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**ACKNOWLEDGEMENT**

Firstly, we would like to express our sincere gratitude to the almighty for his solemn presence throughout the project work.

We express our sincere gratitude to **Dr. Surendra S., Professor,** Head of the Electronics and Telecommunication Engineering Department for providing us with adequate facilities, ways and means by which we are able to complete this project work.

We are deeply indebted to our project coordinators **Mrs. Aparna,** Assistant Professor, Department of Electronics and Telecommunication Engineering and **Mr. Benak Patel,** Asst. Professor, Electronics and Telecommunication Engineering department for providing us with valuable advice and guidance during the course of the study. Without their wise counsel and able guidance, it would have been impossible to complete our project work in this manner.

We would like to express a deep sense of gratitude and thanks profusely to our project guide **Guide name,** designation, Department of Electronics and Telecommunication Engineering for her/his proper guidance and valuable suggestions. Without her/his wise counsel and able guidance, it would have been impossible to complete the project work in this manner.

We would also like to express our special thanks to the Principal **Dr. K. Nagendra Prasad** for providing an opportunity to carry out this project work.

We would like to extend our heartfelt gratitude to the teaching and non-teaching staff of **Department of Electronics and Telecommunication Engineering** for their constructive support and co-operation at each and every juncture of the project work.

Finally, we would also like to express our gratitude to **J N N College of Engineering, Shivamogga** for providing us with all the required facilities without which the project work would not have been possible.

Project associates,

Name USN

# **ABSTRACT**

Every 11 seconds, an older adult is treated in the emergency room for a fall; every 19 minutes, an older adult is injured from a fall. Falls are the leading cause of fatal injury and the most common cause of non-fatal trauma related hospital admissions among older adults. If the elderly fall, it will be difficult for them to request for help. The main objective of this project is to design a fall protection sensor system at affordable cost for the elderly. The system can acknowledge a free fall such that the fall can be protected by an inflated air bag. The implementation combines both hardware and software that work seamlessly in detecting and protecting a fall at home. The input from the 3-axis sensor accelerometer (ADXL335 ) and the microcontroller which will detect the fall and further input to the driver circuit to inflate the air bag according to the algorithm coded used in Arduino IDE

**CHAPTER 1**

## **1.1 INTRODUCTION**

FALLS are a serious problem for elderly people and others prone to falls. One-third to one-half of the population aged 65 years and over have experienced falls. Half of the elderly people who fall do so repeatedly. Falls are a complex phenomenon, suggesting present disease and predicting future disability. They are caused by interactions between the environment and dynamic balance, which is determined by the quality of sensory input, central processing, and motor responses. Falls are the leading cause of injury in older adults and the leading cause of accidental death in those over age 85 years. Even a fall that does not result in injury can have serious consequences. Psychological trauma and fear of falling can produce a downward spiral of self-imposed reduced activity, leading to a loss of strength, flexibility, and mobility, thereby increasing the risk of future falls and injuries. Fall-detection and prevention are important issues for the elderly population. The Hip Protect is the most popular device for preventing falls.

A smart airbag system for fall protection is a cutting-edge safety technology that aims to reduce the risk of injury or fatality from falls. The system utilizes advanced sensors and algorithms to detect the occurrence of a fall and automatically deploy an airbag to cushion the impact and prevent injury.

This type of technology is particularly relevant in industries such as construction, mining, and oil and gas, where workers are frequently exposed to elevated work surfaces and potential falls. The smart airbag system provides an added layer of protection and can significantly reduce the likelihood of serious injury or death in the event of a fall.

In this introduction, we will explore the concept of a smart airbag system for fall protection in more detail, including its key features, benefits, and potential applications. We will also discuss some of the challenges associated with implementing this technology and the future direction of research in this area.

**1.2 Literature survey**

**[1] “Smart Fall Detection and Protection for Elderly People” (T. Padma\*1, Ch. Usha Kumari, M. Bhargav3 2020)**

The elderly people require attention because of their health conditions and in many cases falls lead to many critical consequences. When an elderly person falls results in physical injury and is not possible for them to request for help at that condition. The main intention of this project is to prepare a fall detection and protection system for the elderly people at an affordable cost. In that process a wearable airbag is developed which inflates when the fall occurs. MEMS Accelerometer is used for the fall detection. The processing of data is done by the Microcontroller based on the input given by accelerometer sensor. When the fall is detected Microcontroller triggers the air pump which inflates the airbag. The Microcontroller (NODE MCU) consists of a built in Wi-Fi module by which the entire data were presented to cloud platform.

**[2] “ Arduino based human Airbag system for fall protection for the elderly ”**

**( 2018 ,Hita Prem ,Ashika NA)**

Every 11 seconds, an older adult is treated in the emergency room for a fall; every 19 minutes, an older adult is injured from a fall. Falls are the leading cause of fatal injury and the most common cause of non-fatal trauma related hospital admissions among older adults. If the elderly fall, it will be difficult for them to request for help. The main objective of this project is to design a fall protection sensor system at affordable cost for the elderly. The system can acknowledge a free fall such that the fall can be protected by an inflated air bag. The implementation combines both hardware and software that work seamlessly in detecting and protecting a fall at home. The input from the 3-axis sensor accelerometer (ADXL335 orADXL345) and gyroscope will be fed to the microcontroller which will detect the fall and further input to the driver circuit to inflate the air bag according to the algorithm coded using EMBEDDED C.

**[3] . “A Privacy Protected Fall Detection IoT System for Elderly Persons Using Depth Camera (2018, Xiangbo Kong, Zelin Meng )”**

The proportion of the elderly persons in the world is constantly on the rise, and fall accidents have become a serious problem, especially for those who live alone. Currently, fall detection has attracted a lot of research attention and machine learning (ML) has shown promising performance in this task due to their strengths in person recognition. However, many existing methods using RGB images as the training data, resulting in the main information to be lost, or do not appropriately consider the effect of light, resulting in weak generalizability of the fall detection. Moreover, traditional methods pose a risk of leakage of personal privacy. This paper proposes a fall detection IoT system based on depth camera and fast Fourier transform (FFT) to overcome these problems. We first use depth camera to get the skeleton images of a person who is standing or falling down. We then get the characteristic quantity of these images and train them by ML to get the training model. Finally, we use FFT to encrypt images and detect the fall. We construct a training database that includes 1131 images, and the experimental evaluation of the images demonstrates that our algorithm is effective for detecting falls and maintain privacy.

