POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH

IOT BASED WHEELCHAIR FALL DETECTION

NAME	REGISTRATION NO
AINA RAIHANA BINTI MOHD TAHZIM	**08DEP20F2004**

JABATAN KEJURUTERAAN ELEKTRIK

SESI 2 2022/2023

POLITEKNIK

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This report submitted to the Electrical Engineering Department in fulfillment of the requirement for a Diploma in Electrical Engineering

JABATAN KEJURUTERAAN ELEKTRIK

SESI 2 2022/2023

CONFIRMATION OF THE PROJECT

The project report titled "IOT Based Wheelchair Fall Detection" has been submitted, reviewed and verified as a fulfills the conditions and requirements of the Project Writing as stipulated.

Checked by:

Supervisor's name : Zabidah Binti Haron

Supervisor's signature:

Date : 20 JUNE 2023

Verified by:

Project Coordinator name : Wan Mohd Zamri Bin Wan Ab Rahman

Signature of Coordinator :

Date :

"I acknowledge this work is my own work except the excerpts I have already explained to our source"

1. Signature : 

Name : **AINA RAIHANA BINTI MOHD TAHZIM**

Registration Number : **08DEP20F2004**

Date : 20 JUNE 2023

DECLARATION OF ORIGINALITY AND OWNERSHIP

TITLE : IOT BASED WHEELCHAIR FALL DETECTION

SESSION: 2 2022/2023

1. I, **Aina Raihana Binti Mohd Tahzim** is a final year student of **Diploma in Electrical Engineering, Department of Electrical, Politeknik Sultan Salahuddin Abdul Aziz Shah**, which is located at **Persiaran Usahawan, 40140 Shah Alam Selangor Darul Ehsan**.

   (Hereinafter referred to as 'the Polytechnic').

2. I acknowledge that 'The Project above' and the intellectual property therein is the result of our original creation /creations without taking or impersonating any intellectual property from the other parties.

3. I agree to release the 'Project' intellectual property to 'The Polytechnics' to meet the requirements for awarding the **Diploma in Electrical Engineering** to me.

Made and in truth that is recognized by;

a) **AINA RAIHANA BINTI MOHD TAHZIM**)
(Identification card No: - 020623100314) …...……
) **AINA RAIHANA BINTI MOHD TAHZIM**

In front of me, **ZABIDAH BINTI HARON**) ……
(Identification card No: - 780613015804)) **ZABIDAH BINTI HARON**
As a project supervisor, on the date:

ACKNOWLEDGEMENTS

I gave this project my all. However, it would not have been possible without the kind support and help of many people and organizations. To each one of them, I want to say how grateful I am. I am appreciative of Madam Zabidah Binti Haron's guidance and oversight, as well as the information she provided regarding the Project and helped me with to complete.

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My gratitude and appreciation also go out to my friend who helped me build the Project and those who volunteered their skills to assist me.

ABSTRACT

A fall is among the worst things that may occur to a wheelchair user. With more people utilizing wheelchairs, there is an urgent need for fall detection devices. Due to the rapid advancement of sensor networks and the Internet of Things (IoT), human-computer interaction with sensor fusion has been seen as a viable approach to the issue of fall detection. A device to stop the wheelchair from falling is suggested in this study. The idea for this wheelchair falls detection system is to determine whether the user's position or the algorithm's position suggests a potential fall. The most crucial factor in this study is the ability to identify wheelchair users' movements to ascertain when they require assistance from their loved ones or carers. The initiative asserts that by detecting a person's fall and alerting them by email via a secure application, it can assist in sending help in the event of an emergency. It can assist in avoiding dangers that could endanger life if there is any serious damage. This system's components—a 6-axis MPU6050 Gyroscope/Accelerometer sensor that can be configured to regulate every circuit and its functioning and an ESP8266 NodeMCU wifi module—allow the product to be connected to Blynk applications and controls from as far away as possible.

(Keyword: MPU6050 6-axis Gyroscope/Accelerometer sensor, ESP8266 nodeMCU wifi module)

ABSTRAK

Salah satu perkara paling buruk yang mungkin berlaku kepada pengguna kerusi roda ialah terjatuh. Permintaan untuk sistem pengesanan jatuh adalah kritikal memandangkan peningkatan bilangan orang yang menggunakan kerusi roda. Interaksi manusia-komputer dengan gabungan sensor telah dianggap sebagai penyelesaian yang berkesan kepada masalah pengesanan jatuh kerana perkembangan pesat rangkaian sensor dan Internet of Things (IoT). Dalam penyelidikan ini, gajet untuk mengelakkan kerusi roda terjatuh dicadangkan. Sistem pengesanan jatuh kerusi roda ini digariskan dalam konsep yang direka untuk mengenal pasti sama ada kedudukan algoritma atau kedudukan pengguna menunjukkan kemungkinan jatuh. Pembolehubah yang paling penting dalam kajian ini ialah pengesanan pergerakan pengguna kerusi roda untuk menentukan bila mereka perlu meminta bantuan daripada keluarga atau penjaga mereka. Projek ini membuat tuntutan bahawa ia boleh membantu dalam menyampaikan bantuan sekiranya berlaku kecemasan dengan merasakan kejatuhan seseorang dan memberitahu mereka melalui e-mel menggunakan aplikasi selamat. Sekiranya terdapat sebarang kerosakan yang ketara, ia boleh membantu dalam mencegah bahaya yang boleh membahayakan nyawa. Sensor Gyroscope/Accelerometer MPU6050 6 paksi, yang diprogramkan untuk mengawal semua litar dan operasinya, dan modul wifi ESP8266 nodeMCU digunakan untuk membina sistem ini dan membolehkan menyambungkan produk dengan aplikasi dan kawalan Blynk dari jarak maksimum tertentu.

(Kata kunci: MPU6050 6-axis Gyroscope/Accelerometer sensor, ESP8266 nodeMCU wifi modul)

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CHAPTER 1

1 INTRODUCTION

1.1 Introduction

A fall is defined as an event which results in a person coming to rest inadvertently on the ground or floor or other lower level. Fall-related injuries may be fatal or non-fatal though most are non-fatal. Falling is among the major causes of medical problem that are faced by the elderly and disability people. They tend to be injured by falling more often, especially when they are living alone. When a falling event occurred, medical attention needs to be provided immediately to reduce the risk of faller from getting severe injuries which may lead to death. Based on A fall is defined as an event which results in a person coming to rest inadvertently on the ground or floor or other lower level. Fall-related injuries may be fatal or non-fatal though most are non-fatal [1].

More than nine percent of the population of China was aged 65 or older in 2015 and within 20 years (2017–2037) it is expected to reach 20%1. According to the World Health Organization (WHO), around 646 k fatal falls occur each year in the world, the majority of whom are suffered by adults older than 65 years (WHO, 2018). This makes it the second reason for unintentional injury death, followed by road traffic injuries. Globally, falls are a major public health problem for the elderly. The injuries caused by falls that elderly people experience have many consequences for their families, but also to the healthcare systems and to the society at large [5].

The internet of things (IoT) is a network of interconnected computing devices, mechanical and digital machinery, items, animals, or people that may exchange data across a network without requiring human-to-human or human-to-computer interaction. The Internet of Things (IoT) ecosystem is made up of web-enabled smart devices that use embedded systems, such as processors, sensors, and

communication gear, to gather, send, and act on the data they get from their surroundings. By connecting to an IoT gateway or other edge device, which either sends data to the cloud for analysis or analyses it locally, IoT devices exchange the sensor data they collect. These gadgets converse with other similar devices on occasion, acting on the data they exchange. Although individuals can engage with the devices to set them up, give them instructions, or retrieve the data, the gadgets accomplish most of the job without their help [2].

Several technologies have been developed which utilize webcams to monitor the activities of elderly people. However, the cost of operation and installation is expensive and only applicable for indoor environment. Some users also worried about their privacy issues. Currently commercialized device required user to wear wireless emergency transmitter in form of pendant and wristband. This method will restrict the user movement and produce high false alarm due to frequent swinging and movement of the device.

This project proposed a fall detection system which is cost effective and reliable to detect falls and alert nearby healthcare center or relatives for help and support. For fall detection, accelerometer and gyroscope were used to detect acceleration and body tilt angle of the faller respectively. By coupling accelerometer with gyroscope, the accuracy of the system was improved due to reducing false positives and true negatives. False alarm was minimized due to the device's position mounted on the upper trunk of the user's body. Alert system in form of Short Message Service (SMS) through Gmail was transmitted to the concerned authorities. Moreover, this wearable device requires less implementation cost and provides a quick response. As a result, this fall detection and alert system has sensitivity and specificity respectively.

A fall detection system also known as an assistive device whose main objective is to alert when a fall event has occurred. In a real-life scenario, they have the potential to mitigate some of the adverse consequences of a fall. Specifically, fall detectors can have a direct impact on the reduction in the fear of falling and the rapid provision of assistance after a fall. In fact, falls and fear of falling depend on each other: an individual who falls may subsequently develop fear of falling and, vice versa, the fear of falling may increase the risk of suffering from a fall. Fear of falling has been shown to be associated with

negative consequences such as avoidance of activities, less physical activity, falling, depression, decreased social contact and lower quality of life [3].

An MPU6050 Micro Electro-Mechanical System (MEMS) with a 3-axis Accelerometer and 3-axis Gyroscope will be used in the IOT-based fall detection project. This makes it easier for us to measure a system's or object's acceleration, velocity, orientation, displacement, and many other motion-related parameters. An accelerometer measures a structure's vibration using electromagnetic sensing in this instance, an aircraft. The vibration's force causes the accelerometer to generate an electrical charge that reflects the amount of force applied. The rotational velocity or rate of change of the angular position over time, along the X, Y, and Z axes, is measured by the gyroscope [4].

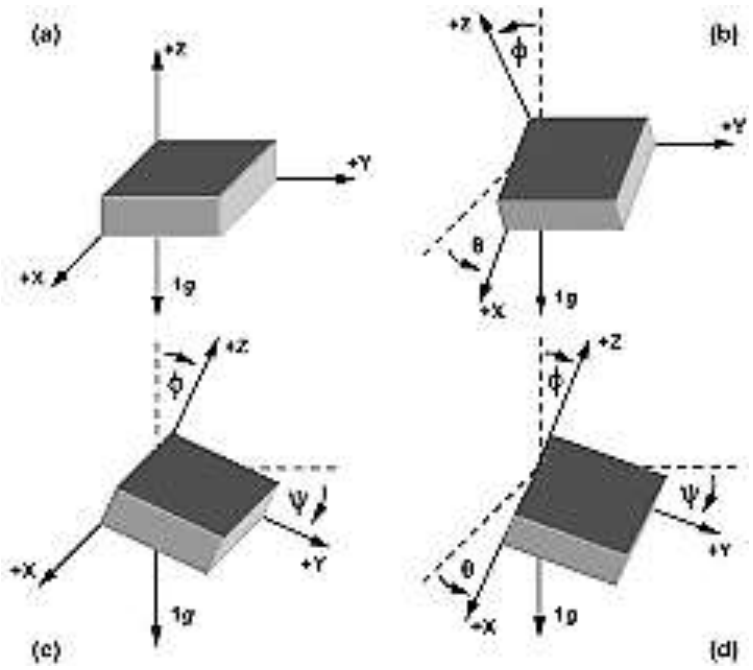


Figure 1.1: Angular Orientation and Acceleration of MPU6050 sensor

1.2 Background Research

Independent-living seniors and people with disabilities have a high likelihood of falling and getting injured. Because no one is aware that the person is falling and becoming unconscious, the faller may sustain more serious injuries. If a falling incident occurs, it is crucial for a response and rescue time. Several technologies are available to assist in detecting falls in elderly people. Another of the systems that detected falls used a webcam to watch elderly people's activities and detect falls. However, only indoor environments can use it because of the high cost of installation and operation. Then, since detecting falls is rather expensive for all tiers of society, improvements must be made to lower that cost rate. Most of the time, commercially available fall detection systems require the user to wear a wireless emergency transmitter, such as a pendant, necklace, or wristband. Wearable technology has limitations, such as the tendency of elderly people to forget to wear them or their inability to use them after falling asleep. A device that can detect falls and automatically call for assistance without the user having to press a button is thus necessary.

Although there are various existing studies which focus on fall detection with individual sensors, such as wearable ones and depth cameras, the performance of these systems are still not satisfying as they suffer mostly from high false alarms. Literature shows that fusing the signals of different sensors could result in higher accuracy and lower false alarms, while improving the robustness of such systems. We approach this survey from different perspectives, including data collection, data transmission, sensor fusion, data analysis, security, and privacy. We also review the benchmark data sets available that have been used to quantify the performance of the proposed methods. The survey is meant to provide researchers in the field of elderly fall detection using sensor networks with a summary of progress achieved up to date and to identify areas where further effort would be beneficial [5].

1.3 Problem Statement

Independent-living seniors and people with disabilities have a high likelihood of falling and getting injured. Because no one is aware that the person is falling and becoming unconscious, the faller may sustain more serious injuries. If a falling incident occurs, it is crucial for a response and rescue time. Several technologies are available to assist in detecting falls in elderly people. Another of the systems that detected falls used a webcam to watch elderly people's activities and detect falls. However, only indoor environments can use it because of the high cost of installation and operation.

Then, since detecting falls is rather expensive for all tiers of society, improvements must be made to lower that cost rate. Most of the time, commercially available fall detection systems require the user to wear a wireless emergency transmitter, such as a pendant, necklace, or wristband. Wearable technology has limitations, such as the tendency of elderly people to forget to wear them or their inability to use them after falling asleep. A device that can detect falls and automatically call for assistance without the user having to press a button is thus necessary.

As illustrated in Figure 1.3, Google Trends2 shows that fall detection has drawn increasing attention from both academia and industry, especially in the last couple of years, where a sudden increase can be observed. Moreover, on the same line, the topic of fall-likelihood prediction is very significant too, which is coupled with some applications focused on prevention and protection. [6]

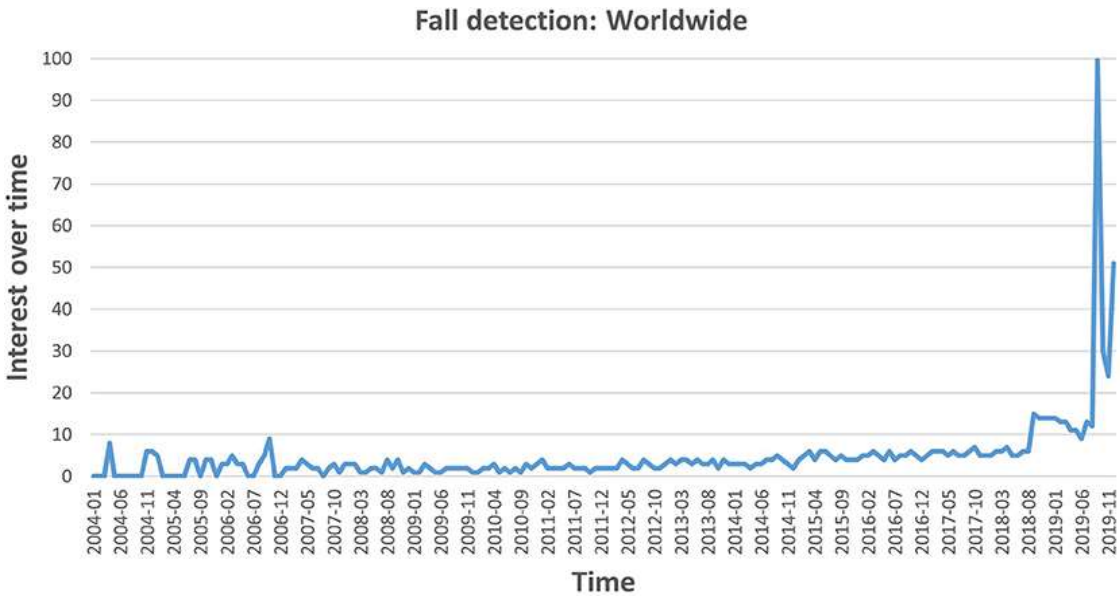


Figure 1.3:. Interest of fall detection over time, from January 2004 to December 2019. The data is taken from Google Trends with the search topic "fall detection." The values are normalized with the maximum interest, such that the highest interest has a value of 100 [6].

