Smart Fall Detection System for Elderly People with IOT and Sensor

A project report submitted in partial fulfilment of the requirements for the degree of B.Tech in Electrical Engineering

By

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CERTIFICATE

To whom it may concern

This is to certify that the project work entitled "Smart Fall Detection System for Elderly People with IOT and Sensor" is the bonafide work carried out by DISHARI SENGUPTA (11701617061), SUBHADIP ROY (11701617028), PROGATI BISWAS (11701617050), SUBHAM RAJAK (11701617027), the students of B.Tech in the Department of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India, during the academic year 2020-21, in partial fulfilment of the requirements for the degree of Bachelor of Technology in Electrical Engineering and that this project has not submitted previously for the award of any other degree , diploma and fellowship.

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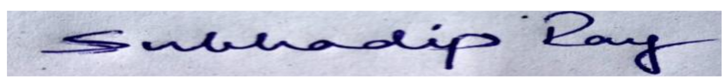

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Place: Kolkata
Date: 04.07.2021

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ABSTRACT

Falling down is among the most common causes of medical attention required by the elderly people. Elderly people often injure themselves from falling down more especially when they are living alone. After a fall occurs, medical attention needs to be provided promptly in order to reduce the risk of victim. 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 indoors... Current commercialized device required user to wear wireless emergency transmitter in form of wristwatch. 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 fall and alert relatives for help and support. For fall detection, accelerometer and gyroscope was 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 in false positives and true negatives... Alert system in form of Short Message Service (SMS) 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 the sensitivity and specificity of 95% and 90% respectively. However, the limitation of this device is unable to detect a user falling against a wall and falling end in sitting position. Recommendation for future work is to develop an interactive display which enables users to input relative’s phone number.

Chapter 1
Introduction

1.1 Literature Review

Fall is the most significant causes of injury for elderly. These falls are because many disabling fractures that could eventually go in front to death due to complications. Most elderly (over 75 years old) have fallen at least once a year, and 24 % of them have severe injuries [1]. This is a serious public health problem with a substantial impact on health and healthcare costs [2]. The cost and burden of caring for older adults is steadily increasing [3].Among people affected by Alzheimer's disease, the probability of a fall increases by three times. Elderly care can be improved by using sensors that monitor the vital signs and activities of patients, and remotely communicate this information toothier doctors and caregivers. The consequences of a fall can vary from scrapes to fractures and in some cases lead to death. Even if there are no immediate consequences, the long-wait on the floor for help increases the probability of death from the accident. For this reason, fall detections an active area of research. In the recent years, passive monitoring solutions have penetrated into health monitoring systems in homes, assisted living environments, and nursing homes. They provide timely interventions in case of emergency [4, 5].Most of the research on falls in which accelerometers issued focus on determining the change in magnitude of acceleration. When the acceleration value exceeds a critical threshold, the fall is detected [6, 7]. The use of wearable and active sensors provides better monitoring ability [8].A contribution is made towards such standardization by collecting the most relevant parameters, data filtering techniques and testing approaches from the studies done so far. State-of-the-art fall detection techniques were surveyed, highlighting the differences in their effectiveness at fall detection. A standard database structure was created for fall study that emphasizes the most important elements of a fall detection system that must be considered for designing a robust system [9], as well as addressing the constraints and challenges. In addition, fall activity patterns are particularly difficult to obtain for training systems. These systems successfully detect falls with sensitivities. However, focusing only on large acceleration can result in many false positives from fall-like activities such assisting down quickly and running. Furthermore, previous studies used complex algorithms like support vector machine (SVM) [10] and Markov model [11] to detect the fall.

However, accuracy of these systems has not been proven to be highly effective. They also use excessive amounts of computational resources and cannot respond in real time. In this paper we propose a new device based on microcontroller (Adriano-UNO) and the sensor is MPU6050 Accelerometer and Gyro Chip.

1.2 Overview & Benefits

- PROJECT PERSPECTIVE

In order to reduce the risk of elderly people getting harm from fall, medical attention needs to be provided immediately. Therefore, a reliable fall detection system can help to detect fall in elderly people and contact the nearest healthcare service for help and support.

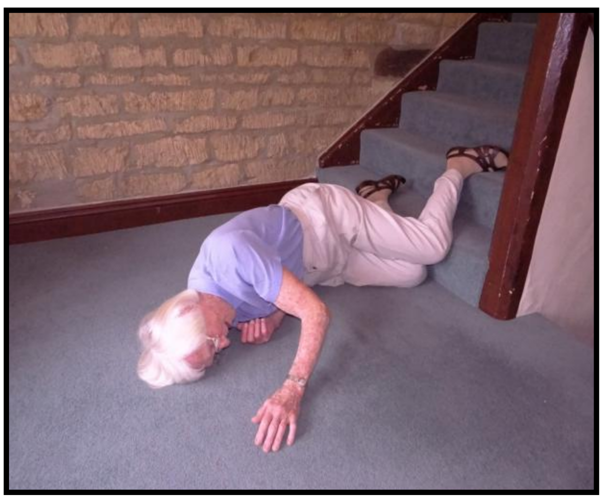
The fall detection system need to be user friendly which means it is easier to be used by the elderly people. The system also must not interfere and disturb activities of daily living of elderly people. The system needs to be cost-effective and durable.

The MPU6050 sensor module has built-in a gyroscope and an accelerometer sensor. The gyroscope is used to determine the orientation and the accelerometer provides information about the angular parameter such as the X, Y, and Z-axis data. We interface this sensor with arguing microcontroller and keep different acceleration thresholds to check whether any false triggering is happening or the user has really fallen. If values exceed thresholds then we via Blink app we get notification in our android device.

- PROJECT OBJECTIVES AND BENIFITS

- ✓ To develop an intelligent and effective fall detection and alert system using Smartphone and wireless sensor node
- ✓ To develop a reliable and cost efficient fall detection and alert system
- ✓ To develop a fall detection system that is user friendly and without causing disturbance to activities of daily living of elderly people

Our Inspiration to help



Chapter-2
Theoretical Concept

2.1 Basics of Internet of Things (IoT)

IoT (Internet of Things) is an advanced automation and analytics system which exploits networking, sensing, big data, and artificial intelligence technology to deliver complete systems for a product or service. These systems allow greater transparency, control, and performance when applied to any industry or system.

IoT systems have applications across industries through their unique flexibility and ability to be suitable in any environment. They enhance data collection, automation, operations, and much more through smart devices and powerful enabling technology.

IoT systems allow users to achieve deeper automation, analysis, and integration within a system. They improve the reach of these areas and their accuracy. IoT utilizes existing and emerging technology for sensing, networking, and robotics. IoT exploits recent advances in software, falling hardware prices, and modern attitudes towards technology. Its new and advanced elements bring major changes in the delivery of products, goods, and services; and the social, economic, and political impact of those changes.

IoT − Key Features

The most important features of IoT include artificial intelligence, connectivity, sensors, active engagement, and small device use. A brief review of these features is given below:

•<u>AI</u> – IoT essentially makes virtually anything “smart”, meaning it enhances every aspect of life with the power of data collection, artificial intelligence algorithms, and networks. This can mean something as simple as enhancing your refrigerator and cabinets to detect when milk and your favourite cereal run low, and to then place an order with your preferred grocer.

•<u>Connectivity</u> – New enabling technologies for networking, and specifically IoT networking, mean networks are no longer exclusively tied to major providers. Networks can exist on a much smaller and cheaper scale while still being practical. IoT creates these small networks between its system devices.

•Sensors – IoT loses its distinction without sensors. They act as defining instruments which transform IoT from a standard passive network of devices into an active system capable of real-world integration.

•Active Engagement – Much of today's interaction with connected technology happens through passive engagement. IoT introduces a new paradigm for active content, product, or service engagement.

•Small Devices – Devices, as predicted, have become smaller, cheaper, and more powerful over time. IoT exploits purpose-built small devices to deliver its precision, scalability, and versatility.

IoT– Advantages

The advantages of IoT span across every area of lifestyle and business. Here is a list of some of the advantages that IoT has to offer:

•Improved Customer Engagement – Current analytics suffer from blind-spots and significant flaws in accuracy; and as noted, engagement remains passive. IoT completely transforms this to achieve richer and more effective engagement with audiences.

•Technology Optimization – The same technologies and data which improve the customer experience also improve device use, and aid in more potent improvements to technology. IoT unlocks a world of critical functional and field data.

•Reduced Waste – IoT makes areas of improvement clear. Current analytics give us superficial insight, but IoT provides real-world information leading to more effective management of resources.

•Enhanced Data Collection – Modern data collection suffers from its limitations and its design for passive use. IoT breaks it out of those spaces, and places it exactly where humans really want to go to analyse our world. It allows an accurate picture of everything.

IoT– Disadvantages

Though IoT delivers an impressive set of benefits, it also presents a significant set of challenges. Here is a list of some its major issues:

•Security – IoT creates an ecosystem of constantly connected devices communicating over networks. The system offers little control despite any security measures. This leaves users exposed to various kinds of attackers. 7

•Privacy – The sophistication of IoT provides substantial personal data in extreme detail without the user's active participation.

•Complexity – Some find IoT systems complicated in terms of design, deployment, and maintenance given their use of multiple technologies and a large set of new enabling technologies.

•Flexibility – Many are concerned about the flexibility of an IoT system to integrate easily with another. They worry about finding themselves with several conflicting or locked systems.

•Compliance – IoT, like any other technology in the realm of business, must comply with regulations. Its complexity makes the issue of compliance seem incredibly challenging when many consider standard software compliance a battle.

IoT software addresses its key areas of networking and action through platforms, embedded systems, partner systems, and middleware. These individual and master applications are responsible for data collection, device integration, real-time analytics, and application and process extension within the IoT network. They exploit integration with critical business systems (e.g., ordering systems, robotics, scheduling, and more) in the execution of related tasks.

Data Collection

This software manages sensing, measurements, light data filtering, light data security, and aggregation of data. It uses certain protocols to aid sensors in connecting with real-time, machine-to-machine networks. Then it collects data from multiple devices and distributes it in accordance with settings. It also works in reverse by distributing data over devices. The system eventually transmits all collected data to a central server.

Device Integration

Software supporting integration binds (dependent relationships) all system devices to create the body of the IoT system. It ensures the necessary cooperation and stable networking between devices. These applications are the defining software technology of the IoT network because without them, it is not an IoT system. They manage the various applications, protocols, and limitations of each device to allow communication.

Real-Time Analytics

These applications take data or input from various devices and convert it into viable actions or clear patterns for human analysis. They analyse information based on various settings and designs in order to perform automation-related tasks or provide the data required by industry.

Application and Process Extension

These applications extend the reach of existing systems and software to allow a wider, more effective system. They integrate predefined devices for specific purposes such as allowing certain mobile devices or engineering instruments access. It supports improved productivity and more accurate data collection.