**[4] “A Wearable Action Recognition System Based on Acceleration and Attitude Angles Using Real-time Detection Algorithm (Bo Wang, Ni Xie, Guoru Zhao, Yingnan Ma**, **2017)”**

Falls are a main cause of trauma and death. The purpose of this study is to adopt unique resultant acceleration and attitude angles to distinguish falls from activities of daily life before impact. In this study, we developed a wearable action recognition system to acquire action data. The moving average filter was employed to deal with raw data, and then complementary filter was adopted to compromise sensor data for attitude angles. The real-time detection algorithm embedded in this device was applied to recognize six actions based on processed data. Eight subjects (five males, three females) participated in the experiment. The optimal features and related thresholds were extracted. In addition, the real-time action detection results indicated that the real-time action recognition model reached an accuracy of 96.25%, with 98% for male and 93.3% for female. Thus, our device potentially achieves a high sensitivity of fall-related actions recognition.

**[5] “Smart Unit Care for Pre Fall Detection and Prevention (2016,** **Ashok Kumar Thella1 , Vinay Kumar Suryadevara1 , Maher Rizkalla1 , and Gahangir Hossain2)”**

Generally fall may occur from moving or resting postures. This may include slipping from bed and fall from a sitting, or from running or walking. The pre-fall is a nonequilibrium state of human position that may lead to serious injuries, and may negatively impact the quality life condition, particularly for elders. Physical disabilities resulting from the fall incidences may lead to high costs involved with the healing process. In this work, an embedded sensor system using Arduino micro-controller was utilized to coordinate the data received from accelerometer and gyroscope. For a given threshold voltage and fall pattern, the fall decision is made by the microcontroller, citing an incoming fall. The study addresses the number of sensors to be coordinated for enhancing probability of receiving a real fall. Sensors are suggested to be placed on the human body within a belt, and safety devices at human body as well as incorporated in a smart room will be coordinated with the processor commands. Near 150 ms time frame was detected from the simulation results, suggesting a safety device to be triggered and activated for protection within this time frame. This paper discusses the research parameters such as response time for the device activation and interfacing the microcontroller to airbag switch, and means of activating the safety devices within the sharp edges in the smart unit care to minimize the impact of the fall injuries.

**1.3 Problem Statement**

Despite the numerous safety measures that have been put in place to protect workers from falls, falls from heights remain a leading cause of workplace injuries and fatalities. Traditional fall protection systems such as harnesses and safety nets can only do so much, and in some cases, they may even exacerbate the injuries sustained from a fall.

This is where smart airbag systems for fall protection come into play. However, the implementation of such systems has been hindered by several challenges. These challenges include the cost of the technology, the need for custom fitting, and the need for proper training and maintenance.

Moreover, there is a need to ensure that the smart airbag system is not triggered unnecessarily, as this can cause inconvenience to workers and increase the cost of maintenance. The system must also be reliable and accurate in detecting falls to avoid false alarms or failing to deploy in time to prevent injury.

Therefore, the problem statement for smart airbag systems for fall protection is to develop a cost-effective, reliable, and accurate system that can detect falls and deploy airbags promptly to prevent injuries. This system should also be easy to use, maintain and must be designed to integrate with existing safety protocols.

* 1. **Objective**

To design and create a Fall Detection System for the elderly that will protect them from hip and back injuries. The system has to be wearable and capable of detecting a fall before the impact. The device has to be able to detect dangerous tilt and if a fall has occurred, must inflate the airbag within a few milliseconds. In the event of a fall or a dangerous tilt, the device has to be able to be very sensitive to the motion and differentiate between ADL’s. Throughout the process, the algorithm must continuously collect data and implement the threshold algorithm when needed.

* 1. **Methodology**

In the event of a fall or dangerous tilt, the device had to be able to sense motion and the different measurable qualities involved with motion. Sensing in the device begins with a digital tri- axis accelerometer, which measures acceleration along the three coordinate axes. To use these sensors to detect falls, the sensor readings have to be outputted to a microcontroller for processing and application to algorithms. For this to occur, first the sensor readings are converted from an analog voltage signal to a discretized bit value for the microcontroller to be able to use them. This is accomplished by passing the sensor outputs through an Analog to Digital Converter (ADC) before entering the microcontroller. The microcontroller has to take the discretized bit data from the ADC and apply different formulas and conversion factors to calculate the necessary factors (acceleration magnitude, angle change, angular velocity). Using these factors, the microcontroller feeds them into an algorithm, comparing the inputs with various threshold values, initiating triggers when certain thresholds are met or exceeded. Upon detecting dangerous tilt, the microcontroller has to initiate a signal which will turn on the motor driver to inflate an airbag

strategically placed at the waist. Throughout the process of sensor readings, the algorithm tries to detect a fall.

* 1. **Scope of the project**

The scope of airbag systems for fall protection is relatively broad, as they can be used in many industries and work environments where workers are at risk of falling from heights. Some of the industries that may benefit from the use of airbag systems for fall protection include.

**Construction:** Construction workers are at a high risk of falling from scaffolding, roofs, and other elevated work surfaces. Airbag systems for fall protection can provide a cushioned landing surface to reduce the risk of injury or death in the event of a fall.

**Entertainment:** Stunt performers, acrobats, and other performers who work at heights may use airbag systems for fall protection to prevent injuries during performances.

**Sports:** Athletes who engage in high-risk sports such as skiing, snowboarding, and parkour may use airbag systems for fall protection to reduce the risk of injury during training and competitions.

**Emergency responders:** Firefighters, rescue workers, and other emergency responders may use airbag systems for fall protection when working in high places, such as during building evacuations or rescues.

**Military:** Military personnel may use airbag systems for fall protection during training exercises and operations, especially those involving rappelling or parachute jumps.