1.4 Research Objectives

This project's major goal is to develop a system that can assist wheelchair users in identifying falls from wheelchairs and alerting their guardians. More specifically the principal objective of this research is:

1. To design an intelligent and effective fall detection and alert system using smartphone and wireless sensor node.
2. To implement a reliable and cost-efficient fall detection and alert system.
3. To develop a fall detection system that is user-friendly and helpful in providing quick assistance.

1.5 Scope of Research

To make it simple to monitor and be attentive to the user's condition when they are in a risky scenario, this project's scope is concentrated on patients who are in hospitals and on those who have family who use private wheelchairs. Additionally, the primary goal of this project is to design an algorithm for a fall detection and notification system that makes use of an accelerometer and gyroscope. To measure the velocity amplitude, this project used three-axis measurements from either the gyroscope or accelerometer sensor. Project will be completed within 35 days, cost of developing project is RM200.00, hardware resources are available for three months.

1.6 Project Significance

A chair with wheels is referred to as a wheelchair. The device comes in many designs that allow for electric propulsion by motors or manual propulsion by the sitting occupant manually turning the rear wheels. Behind the seat, there are frequently handles to allow different people to push. One of the most popular assistive devices to boost mobility and improve quality of life for those who have trouble walking is the wheelchair. For the user and their caregiver, wheelchairs promote mobility and independence, enabling them to participate in daily activities while having limited mobility. A wheelchair not only makes it easier for you to complete everyday duties, but it also has many positive social and mental health effects. A wheelchair is a chair with wheels that facilitates mobility. People with disabilities that restrict their ability to walk use it.

The primary goal of my project is to enable wheelchair users to receive immediate aid from their guardians by reducing the duration of an emergency notification or warning alarm, making it simple to use, and conserving energy by identifying the wheelchair user's position using sensors. Additionally, if there is a major injury or risk to the victim's life, it can eliminate any risk to the user. The website also receives the user position data to record and notify users of emergency alerts. The data that was obtained was also sent to Blynk Application for record and analysis purposes.

1.7 Chapter Summary

In this chapter, I've provided a summary of the impending project, gone into detail about the history of the initial idea that sparked this project, and discussed the difficulties that came up, like how difficult it is to seek assistance when a wheelchair user falls out of his chair. In addition, I discussed the project's goals. The main objective of this project is to assist in sending warnings or emergency warnings to their carers simultaneously to reduce the time it takes to get aid, save money, and make it easier to use. I also recall the significance of the project based on the goals of the study. I'm hoping that a huge number of people, especially those who regularly use wheelchairs, will get something from our effort.

CHAPTER 2

2 LITERATURE REVIEW

2.1 Introduction

To maximize relevance, creativity, generalizability, and effect, high-quality medical education research starts with a thorough literature assessment. A literature review provides context, guides approach, fosters creativity, reduces duplication of effort, and ensures adherence to standards set by the field. Iterative literature reviews should be carried out at various stages of the research procedure. The best use of resources should be made by researchers, including human resources, search engines, and current publications.

A thorough investigation of prior work and associated data will significantly advance the subject of study. The 6-axis notion, namely 3-axis acceleration magnitude and 3-axis gyroscope orientation in this chapter, is used to quantify how far the detecting system falls while someone is seated. This fall detector's advantages include its ability to detect wheelchair users falling from their chairs, rechargeability, increased efficiency, and sensitivity. On the internet, there are numerous sources of information about IOT-Based Wheelchair Fall Detection. The material obtained includes suggestions on current strategies as well as illustrations of various viewpoints. Therefore, the theory is supported and justified by a large body of prior research. The component hardware used in the project is also identified and examined in this literature review.

2.2 Fall detection Challenges in wheelchair application

The accuracy and dependability of fall detectors must be as high as possible. High sensitivity and specificity are characteristics of a reliable fall detection system. This is occasionally attained in test situations, but when used in actual circumstances, the detection rate drops. It is also important to note that fall detectors are intended for older or disabled people, thus these groups should be involved in their creation. Even when their involvement is restricted to a few minutes or a few hours of a set of simulated daily routines. To evaluate the system's performance in a practical setting, that is insufficient. The devices should be worn by users more frequently.

Additionally, false alarms do occur occasionally, which means that the user of the fall detection device may occasionally move in an extreme manner, leading to a significant change in the user's position. As a result, this false alarm can be quite frustrating and lead to people giving up on the device altogether because they view it as a distraction from their daily lives or the lives of their family members or guardians. Additionally, false alarms do occur occasionally, which means that the user of the fall detection system may occasionally move in an extreme manner, changing their posture significantly. Because of how frustrating this false alarm can be, some users may decide to stop using the device altogether if they feel it is interfering with their daily lives or the lives of their family members or guardians.

2.2.1 Previous Research

A fall detection sensor system uses a sensor device, a hardware that detects the body position and motion, which then communicates with the system (the software part) to send out an emergency SMS to the contact person if falling is detected. design an android-based fall detection sensor system at affordable cost for the elderly in Malaysia. Some limitations of this system are the threshold value setting of the system, the system will only detect freefall when the threshold value during freefall match with the threshold value set in the system. If the threshold value during freefall is less than the threshold value set in the system, the system will not detect freefall because the condition does not fulfil.

Development in the fields of wireless sensor technology and smart phones have paved a new way to the wearable fall detection system. As there are many ongoing efforts that are taking place in the field of patient fall detection system [PFDS] especially on the wheelchair. Various researchers have used ADXL335 accelerometer sensor which leads to the complexity of the system and the technologies for monitoring a person's position on the wheelchair. Furthermore, an IoT Cloud based Patient Fall Detection System (PFDS) using tilt sensor SW-520D, Texas Instruments CC3200 and GSM module for wireless communication that includes Geo Tagging. The developed system is less complex, reliable, and cost-effective.

In producing this project, we can also use the Arduino platform which processes the signal from the sensor. The Arduino UNO was chosen due to its cost and effectiveness. The accelerometer MPU-6050 was chosen due to its low cost, easy to mount and requires only 3-analogue connections with less power consumption, taking up to 5V. The chip has a 6-axis device that combines a 3-axis gyroscope, 3-axis accelerometer, and a Digital Motion Processor (DMP) which processes the data inside. DMP helps lower system power consumption by allowing the system processor to read the sensor data in bursts and then enter a low-power mode as the MPU collects more data.

In addition, the use of a single sensor such as an accelerometer can be used as a device that measures the acceleration or rate of change of velocity of a body in its instantaneous rest frame. Single-axis and multi-axis models of the accelerometer are available to detect the magnitude and direction of the proper acceleration, as a vector quantity. Data from accelerometers can be used in machine learning, statistical models or threshold-based for fall detection. The prototype used Bluetooth technology to communicate with the main computer which processes the data, constraining the versatility of the device.

Other than that, the use of accelerometer and gyroscope sensor d a load sensor in the case of wheelchair. These sensors measure the orientation of the person, their speed and their weight. These sensors are calibrated under standard conditions and when a person falls down, and a threshold is determined. These threshold values are taken as a reference value to compare against the incoming readings from the sensors. If a major deviation is measured from the reference value, then we can assume that the person has fallen. Since the main aim is to provide help to the person as soon as possible an alert is sent to the concerned person in the form of a message informing them about the condition. An alarm also goes off to notify people nearby to get their attention and receive help.

Next, they used accelerometer and gyroscope sensors to monitor and detect movement in the user. The accelerometer and gyroscope sensors function to take every movement of the elderly and supported by GPS technology in getting the coordinates to be able to monitor the falling movement of elderly people. The sensors will be placed on the right side of the waist, in the form of a box that has Accelerometer sensor and Gyroscope. When the user is on the move, the application will retrieve the Accelerometer and Gyroscope data. After that, the system receives input in the form of coordinates to be provided by GPS Module, and SIM 800L mounted on Arduino and sensor MPU6050. Elderly coordinates are obtained from GPS Modules that have been assembled on Arduino.

Table 2.1: Comparison Table of Previous Literature Reviews Research

Articles/ Journals	**Fall Detection Sensor System for Elderly (2015) [6].**	**Based Patient Fall Detection System with Geotagging Using Tilt Sensors and Texas Instruments' CC3200 (2019) [7].**	**Glass-Break Detector Using Accelerometer (2018) [8].**	**A Smartphone-Based Online System for Fall Detection with Alert Notifications and Contextual Information Of Real-Life Falls (2021) [9].**	**Real-Time Monitoring System for Elderly People in Detecting Falling Movement Using Accelerometer And Gyroscope (2018) [10].**
Author	Alicia Y.T. Tang, Azhana Ahmad,Chin-Hao Ong	K. Evangili Supriya and K. Raghavendra Rao	Vaclav Mach, Jan Valouch, and Milan Adamek	Yaar Harari1, Nicholas Shawen, Chaithanya K. Mummidisetty , Mark V. Albert , Konrad P. Kording and Arun Jayaraman	B Siregar1, U Andayani1, R P Bahri1, Seniman1 and F Fahmi2
Sensor	ADXL345 Accelerometer	SW-520D Tilt Sensor	accelerometer MPU-6050	-	Sensor MPU6050
Objective	The purpose of this project is the system is expected to help the elderly to call the ambulance when they fall at home and unable to stand up.	The developing Patient Fall Detection System (PFDS) using a low-cost sensor SW-520D based on GeoTagging makes it for the general public and the wireless system for monitoring the patient position on the wheelchair and adjustable bed.	The propose of this project is to prevents the object against the potential intruder. This system is called the Intruder Alarm System (IAS). It is part of the technical security which brings a lot of advantages that the physical security.	a system providing real-time monitoring of falls and near-falls could lead to emergency alerts for immediate medical attention, as well as provide data for post-hoc systematic analysis to develop improved, personalized fall prevention strategies.	This study aims to detect daily activities such as walking, running, and supine using the method of Decision Tree and naïve Bayesian. By using the accelerometer, data will be done pattern recognition process to recognize user activity called Activity Recognition.

Hardware/ software	Arduino UNO, SIMCOM SIM900 Quad-band GSM GPRS Shield Development Board, Arduino Programming Language	CC3200 XL-Launchpad, GSM SIM 900A MODULE, Integration of Sensors with Microcontroller and Cloud, Thing Speak Cloud (MATLAB SOFTWARE)	Arduino UNO	Purple Robot app(sensor data collection app),	Arduino Uno, SIM800L, GPS NEO6M, LM2596, Power Scheme
Method	This project use Arduino controller board based on ATmega328, and SIMCOM SIM900 Quad-band GSM GPRS Shield Development Board. The sensor that has been use is ADXL345 accelerometer. Fall detection sensor system will detect the falling through the algorithm system and then trigger the alarm	This project used microcontroller where it used to acquire the sensors data and uploaded the values to thing speak cloud and these values are stored in the cloud and the graphical representation of both sensors data and the location of the patient is tracked by using Geotagging.	The glass detector in sound and vibration. The Arduino UNO platform use as the main microcontroller (microcontroller MPU-6050) which processes the signal from the sensor. It also uses accelerometer MPU-6050 and calibration method for every axis and direction of the velocity.	The system tracks participant movement using the smartphone's accelerometer and gyroscope and uses a regularised logistic regression to identify falls. A cloud server stores data on falls and near-fall events (i.e., stumbles), and a web portal developed for data exploration is used to log fall-related variables, including the event date and weather, likelihood of falling, and the faller's location and prior activities.	This system uses Arduino as a microcontroller to monitor real-time movement in real-time and for data communication using GSM / GPRS network and provider card that serves to measure falling movement of the elderly person with the data from the sensor collected and analysis which position is the user.

Data/ Result	The RGB LED light blinks red and blue colours continuously and the buzzer triggers alarm simultaneously for 15 seconds when the ADXL345 accelerometer moving to the certain position. Then the alarm will be send to the	If the patient is tilted, then GSM will send an alert to the mobile number and also the real time data of sensors can be downloaded from thing speak in the form of .CSV file. CC3200	The accelerometer was able to detect an even small amount of vibration which can be produced by the potential intruder. The final system is composed of the accelerometer MPU-6050 with the Arduino UNO. This concept also provides the cost efficiency because to just one Arduino UNO can be connected several accelerometers which can communicate on one bus.	The fall detection system records a classification of the faller's activity in the 60 s before the fall, currently based on Google's activity recognition API. The system predicted the following activities before the falls like faller was standing, tilting, where the angle relative to gravity changed significantly.	The accuracy of sending notification data to the server is 100% and the accuracy of sending data to family notification in the form of SMS equal to 93.75%. The system successfully detects the direction of falling: forward, backward, left, or right and able to distinguish between unintentional falling and conscious falling like a bow or prostrate position based on acceleration moment of falling.

2.3 Control System

Using control loops, a control system manages, commands, directs, or regulates the behavior of other devices or systems. It can range from a single home heating controller controlled by a thermostat to big industrial control systems used to operate processes or machinery. Control systems are created through the control engineering process. A feedback controller is used to automatically control a process or operation for constantly modulated control. The control system compares the value or status of the process variable being controlled to the desired value or setpoint and uses the difference as a control signal to bring the plant's process variable output to the setpoint. Software

logic, such as that found in a programmable logic controller, is utilized for sequential and combinational logic [12].

