Project Report on

EMERGENCY SAFETY VEST

Submission to THE ROBOTICS CLUB - SNIST as a part of INDUCTION'24

TEAM NO - 06

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SREENIDHI INSTITUTE OF SCIENCE AND TECHNOLOGY

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2024

CERTIFICATE

This is the project work titled '**EMERGENCY SAFETY VEST'** by 'Pranav Kumar, Nagalakshmi Jhanavi, N. Megnana, Rothithvinayak, D.Nithin,Ginka Varshith, Dhanasari Ambadi, Dharani, J. Annop, Naga Gopi Krishna' under the mentorship of '**B. Sujana , Tanmay**' and is a record of the project work carried out by them during the year 2023-2024 as part of INDUCTION under the guidance and supervision of

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Faculty Advisor
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DECLARATION

The project work reported in the present thesis titled **"EMERGENCY SAFETY VEST"** is a record work done by Team 04 in **THE ROBOTICS CLUB** as a part of **INDUCTION-2024.**

No part of the thesis is copied from books/ journals/ Internet and wherever the portion is taken, the same has been duly referred in the text. The report is based on the project work done entirely by TEAM 06 and not copied from any other source.

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ACKNOWLEDGMENT

This project report is the outcome of the efforts of many people who have driven our passion to explore into implementation of **EMERGENCY SAFETY VEST.** We have received great guidance, encouragement and support from them and have learned a lot because of their willingness to share their knowledge and experience.

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We thank our technical heads "**Mr.G. Kovidh Addhish & Mr. Aarushraj Puducherry"** for being with us till the end of the project completion.

We thank all the members of **Steering Body**, **Executive Body, Technical Advisory Board, Club's Incubation and Competence Committee** of **The Robotics Club** for helping us with crucial parts of the project. We are deeply indebted to **Mr. N V V S Narayana –** The President, **Ms. Mugala Shravani-** The Vice President and **Ms Maliha –** SAB Chairman and **Mr. N Abhinav** – General Secretary **THE ROBOTICS CLUB** respectively and also every other person who spared their valuable time without any hesitation whenever we wanted.

We also thank our faculty advisor **Dr. A. PURUSHOTHAM**, Professor, Mechanical Department, who encouraged us during this project by rendering his help when needed.

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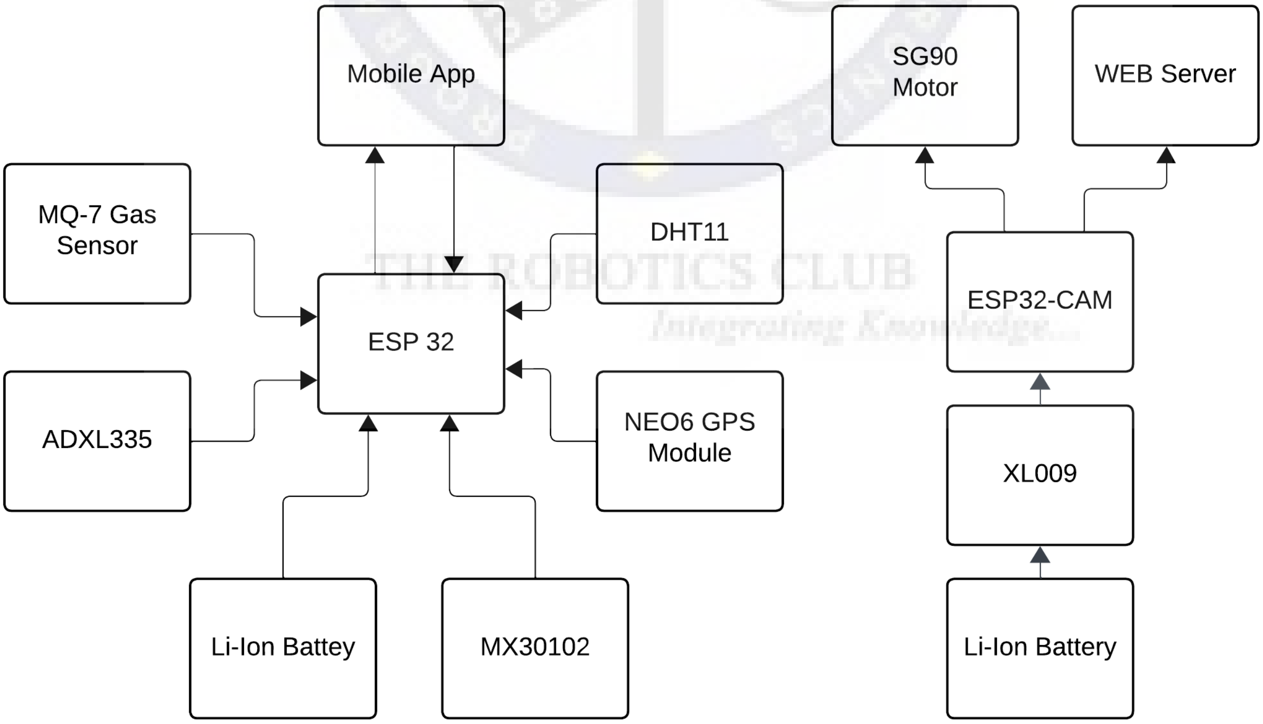
THE PROBLEM:

During emergency situations like natural disaster emergency personnel must worry about their safety as well as the person they are trying to aid or rescue. However, the current methods to monitor the Emergency responder are insufficient, we might not be able to know about the responder's location or vitals when they are busy helping people

TEAM'S APPROACH TO SOLVE THE PROBLEM:

Emergency safety vest is a combination of vest and a helmet, it is used to check all vital parameters of their responder in real-time. It can measure heart rate, temperature, SpO2, the wearer's location and presence of harmful gas. We will be using MAX30102 sensor as it can monitor both hearth rate as well as SpO2.These sensors are on a vest controlled by an ESP32 and this data is sent to Blynk App. If any serious changes occurs or the personnel is lost, we can track its location using the same. The Vest has a second part i.e. the helmet it will have a ESP-32 CAM module attached at top of it, It will also be able to rotate using SG90 servo motors. This is used to monitor the surrounding of the responder.

BLOCK DIAGRAM:



Emergency Safety Vest

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June 22, 2024

Abstract

During emergency situations like natural disaster emergency personnel must worry about their safety as well as the person they are trying to aid or rescue. However, the current methods to monitor the Emergency responder are insufficient, we might not be able to know about the responder's location or vitals when they are busy helping people. Emergency safety vest is a combination of vest and a helmet, it is used to check all vital parameters of their responder in real-time. It can measure heart rate, temperature, SpO2, the wearer's location and presence of harmful gas. We will be using MAX30102 sensor as it can monitor both hearth rate as well as SpO2.These sensors are on a vest controlled by an ESP32 and this data is sent to Blynk App. If any serious changes occurs or the personnel is lost, we can track its location using the same. The Vest has a second part i.e. the helmet it will have a ESP-32 CAM module attached at top of it, It will also be able to rotate using SG90 servo motors. This is used to monitor the surrounding of the responder..

1 Introduction

During emergencies like natural disasters, emergency personnel need to ensure their own safety while helping others. Current methods to monitor responders are inadequate, often leaving us without crucial information about their location or vital signs during critical moments.

To address this, we have developed the Emergency Safety Vest. This innovative gear combines a vest and a helmet to monitor vital parameters of responders in real-time. The vest can measure heart rate, body temperature, blood oxygen levels (SpO2), location, and the presence of harmful gases using the MAX30102 sensor and other devices, all managed by an ESP32 microcontroller. This data is sent to the Blynk App for real-time tracking and alerts.

The helmet is equipped with an ESP-32 CAM module and rotating SG90 servo motors to monitor the responder's surroundings. This comprehensive system enhances the safety and efficiency of emergency personnel during critical operations.

1.1 Existing System

Smart safety vest by Germen bionic is used for people working in warehouse, it used for calculating workers time spent in different location as well as trcak their activity, It has a comfertable design genreallly used in large ware houses where its hard to keep track of workers.