It's worth noting that airbag systems for fall protection may not be

**1.7 Organization of the report**

**Chapter 1** is all about the introduction to the project. It gives brief idea of what we have achieved.

**Chapter 2** deals with the theoretical background of the components.

**Chapter 3** deals with the design and implementation of our proposed system.

**Chapter 4** deals with the software requirements and algorithms.

**Chapter 5** deals with the result and implementation of the system.

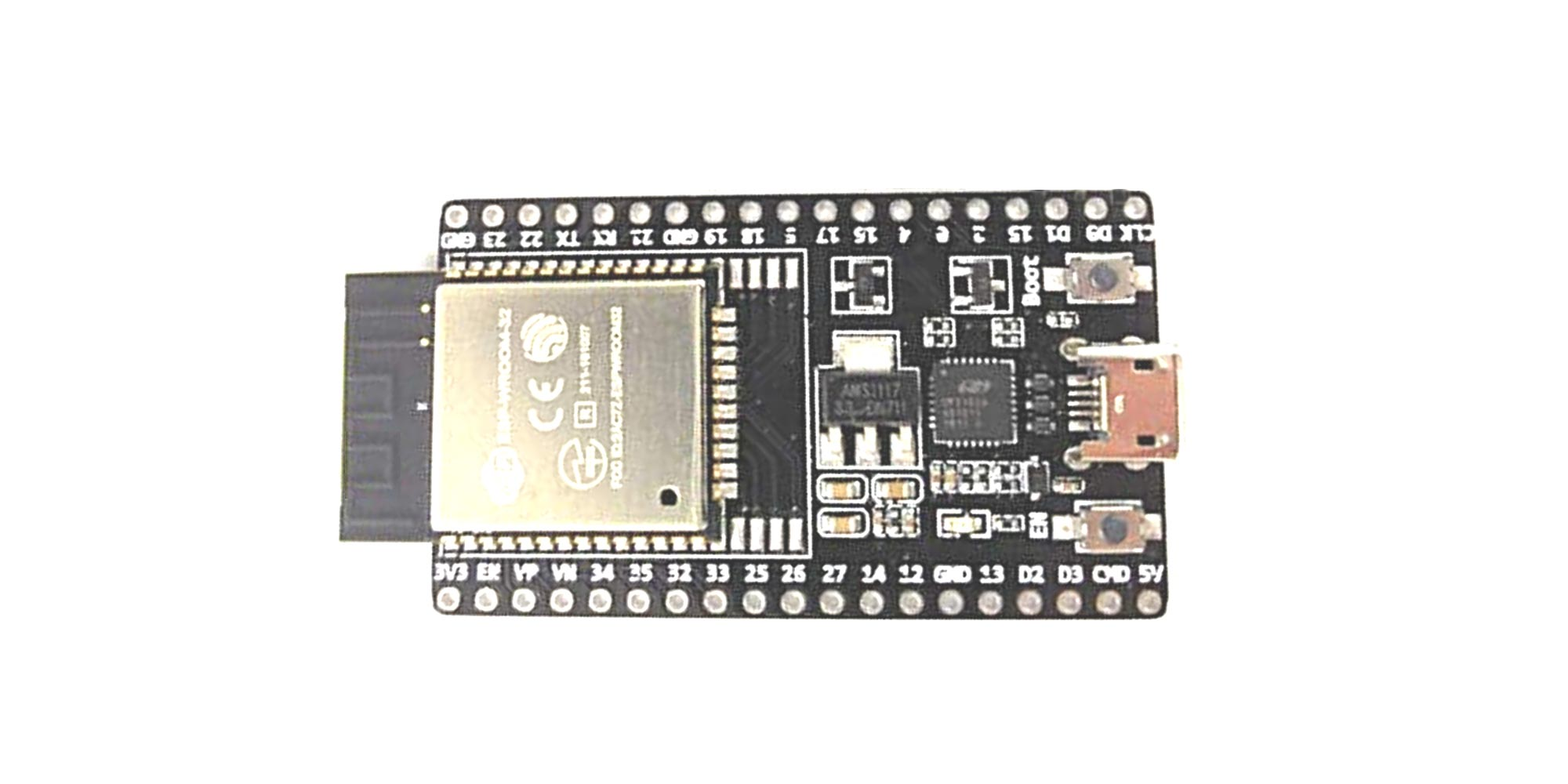
**Chapter 6** deals with the conclusion and future scope of the project.

**Chapter 2**

**Theoretical Background**

**2.1 Hardware Components Description**

1. **NODE MCU (ESP3238)**

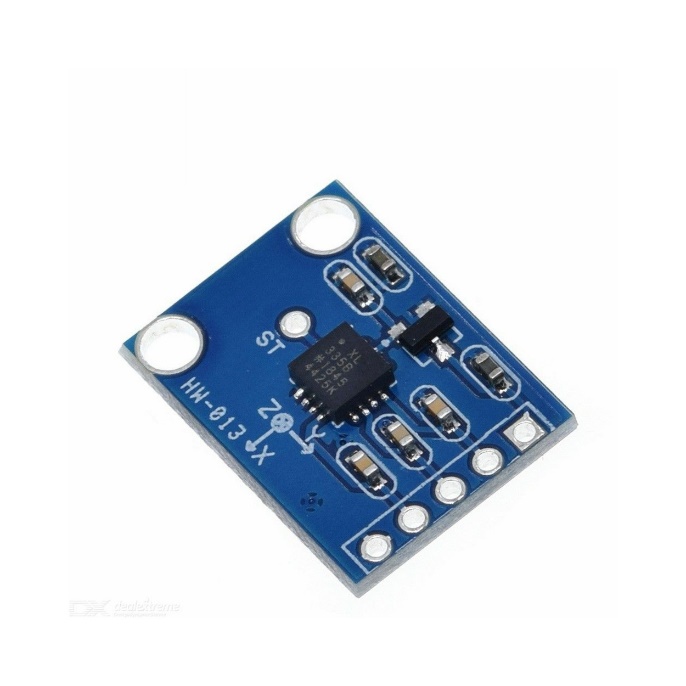


The NODEMCU ESP32 microcontroller can be used in a smart airbag system for fall protection as the brain of the system, responsible for monitoring the accelerometer sensor data and controlling the airbag deployment. Here is an overview of how the NODEMCU ESP32 can be used in a smart airbag system for fall protection: The NODEMCU ESP32 can collect data from an accelerometer sensor that measures changes in velocity and acceleration. The accelerometer can be placed on the body of the person wearing the airbag system to detect a fall. The NODEMCU ESP32 can use the accelerometer data to detect a fall. When the accelerometer detects a rapid change in velocity and acceleration that exceeds a certain threshold, it can send a signal to the microcontroller to trigger the airbag deployment. The NODEMCU ESP32 can control the airbag deployment mechanism through a relay or other actuator. When a fall is detected, the microcontroller can send a signal to rapidly inflate the airbag to cushion the fall. The NODEMCU ESP32 can also implement safety features to prevent accidental airbag deployment or other hazards. For example, a switch can be included to disable the system when it's not needed. the NODEMCU ESP32 can be used in a smart airbag system for fall protection by collecting accelerometer data, detecting a fall, and controlling the airbag deployment mechanism. Safety features can also be implemented to prevent accidental deployment.