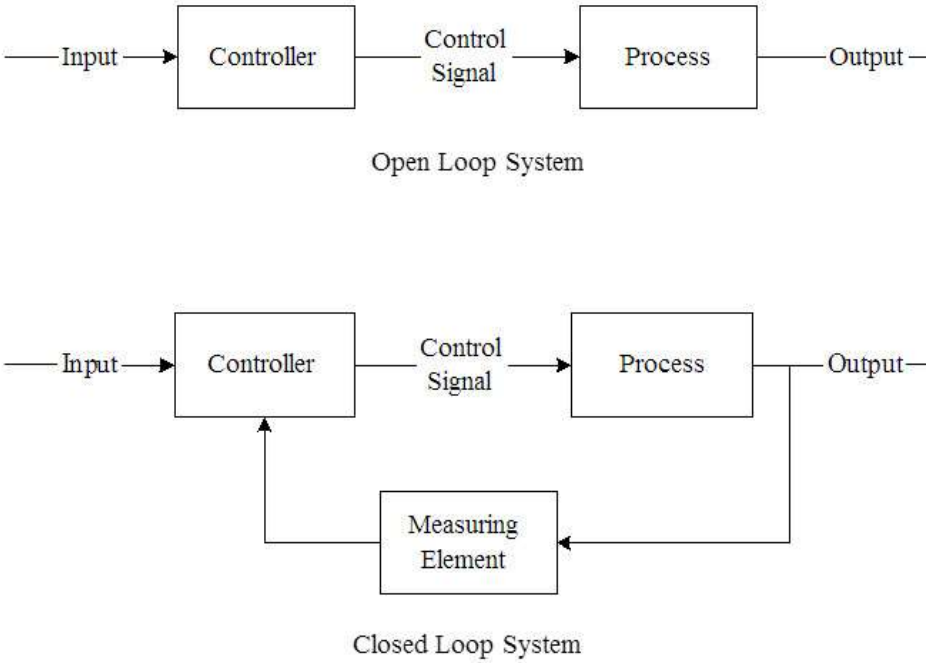


Figure 2.1: Block diagram of open loop and closed loop system

2.3.1 NodeMCU ESP32 Wi-Fi Module

The ESP8266 Wi-Fi Module is a self-contained SOC with an inbuilt TCP/IP protocol stack that can provide access to your Wi-Fi network to any microcontroller. The ESP32 may host applications or offload entire Wi-Fi networking tasks from another application processor. Each ESP32 module comes pre-programmed with an AT command set firmware, which means we can just connect it to our Arduino device and receive almost the same Wi-Fi-ability as a Wi-Fi Shield right out of the box. The ESP8266 module is a low-cost board with a large and rapidly increasing community [13].

2.3.2 MPU6050 6-axis Gyroscope/Accelerometer sensor

The MPU-6050 is the world's first and only 6-axis motion tracking device designed for the low power, low cost, and high-performance requirements of smartphones, tablets, and wearable sensors. MPU6050 is a Micro Electro-mechanical system (MEMS), it consists of a three-axis accelerometer and three-axis gyroscope. It helps us to measure velocity, orientation, acceleration, displacement, and other motion like features. MPU6050 consists of Digital Motion Processor (DMP), which has the property to solve complex calculations [14].

2.3.3 LEDs

A light-emitting diode (LED) is a semiconductor device that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor.[5] White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device. The use of various LED colors can be used as different signals [15].

2.3.4 Buzzer

When a voltage is applied across the two electrodes, the piezoelectric material mechanically deforms due to the applied voltage. This movement of the piezo disk within the buzzer creates sound in a similar manner to the movement of the ferromagnetic disk in a magnetic buzzer or the speaker cone mentioned above [16].

2.4 Chapter Summary

The findings on determining the type of sensor or component that will be utilized for fall detection from wheelchairs are discussed in the first section of

this chapter along with a synopsis of the research papers that were used to design the project. Information about the technical component, including the controller type selected, is revealed in the second section. The analysis and justification of the technologies or methods used by earlier researchers to address the problem statement are also summarized in this chapter. The NodeMCU ESP32 Wifi Module will serve as the project's primary controller.

CHAPTER 3

3 RESEARCH METHODOLOGY

3.1 Introduction

To realize this Project as a product that ready to use with safety characteristic, a very comprehensive plan is undertaking. A step-by-step procedure is done so that the Project can be completed in time. This includes collecting data of sample user positions, design the mechanical part, circuit design testing and verification. Research methodology is the general term for the "how" of any given piece of research. It primarily concerns how a researcher plans a study in a methodical way to get accurate and reliable results that address the goals and objectives of the research.

To realize this project as a ready-to-use product with safety features, a highly thorough approach is being taken. To make sure the project is finished on time, a step-by-step process is used. This entails obtaining information from many perspectives, constructing the component to act as a transmitter and receiver of motion data from the MPU6050 sensor, testing the circuit design, and checking the results.

3.2 Project Design and Overview.

As mentioned in the previous chapter, the designed controller uses a closed-loop system with ESP8266 Wi-Fi Module as the main controller. The design of the controller circuit using NodeMCU ESP32 Wi-Fi Module realizes using Proteus Software and then convert to PCB circuit.

3.2.1 Block Diagram of the Project

A high-level flowchart of the kind used in engineering is a block diagram. It is employed to develop new systems as well as to clarify and enhance existing ones. Its structure provides a high-level overview of the main system elements, crucial process players, and important working relationships.

The block diagram for IOT Based Wheelchair Fall detection is shown in diagram 3.2.1 below. The motion data, which will fluctuate in response to the wheelchair user's position, makes up the first data input. Then the buzzer will bus when falls detected while LED light up as a sign. Finally, a web application such as Gmail will also be used to send a note when the height threshold has been exceeded, indicating that the wheelchair user is facing a significant change in his position. The information will be collected by the MPU6050 sensor and will be sent to blynk Apps through NodeMCU ESP32 Wi-fi module.

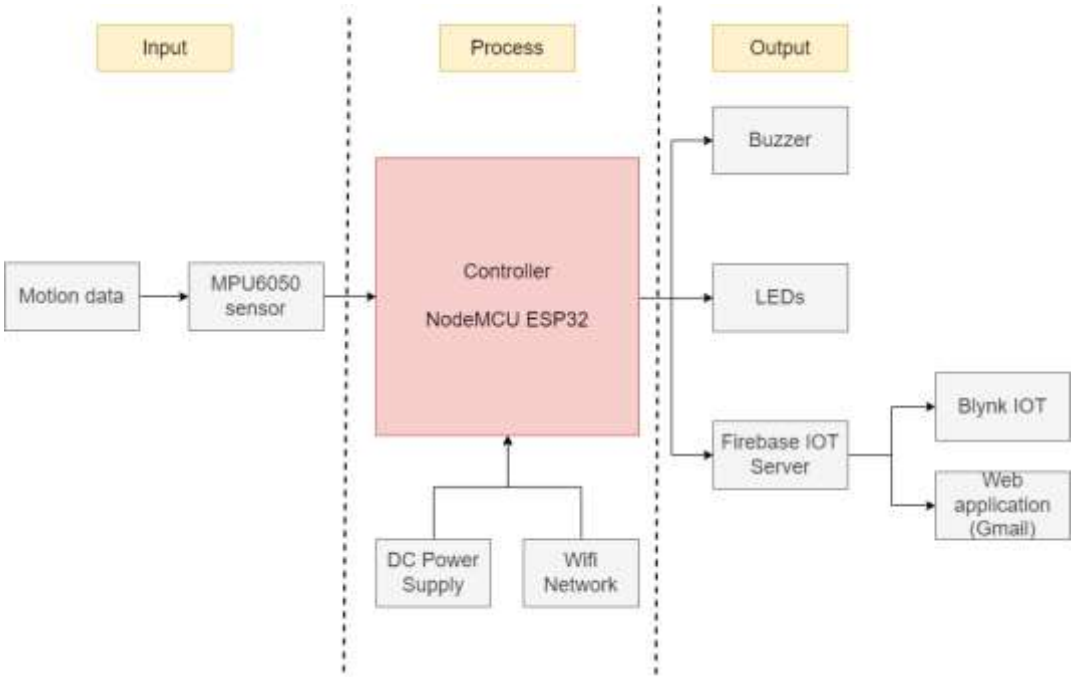


Figure 3.2.1: Block diagram of IOT Based Wheelchair Fall Detection Project

3.2.2 Flowchart of the Project 2

A pictorial representation of a procedure, system, or computer algorithm is called a flowchart. They are regularly used to represent frequently complex processes in simple, understandable diagrams and to document, analyze, plan, improve, and convey them in several professions. Rectangles, ovals, diamonds, and maybe other shapes are used in flowcharts, also known as flow charts, to represent the type of step, and connecting arrows are used to define flow and sequence. Simple hand-drawn charts and intricate computer-drawn diagrams showcasing various processes and paths are both acceptable forms of them. Given the variety of flowcharts available, it is no surprise that they are one of the most widely used diagrams in the world, being utilized by both professional and non-technical people in a wide range of professions.

Figure 3. shows the circuit diagram of the whole system. It is shown that the gyroscope and accelerometer positions, which will fluctuate in response to the wheelchair user's position, make up the first data input. Then it will be assessed whether each motion detection data set passes the three thresholds of threshold 1, threshold 2, and threshold 3. A fall is identified when there is an abrupt change in motion within 10 seconds. Finally, a web application such as Gmail will also be used to send a note when the height threshold has been exceeded, indicating that the wheelchair user is facing a significant change in his position. The information will be collected by the MPU6050 sensor and will be sent to Blynk Apps through NodeMCU ESP32 WIFI Module.

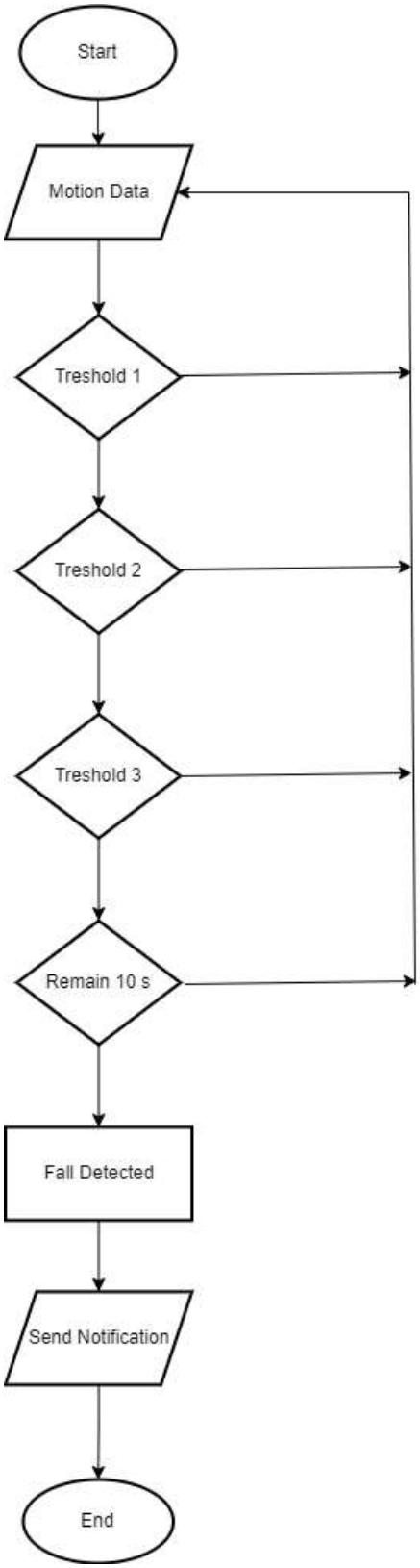


Figure 3.2.2: Flowchart of operation of IOT Based Wheelchair Fall Detection Project

3.2.3 Project Description

The gyroscope and accelerometer positions, which will fluctuate in response to the wheelchair user's position, make up the first data input. Finally, a web application such as Gmail will also be used to send a note when the height threshold has been exceeded, indicating that the wheelchair user is facing a significant change in his position. The information will be collected by the MPU6050 sensor and will be sent to Blynk Apps through WIFI Module ESP32 NodeMCU to send notification.

3.3 Project Hardware

The main controller, as mentioned in the previous chapter, is also summarized in this chapter. The NodeMCU ESP32 Wifi Module. The transmitter and receiver will be used to measure the gyroscope and accelerometer angle. The receiving angle data of the user's end will be detected by the MPU6050 6-axis Gyroscope/Accelerometer sensor. The received data is then sent to the also summarized in this chapter. The NodeMCU ESP32 Wifi Module then processes the data from the sensor, and the data is then sent to a Wi-Fi module. It is a Wi-Fi module and one of the major platforms for the Internet of Things. It can send data to the IoT cloud or web server.

Table 3.3: Movement of Body Motion (example)

Time	Body motion	Threshold 1	Threshold 2	Threshold 3	LED

3.3.1 Schematic Circuit

Figure 3. shows the overall circuit diagram of this Project IOT Based Wheelchair Fall Detection displays the project's overall circuit architecture. The brains of this project are the also summarized in this chapter. The NodeMCU ESP32 Wifi Module. A power bank that contains a highly suitable voltage source for the project will be used to power the two electrolytic capacitors, one resistor, and two LEDs and the also summarized in this chapter. The NodeMCU ESP32 Wifi Module. The ESP8266's 3.3v pin is used to link the MPU6050 6-axis Gyroscope/Accelerometer sensor's VCC pin because the sensor's input voltage is 3V3. then, on the also summarized in this chapter. The NodeMCU ESP32 Wifi Module, the serial data (SDL) pin is connected to pin D2, and the serial clock (SCL) pin is connected to pin D1.

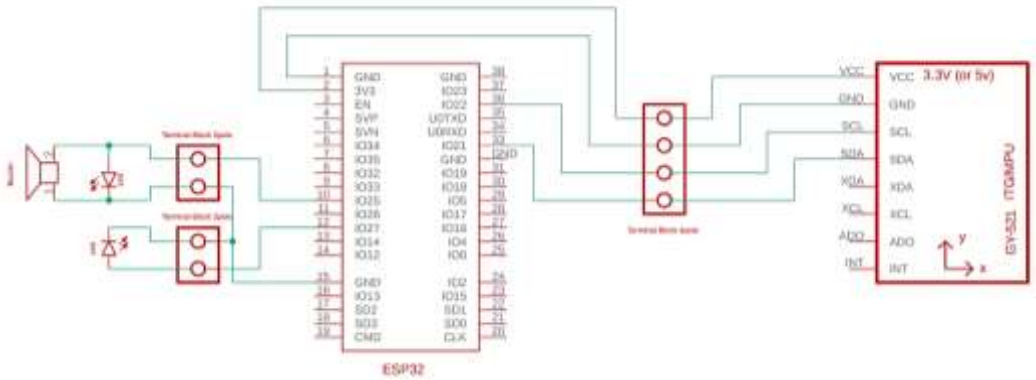
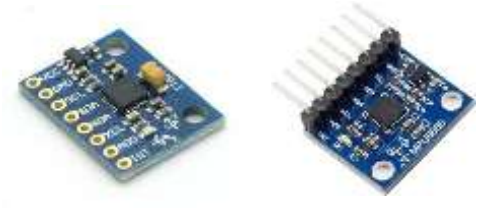


Figure 3.3.1: Circuit Diagram of IOT Based Wheelchair Fall Detection

3.3.2 Description of Main Component

The MPU6050 6-axis Gyroscope/Accelerometer sensor serves as a data source to recognize changes in the wheelchair user's position based on changes in gyroscope position and acceleration, and the also summarized in this chapter. The NodeMCU ESP32 Wifi Module functions as the project's brain. The buzzer and LED are additional tools that serve as signals for whether the user falls off the wheelchair.

