Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF FALL DETECTOR USING NODEMCU FOR ELDERLY PEOPLE

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Bachelor of Electronics Engineering Technology with Honours

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DEVELOPMENT OF FALL DETECTOR USING NODEMCU FOR ELDERLY PEOPLE

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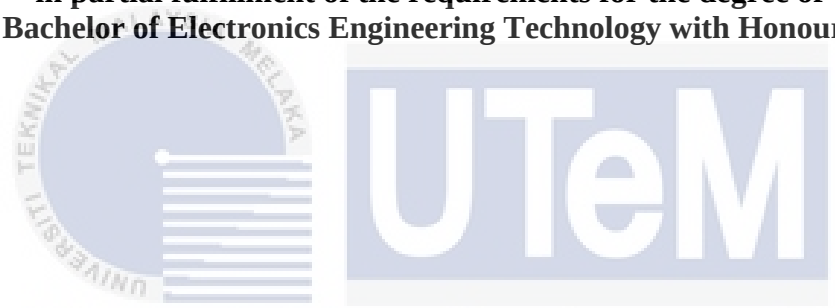
A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology with Honours



Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this project report entitled “Development of Fall Detector Using NodeMCU for Elderly People” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Student Name : MUHAMMAD AMIR ZAHID BIN ABD RAZAK

Date : 16/1/2023

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology with Honours.

Signature : 

Supervisor Name : Dr. Haslinah Binti Mohd Nasir

Date : 16/1/2023

Signature :

Co-Supervisor :

Name (if any)

Date :

DEDICATION

To my beloved father, Abd Razak Bin Osman

and my beloved mother, Zurina Binti Adini

ABSTRACT

The increase of lonely senior citizen living by themselves may cause mental and physical health issues as well as the chances of accidents happen most likely to be high. Thus, this project entitled “Development of Fall Detector Using NodeMCU for elderly people” aims to develop fall detector for elderly people. This project were equipped with NodeMCU and global positioning system (GPS) which integrated with gyroscope and accelerometer sensors that able to sense sudden falls. It will notify their children or close contact if there are emergency aided needed with the current location provided. The project needs to be connected to the internet so that the use of its advantages is comprehensive. This project implement threshold approach on detecting sudden movement and the detection in sensing acceleration, orientation and angular condition is excellent. The development in making this project is to improvise surveillance, community and individual safety.

ABSTRAK

Peningkatan bilangan warga emas yang tinggal bersendirian pada masa kini boleh menyebabkan masalah kesihatan mental dan fizikal serta besar kemungkinan kemalangan boleh berlaku adalah tinggi. Oleh itu, projek yang bertajuk "Pembangunan Pengesan Kejatuhan Menggunakan NodeMCU untuk warga emas" ini dibangunkan, ia bertujuan untuk mengesan kemalangan jatuh pada warga emas. Projek ini dilengkapi dengan NodeMCU dan sistem penentududukan global (GPS) yang disepadukan dengan sensor giroskop dan pecutan supaya dapat mengesan kejatuhan secara tiba-tiba. Peralatan ini akan menghantar pesanan untuk memberitahu anak-anak mereka atau mereka yang mempunyai hubungan rapat jika terdapat bantuan kecemasan yang diperlukan pada lokasi semasa yang disediakan. Projek ini perlu disambungkan ke internet supaya penggunaan kelebihannya adalah menyeluruh. Projek ini melaksanakan pendekatan ambang untuk mengesan pergerakan mengejut dan pengesanan dalam mengesan pecutan, orientasi dan keadaan sudut adalah sangat baik.. Pembangunan dalam membuat projek ini adalah untuk menambah baik pengawasan, keselamatan, komuniti dan individu.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Dr. Haslinah Binti Mohd Nasir for their precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) and my parent for the financial support through the end which enables me to accomplish the project. Not forgetting my fellow colleagues for the willingness of sharing his thoughts and ideas regarding the project.

My highest appreciation goes to my parents and family members for their love and prayer during the period of my study.

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LIST OF SYMBOLS

ADL	-	Activities of Daily Living
GPS	-	Global Positioning System
KKM	-	Kementerian Kesihatan Malaysia
PCA	-	Principal Component Analysis Algorithm
TN	-	Number of ADL correctly classified
FP	-	Number of False Falls
TP	-	Falls correctly identified
I/O	-	Input Output

LIST OF ABBREVIATIONS

V	-	Voltage
mAh	-	Ampere Hour
m	-	Meter
Hz	-	Hertz

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CHAPTER 1

INTRODUCTION

1.1 Background

Due to increase population of senior citizen here in Malaysia and added with lower fertility rate, demand for nursing home has also increased and children may feel sorry to place their parents far from them under someone else care [1]. Based on the report of Kementerian Kesihatan Malaysia (KKM), one over three of senior citizen that aged sixty and above population in Malaysia had experienced fall accidents, this can lead to injury or worst-case scenario are death. This tragic tragedy may have negative effects for the victims, closed families, the healthcare system, and society at whole.

The responsibility of the child is to preserve the health and safety of the parents, but today, with a low number of children and birth rates, the attention that a child can give to a parent becomes limited by the constraints of job and affairs of daily life, it is from this problem that the cause of the elderly accident at home without supervision occurs, one of many popular caused of accidents are falls accident, accidents like this if it happen to young people it will not cause a big problem but if it happen to elderly people it can result in brain injury, bone fractures, lack of ability to do something on their own and even depression in a psychological context.

To make sure help comes quickly, the idea of this fall detector using Node MCU for elderly people was worked out. Even though many fall detector function can now be found in smartwatches, fitness trackers, and other types of wearables but consumers must buy the other packages offered and this makes it much more expensive to own a fall detection

function. The goals are to build a system that can detect fall activities which then the report will be sent to the phone through Telegram app to the people who were in charge to supervise the user who wear it.

1.2 Problem Statement

Falls increase exponentially with age-related biological changes, resulting in a high incidence of falls and fall-related injuries in ageing societies. Because falls are a major public health concern among the elderly, the number of systems designed to detect them has grown dramatically in recent years [2]. From this string of problems arose the idea of the development of fall detector using node MCU for elderly people are being created and develop to improve safety and preventing this kind of accident to happen. It is expected to solve majority of the problems and concerns in nursing parents at home.

1.3 Project Objective

The main aim of this project is to propose an alternative way of using the fall detector device to assist the elderly people to help prompt assistance when needed. Specifically, the objectives are as follows:

a) To develop a low-cost fall detector using gyroscope and accelerometer to detect the falls.

b) To integrate the device with the notification system through Telegram app.

1.4 Scope of Project

The scope of this project are as follows:

a) To develop fall detector using node MCU integrates with gyroscope and accelerometer Sensor to detect any accidents from fall of elderly people.

b) By integrating with Telegram app, the system will be able to notify the close contact to expedite the arrival

c) To propose a low-cost system that meets all requirements by leveraging existing mainstream, dependable technologies.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In today's modern society, in twenty years prediction, the estimation of younger people that will move out from their parent house will be increase and resulting in more seniors going to live alone. Even though this youngster were living in the same city as their parents, there is currently about 70 percent of them prefer to rent or buy their own home. This trend is also due to job demands especially outside the accommodation area or after setting up a household. There are some senior citizens living alone face some difficulties especially related to movement even though they are mentally healthy. These people do not necessarily live in care centers because they can still be independent. To make it easier for young people to ensure the safety of their parents, a safety technology needs to be developed to detect any form of movement that is alarming or dangerous so that prompt help can be delivered.

2.2 Fall Detection Approaches.

To make things clear on how the development of fall detector, this chapter will compile regularly about progress that other research had made throughout the year. The discussion of this topic includes an approach that had been taken to develop a fall detector according to the wishes of the designer. Among the approaches introduced are cell phone-based approaches, sensor-based approaches, camera-based approaches and lastly threshold and machine learning based approaches.

2.2.1 Cell Phone-Based Approaches.

In distribution feeder, electrical energy flows through multiple feeder sections to serve all connected loads. Sometimes, one or more line branches (or laterals) branch emanates from the main feeders. Each MV feeder and/or feeder section can be fairly short, on the order of a few or less than 1 km, or it can be as long as several tens of km, depending on the distance from the substation to the load point.