IoT primarily exploits standard protocols and networking technologies. However, the major enabling technologies and protocols of IoT are RFID, NFC, low-energy Bluetooth, low-energy wireless, low-energy radio protocols, LTE-A, and WiFi-Direct. These technologies support the specific networking functionality needed in an IoT system in contrast to a standard uniform network of common systems.

NFC and RFID

- RFID (radio-frequency identification) and NFC (near-field communication) provide simple, low energy, and versatile options for identity and access tokens, connection bootstrapping, and payments.
- RFID technology employs 2-way radio transmitter-receivers to identify and track tags associated with objects.
- NFC consists of communication protocols for electronic devices, typically a mobile device and a standard device.

Low-Energy Bluetooth

This technology supports the low-power, long-use need of IoT function while exploiting a standard technology with native support across systems.

Low-Energy Wireless

This technology replaces the most power hungry aspect of an IoT system. Though sensors and other elements can power down over long periods, communication links (i.e., wireless) must remain in listening mode. Low-energy wireless not only reduces consumption, but also extends the life of the device through less use.

Radio Protocols

ZigBee, Z-Wave, and Thread are radio protocols for creating low-rate private area networks. These technologies are low-power, but offer high throughput unlike many similar options. This increases the power of small local device networks without the typical costs.

LTE-A

LTE-A, or LTE Advanced, delivers an important upgrade to LTE technology by increasing not only its coverage, but also reducing its latency and raising its throughput. It gives IoT a tremendous power through expanding its range, with its most significant applications being vehicle, UAV, and similar communication.

WiFi-Direct

WiFi-Direct eliminates the need for an access point. It allows P2P (peer-to-peer) connections with the speed of WiFi, but with lower latency. WiFi-Direct eliminate an element of a network that often bogs it down, and it does not compromise on speed or throughput.

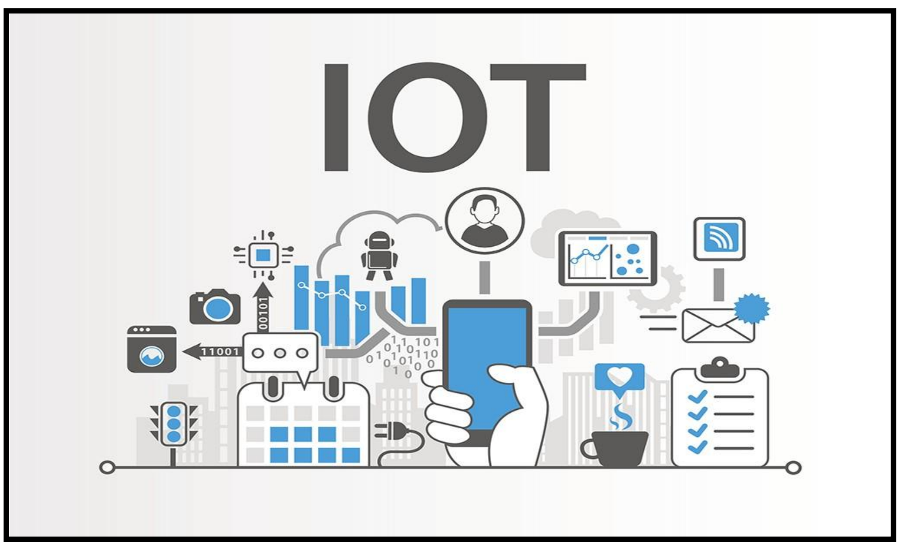


Figure 1: Internet of Things (IoT)

2.2 Fall Risk Factors

A person can be more or less prone to fall, depending on a number of risk factors and hence a classification based on only age as a parameter is not enough. In fact, medical studies have determined a set of so called risk factors:

- **Intrinsic**:

1. Age (over 75)
2. Chronic disease
3. Previous falls
4. Poor balance
5. Low mobility and bone fragility
6. Sight problems
7. Cognitive and dementia problems
8. Parkinson disease
9. Use of drugs that affect the mind
10. Incorrect lifestyle (inactivity, use of alcohol, obesity)

- **Internal Environment**:

1. Need to reach high objects
2. Slipping floors
3. Stairs
4. Incorrect use of shoes and clothes

- **External Environment**:

1. Damaged roads
2. Dangerous steps
3. Poor lighting
4. Crowded places.

2.3 Fall Detection Algorithm

The total sum acceleration vector Acc, contain both dynamic and static acceleration

Components, is calculated from sampled data as indicated in Eq. (1)11

$Acc = \sqrt{(Ax)^2 + (Ay)^2 + (Az)^2}$………….. (1)

Where Ax, Ay, Az are the acceleration in the x, y, z axes, respectively.

Similarly to the acceleration, the angular velocity is calculated from sampled data as indicated in Eq. (2)

$w = \sqrt{(Wx)^2 + (Wy)^2 + (Wz)^2}$………. (2)

Where Wx, Wy, Wz the acceleration in the x, y, z axes, respectively.

When stationary, the acceleration magnitude, Acc, from tri-axial accelerometer is constant, and angular velocity is 0o/s. When the subject falls, the acceleration is rapidly changing and the angular velocity produces a variety of signals along fall direction.

Since the Fall Index (Acc) requires high sampling frequency and fast acceleration changes, it will miss falls that happen slowly. Hence, Acc is not used unless we want to compare the performances of our systems with previous studies that have used the same positions but with deferent speed and accelerations.

The lower and upper fall thresholds for the acceleration and angular velocity used

To identify the fall are derived as follows:

1- Lower fall threshold (LFT):

The negative peaks for the resultant of each recorded activity are referred to as the signal lower peak values (LPVs). The LFT for the acceleration signals are set at the level of the smallest magnitude lower fall peak (LFP) recorded.

2- Upper fall threshold (UFT):

The positive peaks for the recorded signals for each recorded activity are referred to as the signal upper peak values (UPVs). The UFTfor each of the acceleration and the angular velocity signals were set at the level of the smallest magnitude UPV recorded. The UFT is related to the peak impact force experienced by the body segment during the impact phase of the fall.

Fall detection algorithms using thresholds are normally divided into two groups, one is based on the LFT comparison and the other is based on UFT comparison of acceleration data. Although past research has achieved some significant results, the accuracy is still

Below desired levels. In this study adjust the UFT and LFT and found the performance to be 83.33 % and 67.08 %, respectively

2.4 Plan of the Project

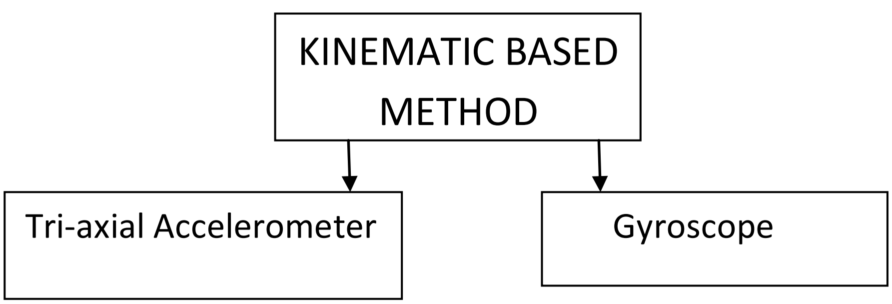
This project overview basically gives us a bird’s eye view over the entire system that comprises of 5 steps-PLANNING, DESIGNING, IMPLEMENTATION, TESTING & EVALUATION.

Analysing the severe consequences of elder persons falling and current market options available to counter the problem, we came up with the plan of introducing arduino based kinematic method.

Hereby we use an accelerometer and a gyroscope to analyse the body movements of the user and predict whether any sharp change in acceleration has occurred or not which will give an indication of a probable fall.

The MPU6050 sensor module is a complete 6-axis (3-axis Accelerometer and 3-axis Gyroscope) Module. It is Micro-Electro-Mechanical Systems (MEMS) that is used to measure acceleration, velocity, orientation, displacement, and many other motion-related parameters. Apart from this, it also has an additional built-in Temperature sensor.

The MPU6050 module is small in size with lower power consumption. Apart from this, it has high repetition, high shock tolerance, and low user price points. Basically, the MPU6050 comes with an I2C and Auxiliary I2C interface. So it can easily interfere with other sensors such as magnetometers and microcontrollers.



Sum Vector Magnitude of Acceleration = $\sqrt{x^2 + y^2 + z^2}$

Where x, y and z is the magnitude of acceleration in its respective direction.

When the magnitude of the acceleration is higher than the threshold, the microcontroller will check for orientation of the user by using gyroscope that came together with MPU6050 Accelerometer. There are two possible outcomes from the gyroscope which is either upright or lying down. If the user is standing upright, the device will continue to monitor the acceleration. However, when a fall occurred and the user is found to be lying down on the ground, notification is sent via BLYNK Application on the care takers mobile.