**Specifications**

* 520 KB of SRAM, 448 KB of ROM and 16 KB of RTC SRAM.
* Support for both Classic Bluetooth v4.2 and BLE specifications.
* 34 Programmable GPIOs.
* Up to 18 channels of 12-bit SAR ADC and 2 channels of 8-bit DAC

**2. Accelerometer (ADXL335)**



The ADXL335 accelerometer sensor can be used in an airbag system to detect acceleration and orientation changes, which can trigger the deployment of the airbag in case of a sudden impact or fall. Here is how the ADXL335 sensor can be used in an airbag system:

The ADXL335 sensor can be placed on the body or the device to be protected, such as a helmet or backpack. The sensor measures acceleration in three axes (X, Y, and Z) and provides data to the microcontroller. The sensor signal can be amplified and filtered to remove noise and provide clean data to the microcontroller. The signal can be amplified using a signal amplifier IC and filtered using an RC filter, Before using the sensor, it should be calibrated to eliminate any bias and to ensure accuracy in the measurement. Calibration can be done by placing the sensor in a stable position and recording the readings from each axis.

**Specifications**

* Operating Voltage: 3V to 6V DC
* Operating Current: 350μA
* Sensing Range: ±3g
* 3-axis sensing
* High Sensitivity for small movement

**Compressor**



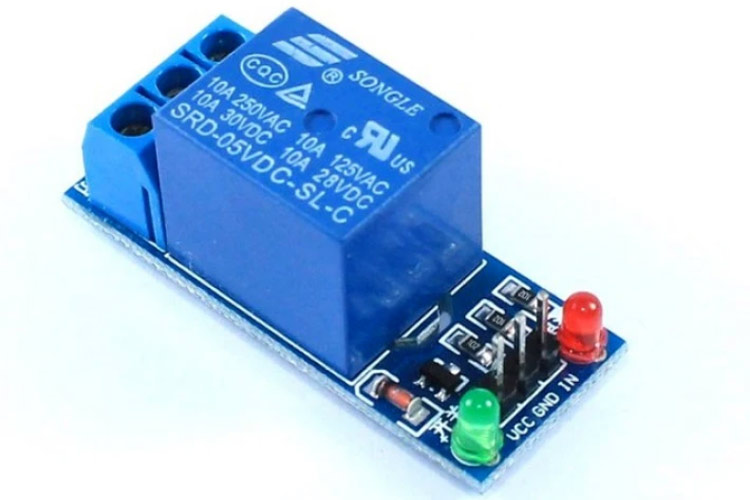
Air compressors work by forcing atmospheric air under pressure to create potential energy that can be stored in a tank for later use. Just like an open balloon, the pressure builds up when the compressed air is deliberately released, converting the potential energy into usable kinetic energy. Air compressor works on the principles of thermodynamics. According to the ideal gas equation without any temperature difference, with an increase in gaseous pressure, its volume reduces.

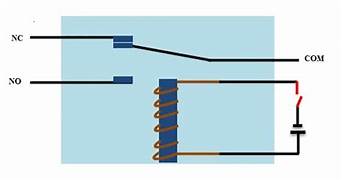
**Specification**: Air pressure: 150PSI

DC12V. Cylinder diameter: 30mm. Air

hose: 3 meters long high quality PU air hose.

1. **Relay**





Relays are used in airbag systems as a switch that controls the deployment of the airbag. When a car experiences a collision, a sensor sends a signal to the airbag control unit, which then activates the relay to allow current to flow through the airbag deployment circuit. The relay works by using an electromagnet to control the flow of current to the airbag inflator. When the relay is activated, the electromagnet pulls a switch closed, completing the circuit and allowing current to flow to the airbag inflator. This causes a chemical reaction that generates a gas to rapidly inflate the airbag. Relays are used in airbag systems to provide a high degree of reliability and safety. They are designed to activate quickly and reliably in the event of a collision, and are tested to ensure that they will operate correctly in a wide range of conditions. Additionally, relays are designed to be robust and durable, so that they can withstand the high forces and vibrations associated with a collision. the use of relays in airbag systems is an important safety feature that helps to ensure that airbags deploy reliably and effectively in the event of a collision.

**Specifications**

* Supply voltage – 3.75V to 6V
* Quiescent current: 2mA

**Buzzer**

****

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.

**Specifications**

The specifications of the buzzer include the following.

* The frequency range is 3,300Hz
* Operating Temperature ranges from – 20° C to +60°C
* Operating voltage ranges from 3V to 5V DC

**AC-DC Adopter**

****

An AC/DC adapter, also known as a power adapter or power supply, is a device that converts alternating current (AC) from a power outlet into direct current (DC) suitable for powering electronic devices. It serves as an intermediary between the power source and the device, ensuring that the device receives the appropriate voltage and current it requires to function properly.

AC/DC adapters are commonly used with various electronic devices such as laptops, smartphones, gaming consoles, routers, and many other consumer electronics. They come in different shapes, sizes, and specifications to meet the power requirements of different devices.

**Chapter 3**

**Design and Implementation**

**3.1 Introduction**

An airbag system for fall protection is designed to protect individuals from serious injuries that may result from falls. The system typically consists of an airbag that is deployed automatically in the event of a fall, along with sensors that detect the fall and trigger the deployment of the airbag.

Here are some key design considerations for an airbag system for fall protection:

**Sensor placement:** The sensors must be placed strategically to detect falls accurately. Typically, they are placed on the individual's body or on the harness used for fall protection.