To create a system that be able to predict fall risk, cell phone based approached were develop using three-dimensional accelerometer sensor. By monitoring the behavior of human walking pose using accelerometer sensor is much cheaper to build. In addition to the proposed work, the authors [3] defined gait symmetry and stability under acceleration data conditions. The proposed gait assessment model was capable of analyzing and evaluating an individual's gait's stability and symmetry. The proposed gait assessment model accurately predicted the fall risk of a walking object. Improved performance and efficiency results were obtained, proving the effectiveness of the work

Fortina and Gravina [4] created a system that uses a smartphone and a wearable accelerometer to send an alert when a fall is detected in real time. The system was capable of triggering fall incidents using various alerting modalities, quickly notifying emergency services. The method was tested on 20 people, and the results showed that it had an 83 percent specificity, 97 percent sensitivity, and 90 percent precision. Because of this work, the fall detection system will be improved in terms of design and evaluation in the future.

The problem of fall prediction is complex, requiring the coordinated coordination of behavioural, physiological, and environmental parameters.

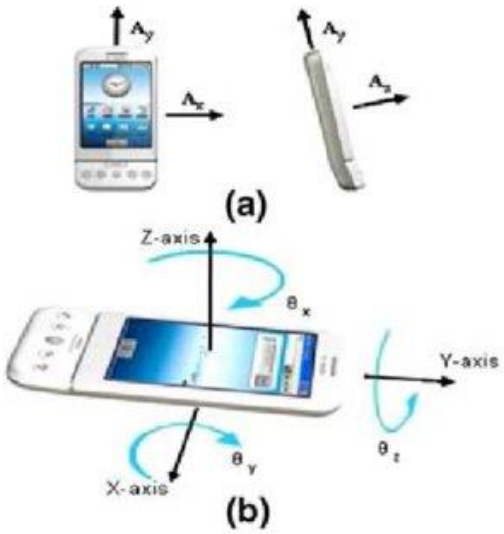


Figure 2.1 Cell phone-based approaches gyroscope [3].

2.2.2 Sensor-Based Approaches.

Many developers and inventors suggested to use the gyroscope and accelerometer sensors, these sensors usually in pair or just one or another. Other related sensor such as barometer and magnetometer also were recorded being use in the study of development of fall detector, but the percentage is small compared to the gyroscope and accelerometer sensor. Based on the figure 2.3 [2] the used of accelerometer alone is 80.2%, 7% the use of gyroscope in fall detector, of a combination of accelerometer and gyroscope there is 6.8% used recorded and the rest is barometer and electrometer which only 5% of usage from all sensors was ever recorded to detect fall.

In Malaysia, the dangerous of fall among elder people are well known as there are many old people sitting in a house or village alone usually. If there is something bad happen to these type of group, immediate assist and help need to be engaged as a delay on this matter can lead to serious injury and even death. The article by Ed Hardy [5] proposed a new system, which involves IoT, cloud computing and smart devices as this type of system is energy efficient and reliable as there are efficient and reliable. By using IoT, real time movement of

elderly people can be observed from time to time. One of the ideas on realizing this idea is to connect the sensor to 6LoWPAN which can allow connection directly with the internet using open standards.

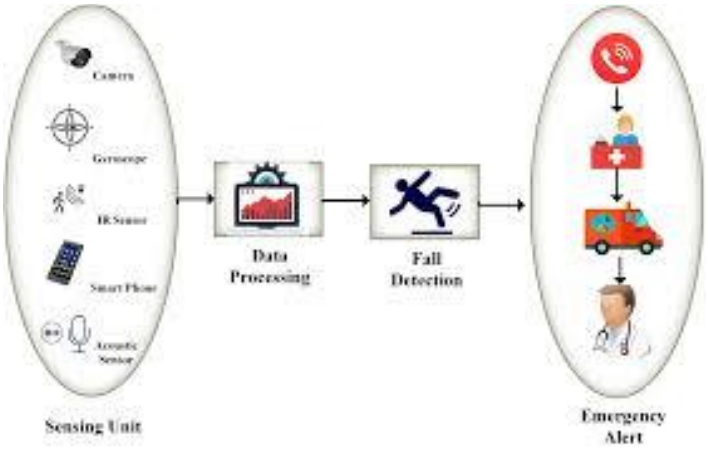


Figure 2.2 Sensor-based approaches [2].

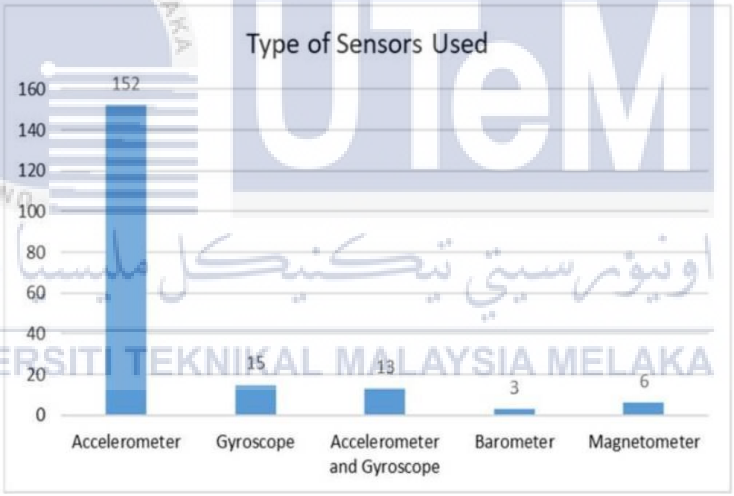


Figure 2.3 numbers on various type of sensor [2].

2.2.3 Camera-Based Approaches.

Other than two mention approaches above, camera-based approaches is one of the approaches that has the most positive impact in detecting and predicting fall activities and individual routing activities [6]. This type of approach combine with ambient sensor will allow the camera to operate in any amount of ambient light present as the module will

automatically dim the camera screen to match the ambient light situation. Another new technology to strengthen the reliability of fall detector is using a single-depth camera which will detect the key joints on a person body and analysed the user position and can provide detailed information in current situation

As technology expanded a new idea on integrating Kinect technology was involve in order to improve the system of fall detector, the research article produced by the student of Mahidol University proposed in using the Kinect 3D camera which usually being heard on Xbox and play station console to detect fall and identified the severity assessment in continuous time frame, with the detailing of framing contain fifteen body joint positions. This system used machine learning model replica with the input of image depth had confirmed to achieve 99.9% fall detection without failed [7].

This system offered load of benefit but good doesn't mean perfect, the system also having some drawback including budget as it used many expensive instrumentations, privacy problems as the user will be observe all the time and the inability to track as camera range are not wide enough and many obstacle can obstruct the view of the camera [8].

Figure 2.4 Example of Camera based-approaches [7].

2.2.4 Threshold and Machine Learning-Based Approaches.

In order to build a robust system of fall detector various screening tests need to be performed to differentiate fall from Activities of Daily Living (ADL). The proposed method

written by the line of author [9] created that the use of smartphone sensors as a paradigm by using three accelerometer which then will be calculate using advance signal processing techniques. To achieve the goal to of differentiating and classification of fall in real life activities two types of algorithms can be used to make a reliable fall detector which is using the threshold system combining it with the principal component analysis algorithm (PCA).

In both aspects, the method surpassed the threshold-based approach. [9] introduced a revised classifier to improve fall performance of the classifier. Following ADL detection, the revised classification technique gathered information well about user's posture. It was easy to distinguish between multiple classifications of the same event using this information, which was made possible by evaluating a large dataset.

However, performance for classification of falls was moderate and satisfactory for distinguishing falling from activities of daily living.