2.5 Circuit Diagram

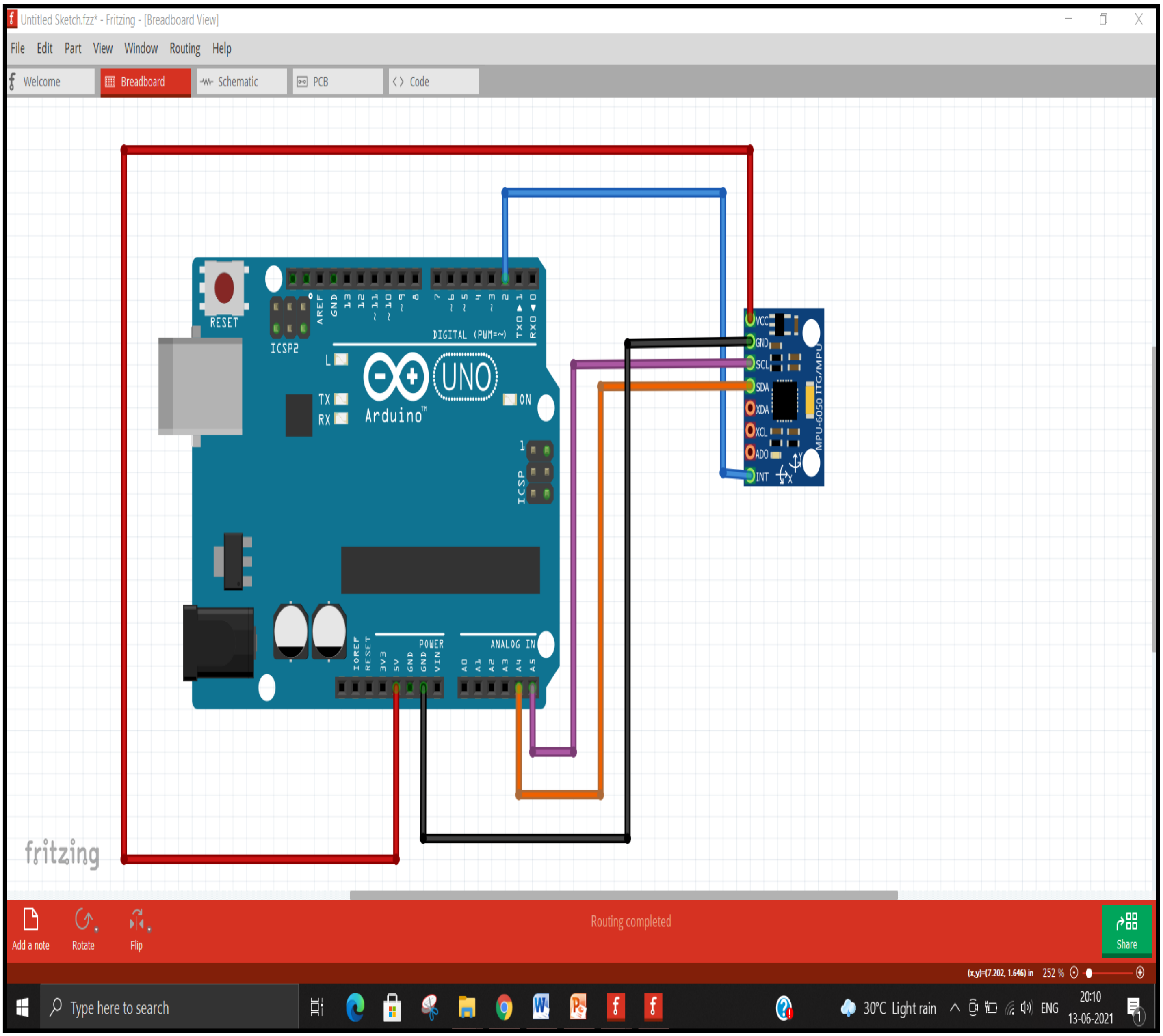


Figure 2: Circuit Diagram of Prototype

Chapter-3

Hardware Modelling

3.1 Components Used

Table 1: Component listing

Sl No.	Components	Quantity
1	Arduino Uno	1
2	MPU6050	1
3	Battery	1
4	Jumper Wire(Male - Female) (Male - Male)	5 2
5	Device (with installed Blynk Application)	As per required

3.2 Main Features of the Prototype

- Light weight
- Automatic control
- 5V operation
- Low cost

3.3 Photographs of the Components

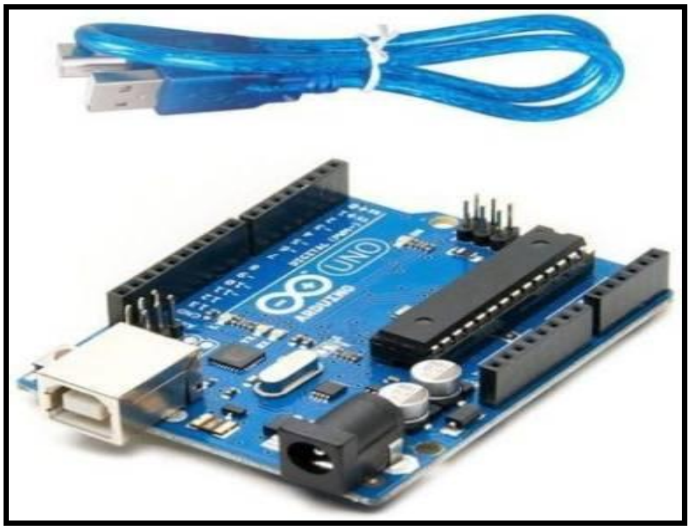


Figure 3: Arduino Uno

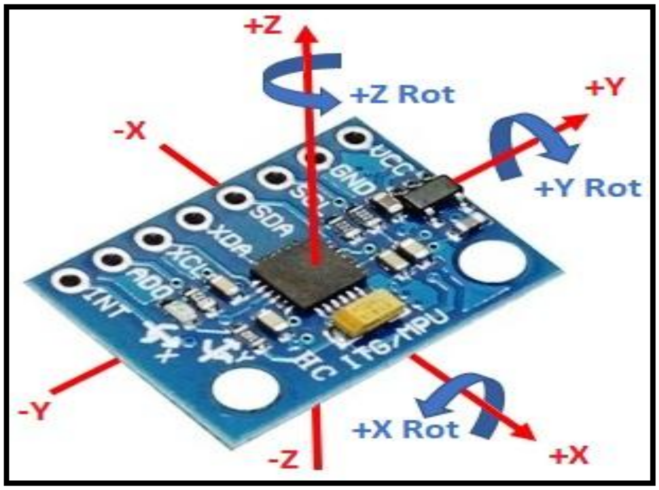


Figure 4: MPU6050

3.4 Operation of prototype

1. Connect MPU6050 to Arduino Uno.

2. Connect Arduino Uno to Laptop.

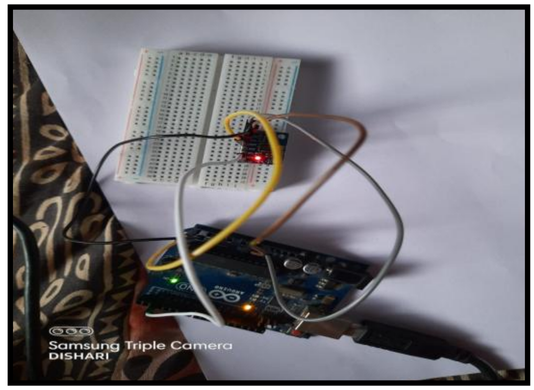


Figure 5: MPU6050 to Arduino UNO

3. Connect Battery to Arduino Uno.

4. Upload the code in Arduino and compile it.

5. Connect the whole circuit within a wrist-watch.

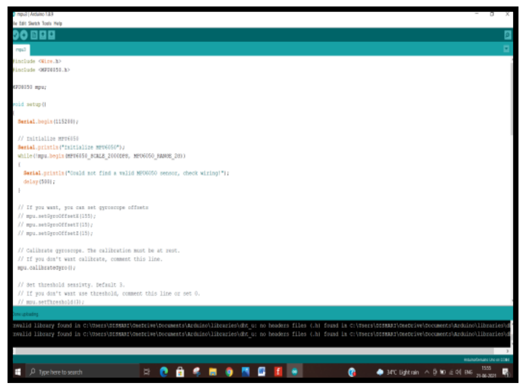


Figure 6: Code Upload

6. Connect this circuit with Blynkapplication.

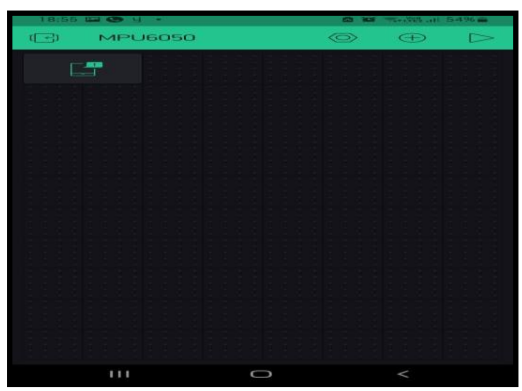


Figure 7: Connection with Blynk

3.5 Hardware Interfacing

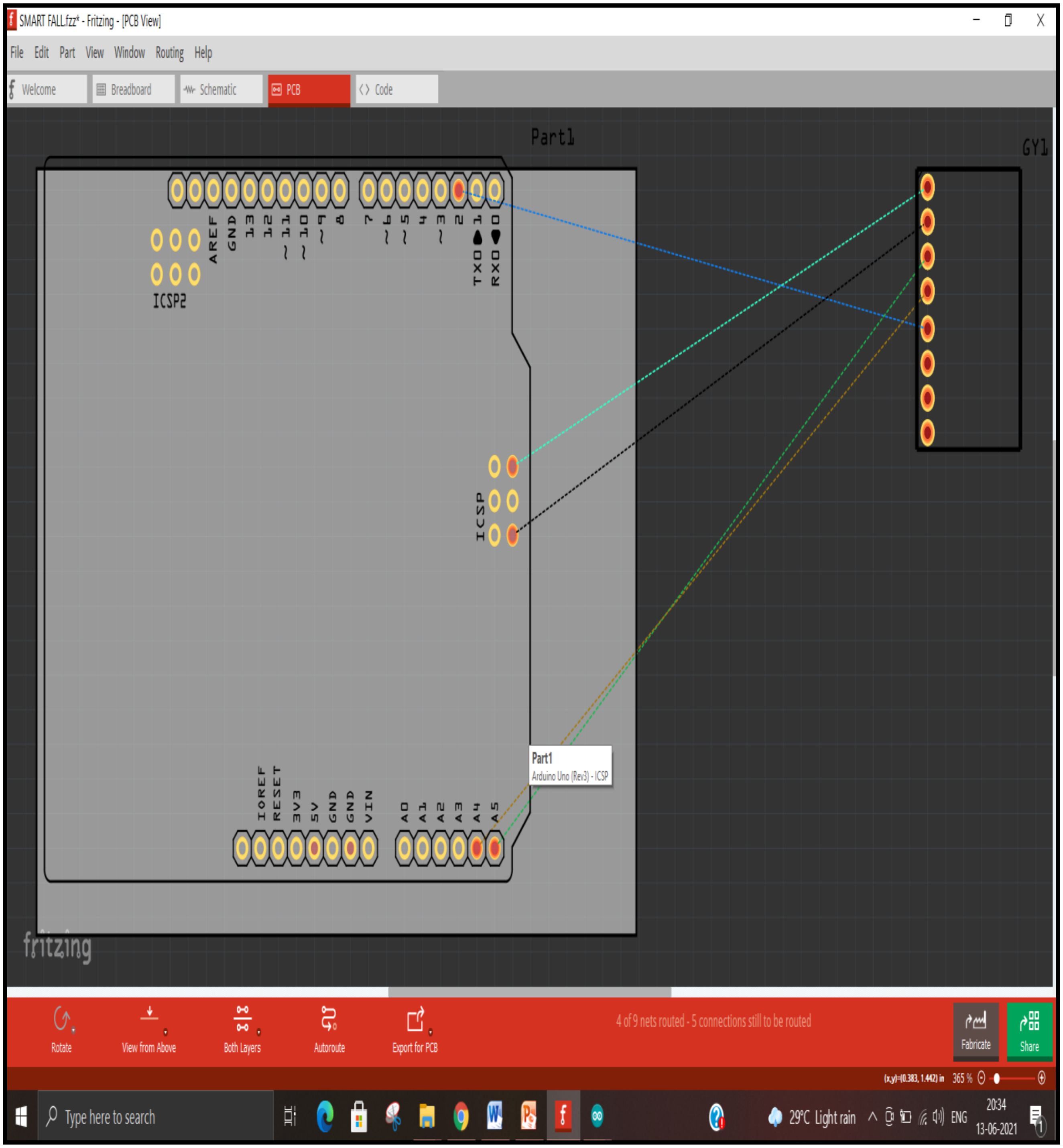


Figure 8: Diagram of interfacing circuit

Chapter-4

Implementation Logic & Operation

4.1 Basics

After assembling the system, what remains is to observe its operation and efficiency of the system. The total system is divided in several sub systems, like