**Airbag size and shape:** The airbag should be designed to cushion the impact of a fall while minimizing the risk of injury. The size and shape of the airbag will depend on the intended application and the specific requirements of the user.

**Inflation system:** The airbag must be inflated quickly to prevent injury. An efficient and reliable inflation system is critical to the overall performance of the system.

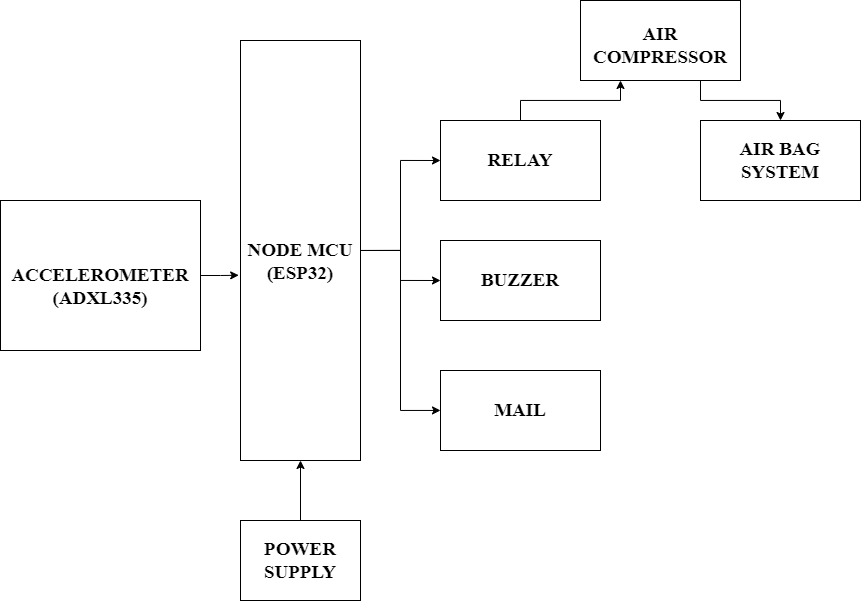
**Material selection:** The materials used for the airbag must be durable, lightweight, and able to withstand the force of impact without tearing or rupturing.

**Deployment mechanism:** The airbag must be deployed quickly and reliably in the event of a fall. There are various mechanisms that can be used to trigger the deployment, such as a mechanical trigger or an electronic sensor.

Maintenance and testing: Regular maintenance and testing of the airbag system are critical to ensuring its reliability and effectiveness

Overall, the design of an airbag system for fall protection requires careful consideration of various factors to ensure that it provides effective protection against falls while being practical and reliable for users.

* 1. **Block diagram**



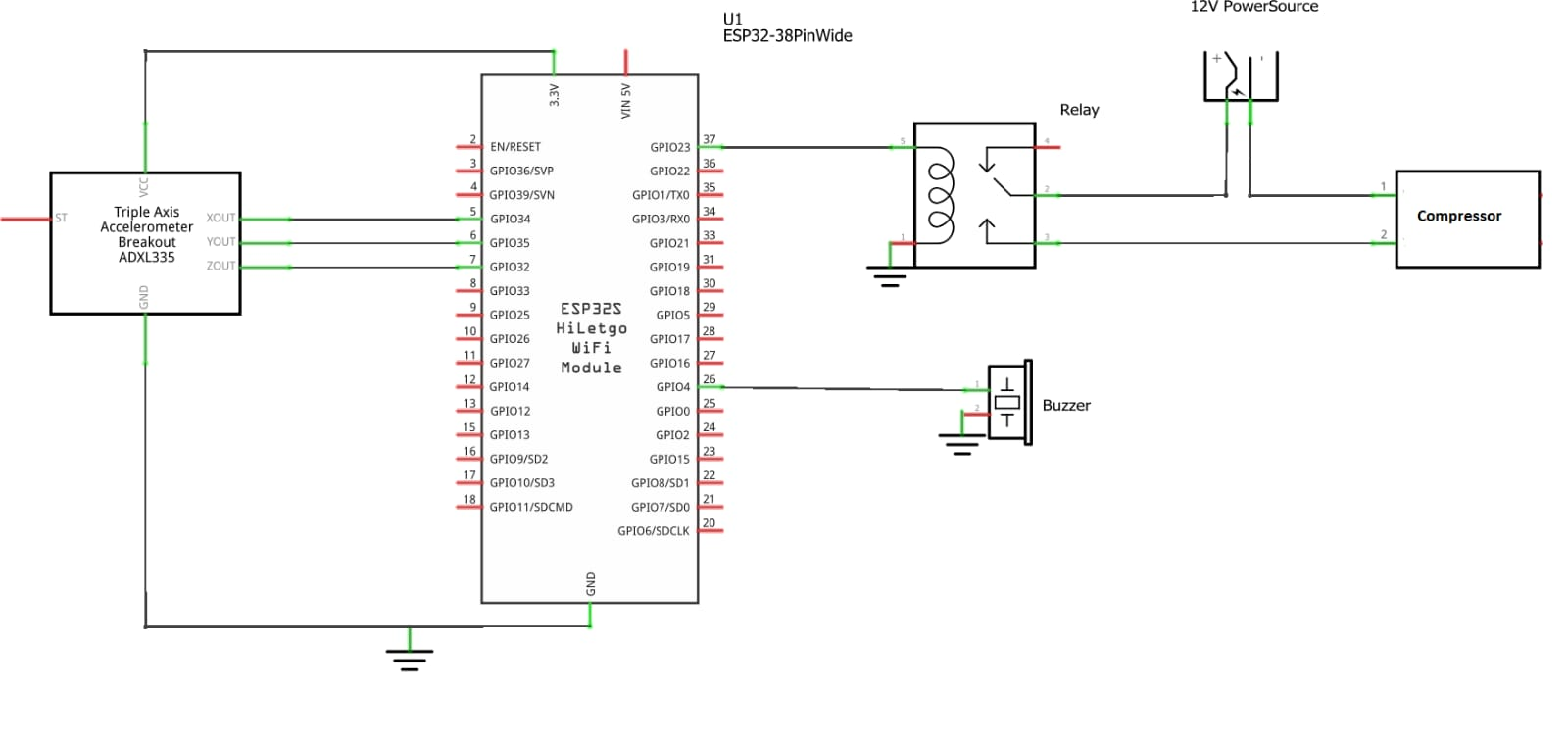
* 1. **Working Principle**

Esp32 is the microcontroller used for this project. It is the main heart of this project. Adxl335 Sensor is used as input to the microcontroller which is for fall detection .A 3-axis acceleration sensor (ADXL 335) is used to acquire the data of acceleration resulting from the various types of activity. Then, the data set is sent to the ESP32 for processing. The system is designed to monitor the activities of an elderly person in daily life. When a fall is taken (an acceleration value is lower than the threshold value), the airbag will open to save the life of the user and also alert the surrounding people through the buzzer alarm. An email notification will be sent to the caretaker after fall detection.