1.2 Proposed System

The proposed system for the vest leverages the ESP32 microcontroller, renowned for its compactness and versatility, alongside the ESP32 CAM module, which features an integrated camera, ensuring the overall system remains streamlined. To provide environmental awareness of the wearer's location, the system incorporates a pan-tilt module capable of rotating 180 degrees both up and down, controlled by an SG90 servo motor. This setup allows for comprehensive monitoring of the surroundings. The vest is further equipped with a suite of sensors to monitor the wearer's health and environmental conditions. The DHT11 sensor measures temperature and humidity, while the ADXL335 sensor captures acceleration data, particularly in the Y direction. For precise location tracking, the NEO 6M GPS module provides accurate latitude and longitude coordinates. Additionally, the MAX30102 sensor is integrated to monitor heart rate and pulse rate, ensuring the wearer's vital signs are continuously tracked. By combining these components, the proposed system aims to deliver a robust solution for real-time health and environmental monitoring, enhancing the safety and well-being of the wearer.

2 Architecture

2.1 Hardware

2.1.1 ESP32

The ESP32 is a versatile Wi-Fi and Bluetooth module that's popular for IoT projects. It has a powerful dual-core processor, which allows it to handle complex tasks smoothly. With support for Wi-Fi (802.11 b/g/n) and Bluetooth (including BLE), it can connect to networks and communicate with other devices. It's packed with integrated features like touch sensors and ADCs, making it ideal for various applications from home automation to industrial IoT. The ESP32 is easy to program using platforms like Arduino and MicroPython, and it's known for its low power consumption, which is great for battery-operated devices. Overall, it's a cost-effective choice with strong community support, making it accessible for both beginners and experienced developers alike.

Figure 1: EPS32

2.1.2 SG90 Servo motors

The SG90 is a popular and affordable micro servo motor commonly used in hobby electronics and robotics projects. It is lightweight and compact, making it ideal for small-scale applications. The SG90 can rotate approximately 180 degrees (90 degrees in each direction) and is controlled by sending a PWM (pulse width modulation) signal from a microcontroller, such as an Arduino. It features plastic gears, operates on 4.8 to 6 volts, and provides a torque of around 1.8 kg/cm. This servo is widely used for its reliability and ease of use in tasks like moving arms, steering wheels, or controlling other small mechanical components.

Figure 2: SG90 Servo Motor

2.1.3 XL6009

The XL6009 is a DC-DC Step-up boost converter module which can boost the voltage from 5V to 35V range. The module has a trimpot to adjust the desired output voltage. This module can take an input voltage of between 5 and 32V DC and converts it to an output voltage between 5 and 35V DC.It is A non-isolated step-up (boost) voltage converter featuring adjustable output voltage and high efficiency. Input Current: 4A (max), no-load 18mA (5V input, 8V output, no-load is less than 18mA.

Figure 3: XL6009

2.1.4 MQ-7 Gas Sensor

The MQ-7 gas sensor is a device used to detect carbon monoxide (CO) gas in the air. It's important because CO is a colorless and odorless gas that can be harmful in high concentrations. The sensor works by measuring changes in its resistance when CO gas comes into contact with its surface. These changes are converted into a voltage signal that can be read by a microcontroller or similar device. This sensor is commonly used in home carbon monoxide detectors, industrial safety systems, and automotive applications to alert users to dangerous levels of CO.

Figure 4: MQ-7 Gas Sensor

2.1.5 ADXL335

The ADXL335 is a small, low-power, three-axis accelerometer sensor manufactured by Analog Devices. It's designed to measure acceleration in three perpendicular axes: X, Y, and Z. This sensor is widely used in various applications where motion detection, tilt sensing, and vibration monitoring are essential. The ADXL335 outputs analog voltages corresponding to the acceleration along each axis, which can be read by a microcontroller or ADC (Analog-to-Digital Converter).