3.3.2.1 MPU6050 6-axis Gyroscope/Accelerom eter sensor



It has both a 3-Axis accelerometer and 3-Axis gyroscope integrated on a single chip. The gyroscope measures rotational velocity or rate of change of the angular position over time, along the X, Y and Z axis. There are two ways to extract useful data from the MPU6050. One way is to read the raw sensor data values, as we did during calibration process, and use that data to compute the new orientation. The second method is to pull the data out of the MPU's onboard Digital Motion Processor (DMP) [17].

3.3.2.2 NodeMCU ESP32 Wifi Module

NodeMCU is a microcontroller development board with wifi capability. It uses an ESP32 microcontroller chip. It is better Processor & Memory. NodeMCU comes with an 80MHz of clock speed and 4MB of flash memory. Built-in TCP/IP Stack - IoT Ready: The NodeMCU contains a Wifi connection and can connect to the internet through Wifi. It is best suited for IoT applications. NodeMCU is an open-source platform based on NodeMCU ESP32 Wifi Module which can connect objects and let data transfer using the Wi-Fi protocol. In addition, by providing some of the most important features of microcontrollers such as GPIO, PWM, ADC, etc, it can solve many of the project's needs alone [18].

3.3.2.3 LEDS

The electrons and holes are confined inside energy bands inside the semiconductor material of the LED. The energy of the photons (light particles) that are released by the LED depends on how far apart the bands are, or what is known as the bandgap. The wavelength of the light emitted, and consequently its colour, are determined by the photon energy. Light of various colours is produced by various semiconductor materials with various bandgaps. By adjusting the makeup of the light-emitting, or active, region, the specific wavelength (colour) can be changed [19].

3.3.2.4 Buzzer

A buzzer is a kind of voice device that converts audio model into sound signal. It is mainly used to prompt or alarm. Typical applications include sirens, alarm device, fire alarm, air defense alarm, burglar alarm, timer, etc. A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, train, and confirmation of user input such as a mouse click or keystroke [20].

3.3.3 Circuit Operation

As has been stated before, wheelchairs provide increased mobility and independence for the user and their carer, allowing them to take part in everyday activities, despite having reduced mobility. As well as helping you carry out daily tasks with ease, a wheelchair offers many social and mental health benefits.

The power bank serves as the voltage source for the NodeMCU ESP32 Wifi Module and sensor in this project. The MPU6050 sensor module has an accelerometer and gyroscope sensor. The accelerometer provides information about the angle, such as X, Y, and Z-axis data, while the gyroscope determines the orientation. We will contrast the amplitude of the acceleration with the threshold value to identify the fall. The gadget notifies the person in question via email and notification if a fall is detected. Here, a microcontroller and Wi-Fi module called NodeMCU ESP32 Wifi Module are used to communicate with the Blynk IoT App and send notices. At the same time, the buzzer will buzz, and LED will light up for 30 seconds. On the Blynk Apps widget page, there are two different kinds of LED colors: blue and yellow, with blue acting as a red LED and yellow as a green LED.

3.4 Project Software

With the Proteus programme, we are simulating this circuit in this project. The Arduino software is the next piece of software we utilize to design the coding for our project. Proteus can design a circuit before we start prototyping. By simulating the circuit and ensuring that current flows into every component we have, this software can help us. This is also to make sure that each component performs as it should. Because it enables us to test the programme in software before testing it on the prototype, it can also assist us in protecting our component from overvoltage because it allows us to test it in software before testing it on the prototype. Besides by using AutoCAD to draw prototype diagram where plan on making hardware design.

3.4.1 Flowchart of the System

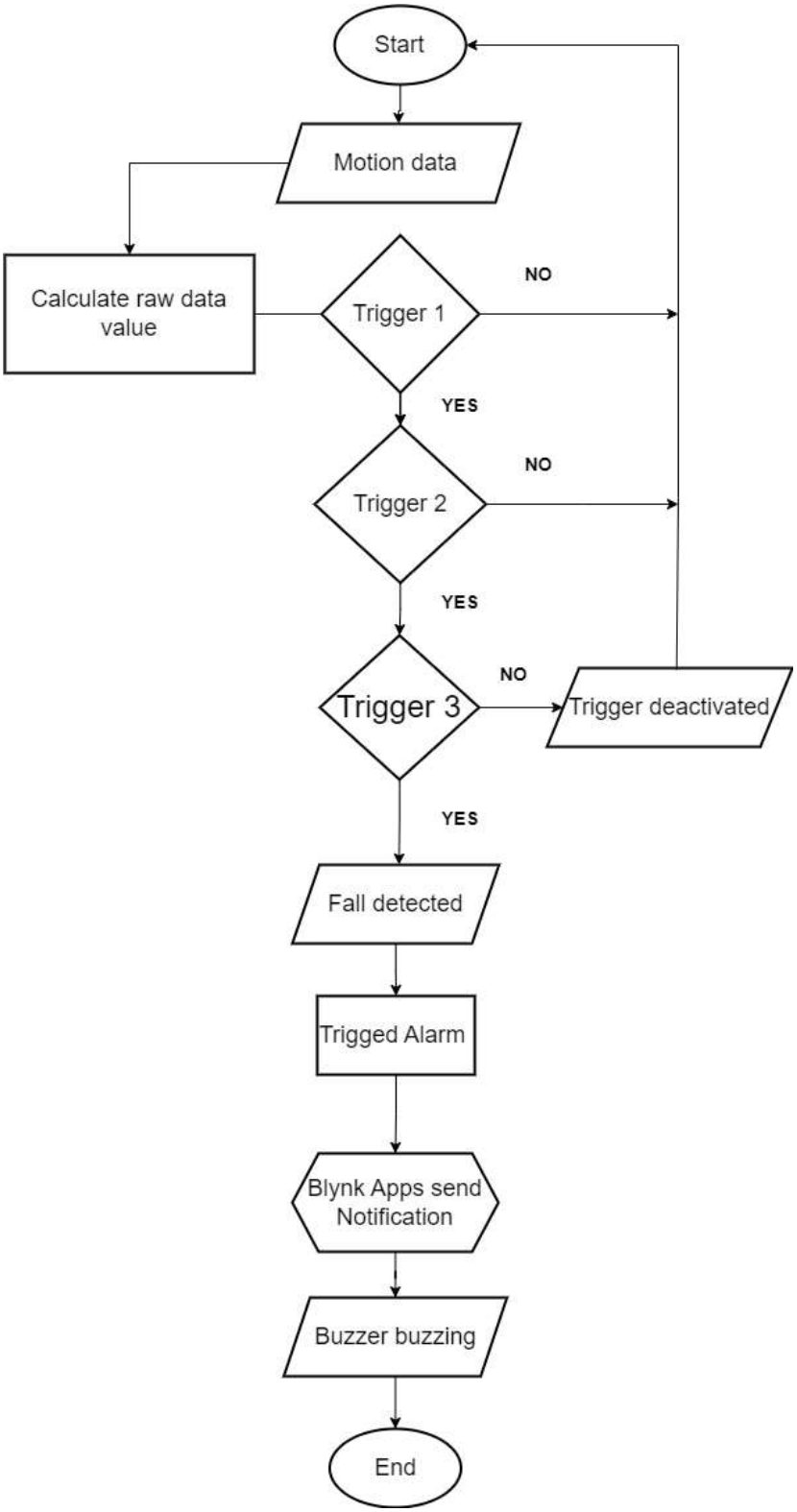


Figure 3.4.1: Flowchart of the System of IOT Based Wheelchair Fall Detection Project**.**

3.4.2 Description of Flowchart

The three common axes (yaw, pitch, and roll) and the 3-axis accelerometer make up the six-axis gyro sensor. This gives the device a total of six axes. There are 6-axis sensors on the market that incorporate a magnetometer and an accelerometer rather than a gyroscope. Being a three-axis gyro with a three-axis accelerometer, which detects acceleration in three axes, a six-axis gyro is a little misnomer (x, y, and z). These sensors can be used to detect which way is down in relation to the sensor since they can sense the acceleration caused by gravity.

The amplitude vector of the acceleration values will be calculated and examined when the sensors' values for acceleration and gyroscope are obtained. The program that has been set into NodeMCU ESP32 Wifi Module will first determine whether the acceleration value exceeds the lower threshold; if so, it waits a half-second before determining whether the upper barrier is met. The change in orientation for the gyroscope value is calculated if the acceleration value exceeds the upper threshold. When an abrupt shift in orientation occurs, it waits 10 seconds before checking to see if the orientation has not changed. In that case, a notice is activated, and an email is sent to the specified email address.

As the internet id has been set in the programming run, Blynk Apps will record all fall detected history data along with a timeline demonstrating that the project is operational and linked to the hotspot line from the mobile phone. On the Gmail website as well as the Blynk Apps page, alert alerts will be triggered and shown.

3.5 Prototype Development

A prototype is simply a look-alike or a duplicate of a part that portrays the product's attributes and explores all possible results before investing in the full creation of the part. A prototype can be anything from a detailed hand-drawn illustration on paper to a functioning example of the product. Prototype development is therefore essentially a collection of procedures used by the producer to build the prototype. Production and development of prototypes are commonly confused.

3.5.1 Mechanical Design/Product Layout

Figure .5.1 shows the design of the product how the circuit that has been mounted on the PCB board will be housed in a prototype box. This prototype will be worn on the user's waist because the area above the human waste has a small range of motion, which is more suitable to collect acceleration and angular velocity data to distinguish falls from ADLs., where a belt will be used to secure it. Additionally, it can provide a position of the user more accurately than if it can be placed on other parts of the body, such as the hand, because frequent hand movements can result in false notification. Additionally, if the device is placed on any part of the wheelchair, it may change the wheelchair's position when the user falls, but the wheelchair stays in its position in some cases.

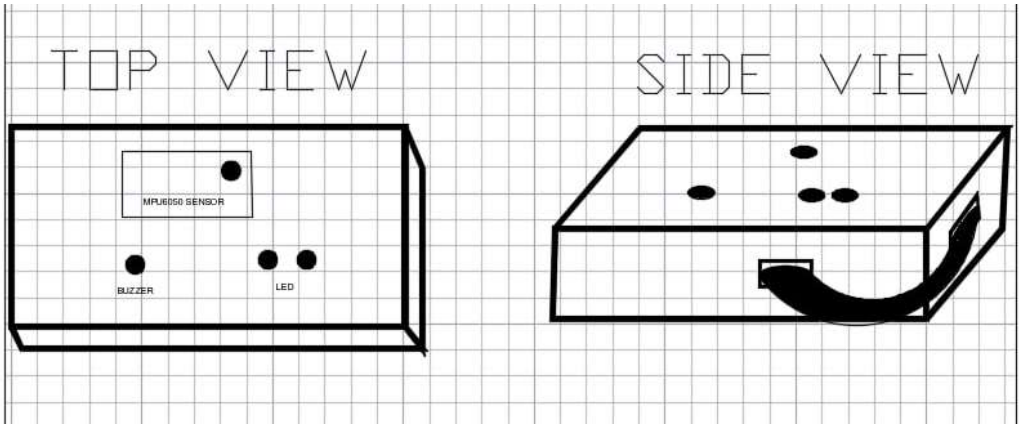


Figure 3.5.1: Front view of the Project

3.6 Sustainability Element in The Design Concept

A wheelchair is a chair with wheels to help people move around. It is used by individuals who have impairments that limit their ability to walk. It typically consists of a seat supported on two large wheels attached towards the back of the seat and two small wheels (casters) in front near the feet, a good braking system, footrests, and a cushion. There are often small additional features to prevent toppling or to assist in mounting curbs. The user moves by pushing with his/her hands circular bars on the outside of the large wheels, known as the hand-rim or push rings.

The sense motion data by using the low-power chips and the MUP6050 sensor integrated with the three-axial accelerometer and the three-axial gyroscope. Based on the interrupt function of MPU6050, a low-power algorithm is developed to control the module's data sensing process and the data transmission process.

This project uses an IOT-based wheelchair fall detection system that is low-cost and ecologically friendly to design and produce. Because lipo batteries are used, they have an energy density that is roughly four times greater than that of nickel cadmium or nickel metal hydride batteries. LiPo batteries are extremely flexible, lightweight, and safe to use. They may be produced in practically any size or shape. Additionally, they have no effect on the environment. The goal of this research is to develop a fall detector that can quickly and cheaply identify falls among wheelchair users. This project will function more delicately and

effectively, has a basic design, and incorporates an entire system into one package. The component's easy placement and use by the user are also indicated by the design, which also indicates that it is a prototype. Additionally, this project showcases the advancements made in IOT Wheelchair Fall Detection, with a focus on the most recent discoveries regarding the development of sensors and circuits that are more precise and accurate as well as straightforward and user-friendly. This project's design is easily adaptable to any model or research objective needed at a low cost.

3.7 Chapter Summary

This chapter detailed the project design and overview, including a flowchart of the project and a block diagram of the project. Aside from that, this chapter discusses the component used in this project. The system will have a transmitter and receiver component that will be connected end to end of the fiber and will use the MPU6050 6-axis Gyroscope/Accelerometer Sensor. We will integrate all of the components from the previous circuit into a single circuit. This project's heart will be the NodeMCU ESP32 Wifi Module.

CHAPTER 4

4 RESULTS AND DISCUSSION

4.1 Introduction

An overview of the collected data is a data analysis. To uncover patterns, correlations, or trends, data must be interpreted using logical and analytical thinking. This chapter will concisely provide and explain the project's findings and analyses. Tables show how quickly the system responds to receiving and delivering data, or to unexpected changes in movement. I think that all the findings and analyses in this chapter have achieved the goals of the research that were previously described.