- MPU6050 section
- Arduino section
- Application System

4.2 Flow Chart

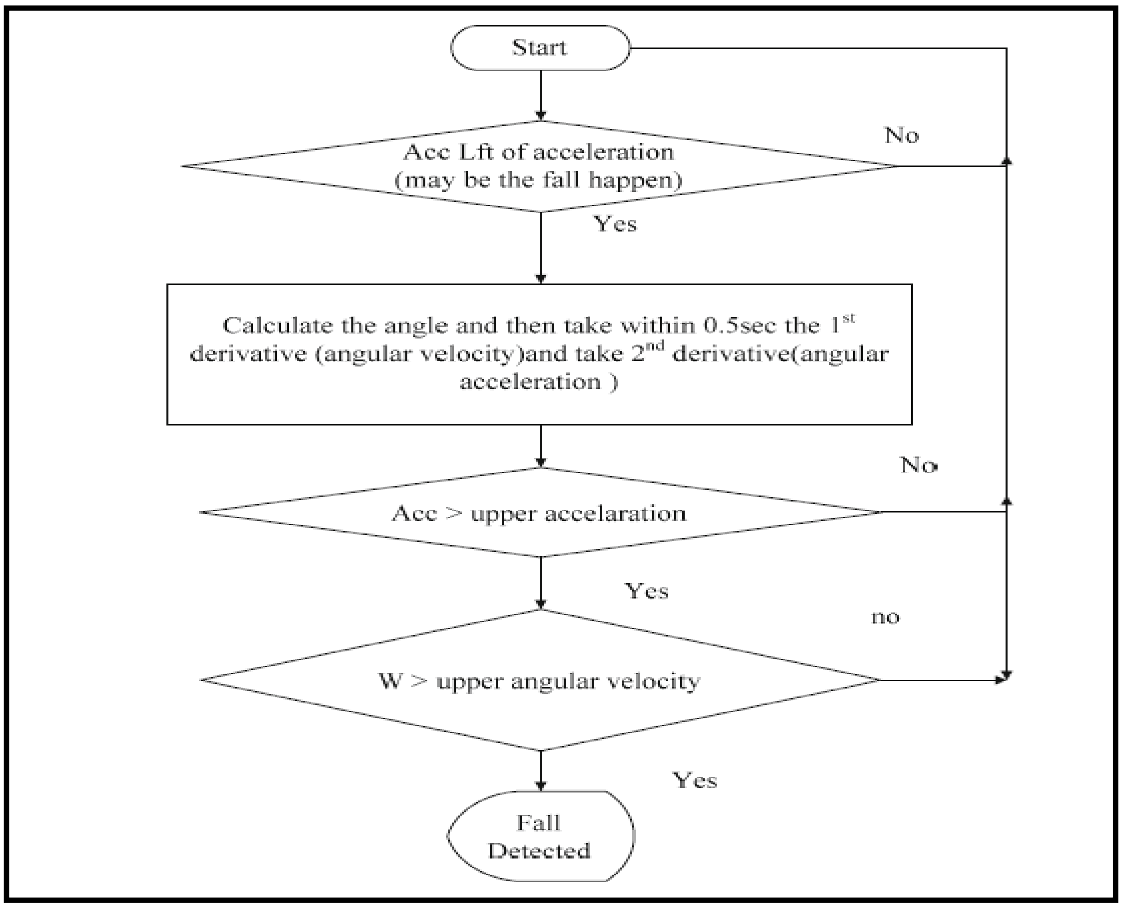


Figure 9: Flow Chart

4.3 Principle & Operation

This project was divided into 5 stages namely planning, design, implementation, testing and evaluation. By splitting into 5 different stages, the flow of the project was more organized and systematic.

The first stage of this project is planning. In order to complete the project on time with limited budget, a proper planning is required. During this stage, information such as acceleration and orientation of a person falling was directly referred to previous research paper.

Designing stage involves brainstorming ideas and solution to overcome the problem statement by this project. After conducting research during planning stage, multiple ideas are generated and become alternatives which each can be used to overcome the problem. By taking consideration of factors and limitation such as budget, time, and components availability, the best design was selected. In order to understand the process of the fall detection and alert system, a flow chart and pseudo code was designed and prepared. Components are selected based on their cost, availability, quality and compatibility. Positioning of the fall detection device on a person body is determined based on previous research paper and experimentation.

After finalizing the design and components selection, the next stage was the implementation stage. Components was purchased and arrived in expected time to avoid delay in the project. In this stage, fall detection and alert system was fabricated into a prototype. Besides that, programming code or algorithm is designed to be programmed into the microcontroller which in this case is ArduinoUNO. It is important for the algorithm to be simple and easy to understand because it is easier to troubleshoot when errors occurred. Besides that, programming code or algorithm is designed to be programmed into the microcontroller which in this case is ArduinoUNO. It is important for the algorithm to be simple and easy to understand because it is easier to troubleshoot when errors occurred.

Testing stage involves performing multiple of different test with the prototype. In order to ensure the prototypes working as per design, several numbers of tests are performed includes front fall, back fall and side fall. During testing phase, acceleration and orientation data are acquired and to be compared with the acceleration value from previous research paper. Necessary modification and adjustment was done during this stage to achieve the best result.

Finally, the evaluation stage ensures the functionality of the fall detection and alert system. It is important to evaluate the performance of the prototype in term of reliability and accuracy. In this stage, the prototype need to reliable in detecting a person fall and accurately differentiate it from activities of daily living (ADL).