Figure 5: ADXL335

2.1.6 DHT11

The DHT11 is a basic and affordable digital temperature and humidity sensor widely used in DIY electronics and IoT projects. It consists of a capacitive humidity sensor and a thermistor for accurate measurements. The sensor communicates with a microcontroller through a single-wire digital interface, making it easy to integrate into various projects without needing complex wiring.

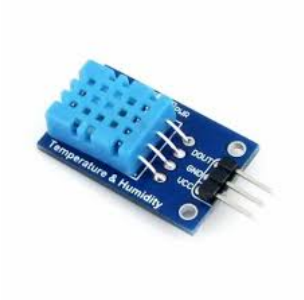

Figure 6: DHT11

2.1.7 ESP32-Cam

The ESP32-CAM is a versatile development board that combines the ESP32 microcontroller with a camera module.It comes with an OV2640 camera and provides onboard TF card slot. The ESP32-CAM is widely used for projects involving video streaming, image capture, and home security applications, making it a valuable tool in the realm of embedded systems and the Internet of Things (IoT).

Figure 7: ESP32-Cam

2.1.8 NE0-6 GPS

The NEO-6 GPS module is a small device that helps determine your exact location anywhere on Earth. It works by receiving signals from satellites in space, then using those signals to calculate your latitude, longitude, and altitude. This information is useful for navigation, tracking, and timing applications. The module communicates with other devices like microcontrollers through a simple interface, allowing it to be easily integrated into projects such as GPS trackers, drones, or even location-based games. Overall, the NEO-6 GPS module is affordable, accurate. .

Figure 8: NEO-6 GPS

2.1.9 LI-ion batteries

A lithium-ion or Li-ion battery is a type of rechargeable battery which uses the reversible reduction of lithium ions to store energy. The anode (negative electrode) of a conventional lithium-ion cell is typically graphite made from carbon. The cathode (positive electrode) is typically a metal oxide. The electrolyte is typically a lithium salt in an organic solvent.

Figure 9: LI - ion batteries

2.1.10 MAX30102

The MAX30102 is an integrated pulse oximetry and heart-rate monitor biosensor module. It includes internal LEDs, photodetectors, optical elements, and low-noise electronics with ambient light rejection. The MAX30102 provides a complete system solution to ease the design-in process for mobile and wearable devices.

Figure 10: MAX30102

2.1.11 Pan tilt brackets

Pan tilt brackets a mechanical mounting solution used to allow a device, such as a camera or a sensor, to move and rotate along two axes: the horizontal axis and the vertical axis. These servo motor mounting bracket are commonly used in robotics, surveillance systems, camera stabilizers.

Figure 11: Pan tilt bracket

2.1.12 Bread Board

A breadboard, solderless breadboard, or protoboard is a construction base used to build semi-permanent prototypes of electronic circuits. Unlike a perfboard or stripboard, breadboards do not require soldering or destruction of tracks and are hence reusable.

Figure 12:

2.1.13 Safety helmet

Safety helmet or Hard Hats are designed to protect the head against falling objects and the side of the head, eyes, and neck from any untoward impacts, bumps, scrapes, and electrical exposure, etc..

Figure 13: Safety helmet

2.1.14 Safety vest

A safety vest is constructed out of reflective material and typically come in a slew of bright colors. Worn most commonly by road flaggers, construction crews and emergency personnel, the function of safety vests is to help alert people that another human is present in their field of vision.

Figure 14: Safety vest

2.1.15 Jumper Wires

A jumper wire is an electrical wire or group of wires used to connect circuits without soldering. They have connectors or pins at their ends. Depending upon the configuration of end connectors, they are classified into three types: male-to-male, male-to-female and female-to-female.

Figure 15: Jumper Wires

2.2 Software

2.2.1 Arduino IDE

Arduino Integrated Development Environment is an open-source application software created by Arduino. It is used to write and upload code on to the Arduino boards. It supports C and C++ programming languages, and has a built-in compiler. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics.

You can compile your code within the IDE to check for errors and then upload the compiled program (known as a sketch) to the connected Arduino board. The IDE handles the compilation and uploading process seamlessly.