**3.4 System flowchart**



**Circuit diagram**

****

**Summary**

The airbag system for fall protection is a safety mechanism designed to protect individuals from injuries or fatalities when working at heights or in elevated positions. It utilizes advanced technology to detect a fall and deploy an airbag rapidly to cushion the impact and minimize the risk of injury.

Fall Detection Sensors: The system incorporates highly sensitive sensors capable of detecting sudden changes in motion and acceleration, indicating a potential fall. These sensors are typically placed on the person or the equipment they are working on.

Control Unit: The control unit serves as the brain of the airbag system. It receives real-time data from the fall detection sensors and analyzes it to determine if a fall has occurred. Upon detecting a fall, the control unit triggers the deployment of the airbag.

Airbag Module: The airbag module is a crucial part of the system responsible for deploying the airbag swiftly and accurately. It consists of a durable, inflatable airbag made from high-strength materials capable of withstanding the impact forces generated during a fall.

Activation Mechanism: The activation mechanism is designed to initiate the airbag deployment once a fall is detected. It can employ various methods such as gas canisters, pneumatic systems, or electronic triggers to rapidly inflate the airbag.

Harness and Straps: To ensure proper positioning and stability, the individual wears a harness integrated with the airbag system. The harness distributes the impact forces evenly across the body while securely holding the airbag in place.

Fall Detection: The system continuously monitors the motion and acceleration patterns of the user. If a sudden and significant change is detected, indicating a fall, the system moves to the next stage.

Activation: Once a fall is detected, the control unit triggers the activation mechanism, rapidly inflating the airbag.

Airbag Deployment: The airbag quickly inflates, expanding around the individual, providing a cushioned landing surface.

Impact Absorption: Upon contact, the inflated airbag absorbs and dissipates the impact energy, reducing the risk of injuries to the person.

Post-Fall Safety: After deployment, the system may incorporate additional features like an automatic deflation mechanism, enabling the individual to easily get up and resume work without hindrance.

**Chapter 4**

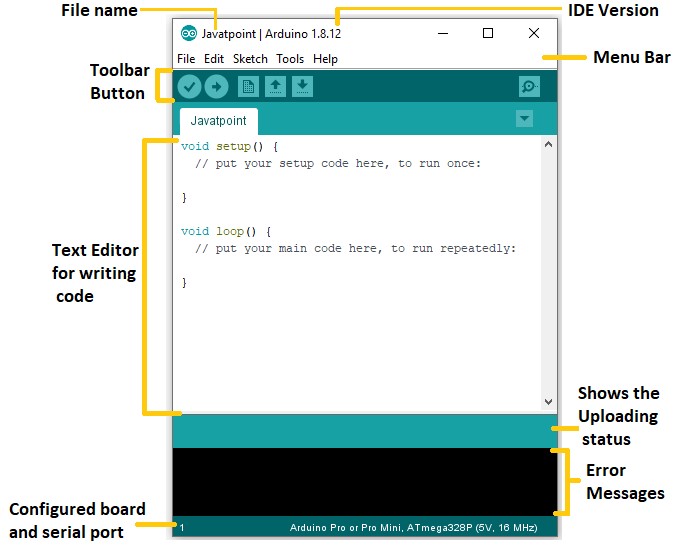
**Software Implementation**

**4.1 Arduino Integrated Development Environment (IDE)**

****

IDE stands for “Integrated Development Environment “it is an official software introduced by Arduino.cc, that is mainly used for editing, compiling and uploading the code in the Arduino Device. Fig 4.1.1 shows Arduino IDE as it is open-source software and is a powerful tool for programming Arduino boards. The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. Sketches are computer programmes created using the Arduino Software (IDE). These drawings are created in a text editor and saved as files with the.ino extension. The editor offers functions for text replacement and text searching. When saving and exporting, the message section provides feedback and shows errors. The console shows text generated by the Arduino Software (IDE), including error messages in their entirety and other data. The configured board and serial port are visible in the window's bottom right corner. You may create, open, and save sketches, validate and submit programmes, view the serial monitor, and more using the toolbar buttons. The default window of the Arduino IDE is displayed in figure 4.1.2. Details on IDE: The IDE environment is mainly distributed into three sections 1. Menu Bar 2. Text Editor 3.

Output Pane

****

The bar appearing on the top is called Menu Bar that comes with five different options as follow

**File:** You can open a new window for writing the code or open an existing one. Following table shows the number of further subdivisions the file option is categorized into.

**Edit:** Used for copying and pasting the code with further modification for font. Sketch: For compiling and programming.

**Tools:** Used for testing projects. The Programmer section in this panel is used for burning a bootloader to the new microcontroller.

**Help:** In case you are feeling skeptical about software, complete help is available from getting started to troubleshooting.