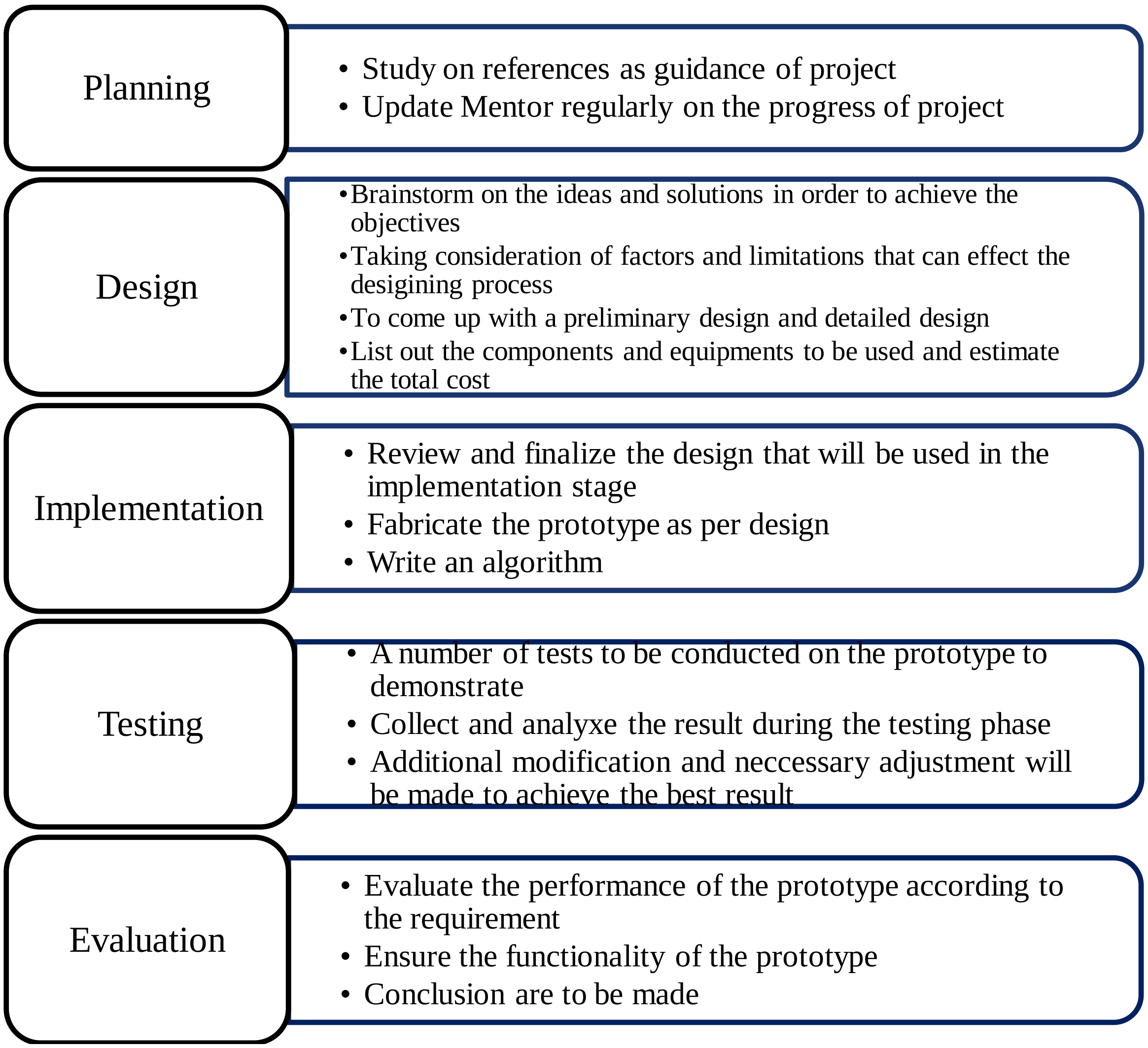


Figure 10: Principle & Operations

4.4 Photographs of Prototype

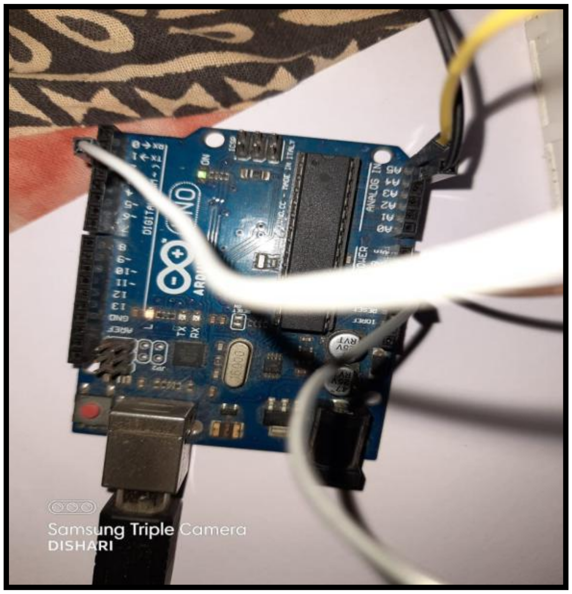


Figure 11: Connection of Arduino UNO

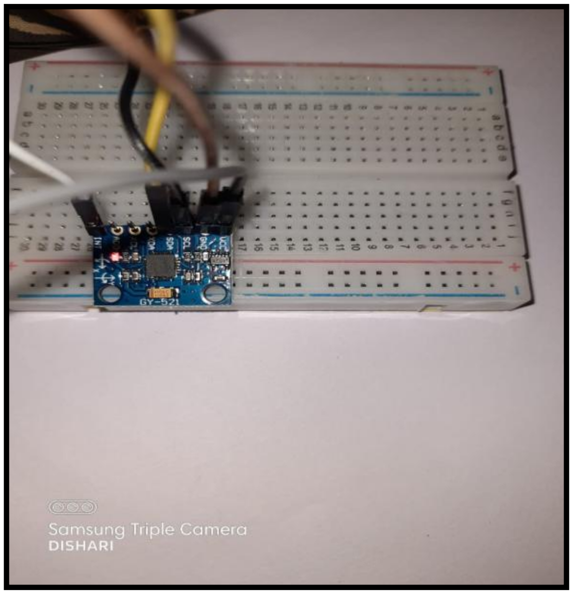


Figure 12: Connection of MPU6050

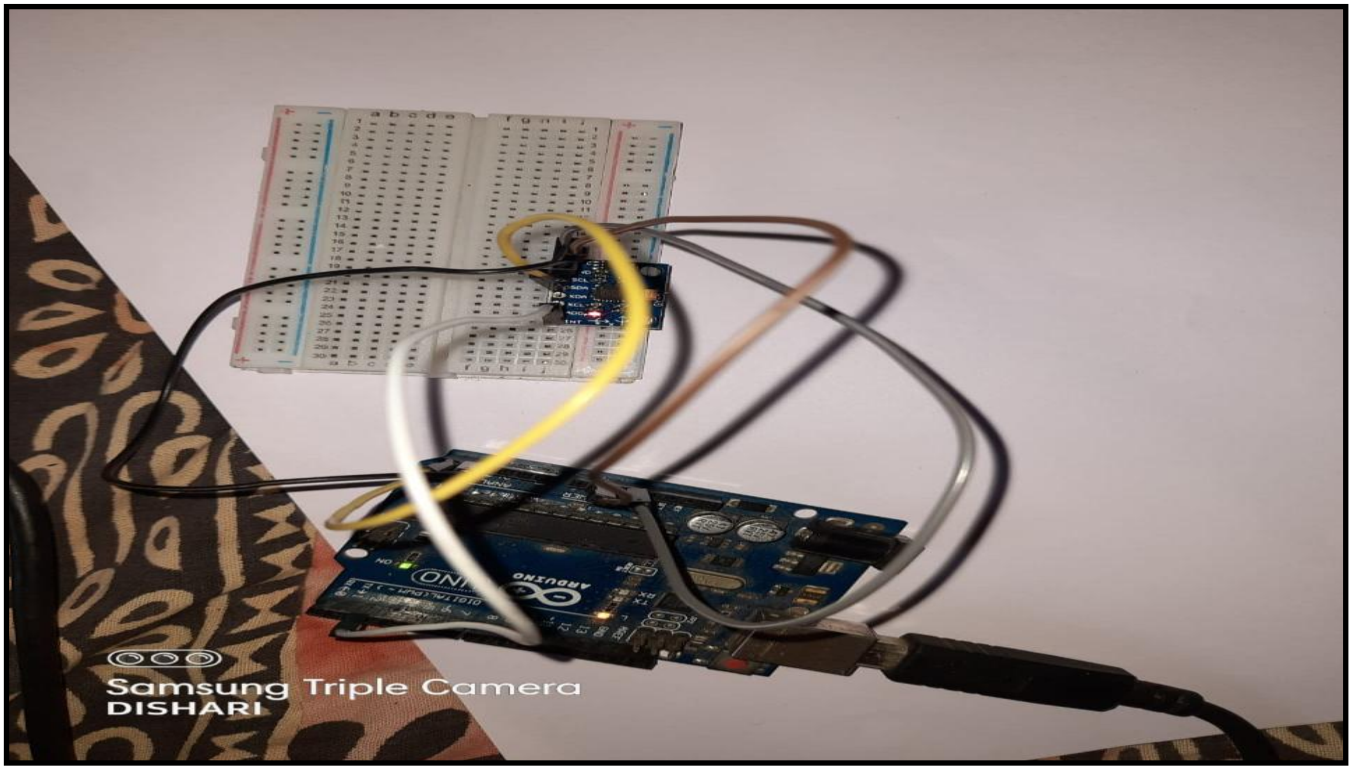


Figure 13: MPU6050 to Arduino UNO

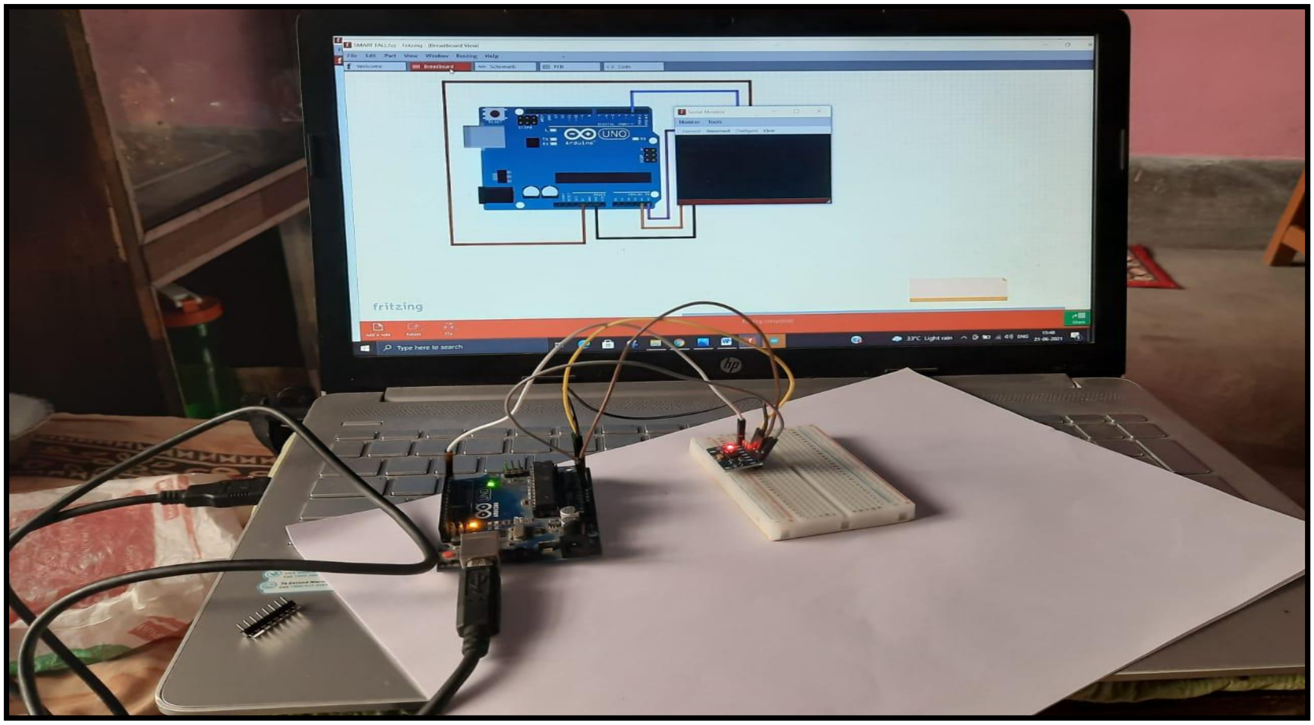


Figure 14: Full picture of Set-up (1)

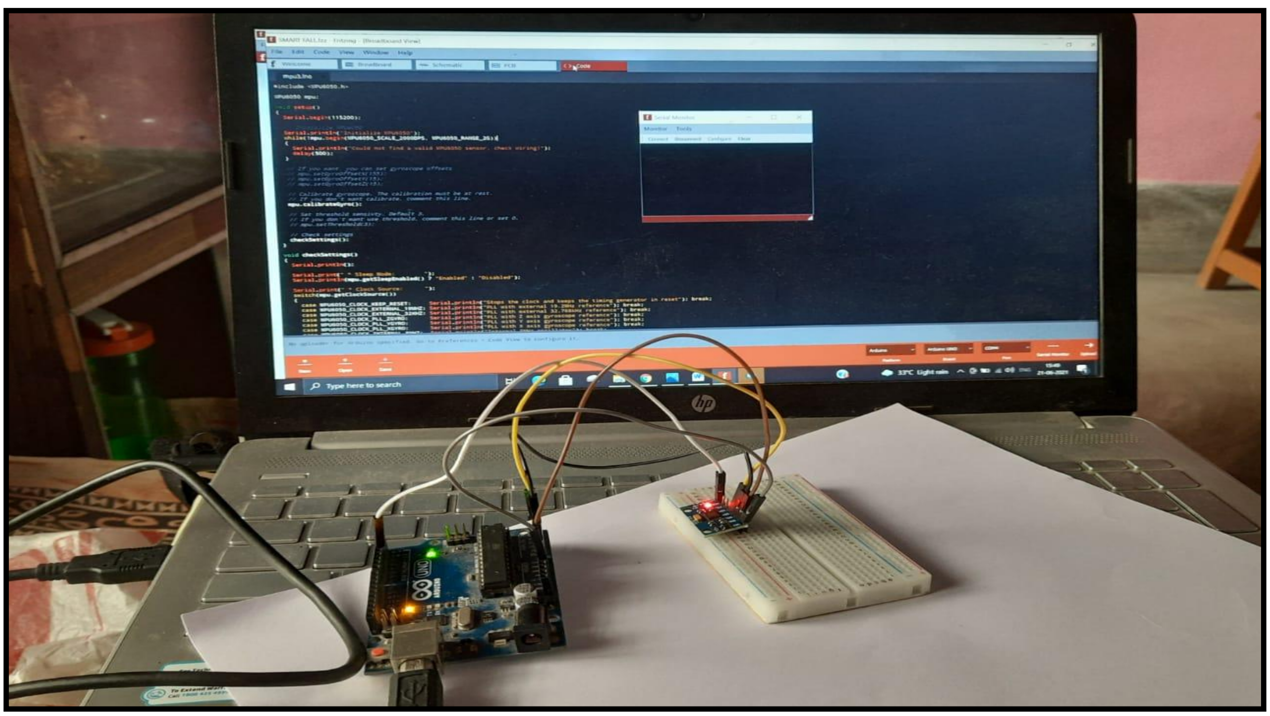


Figure 15: Full picture of Set-up (2)

Figure 16: Figureof Output (1)

Figure 17: Figure of Output (2)