Figure 16: Arduino IDE

2.2.2 Fusion 360

Fusion 360 is a computer-aided designing (CAD) software application for 3-D modelling and simulation. It's other functions include computer-aided manufacturing (CAM) and computer-aided engineering (CAE), as well as designing printed circuit boards.Fusion 360 provides powerful 3D modeling tools that allow users to create complex 3D models of products and components. It supports parametric modeling, direct modeling, and sculpting..

Figure 17: Fusion 360

2.2.3 Fritzing

Fritzing is an open-source electronic design automation (EDA) software to design electronics hardware, printed circuit boards and schematic circuit diagrams. It is an offshoot of the Processing programming language and the Arduino micro controller.Users can connect components by drawing wires to represent electrical connections.

Figure 18: Fritzing

2.2.4 Blynk IOT

Blynk is an IoT platform for iOS or Android smartphones that is used to control micro-controllers.This application is used to create a graphical interface or human machine interface (HMI) by compiling and providing the appropriate address.

Figure 19: Blynk IOT

2.2.5 OverLeaf

Overleaf is an online LaTeX and Rich Text collaborative writing and publishing tool that makes the whole process of writing, editing and publishing scientific documents much quicker and easier. Created with the goal of making science and research faster, more open and more accessible, Overleaf brings the whole scientific documentation process into one place, from idea to writing to review to publication.

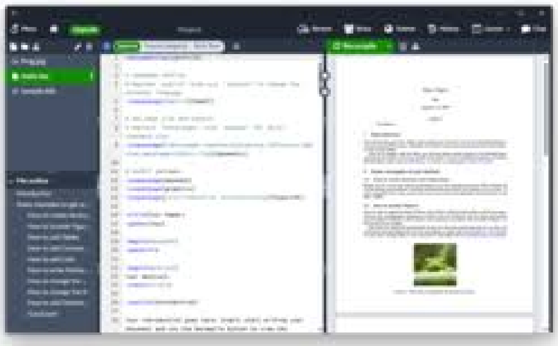

Figure 20: Over Lead

3 Implementation and working:

3.1 Circuit diagram

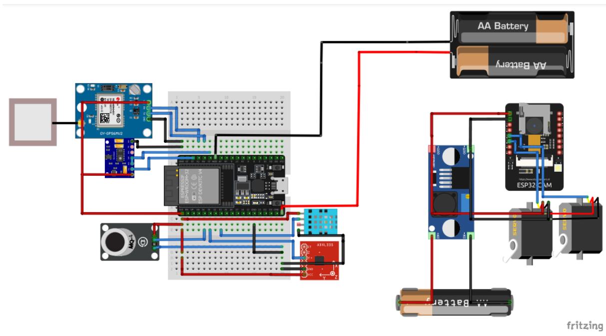

Figure 21: Circuit diagram

3.2 Block diagram

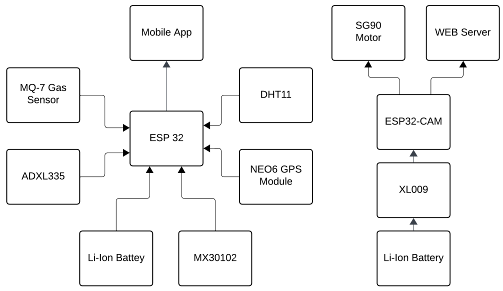

Figure 22: Block diagram

3.3 Working Mechanism

The emergency safety vest is designed to know about the personnel's conditions and the surroundings,providing real-time video feedback and performing the specific operations required.Upon activation,it begins with a WiFi connection,allowing for the control and data transmission for the user interface.The video streaming initiates via the ESP32-CAM module,offering operators a clear view of the surrounding environment.As it moves,the servo motors help the camera to rotate around.DHT11 sensor is a low cost digital sensor for sensing the temperature and humidity of the personnel.Not only the temperature and humidity we can even measure the pulse rate of the personnel using MX30102 which is an pulse oximetr and heart-rate monitor module.For all these we need to know the location using NEO6 GPS module which examines the location and also the position of the personnel.Additionally it even recieves the signals from multiple GPS satellites,as well as other satellite constellations.And even we are having ADXL335 which initially shows the direction of the personnel along their position.For the harmful gases we are having MQ7 Gas sensor which detects by a cycle of high and low temperature.For all the processing we are using li-ion Battery which is rechargeable and which are released by cathode and recieved by anode.Here for the camera working we have only 3.7v but we need 5v for that we have a bugbooster which is XL6009 helps to step up the volts.