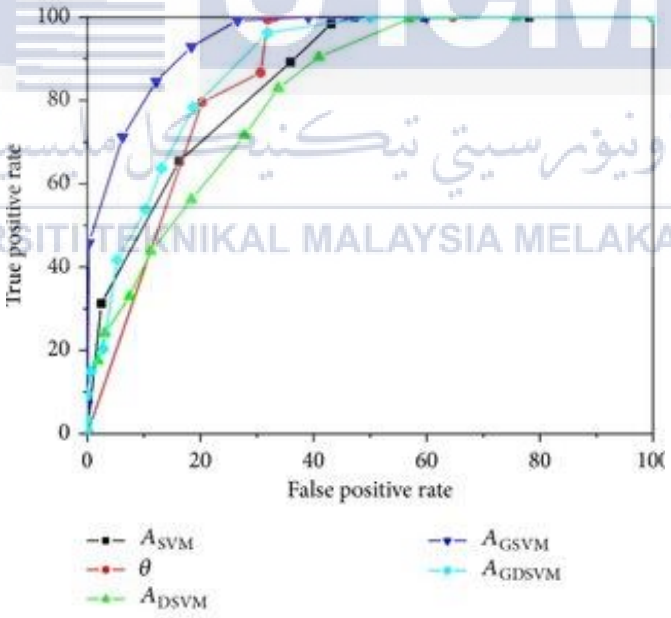


Figure 2.5 positive rate vs false positive rate [9].

2.3 Approach, Technique and Type of sensing.

Table 2.1 Conceptual frameworks for development of fall detector for elderly people using Node MCU. [10].

Topics	Approaches and Technique			
	Wearable Sensors	Smart Phones	Camera System	Kinect
Attach with users all time	X	X	O	O
Users feel comfortable	X	X	O	O
Very high accuracy	O	X	O	O
Cheap price / Low cost	X	O	O	X
Independent from surrounding/environment	O	O	X	O
Limit Resources	O	X	O	O
No personal setting before beginning use	X	O	O	X

Table 2.2 Comparison of fall detection system [11]

Type of Sensing	Sensor Used	Algorithm Type	Classification of falls	Disadvantages
Camera based Sensing	Camera	Detection based on human skeleton, Falling angle, Vertical projection, Histogram, No feedback is considered.	High false rate, Falls can be classified but not implemented	High Computing resources to process data continuously, not protable, limited sensing area
	Pressure sensor, Floor	Altitude change, vibration	Not classified	Low fall detection accuracy for

Ambient Sensing	vibration detectors, Bed exit detection Sensor.	(threshold) No feedback is considered		pressure sensor, High cost for other and portability
Wearable Sesnsors	3-D accelerometer	Threshold based	Not classified	No feedback is considered can be enhanced through efficient algorithm.

2.4 Figures on different approaches.

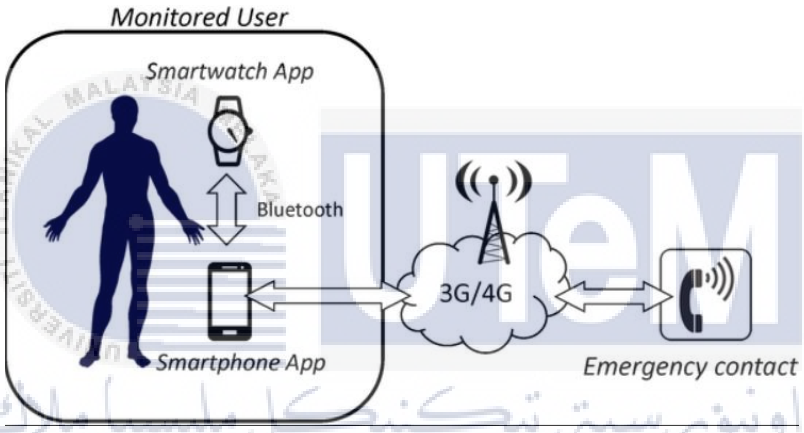


Figure 2.6 Wearable device connection and process flow [4].

Figure 2.7 Process flow when fall occurred [5].

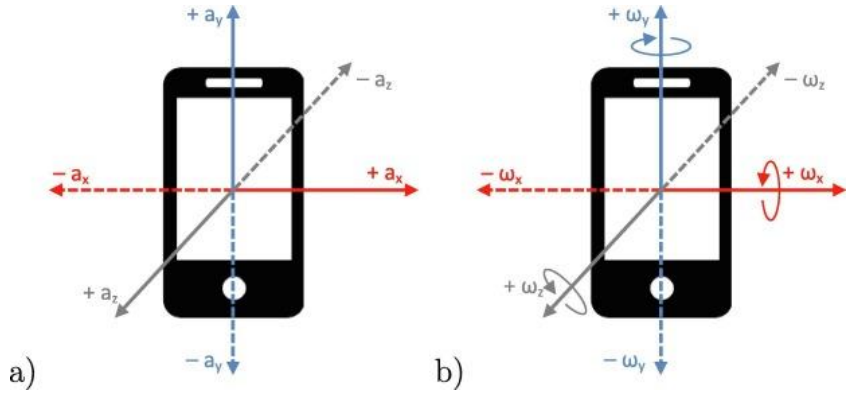


Figure 2.8 Smartphone with built in gyroscope [3].

Figure 2.9 Camera based approaches example [6]

2.5 Analysis Effectiveness formulas.

A fall detection or prediction model must be tested for analysis effectiveness. To evaluate a given model, the four parameters [12], [13] are used:

i. Sensitivity: the system can correctly detect falls. It is defined as the following ratio of the number of correctly classified falls to the total number of falls:

$$\text{Sensitivity} = TP/(TP+FN) \qquad (2.1)$$

* Where, TP = Falls correctly identified, and FN = Fall not detected by the model.

ii. Specificity: the system can prevent false alarms (detecting an event similar to a fall, which is not a fall in actuality). It is calculated as follows using ADL (daily activities):

$$\text{Specificity} = TN/(TN+FP) \qquad (2.2)$$

* Where, TN = Number of ADL correctly classified, FP = Number of False Falls

iii. Accuracy: Accuracy is a model's ability to correctly identify actual falls while also recognising false falls. It is determined by a careful balance of sensitivity and specificity:

$$\text{Accuracy} = (\text{Specificity}+\text{Sensitivity})/2 \qquad (2.3)$$

iv. False Positive Rate: The number of false falls identified as actual falls per hour is referred to as the false positive rate. It is calculated as a proportion of the number of false falls to the total recording time:

$$\text{False Positive Rate} = FP/(\text{ADL time (in hours)}) \qquad (2.4)$$

2.6 Cross referencing.

Falling had become a major problem for people who aged 60 years old and above and health maintenance need to face this challenges obstacle. In order to make a portable fall detection device, accelerometer systems need to be brought in, however the sensor are having some issues as the trigger of sensor are very sensitive to the movement of daily activities such as walking and jumping, this dynamic motion are not easy to avoid as the motion of walking and jumping are quite identical to fall. To avoid false alarm from happen, acceleration of cross product method was introduced. The accelerometer sensor comes with gyroscope features which the data to simulate threshold value on falls, posture transfer and dynamic activities can be collect to compare different methodological [13]. There are three

aspects need to be considered to determine the parameter needed, the three parameter is threshold selection, sensor placement and post fall posture.

2.7 Summary.

The problems of elderly people keep falling and hurting in this modern world had become such a pandemic and it began to take effect on health issue, emergency response team, family and society, with the creation of falling detector early reach in locating falling victims can be more-easy as the information are delivered instantaneously. Starting from the year of 2005-2017 many papers had been published on fall detection to provides other researchers an important research effort and a recognition for institution. Since the demand on fall detector device is quite high, the variation of the number of publications had taken their pattern as starting from 2004 the number of publications about fall detector reach it peak at 2017-2018 where the percentage of publication alone is 24 percent throughout the decade [2]. With the help of many research and publication, the process of research and development can be much easier and be able to produce a system that are robust and reliable.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter present the method used by this project. This chapter will cover every aspect of the project, including the methodology, experimental setup, parameters, equipment, limitations, proposed methodology, and summary used for the development of a fall detector using a node MCU for elderly people. A methodology provides a theoretical framework for determining which method, set of methods, or best practices that can be used.

