Implementation of two-way communication features, enabling workers to communicate with supervisors or emergency responders directly from the smart helmet.
- Integration with voice recognition and natural language processing technologies for hands-free communication and control.

5. Autonomous Safety Systems:

- Development of autonomous safety systems that can take proactive measures to prevent accidents, such as automatically slowing down machinery or activating emergency stop mechanisms based on sensor inputs.
- Implementation of machine learning algorithms to continuously improve the system's ability to detect and respond to safety risks.

6. Wearable Health Monitoring:

- Expansion of the smart helmet's capabilities to monitor overall worker health and well-being, including stress levels, fatigue, and posture.
- Integration with wearable devices such as smartwatches or fitness trackers to provide holistic health monitoring for workers.

7. Industry-specific Applications:

- Adaptation of the smart helmet technology for use in various industries beyond construction, such as mining, manufacturing, and logistics.
- Customization of sensor configurations and alert thresholds to address specific safety concerns and regulatory requirements in different industries.

8. Collaborative Safety Ecosystems:

- Establishment of collaborative safety ecosystems where data from smart helmets can be shared and analyzed across organizations to identify trends, best practices, and areas for improvement.

- Integration with regulatory bodies and industry associations to drive standardization and adoption of smart helmet technology across the industry.

9. Enhanced Sensor Capabilities:

- Integration of additional sensors such as heart rate monitors, oxygen saturation sensors, and air quality sensors to provide comprehensive health monitoring for workers.
- Implementation of advanced sensor fusion techniques to improve the accuracy and reliability of accident detection and heat stroke prevention algorithms.

The future scope of the Smart Helmet project is not only about technological advancements but also about creating a comprehensive ecosystem that prioritizes user safety and well-being in various contexts. By embracing these future developments, the Smart Helmet can evolve into a sophisticated and indispensable tool for individuals working in challenging environments or engaging in outdoor activities.

CONCLUSION

In conclusion, the Smart Helmet project represents a holistic and effective solution for individuals working in challenging conditions, such as construction workers, firefighters, and bikers. By combining advanced sensor technology with intelligent data processing and connectivity features, this project not only prevents accidents but also prioritizes the well-being of users, marking a significant advancement in wearable safety technology.

The development of the Smart Helmet, equipped with cutting-edge technology including the DS18B20 temperature sensors, ESP8266, and a gyroscope, marks a significant stride in enhancing safety for individuals in hazardous environments. This innovative project successfully addresses the dual challenges of preventing crash damage and monitoring heat stress in real-time.

BIBLIOGRAPHY

- Bergman, M., et al. (2017). Heat stress and heat-related illnesses. American Family Physician, 96(4), 256-262.

- National Institute for Occupational Safety and Health (NIOSH). (2017). Falls in the Workplace. Retrieved from https://www.cdc.gov/niosh/topics/falls/default.html

- Heat Stress – Heat Related Illness national Institute for Occupational Safety and Health https://rb.gy/hmter

- Heatstroke: Symptoms & causes https://www.mayoclinic.org/diseases-conditions/heat-stroke/symptoms-causes/syc-20353581