4 Experimental Results and Conclusions:

4.1 Results

Upon the completion and deployment of the emergency safety vest,remarkable improvements were seen in the personnel.The primary achievement of the project is that,one can know about the personnel's condition without human intervention.As the vest is equipped with highly modulated sensors in an effective way;Due to the gas sensors we will be able to know the harmful gases and take action accordingly,we can even know the vital parameters of the personnel.Due to video streaming we can know the personnel location and the surrounding.Overall,the vest was a success as it was a cost effective and easy.

4.2 Future Enhancements

This model is a prototype, The GPS module used in this is not the best, In future .The GPS module can be changed, The placement of components is good but its not in a proper way, It can be improved and made comfortable for the wearers, An GPRS/GSM module can be added so the person doesn't have to depend on Wi-FIi for information.

4.3 Conclusion

The emergency safety vest project aims to solve the challenges faced by a personnel during emergency situations like natural disasters. The current methods to monitor the emergency responder are insufficient. This robot, using modern technology, can check all vital parameters of their responder in real-time.And can know the necessary conditions of the personnel.

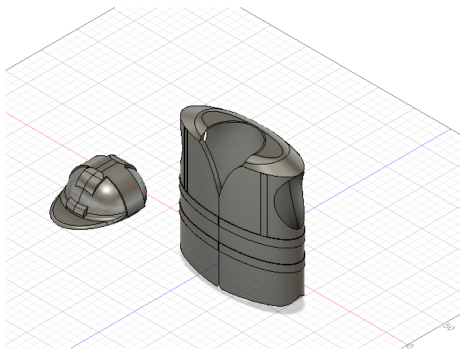

Figure 23: CAD Design of Prototype

4.4 References

https://www.elokon.com/en-EN/newsroom/details/smart-safety-vest-for-eloshield https://issuu.com/irjet/docs/irjet-v10i3203