3.2 Methodology

There is two system which for the 6-axis motion sensor and GPS module, this system will start when the device is turned on and enable the accelerometer and the global positioning system or GPS. These two sensors will gather the data continuously to observe movement and location of the user. If there is a sudden movement and change on posture and acceleration the system will send a message through Telegram app to the in-charge person who is responsible for taking care of the users. If there is no more trigger warning the system will end. The person who are responsible also can track the position of user whenever they want by sending command through telegram. Subsequently, Figure 3.1 shows the research design of this thesis.

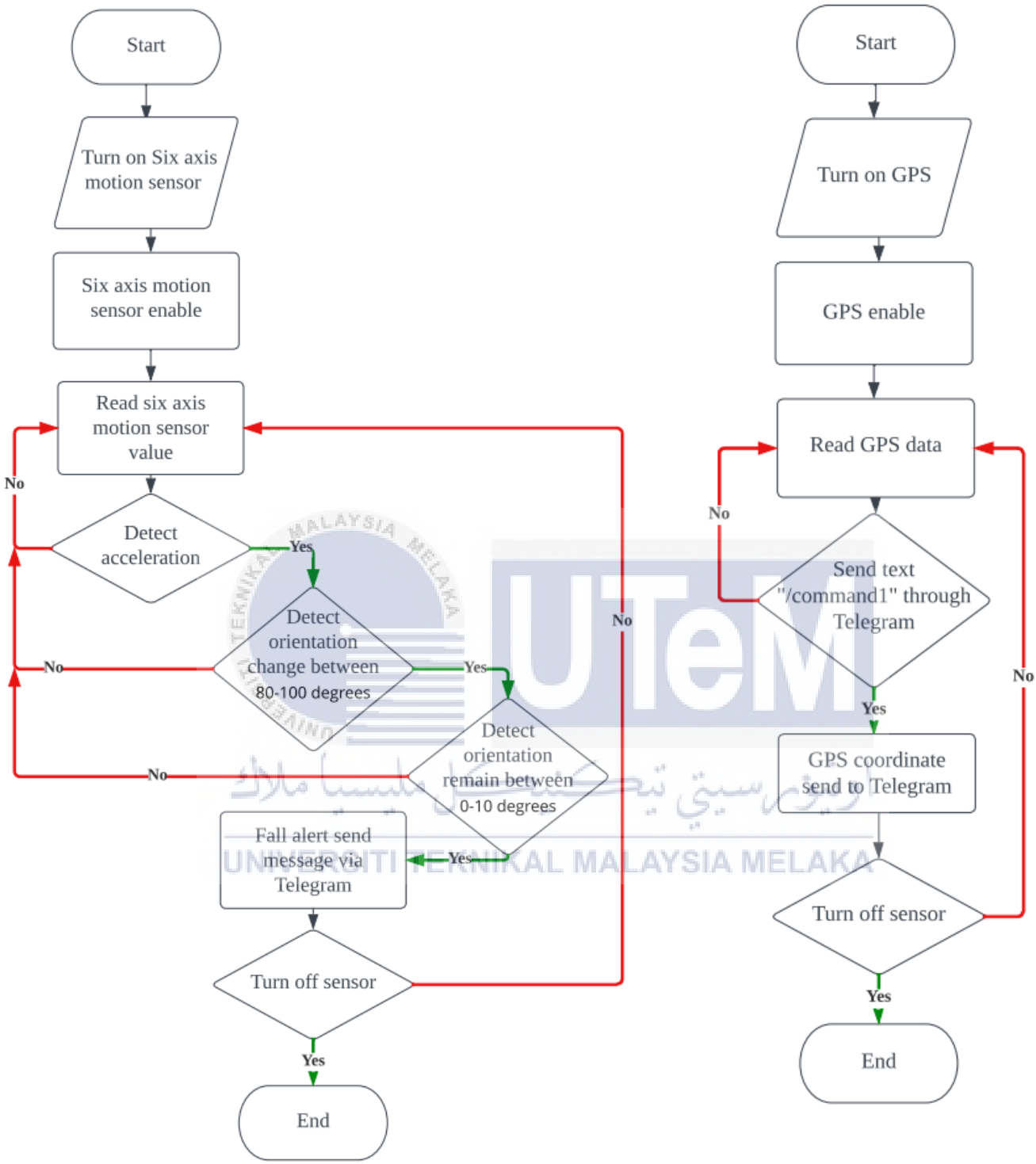


Figure 3.1 General process flow.

3.2.1 Experimental setup

For this experimental setup, many experiments will be run upwards to the two sensors. For the first sensor, the accelerometer sensor will be tested in the form of physical method by classifying between daily routine activities with fall incident, the test will be conduct by wearing the device and data collection will be made by testing three mode of movement which is static, walking, and brisk walk or running, this type of testing was made to ensure there is no false alarm will be sent. For the second sensor, the global positioning system or GPS will be test on four different locations to determine the accuracy per meter, sensor quality, sensor tracking and sensor signal loss. The GPS is important to make sure the information given are good and can be trusted.

3.3 Software and Hardware Implementation.

This project is divided into three stages which in stage 1, the stage emphasizes hardware development and specification to identify limitations in developing this project, how to organize hardware placement and where to place the hardware to get the best value of threshold.

On stage 2, software development were chosen as a step to identified specific software tools that will be paired to aid the program is Telegram app to interact data with android system in phone. For this stage, Arduino ide is one of the software that been used to store data and store command so that the system can work in systematic ways and telegram app were chosen to become a platform to send and receive notification from the nodeMCU.

For the third and last stage, the importance of software and hardware integration is needed to build a reliable project as the node MCU act as microcontroller to monitor all the hardware data and parameter that been provided by the sensor attached. The coding that had

been build using the Arduino ide software allow controller to access all the data form sensor and Telegram app act as a bridge from controller to android system to notify user through telegram message service when certain threshold had been reached.

3.3.1 Stage 1: Hardware Implementation.

Table 3.1 List of hardware.

Components	Specification	Purpose
Battery 	Type: Li-Ion Battery Nominal Voltage: 3.7V Capacity: 2000mAh	To give sufficient amount of voltage and ampere to the board so that the system can operate in stable condition.
Node MCU 	Controller: ESP8266 microcontroller Operating Voltage: 3.3V Digital I/O pin: 11	Act as a controller to store data and programs. Monitor the input information and deliver the output needed.
MPU 6050 	Operating Voltage: 2.3V-2.4V Consumption: 3.9mA 3 axis-gyroscope.	Provide in the measurement of velocity, orientation, acceleration and displacement features.
NEO-6M 	Operating Voltage: 2.7V-6V Position Accuracy: 2meter Update rate: 5Hz	Tracking user coordinates by synchronizing location, velocity and time data.

Switch 	Mechanical life : 40,000 Voltage : 2 to 4V DC Current : 10mA	To ensure that the nodemcu can be turn on and off whenever the user feel necessary to save battery power.

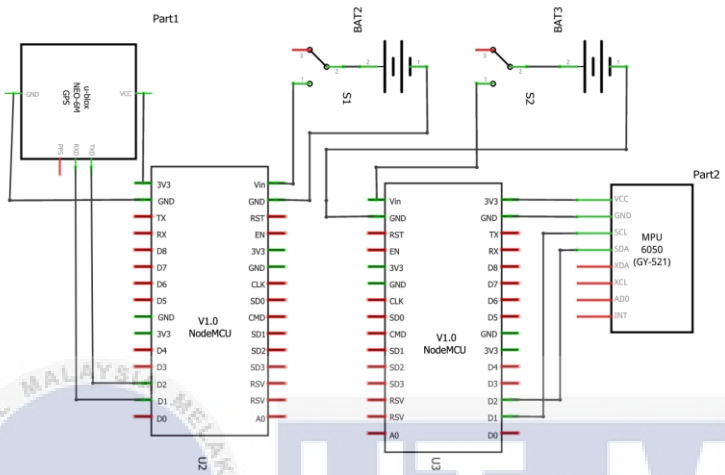


Figure 3.2 Schematic diagram

Based on the Table 3.1, Schematic as depicted in Figure 3.2 were made. There is a reason why all this component were used in order to create this project. Firstly, for the supply voltage, the li-ion battery were used to ensure the device can be used in a long time period before need to be charged back, by using this type of battery the sustainable device can be create.