4.2 Results and Analysis

4.2.1 Final Product

Figure 4.2.1 (a): Top View

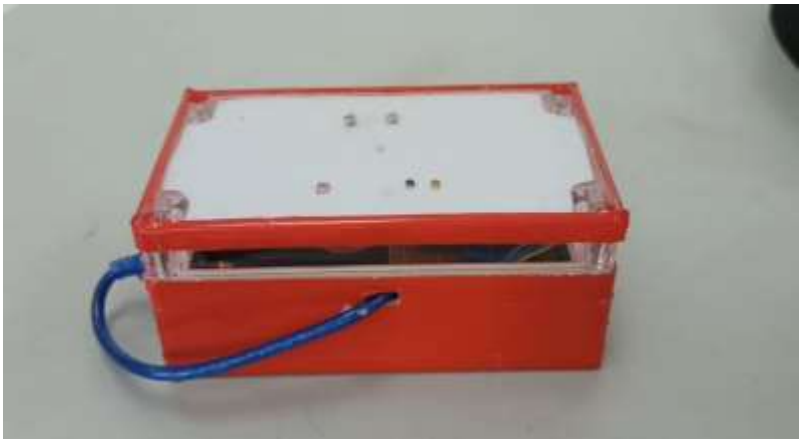


Figure 4.2 (b): Front View

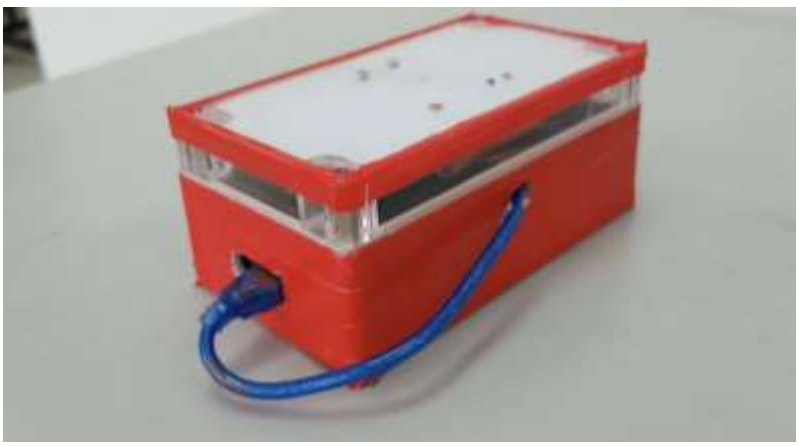


Figure 4.2 (c): Side View

4.2.2 Blynk Apps

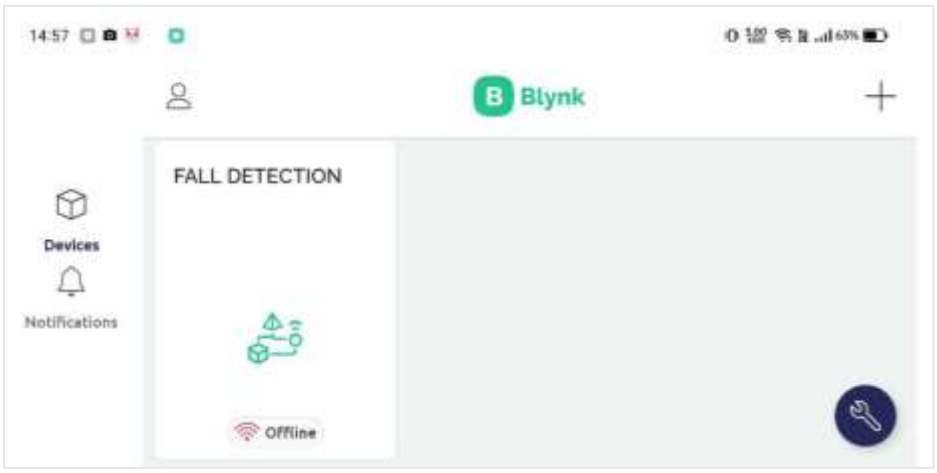


Figure 4.2.2 (a): Main Page Blynk Apps

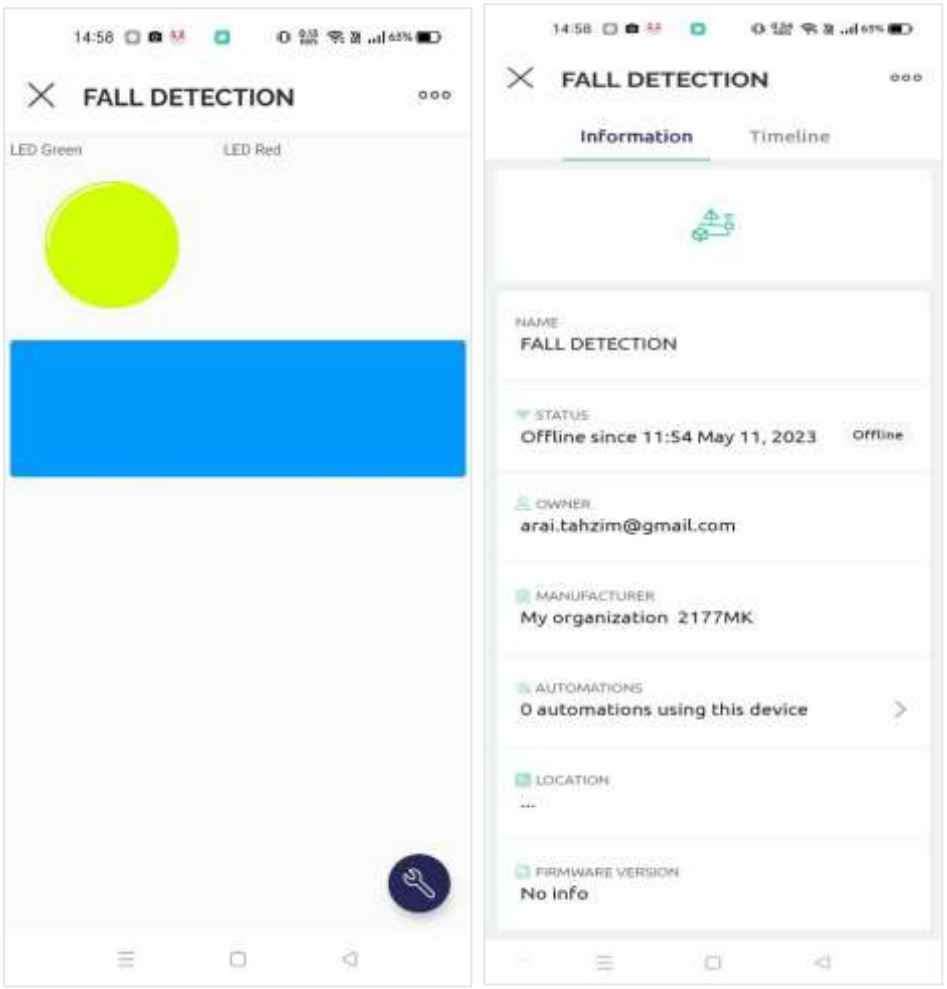


Figure 4.2.2 (b): Fall Detection Developer Mode

4.2.3 Result

4.2.3.1 Fall Detection

Time	Body motion	Threshold 1	Threshold 2	Threshold 3	LED
18:19	9	Off	Off	Off	Green
18:20	9	Off	Off	Off	Green
18:21	12	Activated	Off	Off	Green
18:22	17	Activated	Activated	Activated	Red
18:23	9	Off	Off	Off	Green
18:24	13	Activated	Off	Off	Green
18:25	14	Activated	Activated	Off	Green
18:26	18	Activated	Activated	Activated	Red
18.27	19	Activated	Activated	Activated	Red
18.28	20	Activated	Activated	Activated	Red
18.29	13	Activated	Off	Off	Green
18:30	19	Activated	Activated	Activated	Red
18:31	14	Activated	Activated	Off	Green
18:32	9	Off	Off	Off	Green
18.33	9	Off	Off	Off	Green
18:34	9	Off	Off	Off	Green
18:35	8	Off	Off	Off	Green
18:36	8	Off	Off	Off	Green
18:37	8	Off	Off	Off	Green
18:38	9	Off	Off	Off	Green
18:39	9	Off	Off	Off	Green
18:40	9	Off	Off	Off	Green
18:41	13	Activated	Activated	Off	Green
18:42	18	Activated	Activated	Activated	Red
18:43	13	Activated	Off	Off	Green
18:44	16	Activated	Activated	Off	Green
18:45	19	Activated	Activated	Activated	Red
18:46	13	Activated	Off	Off	Green
18:47	9	Off	Off	Off	Green
18:48	9	Off	Off	Off	Green

Table 4.2.3.1: Data Collected on May 9,2023 at 6:19 PM

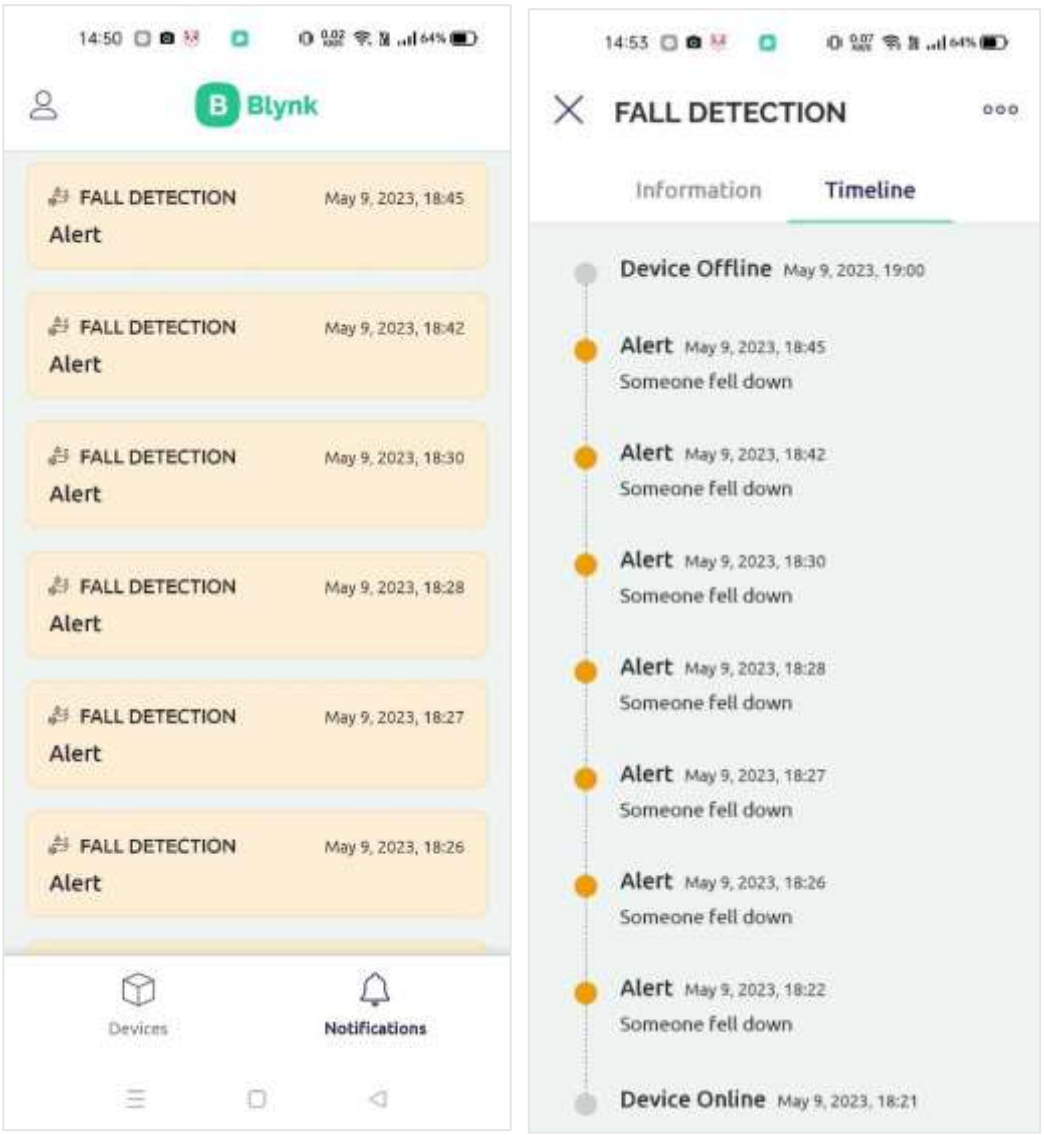


Figure 4.2.3.1: Fall Detection Notification Records

4.2.3.2 Alarm Notification

Time	Fall Detected	Alarm Notification			
		The Time Frame for Getting Notice (s)	Buzzer (3s)	Blynk Apps	Gmail
18:19	Not Activated	-	-	-	-
18:20	Not Activated	-	-	-	-
18:21	Not Activated	-	-	-	-
18:22	Activated	00:01:40	Buzz	Send	Send
18:23	Not Activated	-	-	-	-
18:24	Not Activated	-	-	-	-
18:25	Not Activated	-	-	-	-
18:26	Activated	00:01:35	Buzz	Send	Send
18.27	Activated	00:01:38	Buzz	Send	Send
18.28	Activated	00:01:40	Buzz	Send	Send
18.29	Not Activated	-	-	-	-
18:30	Activated	00:01:40	Buzz	Send	Send
18:31	Not Activated	-	-	-	-
18:32	Not Activated	-	-	-	-
18.33	Not Activated	-	-	-	-
18:34	Not Activated	-	-	-	-
18:35	Not Activated	-	-	-	-
18:36	Not Activated	-	-	-	-
18:37	Not Activated	-	-	-	-
18:38	Not Activated	-	-	-	-
18:39	Not Activated	-	-	-	-
18:40	Not Activated	-	-	-	-
18:41	Not Activated	-	-	-	-
18:42	Activated	00:01:40	Buzz	Send	Send
18:43	Not Activated	-	-	-	-
18:44	Not Activated	-	-	-	-
18:45	Activated	00:01:40	Buzz	Send	Send
18:46	Not Activated	-	-	-	-
18:47	Not Activated	-	-	-	-
18:48	Not Activated	-	-	-	-

Table 4.2.3.2: Status of Received Alert Notifications through Apps and Gmail in 20 minutes.