4.5 Source Code

```
#define BLYNK_TEMPLATE_ID "TMPL3T6gQDCT3"
#define BLYNK_TEMPLATE_NAME "SCB"
#define BLYNK_AUTH_TOKEN
"wiNDgCTL8OOFD-NOD3V2zn-SvVhdsBmQ"
#define BLYNK_PRINT Serial

#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
#include <DHT.h>
#include <Wire.h>
```

```
#include <SoftwareSerial.h>
#include <TinyGPSPlus.h>
#include <PulseSensorPlayground.h>

// Pin where the pulse sensor is connected
const int PulseSensorPin = 32;
PulseSensorPlayground pulseSensor;
int myBPM;

// WiFi credentials
char ssid[] = "Error";
char pass[] = "idontknow";

// DHT Sensor setup
#define DHTPIN 33
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);

// ADXL335 Sensor setup
const int xPin = 26;
const int yPin = 35;
const int zPin = 27;


const float sensitivity = 0.300;
const float zero_g_voltage = 1.65;

// NEO-6M GPS setup
TinyGPSPlus gps;
SoftwareSerial gpsSerial(16, 17); // RX, TX

// MQ7 setup
#define MQ7PIN 34

// Initialize Blynk
BlynkTimer timer;

void setup() {
  // Initialize serial communication
  Serial.begin(115200);
  // Initialize WiFi and Blynk
  Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);

  // Initialize DHT sensor
  dht.begin();

  //Configer Pulse sensor
  pulseSensor.analogInput(PulseSensorPin);
  pulseSensor.setThreshold(550);

  // Initialize GPS
  gpsSerial.begin(9600);
}

void loop() {
  Blynk.run();
  timer.run();

  float dhtValue = dht11Values();
  String adxlValue = adxl335Values();
  float mq7Value = mq7Values();
  float pulseVal = pulseValue();
  String neo6Val = neo6Value();

  // Send values to Blynk
  Blynk.virtualWrite(V0, dhtValue);
  Blynk.virtualWrite(V1, adxlValue);
  Blynk.virtualWrite(V2, mq7Value);
  Blynk.virtualWrite(V3, pulseVal);
  Blynk.virtualWrite(V4, neo6Val);

  Serial.println(adxlValue);
  Serial.println(dhtValue);
  Serial.println(mq7Value);
  Serial.println(pulseVal);
  Serial.println(neo6Val);
  Serial.println("===========");

  delay(1000);
}

float dht11Values() {
  float temperature = dht.readTemperature();
  if (isnan(temperature)) {
    Serial.println("Failed to read from DHT sensor!");
    return 0;
  }
  return temperature;
}

String adxl335Values() {
  int xReading = analogRead(xPin);
  int yReading = analogRead(yPin);
  int zReading = analogRead(zPin);


  float xVoltage = xReading * (3.3 / 4095.0);
  float yVoltage = yReading * (3.3 / 4095.0);
  float zVoltage = zReading * (3.3 / 4095.0);

  // Convert the voltage to acceleration in g
  float xAccel = (xVoltage - zero_g_voltage) / sens;
  float yAccel = (yVoltage - zero_g_voltage) / sens;
  float zAccel = (zVoltage - zero_g_voltage) / sens;

  String output =
  createOutputString(xAccel, yAccel, zAccel);
  return output;

}

float mq7Values() {
  return analogRead(MQ7PIN);
}

float pulseValue() {
```

```
    if (pulseSensor.begin()) {
    Serial.println("Pulse Sensor started");
  } else {
    Serial.println("Failed to start Sensor.");
  }
   myBPM = pulseSensor.getBeatsPerMinute();
  if (pulseSensor.sawStartOfBeat()) {
    return myBPM/2;
  }
}

String neo6Value() {
  String gpsData = "";

  while (gpsSerial.available() > 0) {
    gps.encode(gpsSerial.read());
  }

  if (gps.location.isUpdated()) {
    gpsData += "Lat: ";
    gpsData += String(gps.location.lat(), 6);
    gpsData += ", Lon: ";
    gpsData += String(gps.location.lng(), 6);
    gpsData += ", Alt: ";
    gpsData += String(gps.altitude.meters());
    gpsData += "m, Speed: ";
    gpsData += String(gps.speed.kmph());
    gpsData += "km/h, Sat: ";
    gpsData += String(gps.satellites.value());
  } else {
    gpsData = "No GPS data available";
  }

  return gpsData;
}
String createOutputString
(float xAccel, float yAccel, float zAccel) {
  String direction;

  if (xAccel > 0.5) {
    direction = "Right";
  } else if (xAccel < -0.5) {
    direction = "Left";
  } else if (yAccel > 0.5) {
    direction = "Forward";
  } else if (yAccel < -0.5) {
    direction = "Backward";
  } else if (zAccel > 0.5) {
    direction = "Up";
  } else if (zAccel < -0.5) {
    direction = "Down";
  } else {
    direction = "Stable";
  }


  String output =
    "X: " + String(xAccel, 2) + " g, " +
    "Y: " + String(yAccel, 2) + " g, " +
    "Z: " + String(zAccel, 2) + " g, " +
    "Direction: " + direction;

  return output;
}
```

4.6 List of Expenses

Component	Price (in INR)
ESP-32 CAM	500
SG90 Servo motors (x 2)	200
2-Axis Pan Tilt bracket	120
XL6009 (x2)	200
ESP 32	270
MAX30102 Sensor	250
ADXL335	350
DHT 11Sensor	80
MQ – 7 Gas Sensor	100
NEO6 GPS Module	350
Li-ion Battery and holder	230
Bread Board	45
Jumper Wires	40
Safety Helmet	200
Safety Vest	200
Total	3,135