Secondly, the nodeMCU are the brain in this project act as a microcontroller, it regulate the incoming data from the sensor of 6-axis accelerometer and GPS module. The nodeMCU also responsible to handle data and command so that user can communicate with the sensor. The main reason why there is two nodeMCU involve in creating this project is because the nodeMCU are not capable in reading two sensor data simultaneously, in this project the data of of 6-axis accelerometer must be carried out continously without being interrupt by other sensor, otherwise there will be a conflict of trigger during data collection

run by the sensor to nodeMCU, also one nodeMCU are not capable to power up this sensor efficiently if both sensor connect to one nodeMCU.

Lastly, the switch were used to make sure that the device can be turn on or off to offer the user an option when to use the device whenever or wherever the user want.

3.3.2 Stage 2: Software Implementation.

Table 3.2 List of software

Software	Purpose
Arduino IDE 	This Arduino IDE software offer user to write and upload computer code to the physical board to make a system.
TELEGRAM 	Telegram app helps connect different apps and devices. Using this app and appropriate coding, the microcontroller is able to interact with devices or smartphone.

In Table 3.2, there are two types of software that were involved to make this project a reality, the first one is the arduino IDE software, with this software coding can be written and the coding can be uploaded to the nodeMCU to store a set of command to be execute.

The second one is, Telegram app which the user will be dealing with to check for notification and send command to the nodeMCU, this application also can act as a data storage to store past event through message that been sent into it.

3.3.3 Stage 3: Software and hardware implementation.

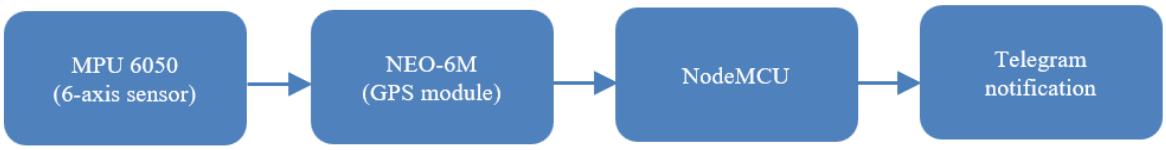


Figure 3.3 Block Diagram of fall detector using nodeMCU for elderly people.

The block diagram represent a system where the MPU-6050 is used to measure the movement and orientation of an object, the NEO-6M is used to determine the object's location, and the NodeMCU is used to connect the device to the internet and send location and movement data to a user via Telegram notifications.

3.4 Data Collection.

Process of data collection involves a controller that works to upload a coding to physical components, store data of desired value parameter and to view output data that comes from sensor connected to it. Other than controller, sensor is needed to detect any changes in the environment and respond to some output on other system. The community of research and development on fall detector system now has the tool to collect and analyze fall related data for the purpose of detection and prevention of unintentional falls.

3.5 Development Stage.

Over 80% cases of falls on injury-related involving patients need to be hospitalized and most patient are among the elderly [14]. Hence, this project purpose is not made to prevent falls and injuries but to send an immediate response unit to the place where the user is having accident and hopefully can prevent the pain from getting worse. To differentiate fall incident from daily activities, human activities on gait and pose need to be recognized. The system that will be designed will be using threshold-based approach to discriminate

daily activities which includes jumping, walking, sitting, running, and lying from fall. There are important stages that need to be implement in the system which is signal filtering and classification, and this stage is what differentiates threshold based approached form other approached introduced.

3.5.1 Creating Telegram Bot.

Telegram bots can be used to interact with NodeMCU devices in a number of ways. For example, the use of a bot is to send and receive messages, receive notifications, or perform other tasks. One of the advantages of using a Telegram bot is that it allows interaction with NodeMCU device remotely, without having to physically access it. This can be useful if the user want to control the NodeMCU device from a different location, or want to monitor it remotely.

Figure 3.4 Steps on creating Telegram Bot.

This is the step to create a Telegram bot:

1. Open the Telegram app on device (phone or tablet)
2. Search for the "BotFather" account
3. Start a chat with the "BotFather"
4. Type the command "/newbot" to create a new bot
5. Follow the prompts to enter a name for your bot and select a unique username for it

Once these steps completed , the "BotFather" will provide token. This is a unique string of characters that serves as bot's API key, which will be needed in order to access the Telegram API and control the bot.

3.5.2 6-axis sensor reading.

For the 6-axis sensor to read the data of orientation and acceleration, the sensor itself can produce an output of data to be measured, but in this case it will be a difficult task for identifying fall incident just by using the basic data provided by the sensor. In this sub section, how the data were collected to identified fall incident will be elaborate.

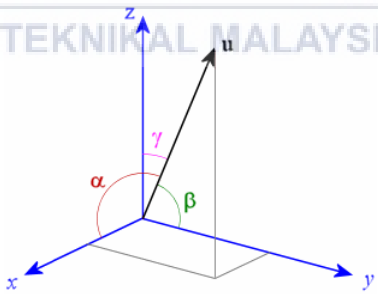


Figure 3.5 3-dimensional space axis.

The MPU6050 is a type of sensor called an accelerometer and a gyroscope sensor. It can measure both the acceleration and the angular rate of an object in 3-dimensional space as shown at Figure 3.5 [16]. The 3 axes it measures are the x-axis, y-axis, and z-axis. These axes are perpendicular to each other and are used to represent a 3D coordinate system.

Accelerometer sensors measure linear acceleration, which is the rate at which an object is changing its velocity in a specific direction. For the MPU6050, the x-axis, y-axis, and z-axis are used to measure the linear acceleration of an object along the x, y, and z directions respectively .

Gyroscope sensor measure angular rate, which is the rate at which an object is changing its orientation. For the MPU6050, the x-axis, y-axis, and z-axis are used to measure the angular rate of an object around the x, y, and z axes respectively. A 3-axis vector can be defined as a combination of the 3 linear acceleration and angular rate measurements that the sensor makes. The vector can be represented by 3 components, one for each axis. Each component is a scalar quantity, and the vector can be represented mathematically as a column vector.

It's a combination of both the data of linear acceleration and angular rate that been getting from the sensor, so the device can know how the object is moving in space. And by knowing the linear acceleration and angular rate of object in all 3 axis calculation of attitude, displacement and position of the object in space can be made.


```
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;
```

Figure 3.6 Formula used to get the 3-dimensional space axis [17].

Those big numbers 2050, 77, and 1947 in Figure 3.6 are the constants being used to adjust the measurements. Thee sensor gives a number for how much something is moving

on each of the three axes (x, y, and z). But, the sensor might not always give the same "zero point" or starting measurement. By subtracting a constant value from each of the sensor measurements, it makes sure that the new measurements always start from the same "zero point". Then it goes on to divide the measurement by another constant, which is 16384. This further scales the measurement so that it falls in a specific range. By doing this it can be sure that measurements always fall between a certain range, so the code can more easily process the data it gets from the sensor.

3.6 Limitation of proposed methodology.

The creation purpose of this project is to create a device that can deliver the output which is desired is very difficult, especially if it involves the presence of many simulations to get good results. Among the challenges or limitation that need to be faced are how to mimic the fall in real life performance, the sensor needs to be sensitive and specific, as the experiment will often be conduct in a controlled situation the successful detection rate can be estimated in accordance with the given force but if the test were conducted in real life the detection rate cannot be guested.

Second, due to the lack of willing participants aged sixty and above the test will largely be conducted by young people, this will also make the detection rate decreased as the pose or the fitness of the young people and older people are different. The reason not to use old people aged sixty and above as a test subject is because it is too dangerous as anything could happen to them during the experiment period.

Lastly, smartphone-based device and system also can become a challenge as real-time information hard to be delivered as it depends on internet connection and WiFi to deliver a message.