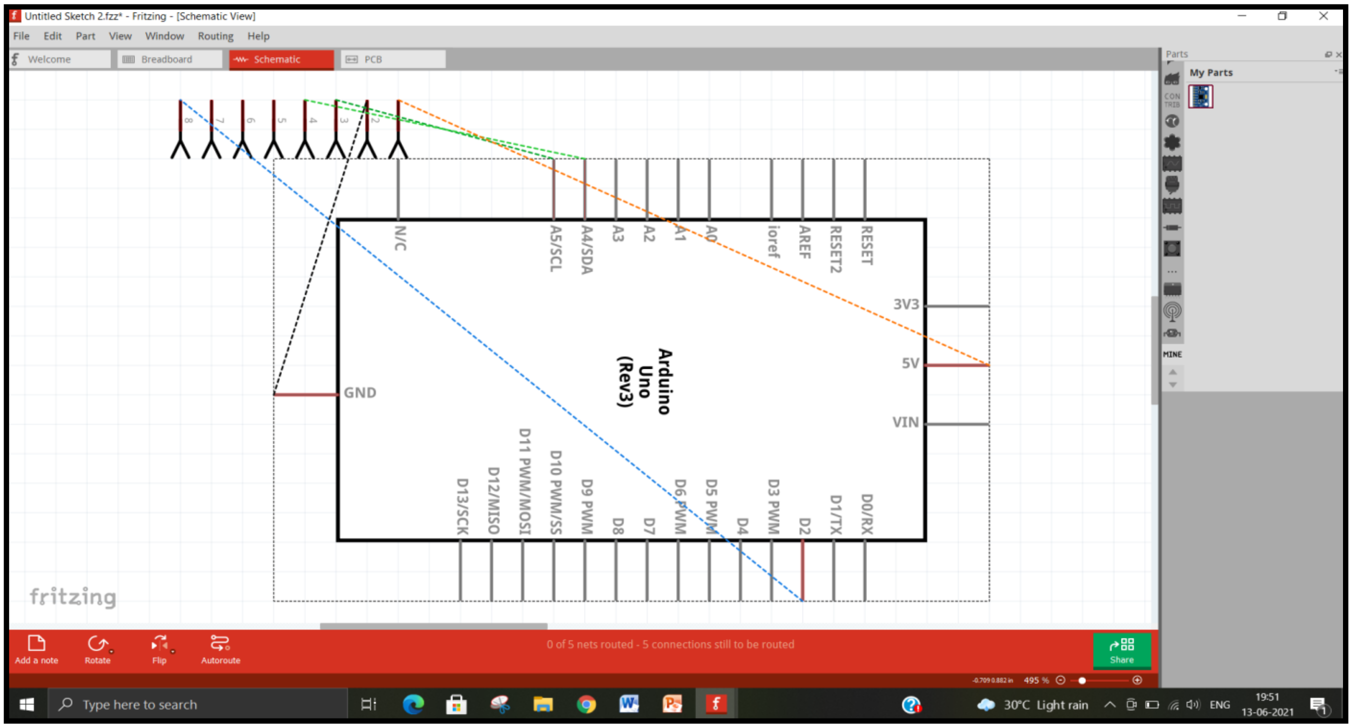


Figure 18: Figure of Schematic Circuit

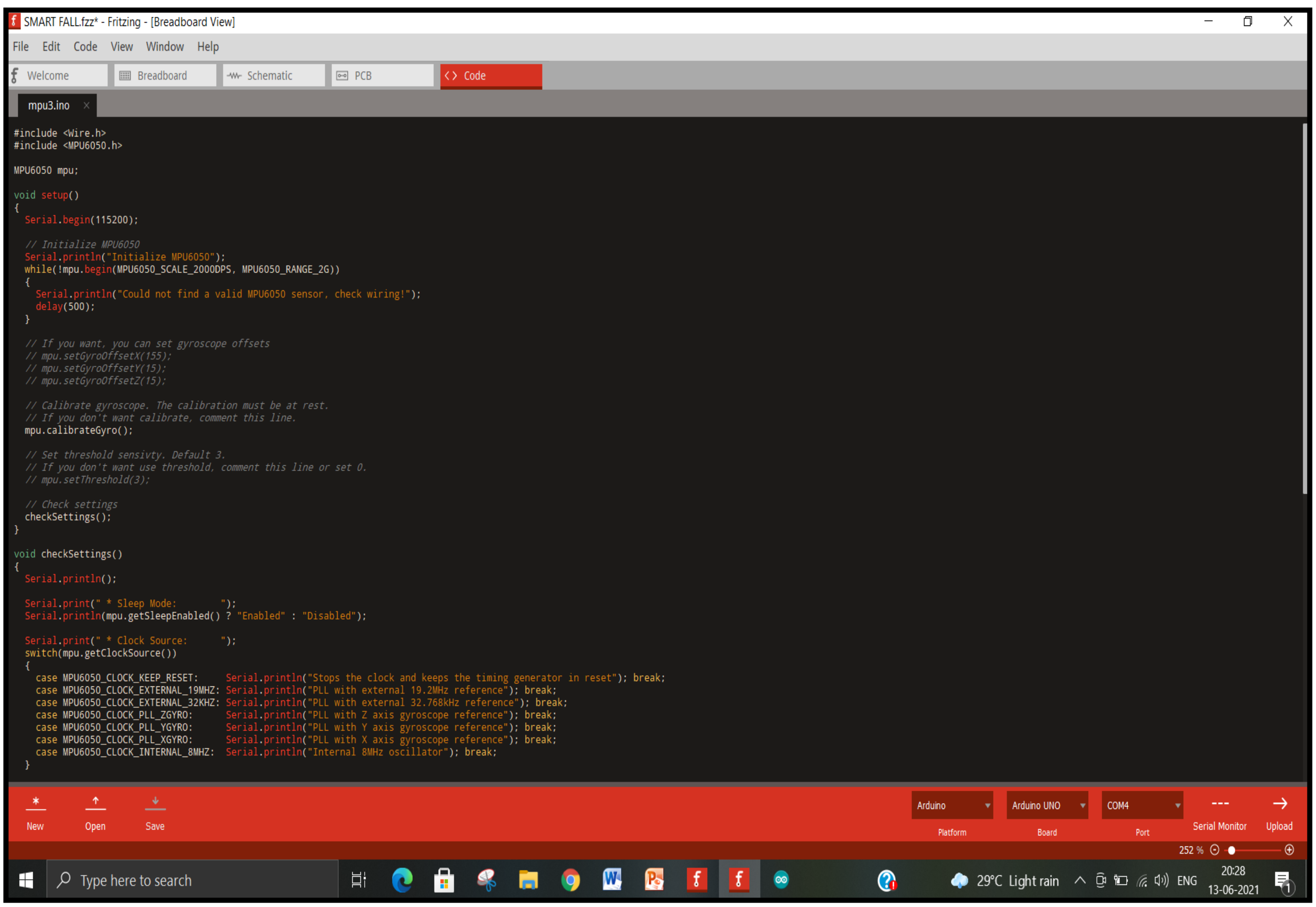


Figure 19: Figure of Code Uploading

Chapter-5
Conclusion & Future Scope

5.1 Conclusion

The several fall-feature parameters of the 6-axes acceleration were introduced and applied according the algorithm. Possible falls were chosen through the simple threshold and then applied to the MPU to solve the problems such as deviation of interpersonal falling behavioural patterns and similar fall actions. The test of the proposed device studied along a different 350 case studies. The parameters of upper and lower of acceleration and velocity have adjusted to give best fall detection with sensitivity, specificity, and accuracy which were over than 95 %. These results demonstrate the reduction of the computing effort and resources, compared to those of using all the events applied. Then the proposed algorithms were very simple because it dependson a simple sensor (measure the angle) and the program calculates the angular velocity and acceleration. They can be implemented into an embedded system such as an 8051-based microcontroller with 128 Kbyte ROM. In the future, if the proposed algorithms are implemented to the embedded system, its performance will be tested in a real time.

5.2 Results

Some existing acceleration-based fall detection systems are only used to distinguish falls from ADL. However, some activities like sitting down fast also feature large vertical acceleration. Figure 20shows the acceleration and rotational rate of the trunk where the cases as follows: (a) run on a damaged road, (b) walking fast (c) step up a Stair. In Fig. 20along three cases there is no fall then there is no alarm. Figure 21shows the acceleration and rotational rate of the trunk and thigh for sitting fast. Where the cases as follows: (a) is a dangers fall detected, (b) is a fall posture. In Fig. 21(a) the fall detectedvery fast and give alarm in the first moment and continued along 30 s while in Fig. 21 (b) give alarm after 10 s because there is no fall.