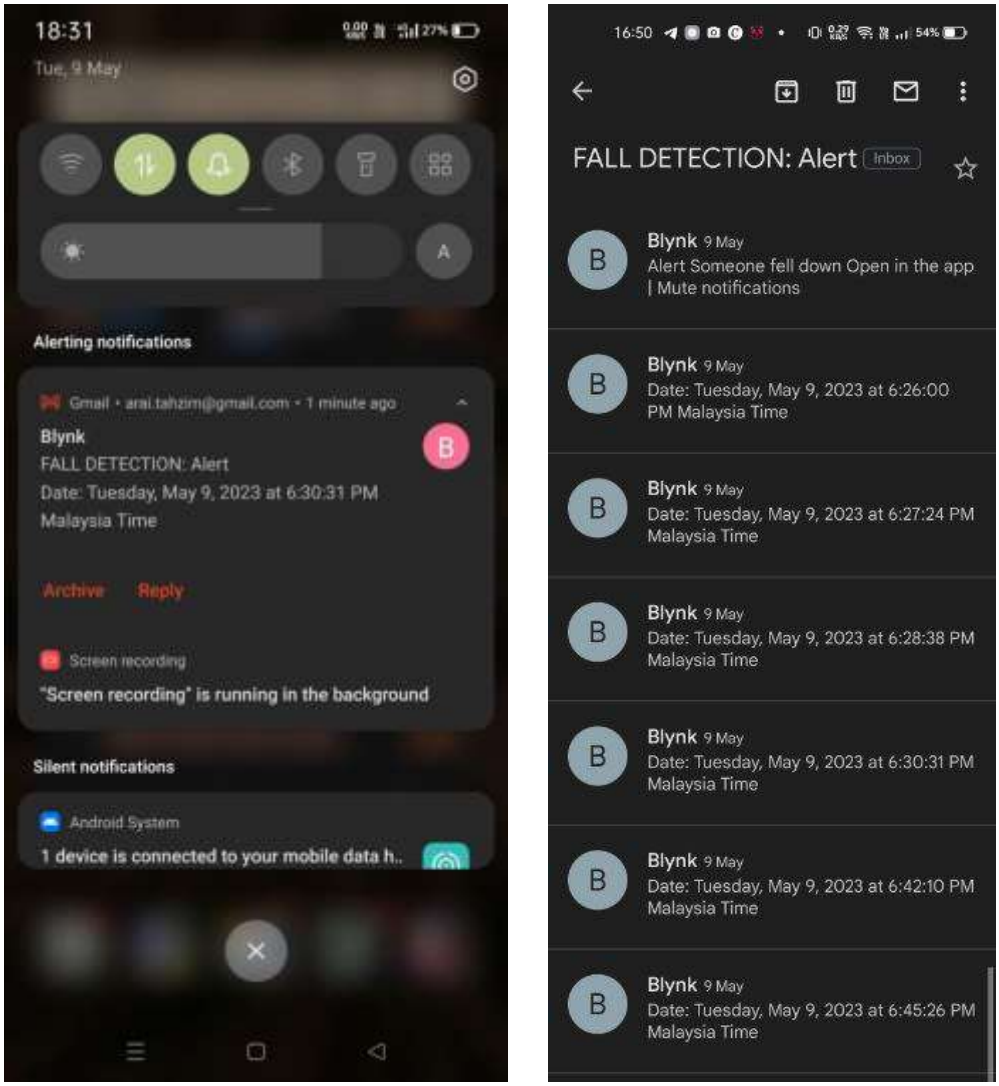


Figure 4.2.3.2 (a): Alert Notification Send to Device

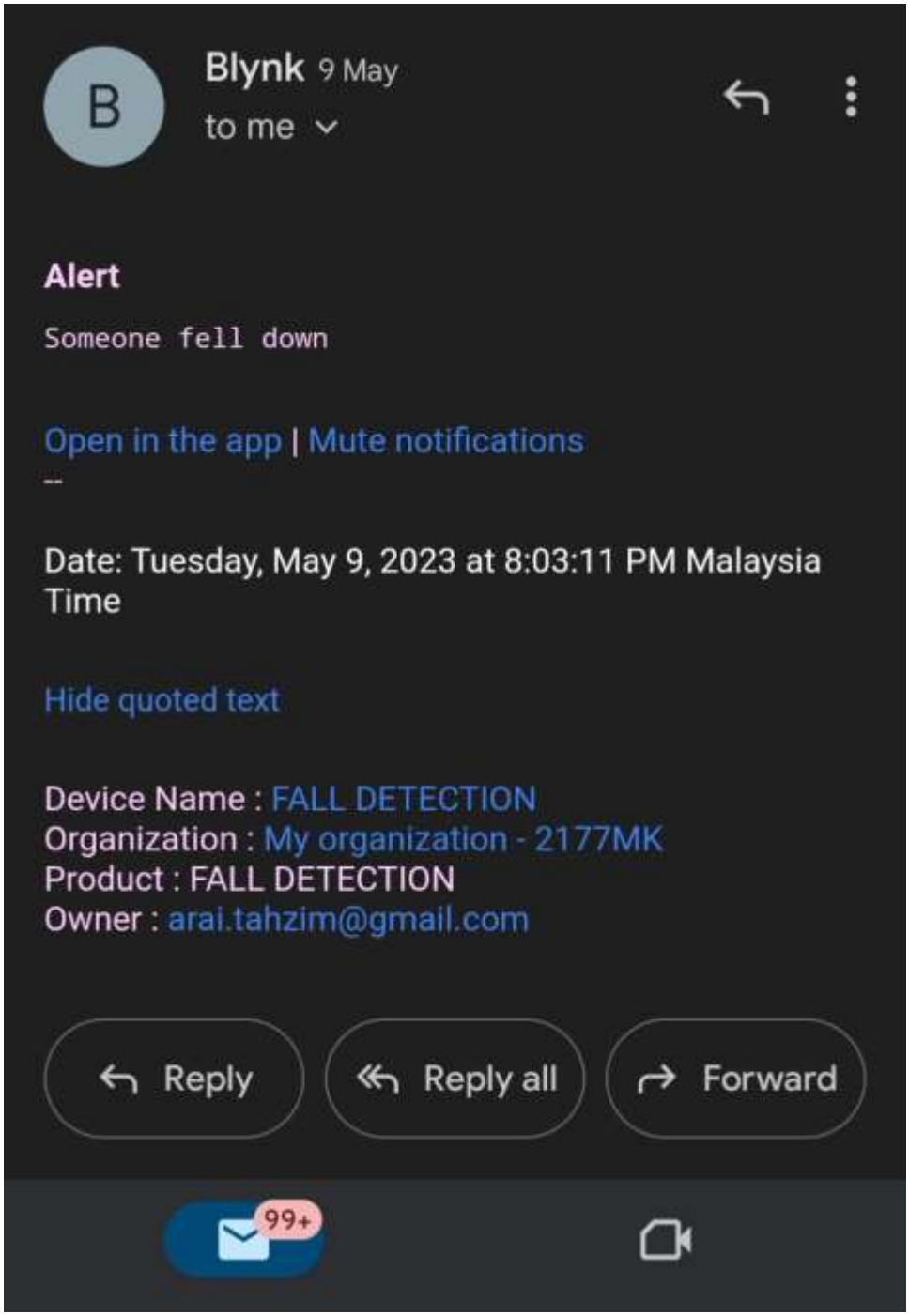


Figure 4.2.3.2 (b): Alert Notification Send through e-mail.

4.2.3.3 Average fall in 1 month

No.	Week	Number of falls
1	1	1
2	2	2
3	3	0
4	4	1

Table 4.2.3.3: Average Falls In 1 Month

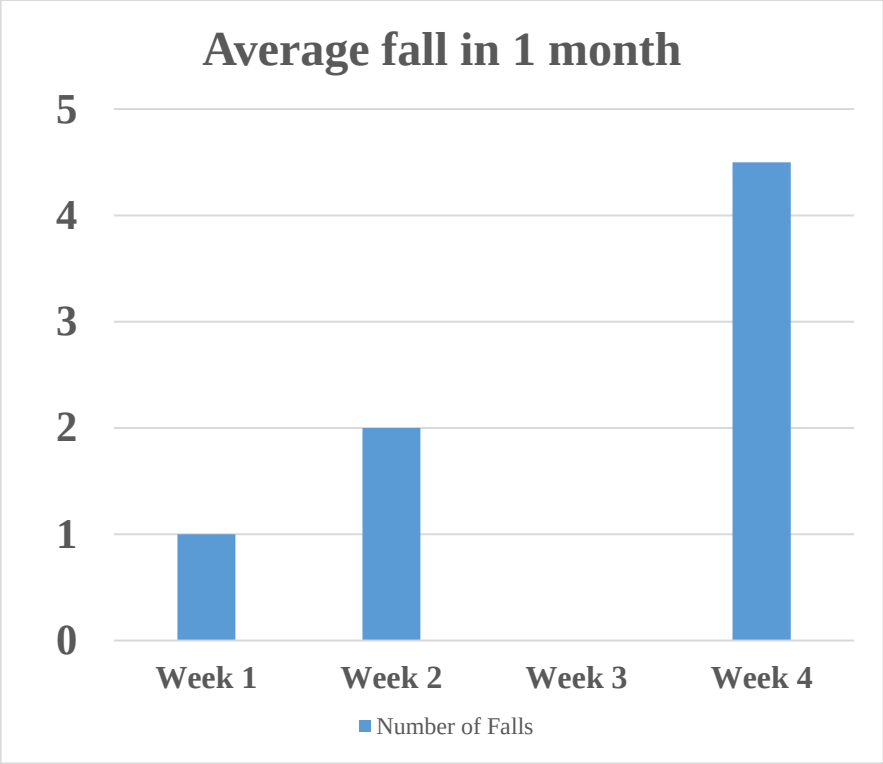


Figure 4.2.3.3: Statistic of Average Falls In 1 Month

4.3 Discussion

Figure 4.2.1 (a), (b), and (c) exhibit the finished product project, which comprises three of the main system components: power supply, movement detector, and signaling section, as was previously mentioned in the findings section. The NodeMCU ESP32 Wifi Module is used as an intermediary to run the device to evaluate and receive input data from sensors consisting of accelerometer and gyroscope sensors that have been combined into one sensor that has been modified in accordance with the progress of technological changes today and suitable, which is the MPU6050 sensor. One of the key factors in this product's success is the sensor. The NodeMCU ESP32 Wifi Module will record and analyze every shift in the user's posture or movement while using this device in accordance with the program that has been installed on it. The signaling portion then includes When a device successfully connects to the Hotspot data that has been assigned to it, the Buzzer component will buzz once. The second time it will buzz, the Alert alarm will sound for three seconds. The second part is an LED that flashes red for three seconds when the person is falling and uses a green LED to show when they are in a normal safe position.

Figure 4.2.2 (a) and (b) show the user's perspective of the Blynk application, which I use in this project. Users can access data through the facility of an application that is simple to download and available for all types of used devices, namely the Blynk Application, which enables users to view data through their devices wherever they are. As seen above, status is shown on the LCD in Blynk Apps. to prevent the sending of erroneous alert notifications. This demonstrates the third goal of this project, which is to create a fall detection system that is beneficial in delivering prompt aid and is user-friendly.

The value of motion that changes significantly within 10 seconds will be examined and needs to pass through three thresholds, namely Threshold 1, Threshold 2, and Threshold 3. Then refer to the result section, the first in table 4.2.3.1 where movement data is recorded. The rate of change of motion that is sudden in a short period of time and high sensitivity make thresholds 1 and 2 typically simple to activate, whereas threshold 3 is a marker that determines whether alert notifications need to be sent to receivers that have a Blynk Apps account. Stated the. Within 10 seconds, a major change in Motion will set off threshold 3 and sound the alert. Therefore, the signaling section's component will function to alert those around. Based on figure 4.2.3.1, it shows the timeline that the device is online as well as the record history of receiving and delivering alert notifications to users via Blynk Apps. The graph below shows the motion changes detected by the MPU6050 sensor.

Figure 4.3: Motion Changes Detected By The MPU6050 Sensor In 20 Minutes.

The definition of an emergency communication system is a system that enables the one-way, real-time transmission of messages to a group or groups of individuals at a location, facility, or activity. To quickly communicate essential information to a specific audience, a notification system is utilized. While a crisis can happen anywhere at any time, we never plan to find ourselves in one. The most important thing an organization can do in a crisis or dangerous situation is to swiftly warn and alert those who are in danger. According to a specific time, Table 4.2.3.2 indicates the state of fall detection. The Time Frame for Getting Notice specifies how quickly the notification should be provided to the user to determine whether the user's guardian should be alerted in case the victim needs emergency assistance right away.

Sometimes this unexpected fall from the wheelchair occurs with no warning or expectation. Accidents can occur for a variety of reasons, and they may even be brought on by the wheelchair user themselves or the other way around. According to the graph in Figure 4.2.3.3, falling from a wheelchair occurs on average occasionally but not very often. Because the sufferer's safety and life may be in danger in this situation of a fall, prompt assistance must be provided before it is too late to save the victim.

The final version of this product has some restrictions. Among them, using power supplies like power banks is a little less secure since it may interfere with the product's circuit and increase the chance of a harmful accident because the power bank may be affected by the anticipated appearance of heat in the circuit that transmits electric current. Because of its enormous size to fit on the user's body and the weight of the power source, which is too heavy, using this power bank is also less suitable. Additionally, there is a significant likelihood of a false alert because the device may accidently fall due to its size and weight, miss notifications due to the usage of weaker data in locations with poor signal lines, or be incompatible with the service provider. used.

4.4 Chapter Summary

The outcomes of this project have been linked to this chapter to illustrate that the aims of the project that were previously set have been effectively attained. The discussion has also been provided based on the project results, such as the description and development of the final project, the specification of the body motion that change frequently, the results that have been collected and recorded for 20 minutes, the user view of the Blynk Application, and the limitations of this project and its solution. This project's body motion change and period to receives the alarm has been demonstrated, as indicated in the result sections.

CHAPTER 5

5 CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

Based on the findings and debate from the previous chapter, this chapter's conclusion. A conclusion must be drawn to summarize the overall findings to reap the project's benefits and maximize its potential. This part will also examine and provide recommendations for future work to enhance the functioning and operation of the project for a different researcher based on the project established and mentioned specifically in this report. The conclusion also discusses the methods discovered during the project to complete the work within the deadline specified in Chapter 6's Gantt Chart.

5.2 Conclusion

Finally, IOT-based wheelchair fall detection can assist in alerting users when they are in danger of slipping from their position. Thus, this can help them in an emergency. Additionally, it can result in cost savings when producing this project as well as new innovations in repair. Furthermore, records and data analysis allow for the saving and determination of whether a user is in danger of falling from his or her seated position. It is thus demonstrated that IOT development is advancing over time and that product manufacturing is becoming more innovative. Moreover, it is possible to use gyroscope and accelerometer sensors in applications where the three axes are measured, and the data is decoded for analysis. This ensures that the output is accurate and that there is less chance of a false notification occurring.

In conclusion, I found that this project fully accomplished the three main goals that were previously mentioned, such as being able to design an intelligent and effective fall detection and alert system using smartphone and wireless sensor node and implement a reliable and cost-effective fall detection and alert system, based on the results that were attached in the previous section. Additionally create a user-friendly fall detection system that aids in offering prompt assistance through Blynk Apps.

In order to complete this project, a variety of skills were learned and put into practise, including how to design the schematic diagram, flowchart, and block diagram of the project using the appropriate software or website, how to create the source code according to the requirements, how to find and purchase the right components and sensors, how to solder, how to test the project and how to spot damage when the system fails. The presenter certificates for this project's ICOESS 2023 and EEEiC are displayed in Appendices E and F. Additionally, a user manual has been created.

5.3 Suggestion for Future Work

Most of the projects that can be seen in the past use a lot of hardware equipment and have a high production cost, so the next project should incorporate some innovation in the fall detection project. A person's movement can also be detected thanks to the use of more advanced sensors that produce more accurate data. Smartphone-based fall detection and rescue systems are examples that can be used. These are good alternatives to embedded-system-based solutions. Smartphones are a great option for creating fall detection systems due to their wide availability, affordability, availability of all types of motion sensors, network connectivity, good battery life, and widespread use of smartphones. Most wearable fall detection systems with multiple sensors are waist- or chest-mounted. Only indoors, multiple sensor-based solutions that combine wearable and stationary sensors may be more useful for mass monitoring in nursing homes, hospitals, care facilities, etc.

The next step is to enhance the fall detection system, which uses both wearable and non-wearable sensors to detect and prevent falls. Sensors for wearable systems must be placed on the user; these sensors could be a watch, a necklace, or a wearable camera, which is typically fastened to clothing or worn around the wrist. Additionally, by using the Global Positioning System (GPS), it may also increase the application of fall detection that can be utilised both indoors and outdoors. This may make it simpler to locate the victim and other related information.

According to the project's findings, we can see that the condition shown in this Blynk Application matches the measurements that were taken and that there is a delay after the initial data is displayed, which may be caused by the coding settings that I made. The coding settings and parameters should be checked in the future to prevent delays in acquiring the most accurate results. In addition, the difficulties connecting the device to the Blynk Apps creates obstacles that call for a high-performance service provider in a specific coverage area.