The button appearing on the top right corner is a Serial Monitor – A separate pop-up window that acts as an independent terminal and plays a vital role for sending and receiving the Serial Data. You can also go to the Tools panel and select Serial Monitor pressing Ctrl+Shift+M all at once will open the Serial Monitor. The Serial Monitor will actually help to debug the written Sketches where you can get a hold of how your program is operating. Your Arduino Module should be connected to your computer by USB cable in order to activate the Serial Monitor. The Arduino IDE is a software development platform that provides a user-friendly interface and a complete set of tools for programming Arduino boards. The IDE is designed to be simple and easy to use, making it a popular choice for beginners and experienced developers alike. Developers can write code in the text editor provided by the IDE. The code is written in a variant of the C++ programming language that is designed for Arduino development. Once the code is written, it can be verified by clicking on the "Verify" button in the IDE. This compiles the code and checks for any syntax errors .If the code are free of errors, it can be uploaded to the Arduino board by clicking on the "Upload" button in the IDE. This transfers the compiled code to the board and runs it. The IDE also provides a serial monitor, which allows developers to view the output from the board and send data to the board over the serial port. This can be useful for debugging and testing. The IDE comes with a set of libraries that developers can use to simplify common tasks, such as reading data from sensors or controlling motors. Developers can also create their own libraries and add them to the IDE. This allows for faster development and easier reuse of code.

**Program:**

#include <math.h>

const int x\_out = 39;

const int y\_out = 34;

const int z\_out = 35;

int buzzer=33;

int relay=32;

#include <WiFi.h>

#include <EMailSender.h>

#include "Arduino.h"

uint8\_t connection\_state = 0;

uint16\_t reconnect\_interval = 10000;

EMailSender emailSend("madhugd6361@gmail.com", "grcmdnbewrksloam");

const char\* ssid = "vivo 1907"; // Enter SSID here

const char\* password = "impanlee"; //Enter Password here

void sendmail()

{

EMailSender::EMailMessage message;

message.subject = "Alert!";

message.message = "Fall Detected";

EMailSender::Response resp = emailSend.send("impanab22@gmail.com", message);

Serial.println("Sending status: ");

Serial.println(resp.status);//1

Serial.println(resp.code);//0

// int c = resp.status.toInt();

if(resp.status)

{

Serial.print("Mail Sent");

delay(5000);

}

else

{

Serial.println("Error in sending mail, respnse code: ");

Serial.print(resp.code);

delay(5000);

}

Serial.println(resp.desc);

}

void setup(void){

Serial.begin(9600);

WiFi.begin(ssid, password);

while (WiFi.status() != WL\_CONNECTED) {

delay(1000);

Serial.print(".");

}

Serial.println("WiFi connected..!");

pinMode(relay,OUTPUT);

pinMode(buzzer,OUTPUT);

delay(2000);

}

void loop() {

int x\_adc\_value, y\_adc\_value, z\_adc\_value;

x\_adc\_value = analogRead(x\_out);

y\_adc\_value = analogRead(y\_out);

z\_adc\_value = analogRead(z\_out);

Serial.print("x = ");

Serial.print(x\_adc\_value);

Serial.print("\t\t");

Serial.print("y = ");

Serial.print(y\_adc\_value);

Serial.print("\t\t");

Serial.print("z = ");

Serial.print(z\_adc\_value);

Serial.println("");

delay(1000);

if((x\_adc\_value>1800) && (x\_adc\_value<2000) &&(y\_adc\_value>1800)&&(y\_adc\_value<2000)){

Serial.println("NO");

digitalWrite(relay,0);

}

else{

Serial.println("Fall");

digitalWrite(relay,1);

tone(buzzer,2000);

sendmail();

noTone(buzzer);

}

}

**Here's the algorithm for the provided program:**

1. Initialize the constants for the sensor pin numbers (x\_out, y\_out, z\_out) and the variables for the buzzer and relay pin numbers.
2. Include the necessary libraries: math.h, WiFi.h, EMailSender.h, and Arduino.h.
3. Declare the necessary variables for the Wi-Fi connection state and reconnect interval.
4. Create an instance of the EMailSender class with your email credentials.
5. Specify the SSID and password for your Wi-Fi network.
6. Implement the sendmail() function to send an email alert using the EMailSender library.
   1. Create an EMailSender::EMailMessage object and set the subject and message.
   2. Send the email using the send() function of the emailSend object.
   3. Print the sending status, response status, response code, and response description.
   4. If the email is sent successfully (resp.status is true), print "Mail Sent" and delay for 5 seconds.
   5. If there is an error in sending the email, print "Error in sending mail, response code" and delay for 5 seconds.
7. Set up the Arduino by initializing the serial communication, connecting to the Wi-Fi network, and waiting for a successful connection.
   1. Begin the serial communication with a baud rate of 9600.
   2. Start the Wi-Fi connection with the provided SSID and password.
   3. Wait until the Wi-Fi connection is established by continuously checking the connection status.
   4. Print "WiFi connected..!" when the connection is successful.
   5. Set the pin modes for the relay and buzzer as OUTPUT.
   6. Delay for 2 seconds to allow for initialization.
8. Enter the main loop:
   1. Read analog values from the x\_out, y\_out, and z\_out pins using the analogRead() function.
   2. Print the values of x, y, and z on the serial monitor.
   3. Delay for 1 second.
   4. Check if the x and y values are within the specified range (1800-2000):
9. If true, print "NO" on the serial monitor and turn off the relay by setting its pin LOW.
10. If false, print "Fall" on the serial monitor, turn on the relay by setting its pin HIGH, activate the buzzer using the tone() function with a frequency of 2000 Hz.
11. Call the sendmail() function to send an email alert.
12. Turn off the buzzer using the noTone() function.
13. e. Repeat the loop.

**Chapter 5**

**Results and Discussions**

Airbag systems for fall protection have shown promising results in preventing injuries and fatalities in various industries where falls from heights are a significant risk. These airbag systems work by deploying a cushioned airbag at the moment of impact, reducing the force of the fall and absorbing the energy of the fall.

Studies and field tests have demonstrated that airbag systems for fall protection can effectively reduce the risk of injury and death in the event of a fall from a height. For instance, a study conducted by the National Institute for Occupational Safety and Health (NIOSH) found that airbag systems reduced impact forces by 75% and peak forces by 88% compared to traditional fall protection systems.

Additionally, airbag systems for fall protection have several advantages over other types of fall protection systems, such as harnesses and lanyards. Airbag systems are more comfortable to wear, do not restrict movement, and do not require a tether to anchor the worker to a fixed point. They also have a lower risk of causing secondary injuries, such as whiplash, which can occur with traditional fall protection systems.