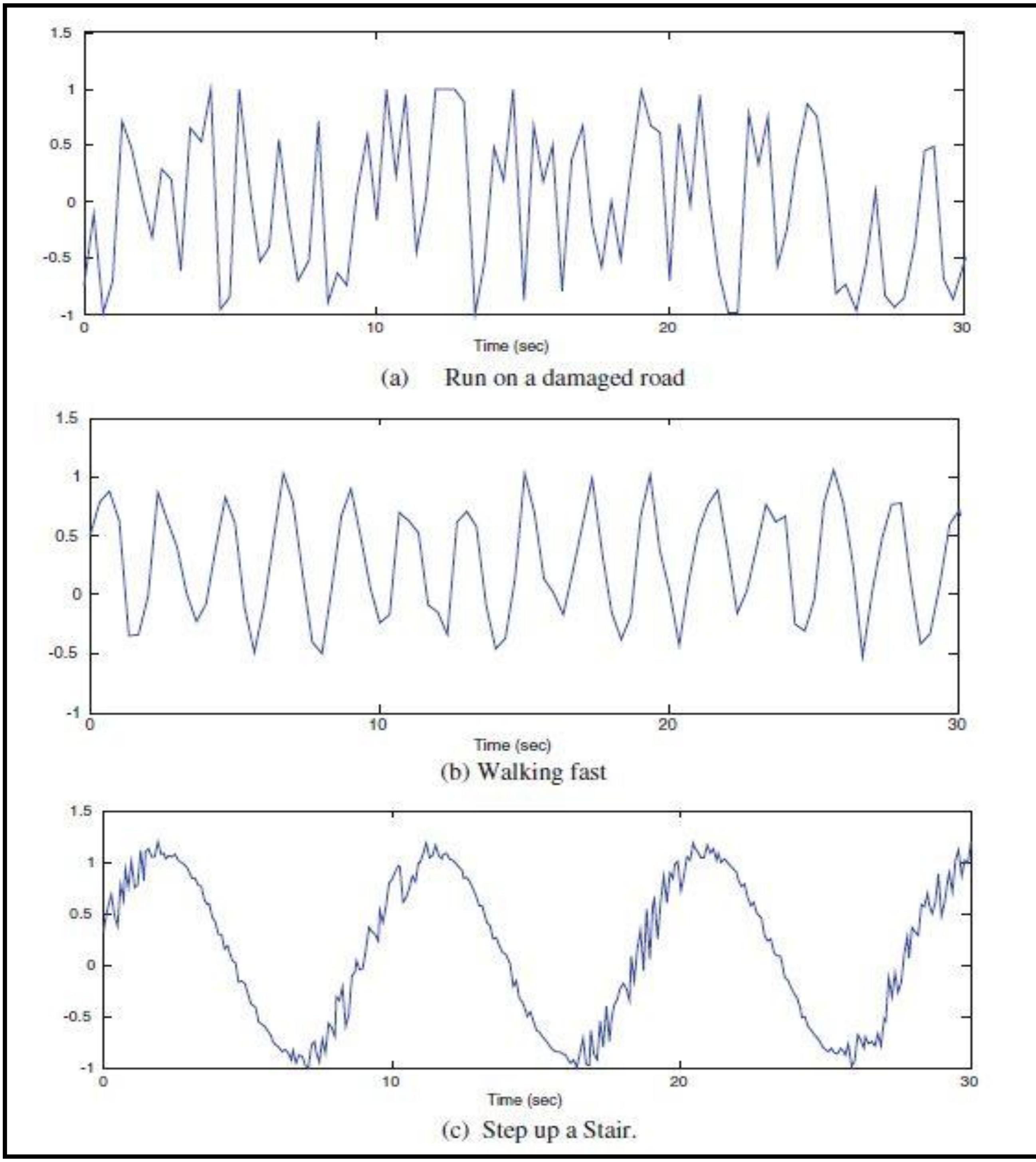


Figure 20: Result: (a) Run on a Damaged Road (b) Walking Fast (c) Step up a stair

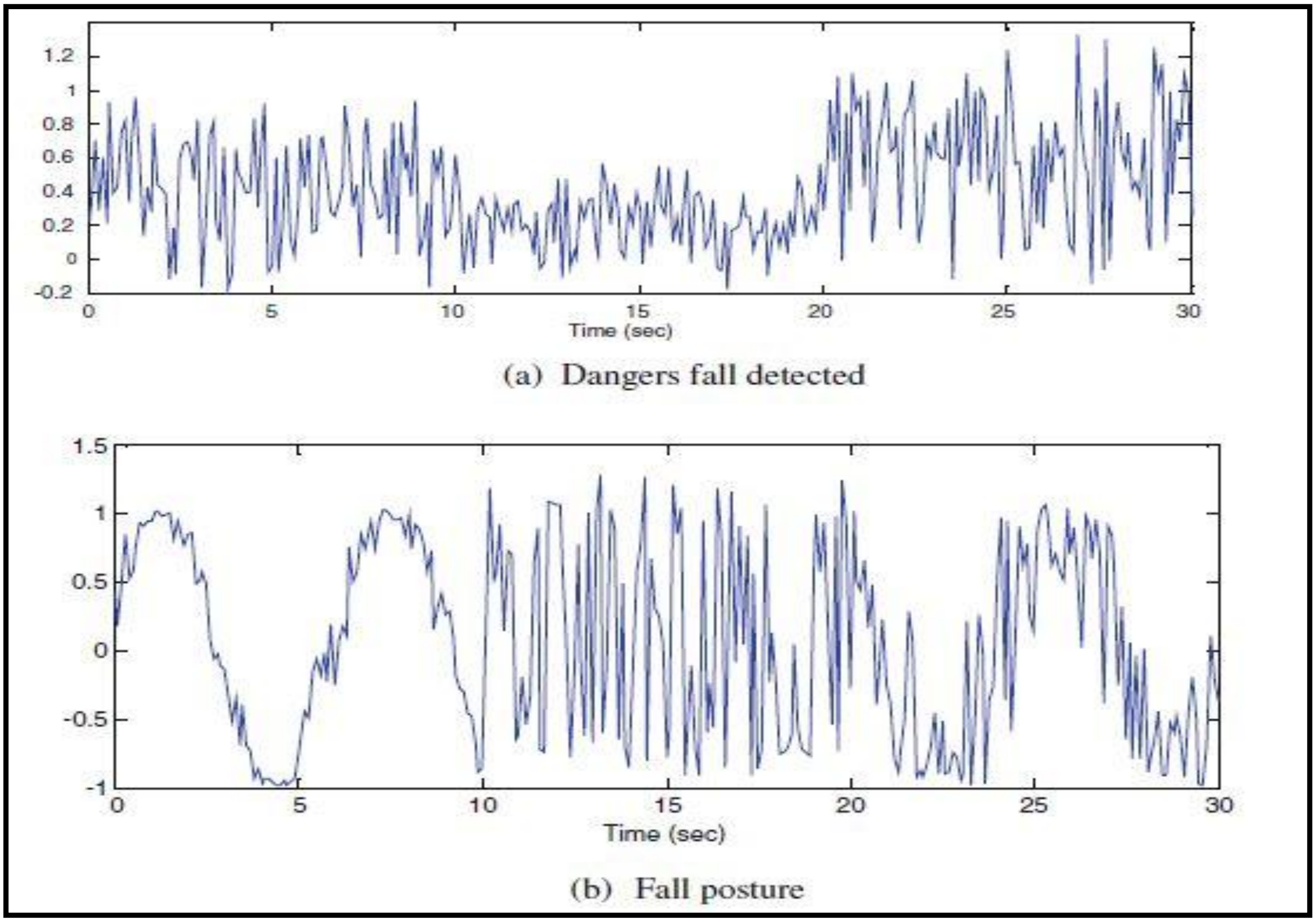


Figure 21: Result Analysis: (a) Danger fall detected (b) Fall posture

5.3 Advantages of this Project

- Easy to reach
- Light weight
- Low cost
- Easy to wear & remove

5.4 Disadvantages of this Project

- High false alarm rate due to frequent hand movement

5.5Cost Estimation of the Project

Table 2: Costing of the projects

Sl No.	Components	Quantity	Cost(Rs)
1	Arduino Uno	1	600
2	MPU6050	1	220
3	9 V Battery	1	50
4	Jumper Wires	7	30
5	Soldering Iron	1	-
6	Soldering material	1	-
7	De-soldering pump	1	-
	Total		900

5.6Future Works

In the future, if the proposed algorithms are implemented to the embedded system, its performance will be tested in a real time. Also we will try to include a GPS tracker in it.

References

1. Hwang, J.Y., Kang, J.M., Jang, Y.W., Kim, H.C.: Development of novel algorithm and real time monitoring ambulatory system using Bluetooth module for fall detection in the elderly. In: Engineering in Medicine and Biology Society, IEMBS 2004, 26th Annual International Conference of the IEEE, vol. 1, pp. 2204–2207, September 2004

2. B. Najafi, K. Aminian, F. Loew, Y. Blanc and P. A. Robert, "Measurement of stand-sit and sit-and transitions using a miniature gyroscope and its application in fall risk evaluation in the elderly", IEEE Trans. Biomed. Eng., vol. 49, no. 8, pp. 843-851, 2002.

3. National Institute ofNursing Research, Informal Caregiving Research for Chronic Conditions RFA, (2001).

4. E. Mattila, I. Korhonen, J. Merilahti, A. Nummela, M. Myllymaki, and H. Rusko, "A concept for personal wellness management based on activity monitoring," in Pervasive Computing Technologies for Healthcare,2008. Pervasive Health 2008. Second International Conference on, 302008-feb. 1 20 08, pp. 32 –36.

5. M. Alwan, D. Mack, S. Dalal, S. Kell, B. Turner, and R. Felder, "Impact of passive in-home health status monitoring technology in home health: Outcome pilot," in Distributed Diagnosis and Home Healthcare, 2006.D2H2. 1st Transdisciplinary Conference on, 2006, pp. 79 –82.

6. Lindemann, U., Hock, A., Stuber, M., Keck, W., Becker, C.: Evaluation of a fall detector based on accelerometers: a pilot study. Med. Biol. Eng. Comput. **43**(5), 548–551 (2005)

7. M. Avvenuti, C. Baker, J. Light, D. Tulpan, and A. Vecchio, "Non-intrusive patient monitoring of alzheimer's disease subjects using wire-less sensor networks," Privacy, Security, Trust and the Management of e-Business, World Congress on, vol. 0, pp. 161–165, 2009.

8. Kangas, M., Konttila, A., Lindgren, P., Winblad, I., Jämsä, T.: Comparison of low-complexity fall detection algorithms for body attached accelerometers. Gait Posture **28**(2), 285–291 (2008)

9. Abbate, S., Avvenuti, M., Corsini, P., Light, J., Vecchio, A.: Monitoring of human movements for fall detection and activities recognition in elderly care using wireless sensor network: asurvey, pp. 1–20. InTech (2010)

10. Zhang, T., Wang, J., Xu, L., Liu, P.: Fall detection by wearable sensor and one-class SVM algorithm. In: Huang, D.-S., Li, K., Irwin, G.W. (eds.) ICIC 2006. LNCIS, vol. 345, pp. 858–863. Springer, Heidelberg (2006)

11. Ganti, R.K., Jayachandran, P., Abdelzaher, T.F., Stankovic, J.A.: Satire: a software architecture for smart attire. In: Proceedings of the 4th International Conference on Mobile Systems, Applications and Services, pp. 110–123. ACM, June 2006