5.4 Chapter Summary

The conclusion was drawn considering the earlier findings and discussions, as well as an analysis of the project's objectives, advantages, and lessons learned during the creation of this product. The limitations and suggestions for further research have been provided, mainly concentrating on the emergency assistance and monitoring towards wheelchair users.

CHAPTER 6

6 PROJECT MANAGEMENT AND COSTING

6.1 Introduction

The cost of obtaining supplies and parts is included in the implementation of hardware costs, and most of the hardware components are obtained through online sources. Before purchasing certain items, polls were run at many online retailers so that customers could compare prices, such as on Shopee. Due to the time and money, it would save, this technique will also make things simpler. The estimated total gross expenditure for carrying out this project is RM200.00, with additional costs coming in at RM 76.00.

6.2 Gant Chart and Activities of the Project

The start and end dates of a project's terminal items and summary elements are displayed on the Gantt Chart in this project. A Gantt chart is one of the most common and effective ways to show activities, projects, or events versus time; it is used in project management. The tasks that need to be completed by the deadline are shown on this Gantt chart. The number of weeks it will take to accomplish each work must be specified. 4.2(a) and 4.2(b) show a Gantt chart for projects 1 and 2, respectively. It lists the tasks that need to be finished each week. This Gantt chart serves as a reminder for everyone to complete their work on time.

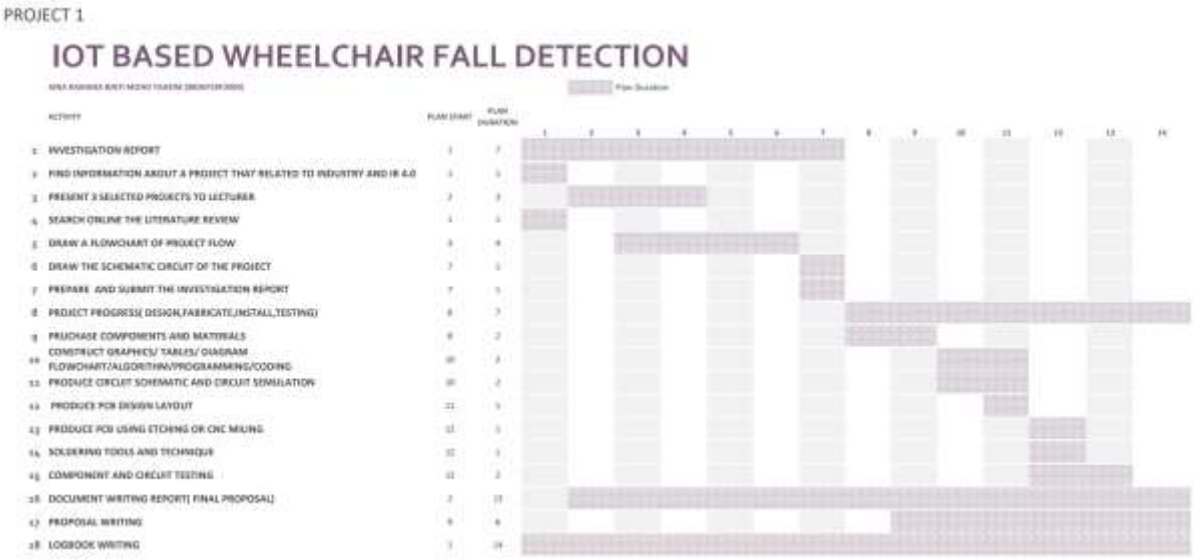


Figure 6.2(a): Gantt Chart for Project 1

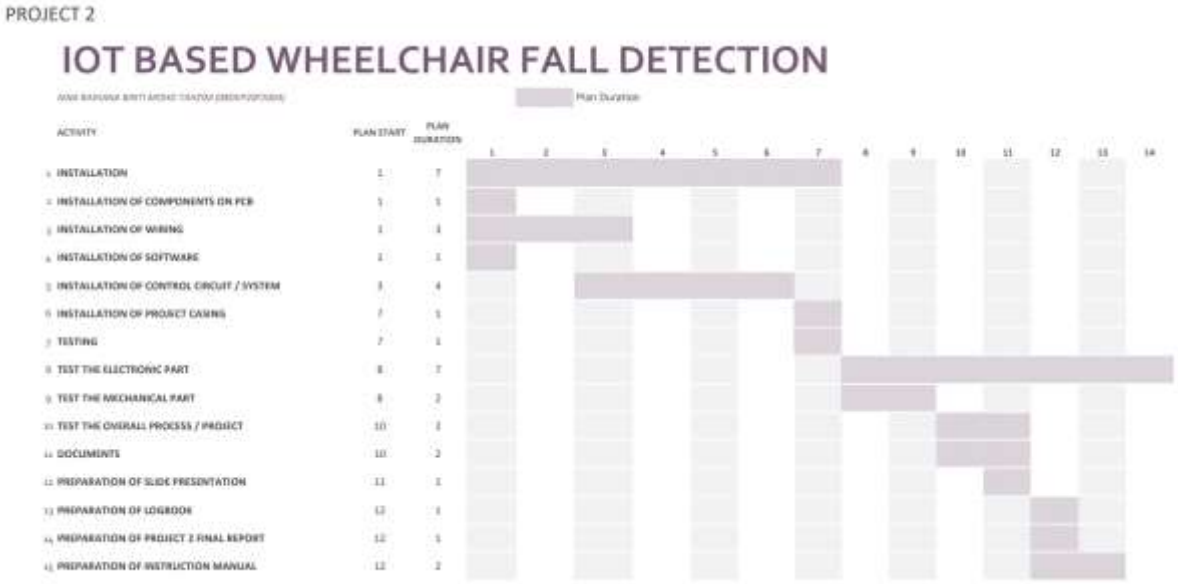


Figure 6.2(b): Gantt Chart for Project 2

6.3 Milestone

A milestone is a defined moment in a project's life cycle that is used to track progress toward the end goal. Milestones in project management are used to mark the start or end date of a project, external evaluations or input, budget checks, submission of a major deliverable, and so on. A milestone is a reference point inside a project that denotes an important event or a branching decision point. Table 4.3 shows the milestone of IOT Based Wheelchair Fall Detection Project.

Description	Date	Cumulative project completion percentage
Completion Of Project Planning	15.09.2022	10%
Completion Of Model System	28.10.2022	27%
Completion Of Project Implementation	08.11.2022	30%
Completion Of Project Management and Finance	20.11.2022	45%
Completion Final Proposal Report and Mini Project Presentation	01.12.2022	59%
Completion Of Project Programming Design	30.03.2023	76%
Completion Of Project Wiring and Casing Installation	20.04.2023	85%
Completion Final Report and Project Presentation	18.05.2023	100%

Table 6.3: Milestone of IOT Based Wheelchair Fall Detection Project.

6.4 Cost and Budgeting

During this project, materials and component purchases will cost money. Cost-involved parts include the Node MCU ESP8266 12 E Board. , USB, MPU6050 6-axis Gyroscope/Accelerometer, Jumper Wires (FF), 20 cm (10 pieces set), buzzer and LEDs. To make things simpler and save money, every one of these components are purchased using online methods.

According to Table 6.4, the overall gross budget estimate for carrying out this project is **RM124.00**, and other expenses are **RM 76.00**. This project can be compared to other projects that can cost over a thousand ringgit in terms of cost, but according to the budget cost, it is less expensive. The project's cost is also consistent with one of the essential features of a good developer, which is having a low cost but high-quality project.

This project is self-financed, and some of the materials and components were obtained from the nearby electronic store. According to the cost projection, the price is pegged at **RM104.00**. The development costs are still manageable over the course of 7 months at RM15.30 per month. Based on the research done, it is possible and doable.

No.	Component and materials	The unit price	Quantity	Total
1.	Node MCU ESP8266 12 E Board	RM40.00	1	RM40.00
2.	USB Node MCU ESP8266	RM 6.90	1	RM 6.90
3.	MPU6050 6-axis Gyroscope/Accelerometer	RM15.50	1	RM15.50
4.	Buzzer	RM 1.50	1	RM 1.50
5.	Jumper Wires (FF) 20 cm (10 pieces set)	RM 2.50	1	RM 2.50
6.	LED	RM 0.96	2	RM 1.92
7.	Canvas Belt Polyester Material	RM16.40	1	RM16.40
8.	Waterproof Clear Plastic Electronic Project Box Enclosure Cover Case	RM 9.97	1	RM 9.90
9.	Super Glue	RM 1.65	1	RM 1.65
10.	Strong Double-Sided Tape	RM 7.75	1	RM 7.73
11.	Others	RM20.00	-	RM120.00
			Total:	**RM124.00**
No.	**List of other costing**	**The unit price**	**Quantity**	**Total**
1.	Transportation	RM6.00	7	RM35.00
2.	Postage	RM4.90	5	RM19.00
3.	Craft Work	RM0.50	14	RM 7.00
4.	Internet	RM6.00	1	RM 6.00
5.	Application	RM8.00	1	RM 8.00
			Total	**RM76.00**
			Overall total	**RM200.00**

Table 4.4: List of Components and Materials of IOT Based Wheelchair Fall Detection Project.

6.5 Chapter Summary

All the information in this chapter about the price of making this product is already shown in the table above. To make sure that the costs that must be incurred do not overwhelm the project's development, we must establish a similar table today because every customer is still concerned with cost when making a purchase. Therefore, the objective of this product is to create a successful, affordable, high-quality project. The product is reasonably priced, coming in at under RM 300. Not to mention, this product's concept was developed employing the most modern design.

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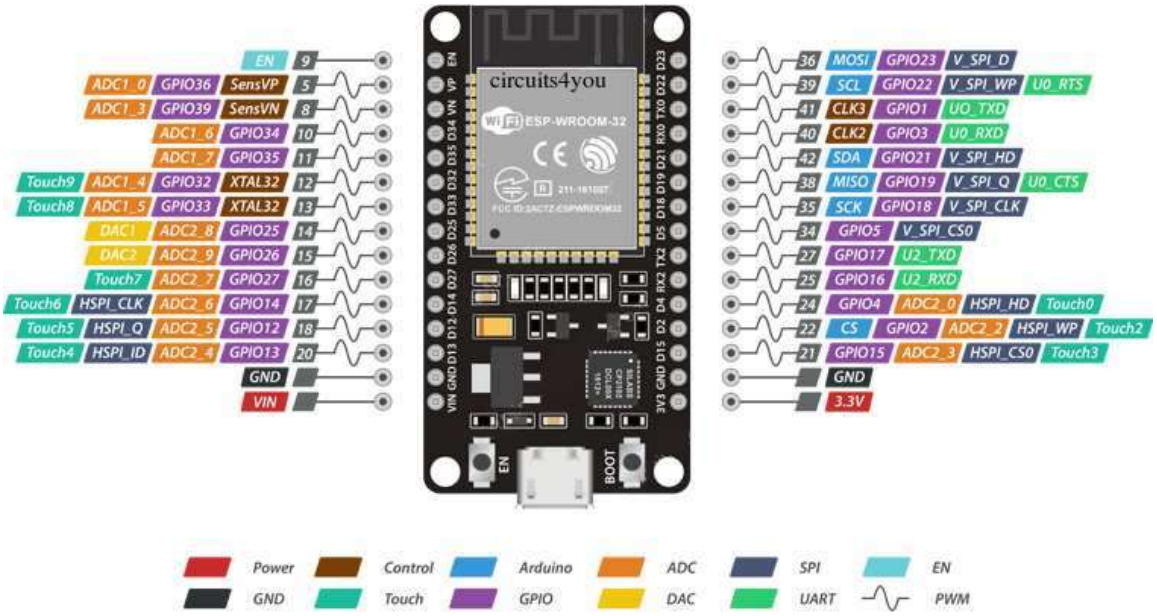
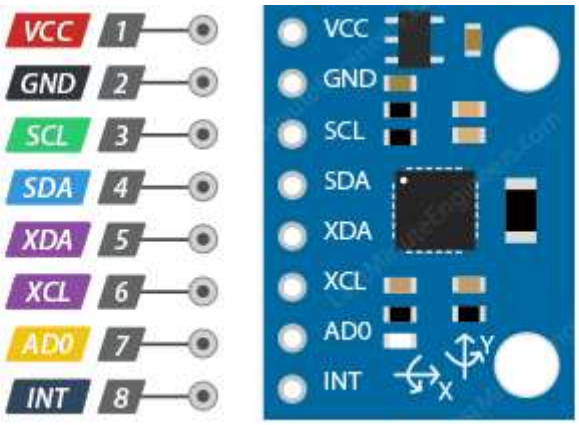
7 APPENDICES

APPENDIX A DATA SHEET

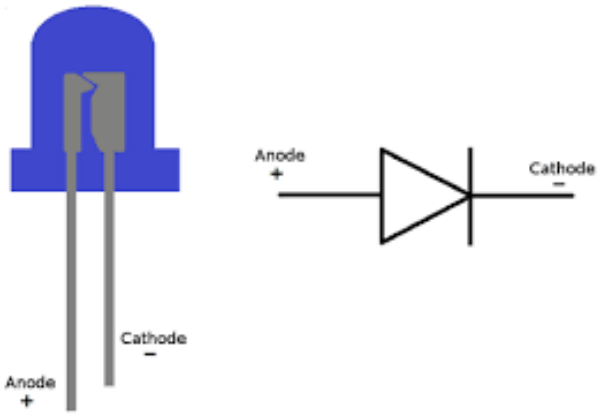
i. NodeMCU ESP32 Wi-Fi Modul [21].