However, airbag systems for fall protection also have some limitations and challenges. For instance, they can be more expensive to purchase and maintain than traditional fall protection systems. They also require adequate space for deployment, which may not be available in all work environments. Finally, airbag systems must be properly maintained and inspected to ensure that they are functioning correctly and ready to deploy in the event of a fall. Overall, the results of airbag systems for fall protection are promising, and they offer a viable alternative to traditional fall protection systems in certain work environments. However, as with any safety equipment, proper training, maintenance, and inspection are critical to ensuring that airbag systems function effectively and provide the intended level of protection.

**CHAPTER 6**

**Conclusion & Future Scope**

**6.1 Advantages**

A smart airbag system for fall protection can have several advantages over traditional fall protection systems, including:

**Reduced impact force:** Smart airbags can reduce the impact force of a fall by absorbing and dissipating the energy of the fall, which can help prevent injuries.

**Lightweight and portable:** Smart airbag systems can be designed to be lightweight and portable, making them easy to transport and install in a variety of settings.

**Customizable:** Smart airbag systems can be customized to fit the specific needs of different environments and users. For example, airbag size and inflation can be adjusted based on the user's weight and height.

**Fast response time:** Smart airbag systems can respond quickly to a fall, inflating within milliseconds to provide protection.

**Reusable:** Unlike traditional fall protection systems, smart airbag systems can be reused after a fall, making them more cost-effective over time.

**User-friendly:** Smart airbag systems are typically easy to use, with simple activation mechanisms that do not require extensive training.

**Low maintenance:** Smart airbag systems require minimal maintenance, reducing the time and cost associated with upkeep.

Overall, a smart airbag system for fall protection can offer improved safety and convenience compared to traditional fall protection systems.

**6.2 Limitations**

**Limited reusability:** Airbags can only be used once, which can be expensive if the fall protection system needs to be deployed frequently.

**Large size and weight:** Airbags can be large and heavy, making them challenging to move and store. This can be especially problematic for industries where portability is essential, such as in the case of mobile entertainment stages.

**Airbag deployment time:** Airbags take time to deploy fully, which can be a disadvantage if a worker falls quickly or if there is limited space for the airbag to expand.

**Maintenance requirements:** Airbags require regular maintenance to ensure they are in good working condition, which can be time-consuming and expensive.

**Limited protection from lateral falls:** Airbags are designed to protect workers from vertical falls, but they may not be effective in preventing injuries from lateral falls, which can be a significant risk in some industries.

**6.3 Applications**

Airbag systems have been widely used for fall protection in various industries, such as stunt work, gymnastics, and skiing. In these applications, the airbag system is designed to cushion the impact of a fall and prevent or reduce injuries.

In the case of stunt work, for example, airbag systems are used to protect performers during high falls or other dangerous stunts. The airbag system is typically placed at the bottom of the fall zone, and when activated, it quickly inflates to provide a soft landing for the performer.

Similarly, in the sports industry, airbag systems are often used to protect athletes during training or competitions. For example, in freestyle skiing, airbag systems are used to cushion the landing of skiers who are performing jumps or tricks. The airbag system is placed at the bottom of a ramp or jump, and when the skier lands, the airbag quickly inflates to absorb the impact of the landing.

Airbag systems have also been used in construction and other industries as a form of fall protection. In these applications, the airbag system is typically placed at the bottom of a work area, such as a scaffolding or platform, and is activated if a worker falls from a height. The airbag system can help to prevent serious injuries or even save lives by cushioning the impact of the fall .airbag systems have proven to be an effective and reliable form of fall protection in a variety of industries. They are often used in situations where traditional forms of fall protection, such as harnesses or safety nets, may not be feasible or effective.

**6.4 Conclusions**

Airbag systems are a type of fall protection that can provide effective cushioning for individuals who are working at height or performing high-risk activities. These systems work by deploying a large airbag to cushion the fall of a person who has fallen from a height.

The use of airbag systems for fall protection has several advantages. They are lightweight and easy to set up, making them ideal for use in a variety of settings. They also provide a large surface area for impact absorption, which can help to reduce the risk of injury in the event of a fall. Additionally, airbag systems can be re-used multiple times, making them a cost-effective option for companies and organizations that need to provide fall protection for their workers or members.

However, it's important to note that airbag systems are not suitable for all types of fall protection situations. They may not be appropriate for use in areas with limited space or in situations where there are obstacles that could interfere with the deployment of the airbag. Additionally, airbag systems may not provide the same level of protection as other types of fall protection equipment, such as harnesses or guardrails.

airbag systems can be an effective option for fall protection in certain situations, but they should be used with caution and only after a thorough risk assessment has been conducted to determine their suitability for a particular application.

This Project is developed with a reusable wearable airbag to protect the head from fall injuries. The code was developed by using Arduino IDE which is flexible and easy to access. The information to the family members is also possible via webpage through the inbuilt Wi-Fi module. Practically observed if the battery is replaced with the higher capacity the inflation time can be reduced further.

**6.5 Future Scope**

The airbag system for fall protection has the potential to become an important safety technology in many industries that involve working at heights. As the technology continues to improve, it is likely that we will see even more widespread adoption of airbag systems for fall protection.

One area where airbag systems for fall protection could see increased use is in the construction industry. Construction workers are often required to work at great heights, and falls are a common cause of injuries and fatalities in the industry. Airbag systems could provide an additional layer of protection for workers, especially in situations where traditional fall protection equipment may not be sufficient.

In addition to the construction industry, airbag systems for fall protection could also be useful in other industries such as mining, oil and gas, and telecommunications. Any industry that involves working at heights could potentially benefit from the use of airbag systems.

As the technology improves and becomes more affordable, it is also possible that we will see airbag systems for fall protection become more commonly used in recreational activities such as rock climbing and bungee jumping.

Overall, the future scope of airbag systems for fall protection is promising, and we can expect to see continued innovation and adoption of this technology in various industries.

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**Appendix**

|  |  |  |
| --- | --- | --- |
| **SI NO** | **Name of the components** | Amount |
| 1 | NODE MCU ESP32 | 450 |
| 2 | Accelerometer ADXL335 | 520 |
| 3 | Buzzed | 20 |
| 4 | Relay | 150 |
| 5 | Bread board | 30 |
| 6 | 12v adopter ac-dc | 300 |
| 7 | USB | 100 |
| 8 |  | 100 |
| 9 | Others | 200 |
|  |  |  |