3.7 Summary.

This section presented a process for creating and building a fall detection system for elderly people using a Node MCU as a microcontroller. The planned system will send alerts to distant family members via Telegram app message service if fall occur. The telegram application was chosen to send the alert since it is free software and a widely known program. Everyone can easily use the software, and it is not extremely complicated. It is cost effective since the total costs of goods is (RM 71), which is quite low when compared to the impact that it can bring to the society and health.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This study was conducted to meet the three main objectives of this project as stated in chapter 1 section 1.3 which is to develop easy monitoring smartphone based, develop low-cost alternative of nursing and to integrate software and hardware into building the fall detector. The results are presented according to the three main areas of concern namely the process of developing a fall detector using node MCU for elderly, the study on the effectiveness of the project and finally the usability of the prototype. The expected results for each area will be elaborated and discussed throughout this chapter.

4.2 Results

Results sections were created to show the design and interface of the project to give a clear image of the finish product.

4.2.1 6-axis accelerometer and gyroscope working scheme.

The development of fall detector using node MCU for elderly people expected to deliver output that can detect acceleration and rotation when put on someone body. From the data that continuously being collected, the node MCU will monitor and process all the data parameter that come from the MPU 6050 in a cartesian coordinate system covering the acceleration and rotation as depicted in Figure 4.6.

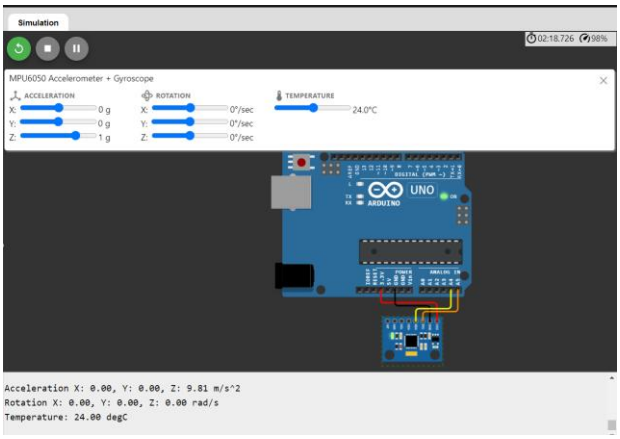


Figure 4.1 MPU 6050 connection and parameters [18].

The threshold value regarding the speed and rotation of device to detect falls will be identified as falls. If fall is detected, message through telegram will be sent to family members or any concerned person. This type of notification is made possible by the configuration command that been made on telegram, this software tools were used to help controller interact with android devices so that any notification that needed to be show, will be showed through telegram message service.

4.2.2 GPS module working scheme.

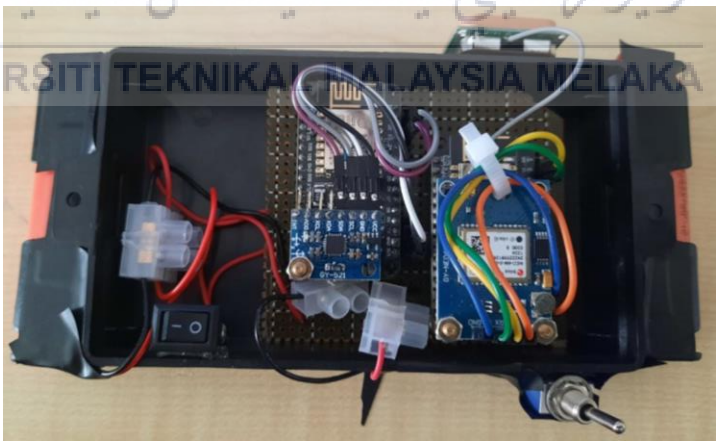
On these modules, the u-blox NEO-6M GPS engine is quite good, and it also has high sensitivity for indoor applications. The position of the antenna mounting is critical for the GPS receiver's optimal performance. The patch antenna should be oriented parallel to the geographic horizon when in use. The antenna must have a clear view of the sky, with as many visible satellites as possible in a direct line of sight. The use of the module indoors will not be interrupted once the signal is secure. The presence of Neo-6M works as a global positioning system (GPS) to allow family members to monitor the position of user that wearing the device. The module will provide information to the node MCU about where the

user is located, and the notification will be appeared on the telegram message service whenever the responsible person wanted to know on the location of the user.

For results section, the project model will be depicted, which shows the key components of the system and how the hardware interacts with one another. This section also shows what is the results of telegram notification when fall is detected, and tracking is enable.

4.2.3 Device Modelling

For this development of fall detector using nodemcu for elderly people project, the design of the project were depicted in the Figure 4.1, 4.2, 4.3 and 4.4 below, the reason why the device is placed on the chest is because the chest area has a small range of movement but can provide a high impact in the event of any drastic change of posture and shocks. Wearing this equipment on the chest will also not interfere with a person's daily affairs when compared to other parts of body.

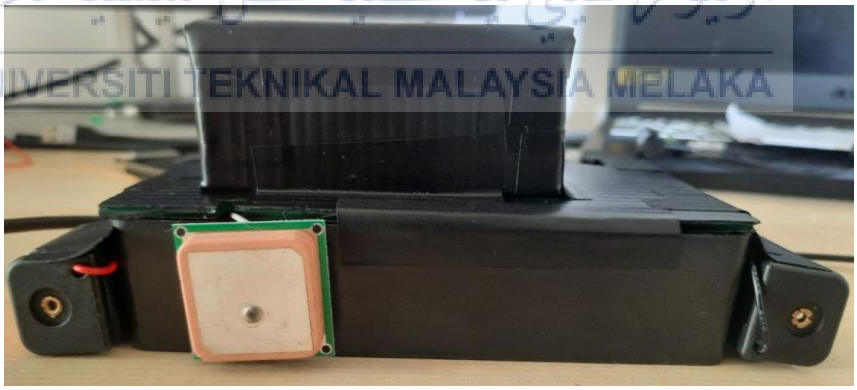


a) Without casing

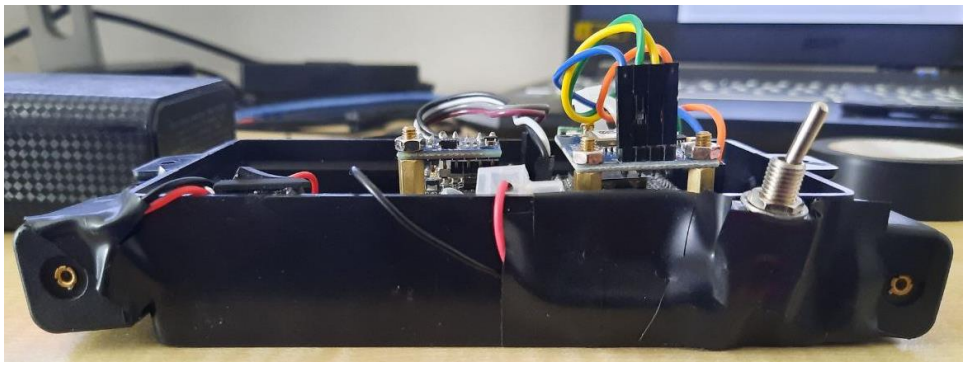
b) With casing

Figure 4.2 Device top view.