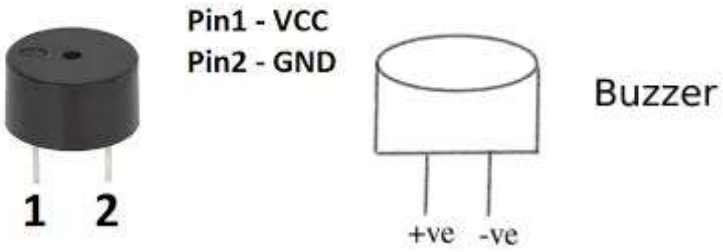
ii. MPU6050 Accelerometer and Gyroscope Sensor [22].



iii. LED [23]



iv. Buzzer [24]



APPENDIX B PROGRAMMING

```
#define BLYNK_PRINT Serial
#define BLYNK_TEMPLATE_ID  "TMPLw-44Rorf"
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
#include <Wire.h>
#include <WiFi.h>

char auth[] = "YhMbQrmIKg_scwMOPGJruBm_VRBWJXAY";
char ssid[] = "Arai Tahzim";
char pass[] = "lantaklah";

const int MPU_addr = 0x68; // I2C address of the MPU-6050
int16_t AcX, AcY, AcZ, Tmp, GyX, GyY, GyZ;
float ax = 0, ay = 0, az = 0, gx = 0, gy = 0, gz = 0;

boolean fall = false;     //stores if a fall has occurred
boolean trigger1 = false; //stores if first trigger (lower
threshold) has occurred
boolean trigger2 = false; //stores if second trigger (upper
threshold) has occurred
boolean trigger3 = false; //stores if third trigger (orientation
change) has occurred
byte trigger1count = 0;   //stores the counts past since trigger 1
was set true
byte trigger2count = 0;   //stores the counts past since trigger 2
was set true
byte trigger3count = 0;   //stores the counts past since trigger 3
was set true
int angleChange = 0;
int ledBuzzer = 25;
int led = 27;
```

```
bool eventTrigger = false;

WidgetLED red(V0);
WidgetLED green(V1);
WidgetLCD lcd(V2);

void setup() {
  Serial.begin(115200);
  Blynk.begin(auth, ssid, pass);
  pinMode(ledBuzzer, OUTPUT);
  pinMode(led, OUTPUT);
  Wire.begin();
  Wire.beginTransmission(MPU_addr);
  Wire.write(0x6B);
  Wire.write(0);
  Wire.endTransmission(true);
  Serial.println("Wrote to IMU");
  for ( int X = 0; X < 2; X++)
  {
    digitalWrite(ledBuzzer, HIGH);
    digitalWrite(led, LOW);
    delay(500);
    digitalWrite(ledBuzzer, LOW);
    digitalWrite(led, HIGH);
    delay(500);
  }
  digitalWrite(led, LOW);
  lcd.clear();
  red.off();
  green.on();
  lcd.print( 0, 0, "Status : Normal ");
  delay(1000);
```

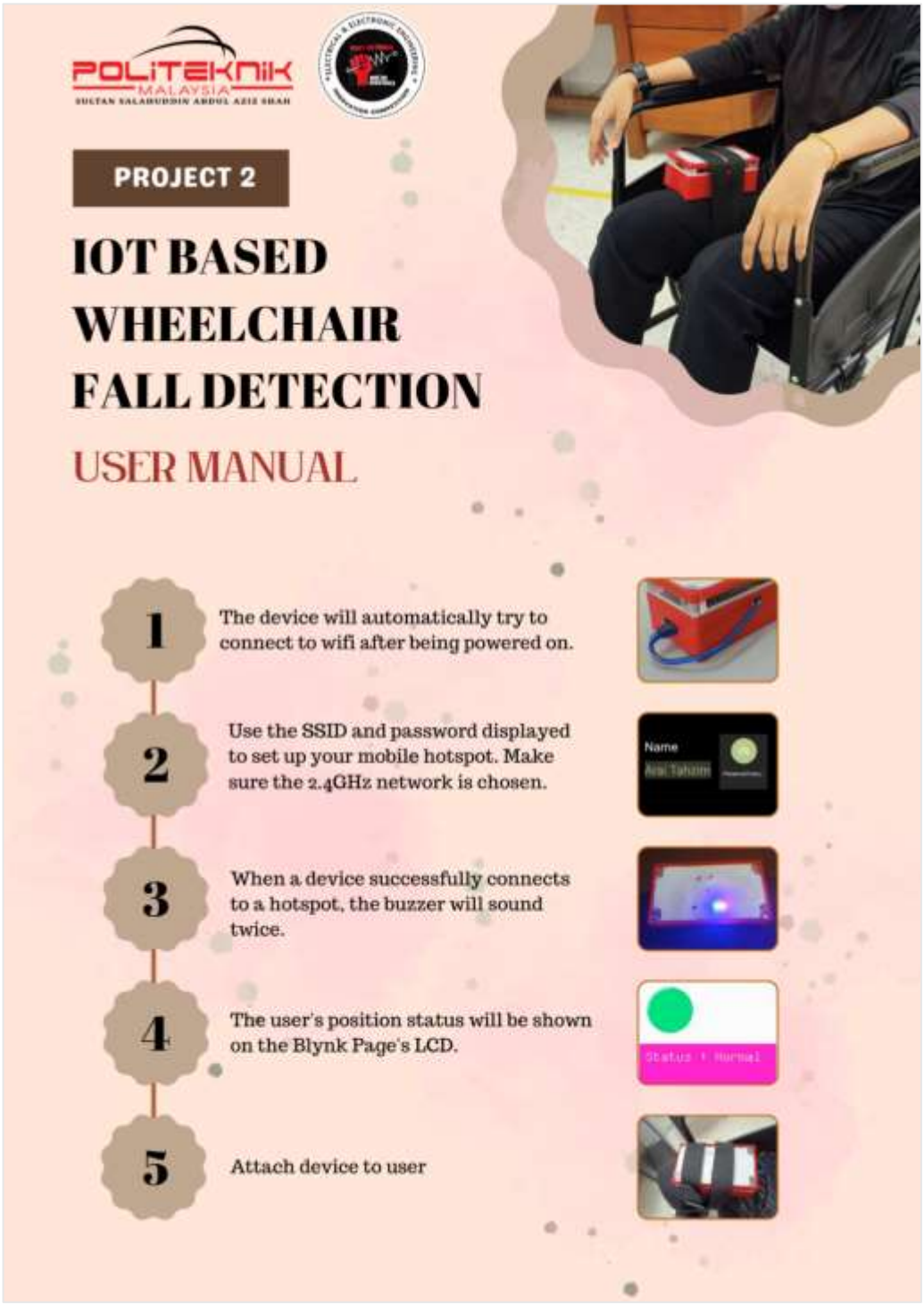
```
}

void loop() {

  Blynk.run();
  mpu_read();
  ax = (AcX - 2050) / 16384.00;
  ay = (AcY - 77)   / 16384.00;
  az = (AcZ - 1947) / 16384.00;
  gx = (GyX + 270)  / 131.07;
  gy = (GyY - 351)  / 131.07;
  gz = (GyZ + 136)  / 131.07;

  // calculating Amplitute vactor for 3 axis
  float Raw_Amp = pow(pow(ax, 2) + pow(ay, 2) + pow(az, 2), 0.5);
  int Amp = Raw_Amp * 10;  // Mulitiplied by 10 bcz values are
between 0 to 1
  Serial.println(Amp);

  if (Amp <= 2 && trigger2 == false) { //if AM breaks lower
threshold (0.4g)
    trigger1 = true;
    Serial.println("TRIGGER 1 ACTIVATED");
  }
  if (trigger1 == true) {
    trigger1count++;
    if (Amp >= 12) { //if AM breaks upper threshold (3g)
      trigger2 = true;
      Serial.println("TRIGGER 2 ACTIVATED");
      trigger1 = false;
      trigger1count = 0;
    }
  }
```

```
  if (trigger2 == true) {
    trigger2count++;
    angleChange = pow(pow(gx, 2) + pow(gy, 2) + pow(gz, 2), 0.5);


    Serial.println(angleChange);
    if (angleChange >= 30 && angleChange <= 400) { //if orientation
changes by between 80-100 degrees
      trigger3 = true;
      trigger2 = false;
      trigger2count = 0;
      Serial.println(angleChange);
      Serial.println("TRIGGER 3 ACTIVATED");
    }
  }
  if (trigger3 == true) {
    trigger3count++;
    if (trigger3count >= 10) {
      angleChange = pow(pow(gx, 2) + pow(gy, 2) + pow(gz, 2), 0.5);
      //delay(10);
      Serial.println(angleChange);
      if ((angleChange >= 0) && (angleChange <= 10)) { //if
orientation changes remains between 0-10 degrees
        fall = true;
        trigger3 = false;
        trigger3count = 0;
        Serial.println(angleChange);
      }
      else { //user regained normal orientation
        trigger3 = false;
        trigger3count = 0;
        Serial.println("TRIGGER 3 DEACTIVATED");
      }
    }
```

```
}
if (fall == true) { //in event of a fall detection
  lcd.print( 0, 0, "Status : ");
  lcd.print( 0, 1, "Someone fell down ");

  Blynk.logEvent("Alert", "Someone fell down ");
  Serial.println("FALL DETECTED");
  for ( int X = 0; X < 30; X++)
  {
    digitalWrite(ledBuzzer, HIGH);
    digitalWrite(led, LOW);
    delay(50);
    digitalWrite(ledBuzzer, LOW);
    digitalWrite(led, HIGH);
    delay(50);
  }
  digitalWrite(led, LOW);
  red.on();
  green.off();
  delay(1000);
  lcd.clear();
  lcd.print( 0, 0, "Status : Normal");
  red.off();
  green.on();
  fall = false;
}

if (trigger2count >= 6) { //allow 0.5s for orientation change
  trigger2 = false;
  trigger2count = 0;
  Serial.println("TRIGGER 2 DECACTIVATED");
}
```

```
  if (trigger1count >= 6) { //allow 0.5s for AM to break upper
threshold
    trigger1 = false;
    trigger1count = 0;
    Serial.println("TRIGGER 1 DECACTIVATED");
  }
  delay(100);
}


void mpu_read() {
  Wire.beginTransmission(MPU_addr);
  Wire.write(0x3B);  // starting with register 0x3B (ACCEL_XOUT_H)
  Wire.endTransmission(false);
  Wire.requestFrom(MPU_addr, 14, true); // request a total of 14
registers
  AcX = Wire.read() << 8 | Wire.read(); // 0x3B (ACCEL_XOUT_H) &
0x3C (ACCEL_XOUT_L)
  AcY = Wire.read() << 8 | Wire.read(); // 0x3D (ACCEL_YOUT_H) &
0x3E (ACCEL_YOUT_L)
  AcZ = Wire.read() << 8 | Wire.read(); // 0x3F (ACCEL_ZOUT_H) &
0x40 (ACCEL_ZOUT_L)
  Tmp = Wire.read() << 8 | Wire.read(); // 0x41 (TEMP_OUT_H) & 0x42
(TEMP_OUT_L)
  GyX = Wire.read() << 8 | Wire.read(); // 0x43 (GYRO_XOUT_H) & 0x44
(GYRO_XOUT_L)
  GyY = Wire.read() << 8 | Wire.read(); // 0x45 (GYRO_YOUT_H) & 0x46
(GYRO_YOUT_L)
  GyZ = Wire.read() << 8 | Wire.read(); // 0x47 (GYRO_ZOUT_H) & 0x48
(GYRO_ZOUT_L)


}
```

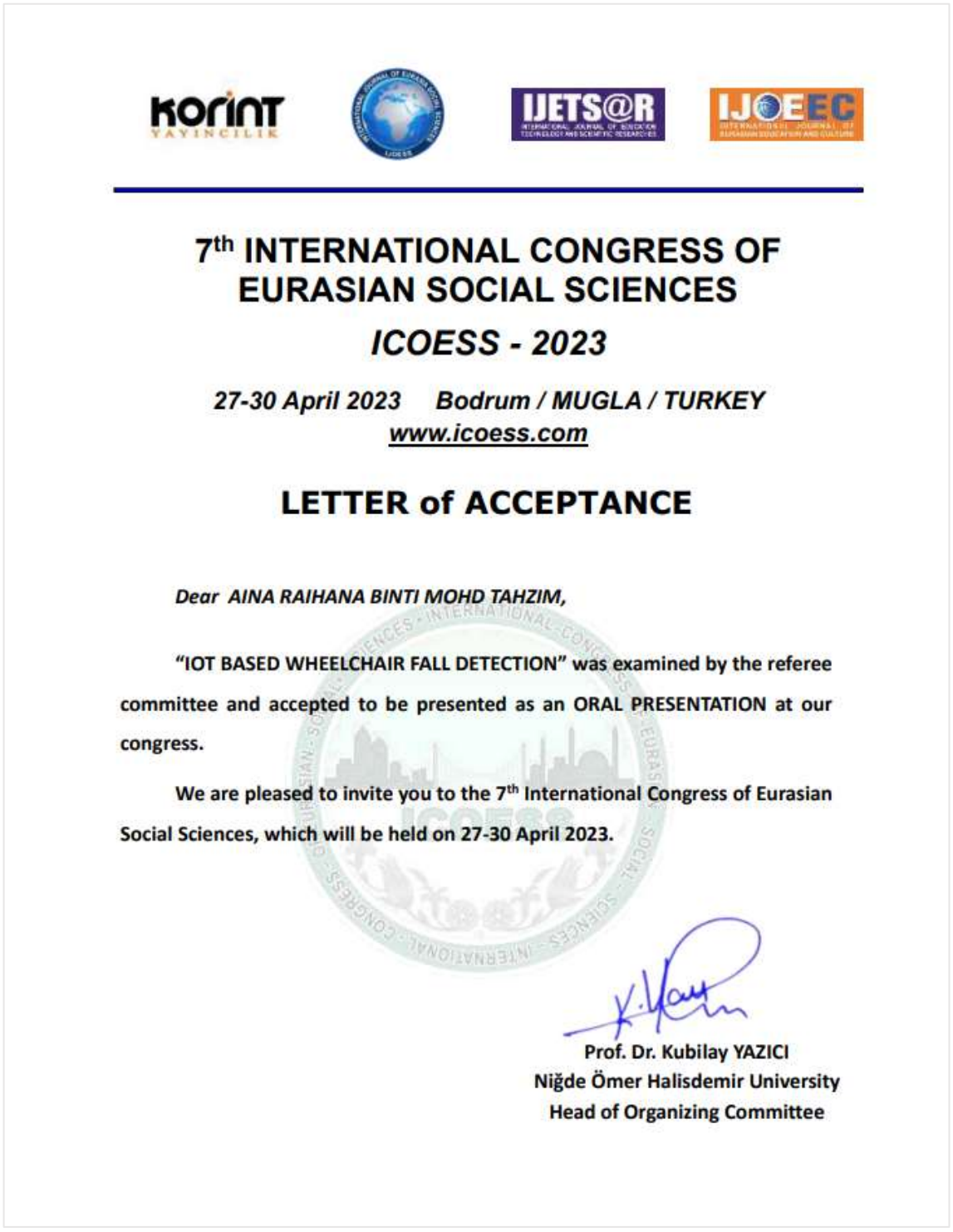
APPENDIX C PROJECT MANUAL/PRODUCT CATALOGUE



APPENDIX D PROJECT POSTER

APPENDIX E PROJECT BROCHURE

APPENDIX F ICOESS PARTICIPATION



7th INTERNATIONAL CONGRESS OF EURASIAN SOCIAL SCIENCES

ICOESS - 2023

27-30 April 2023 Bodrum / MUGLA / TURKEY

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LETTER of ACCEPTANCE

Dear AINA RAIHANA BINTI MOHD TAHZIM,

"IOT BASED WHEELCHAIR FALL DETECTION" was examined by the referee committee and accepted to be presented as an ORAL PRESENTATION at our congress.

We are pleased to invite you to the 7th International Congress of Eurasian Social Sciences, which will be held on 27-30 April 2023.

Prof. Dr. Kubilay YAZICI
Niğde Ömer Halisdemir University
Head of Organizing Committee

7th INTERNATIONAL CONGRESS OF EURASIAN SOCIAL SCIENCES

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LETTER of ACCEPTANCE

Dear Zabidah binti haron,

"IOT BASED WHEELCHAIR FALL DETECTION" was examined by the referee committee and accepted to be presented as an ORAL PRESENTATION at our congress.

We are pleased to invite you to the 7th International Congress of Eurasian Social Sciences, which will be held on 27-30 April 2023.

Prof. Dr. Kubilay YAZICI
Niğde Ömer Halisdemir University
Head of Organizing Committee

APPENDIX G EEEiC PARTICIPATION CERTIFICATE