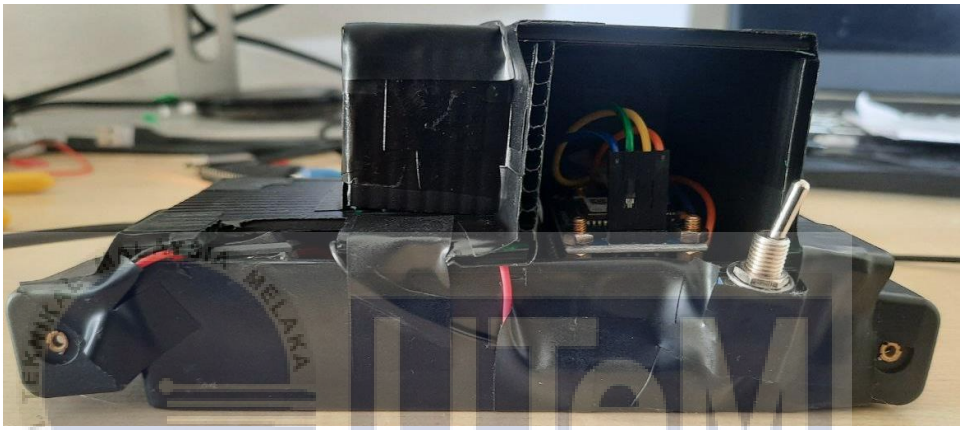
a) Right side view without casing



b) Right side view with casing

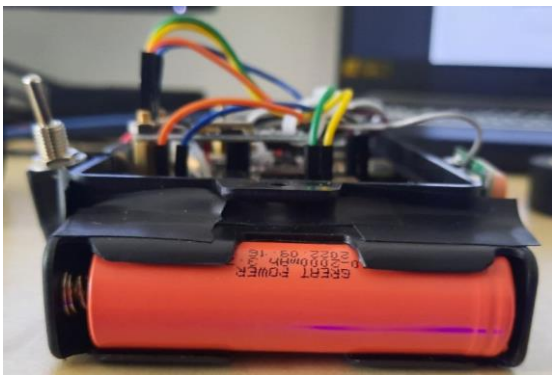


c) Left side view without casing



d) Left side view with casing

Figure 4.3 Device side view.



a) Front view without casing b) front view with casing

Figure 4.4 Device front view

Figure 4.5 Way of wearing the devices.

4.2.4 Telegram Notification

For the application selection, the telegram application was chosen as the information transfer and control platform, this application is easier to program and more user friendly. This application not only can receive message from the sender, but it also can be set to control, from the Figure 4.5 below if message "/command" were send into a telegram group it will activate the nodemcu that control the GPS module to send the data acquired where it includes latitude and longitude information in HTTP addressing format.

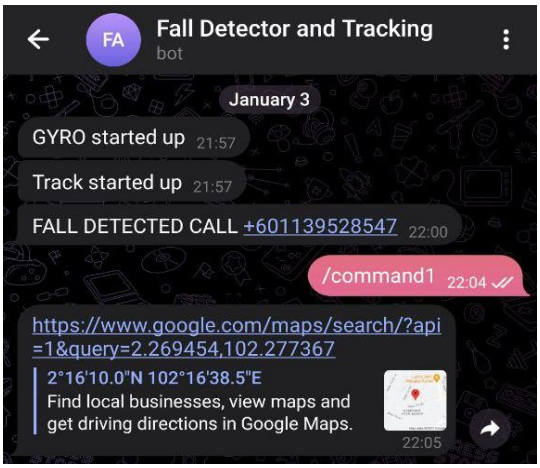


Figure 4.6 Telegram notification and GPS command.

4.3 Analysis

Analysis was conducted to get a better understanding on how thing works in this development of fall detector using NodeMCU for elderly people.

4.3.1 Analysis of accuracy on GPS module (Neo-6M).

There are four tests conducted at four different locations to make sure that the GPS module send the right latitude and longitude of the victim.

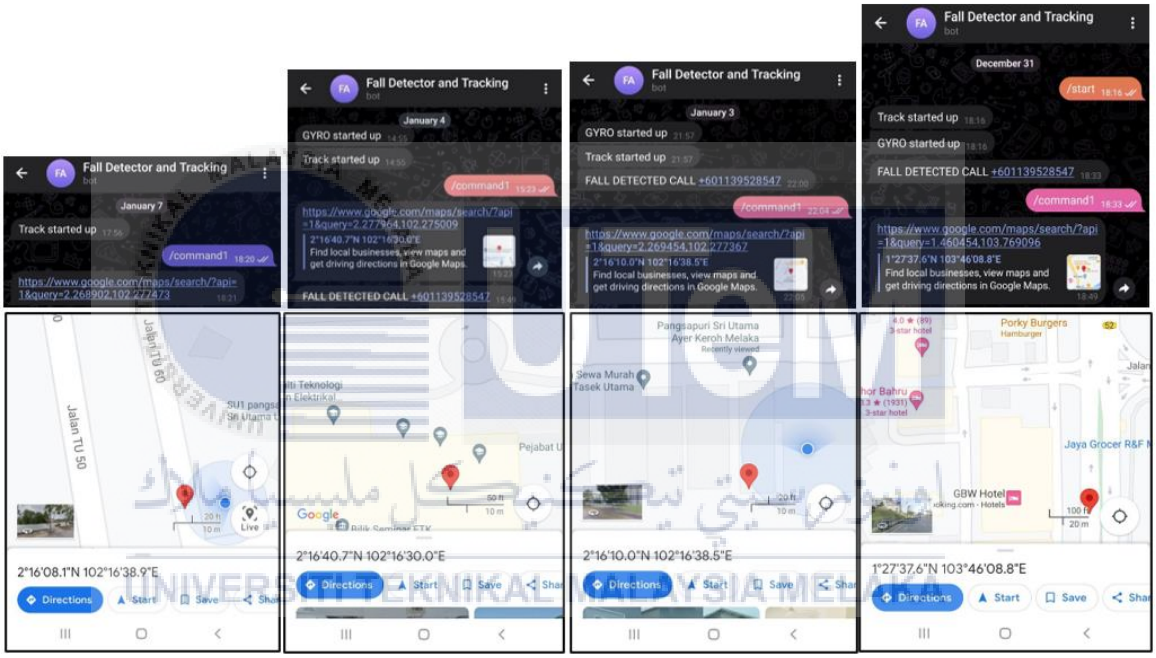


Figure 4.7 Comparison of distance between GPS module and android GPS.

Table 4.1 GPS accuracy based on floor level and distance difference.

Test	Floor Level	Distance Difference
Test 1	Ground floor	8.00 meter
Test 2	1st floor	10.00 meter
Test 3	4th floor	10.00 meter
Test 4	13th floor	30.48 meter

GPS accuracy can be affected by a variety of factors, including the height of the user. In general, during the testing of GPS accuracy, this type of GPS module is better at lower

altitudes with a bright sky condition, it is because when there is a change of height altitude position there are less interference from objects such as buildings and trees and this GPS module can locate the user more accurately. However, other factors such as the number and distribution of satellites in view, atmospheric conditions, and the quality of the receiver can also impact GPS accuracy. Therefore, there are many other factors need to be considered in determining the accuracy of this GPS module.

4.3.2 Analysis of classification on 6-axis accelerometer & gyroscope module.

The first test for the MPU6050 is to differentiate three types of user condition which is when they were in static mode, walking mode and running or brisk walking mode. This test was conducted to make sure that this project knows how to differentiate between daily routine activities with fall incident.

4.3.2.1 Static Mode

During user static mode, the value read is on 9 with tolerance of +- 1 value, this value indicates that user is in the static mode. How the serial monitor read this type of value is from the coding that have been set up earlier in methodology section which it will calculate the vector of 3-axis by using mathematic equation. While in this static mode the MPU6050 will constantly read the 3-axis condition of the user and will react if there is a change of orientation and acceleration.

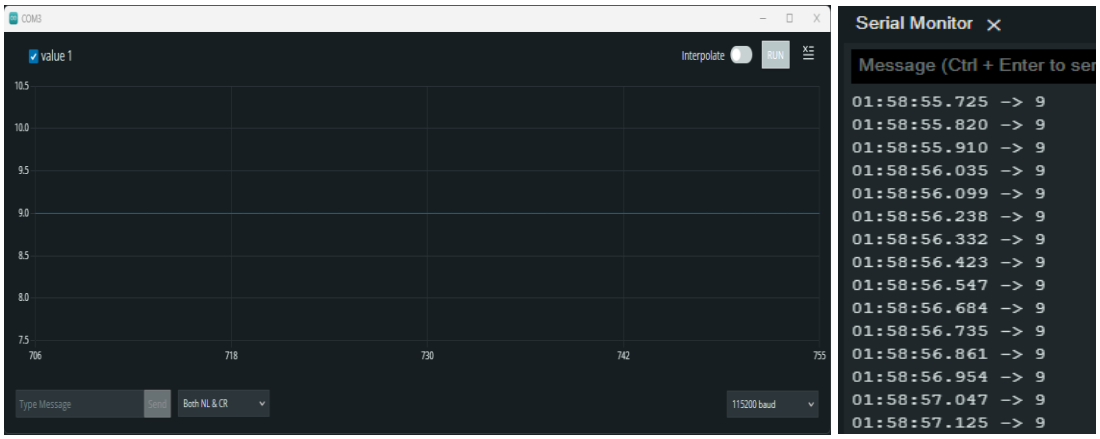


Figure 4.8 Static mode data value.

4.3.2.2 Walking Mode.

During walking mode, the MPU6050 will constantly check the user condition and from here the pattern start to form and the value start to change according to the user condition. During testing the maximum value during walking is 12 and the minimum value is 8, if it doesn't hit the threshold value to trigger the fall incident it will keep on monitoring the user condition.

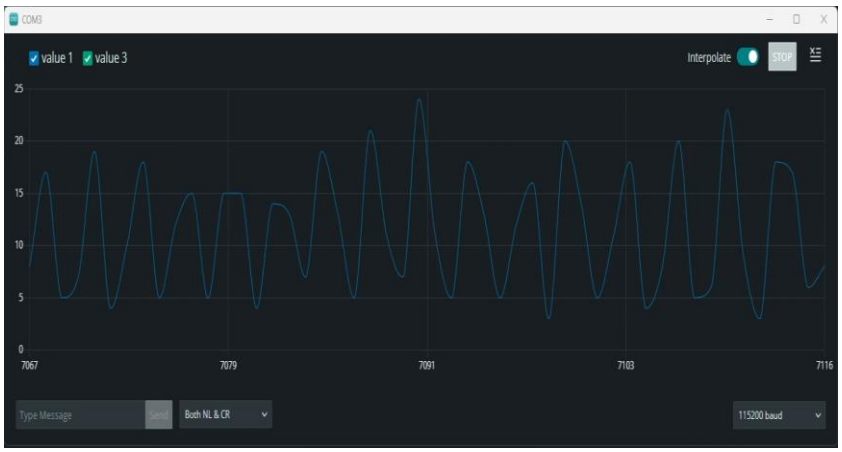
Figure 4.9 Walking mode data value.

4.3.2.3 Running / Brisk Walking Mode

During running or brisk walk mode, the value is getting higher from the walking mode which the maximum value read at 23 and minimum value read at 3, this rapid of change of value indicates that the posture and acceleration of user are getting more active. In this mode the triggered of fall incident can occur at any time but with the aid of condition that had been written, it will cancel the triggered so that false alarms are not given.

This trigger cancelation will only happen when trigger 3 are activated and then deactivated but it must be on certain condition.

- For first triggered the threshold value of 3-axis vector had been breached
- Then move on to the second trigger it will check the change of orientation of the user which if the user orientation is reaching 80 degree and above the triggered will activated.
- Last trigger it will check if the user orientation remains the same between 0 to 10 degree and from the serial monitor below the orientation were not remain the same hence cancelling the third triggered.



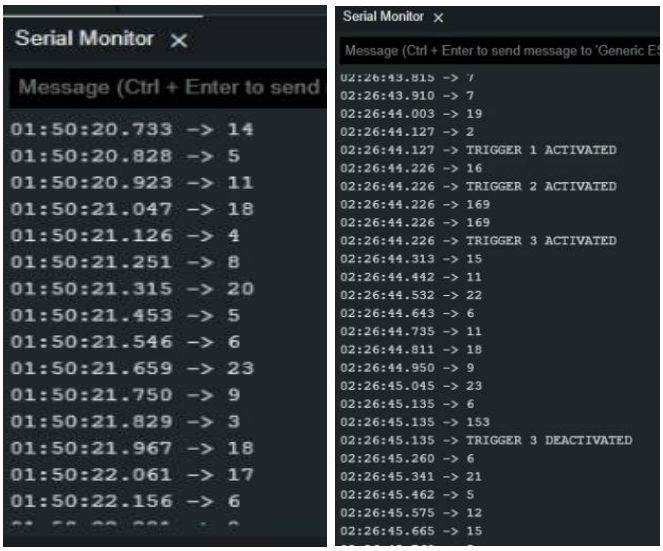


Figure 4.10 Running / Brisk walk mode data value.

Overall, the accuracy of the data produced by the MPU6050 can be quite good, provided that the device is used correctly, and the appropriate settings and calibration procedures are followed. However, it is always important to carefully consider the specific requirements of application and to test the device under a variety of conditions to ensure that it meets the criteria needed.

4.4 Summary

As a summary, this chapter of results and discussion mainly talk about the expected results on how the project will turn out to be. The system flow also had been briefed includes with short discussion so that the project will look more manageable and systematic.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This thesis presents a method for building and creating an ideal fall detector system that can differentiate between fall from daily activities, in order to helps response team and relative to react quickly if any incident occur. A fall detector using NodeMCU for elderly people can be a valuable tool for ensuring the safety and well-being of seniors who may be at risk of falling. The NodeMCU device can be used to detect sudden changes in acceleration, which can indicate a fall, and then trigger an alert system to notify caregivers or emergency services.The use of this technology can provide peace of mind for both elderly individuals and their families, as it can provide an extra layer of safety and security in the event of a fall or other emergency. However, it is important to note that fall detection technology should not be seen as a replacement for other safety measures and precautions. It is still essential for elderly individuals to take steps to reduce their risk of falling, such as maintaining a safe and clutter-free environment, engaging in regular physical activity, and wearing appropriate footwear. Overall, the use of a fall detector using NodeMCU can be a useful tool in a comprehensive approach to senior safety, and can help to provide added peace of mind for both seniors and their loved ones.From the research that had been conducted, there are two category that frequently related in order to create a system that effective which is health that bring wellness and home care and then, safety that required security and mobility to track the user everywhere it goes. Although the system for fall detection has not yet achieved satisfactory results but the concept and resources are there ready to be used.

5.2 Future Works

The development of fall detector devices has come a long way, but there is still much room for improvement in terms of accuracy, reliability, and user experience. For future works, Among the improvement that can be made are:

1. Smartphone-based improvements: Improving the real-time capabilities of smartphone-based fall detector devices by developing more robust and reliable internet connection and WiFi.
2. Fall scenarios recognition: Incorporating technology to recognize different fall scenarios, such as a fall from standing or a fall from bed, which can help to determine the appropriate response.
3. Power efficiency: Improving the power efficiency of the devices to increase battery life, reduce the frequency of battery replacement and make it more affordable for the elderly.

In conclusion, fall detector devices have the potential to greatly improve the safety and well-being of older adults, and to provide peace of mind for their caregivers and loved ones. However, there are still many challenges that need to be addressed in order to fully realize this potential. Future work on fall detector devices should focus on increasing accuracy and reliability, reducing false alarms, integrating with other technologies, and personalizing the devices to suit the needs of different user groups. Additionally, it is important to conduct more real-life testing with older adults to better mimic real-world scenarios and to improve the performance of the devices. With continued research and development, fall detector devices can become an essential tool for preventing falls and improving the quality of life for older adults.

5.3 Potential commercialization.

The potential commercialization of fall detector devices is promising due to the growing aging population and the increasing incidence of falls among older adults. Fall detector devices are designed to detect falls and alert caregivers or emergency services in the event of a fall. These devices can be worn as pendants or wristbands and can include features such as GPS tracking and two-way communication. As the demand for fall detection and monitoring solutions increases, there will likely be more companies entering the market and offering a variety of fall detector devices at different price points [20]. Additionally, advances in technology, such as the integration of AI and machine learning, are expected to improve the accuracy and reliability of fall detector devices and further increase their commercial potential.

The target market for fall detector devices is typically for older adults or individuals with mobility issues who are at a higher risk of falling. These devices can also be used by caregivers or family members to monitor the safety and well-being of their loved ones. Overall, the ability of fall detector devices to provide peace of mind for caregivers and family members, and potentially reduce healthcare costs associated with falls, make them an attractive option for both personal and healthcare use.

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APPENDICES

Appendix A Gantt chart on project planning PSM 2.