Appendix: A

Software Coding

PROGRAM CODE:

```
#include <Wire.h>
#include <MPU6050.h>

MPU6050 mpu;

void setup()
{
Serial.begin(115200);

  // Initialize MPU6050
Serial.println("Initialize MPU6050");
while(!mpu.begin(MPU6050_SCALE_2000DPS, MPU6050_RANGE_2G))
  {
Serial.println("Could not find a valid MPU6050 sensor, check wiring!");
delay(500);
  }

  // If you want, you can set gyroscope offsets
  // mpu.setGyroOffsetX(155);
  // mpu.setGyroOffsetY(15);
  // mpu.setGyroOffsetZ(15);

  // Calibrate gyroscope. The calibration must be at rest.
  // If you don't want calibrate, comment this line.
Mpu.calibrateGyro();

  // Set threshold sensivty. Default 3.
  // If you don't want use threshold, comment this line or set 0.
  // mpu.setThreshold(3);

  // Check settings
checkSettings();
```

```
}
voidcheckSettings()
{
Serial.println();

Serial.print(" * Sleep Mode:        ");
Serial.println(mpu.getSleepEnabled() ? "Enabled" :"Disabled");

Serial.print(" * Clock Source:      ");
switch(mpu.getClockSource())
  {
case MPU6050_CLOCK_KEEP_RESET:     Serial.println("Stops the clock and keeps 
the timing generator in reset"); break;
case MPU6050_CLOCK_EXTERNAL_19MHZ: Serial.println("PLL with external 19.2MHz 
reference"); break;
case MPU6050_CLOCK_EXTERNAL_32KHZ: Serial.println("PLL with external 
32.768kHz reference"); break;
case MPU6050_CLOCK_PLL_ZGYRO:      Serial.println("PLL with Z axis gyroscope 
reference"); break;
case MPU6050_CLOCK_PLL_YGYRO:      Serial.println("PLL with Y axis gyroscope 
reference"); break;
case MPU6050_CLOCK_PLL_XGYRO:      Serial.println("PLL with X axis gyroscope 
reference"); break;
case MPU6050_CLOCK_INTERNAL_8MHZ:  Serial.println("Internal 8MHz 
oscillator"); break;
  }

Serial.print(" * Gyroscope:         ");
switch(mpu.getScale())
  {
case MPU6050_SCALE_2000DPS:        Serial.println("2000 dps"); break;
case MPU6050_SCALE_1000DPS:        Serial.println("1000 dps"); break;
case MPU6050_SCALE_500DPS:         Serial.println("500 dps"); break;
case MPU6050_SCALE_250DPS:         Serial.println("250 dps"); break;
}39
Serial.print(" * Gyroscope offsets: ");
Serial.print(mpu.getGyroOffsetX());
Serial.print(" / ");
Serial.print(mpu.getGyroOffsetY());
Serial.print(" / ");
Serial.println(mpu.getGyroOffsetZ());

Serial.println();
}

void loop()
```

```
{
  Vector rawGyro = mpu.readRawGyro();
  Vector normGyro = mpu.readNormalizeGyro();

Serial.print("Xraw = ");
Serial.print(rawGyro.Xaxis);
Serial.print("Yraw = ");
Serial.print(rawGyro.Yaxis);
Serial.print("Zraw = ");
Serial.println(rawGyro.Zaxis);

Serial.print("Xnorm = ");
Serial.print(normGyro.Xaxis);
Serial.print("Ynorm = ");
Serial.print(normGyro.Yaxis);
Serial.print("Znorm = ");
Serial.println(normGyro.Zaxis);

delay(10);
}
```

Appendix:B
Details of Hardware

Arduino Uno:

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital digital I/O pins and is programmable with the Arduino IDE via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

<u>Technical Specifications:</u>

- Microcontroller : Microchip ATmega328P
- Operating Voltage : 5 Volts
- Input Voltage : 7 to 20 Volts
- Digital I/O Pins : 14(of which 6 can provide PWM output)
- UART : 1
- SPPI : 1
- Analog Input Pins : 6
- DC Current per I/O Pin : 20 mA
- DC Current for 3.3V Pin : 50 mA
- Flash Memory : 32 KB of which 0.5 KB used by bootloader
- SRAM : 2 KB
- EEPROM : 1 KB
- Clock Speed : 15 MHz
- Length : 68.6 mm
- Width : 53.4 mm
- Weight : 25 g

General pin functions

- **LED**: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off.
- **VIN**: The input voltage to the Arduino/Genuino board when it is using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V**: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- **3V3**: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND**: Ground pins.
- **IOREF**: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V.
- **Reset**: Typically used to add a reset button to shields that block the one on the board.

Special pin functions

Each of the 14 digital pins and 6 analog pins on the Uno can be used as an input or output, under software control (using pinMode (), digital Write (), and digital Read () functions). They operate at 5 volts. Each pin can provide or receive 20 mA as the recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50K ohm. A maximum of 40mA must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller. The Uno has 6 analog inputs, labeled A0 through A5; each provides 10 bits of resolution (i.e. 1024 different values). By default, they measure from ground to 5 volts, though it is possible to change the upper end of the range using the AREF pin and the analogReference () function.

In addition, some pins have specialized functions:

- **Serial** / UART: pins 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL serial chip.

- **External interrupts**: pins 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM** (pulse-width modulation): pins 3, 5, 6, 9, 10, and 11. Can provide 8-bit PWM output with the analogWrite () function.
- **SPI** (Serial Peripheral Interface): pins 10 (SS), 11 (MOSI), 12 (MISO), and 13 (SCK). These pins support SPI communication using the SPI library.
- **TWI** (two-wire interface) /I^2C : pin SDA (A4) and pin SCL (A5). Support TWI communication using the Wire library.
- **AREF** (analog reference): Reference voltage for the analog inputs.

Communication

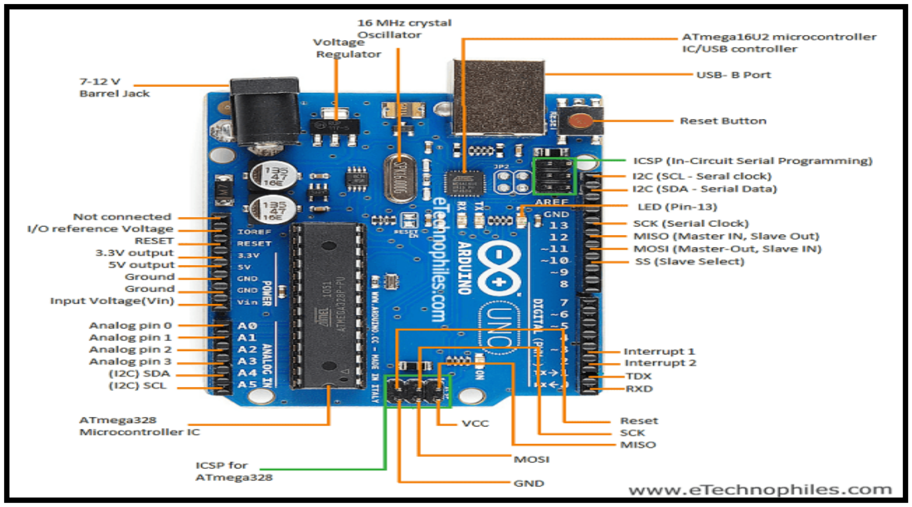
The Arduino/Genuino Uno has a number of facilities for communicating with a computer, another Arduino/Genuino board, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A SoftwareSerial library allows serial communication on any of the Uno's digital pins.

Automatic (software) reset

Rather than requiring a physical press of the reset button before an upload, the Arduino/Genuino Uno board is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip.

This setup has other implications. When the Uno is connected to a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened.

Figure 22: Arduino Uno



MPU6050:

MPU6050 is a Micro Electro-Mechanical Systems (**MEMS**) which consists of a 3-axis Accelerometer and 3-axis Gyroscope inside it. This helps us to measure acceleration, velocity, orientation, displacement and many other motion related parameter of a system or object. This module also has a (DMP) Digital Motion Processor inside it which is powerful enough to perform complex calculation and thus free up the work for Microcontroller.

The module also have two auxiliary pins which can be used to interface external IIC modules like a magnetometer, however it is optional. Since the IIC address of the module is configurable more than one **MPU6050 sensor** can be interfaced to a Microcontroller using the AD0 pin. This module also has well documented and revised libraries available hence it’s very easy to use with famous platforms like Arduino.

Table 3: Pin configuration of MPU6050

Pin Number	**Pin Name**	**Description**
1	Vcc	Provides power for the module, can be +3V to +5V. Typically +5V is used

2	Ground	Connected to Ground of system
3	Serial Clock (SCL)	Used for providing clock pulse for I2C Communication
4	Serial Data (SDA)	Used for transferring Data through I2C communication
5	Auxiliary Serial Data (XDA)	Can be used to interface other I2C modules with MPU6050. It is optional
6	Auxiliary Serial Clock (XCL)	Can be used to interface other I2C modules with MPU6050. It is optional
7	AD0	If more than one MPU6050 is used a single MCU, then this pin can be used to vary the address
8	Interrupt (INT)	Interrupt pin to indicate that data is available for MCU to read.

Features

- MEMS 3-aixs accelerometer and 3-axis gyroscope values combined
- Power Supply: 3-5V
- Communication : I2C protocol
- Built-in 16-bit ADC provides high accuracy
- Built-in DMP provides high computational power
- Can be used to interface with other IIC devices like magnetometer
- Configurable IIC Address
- In-built Temperature sensor

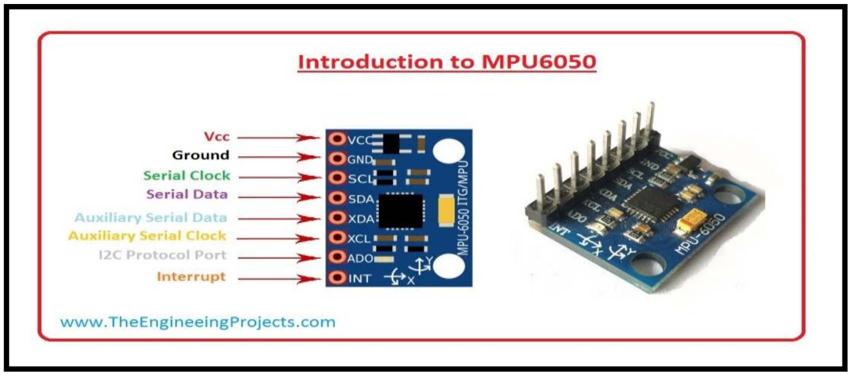


Figure 23:MPU6050

Battery:

A **battery** is a power source consisting of one or more electrochemical cells with external connections for powering electrical devices such as flashlights, mobile phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, and the free-energy difference is delivered to the external circuit as electrical energy.

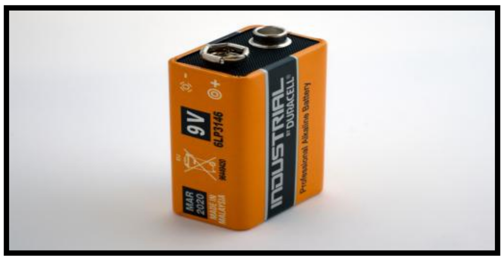
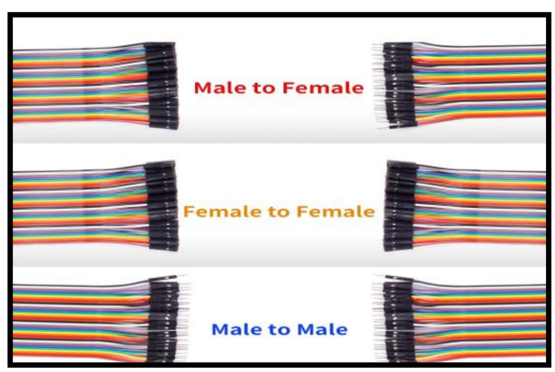


Figure 24: Battery

Jumper Wire:

A **jump wire** (also known as jumper, jumper wire, jumper cable, DuPont wire or cable) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.There are different types of jumper wires. Some have the same type of electrical connector at both ends, while others have different connectors. Some common connectors are mentioned in the figure

Figure 25: Jumper Wires



BLYNK Application:

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, vizualize it and do many other cool things.

There are three major components in the platform:

Blynk App - allows to you create amazing interfaces for your projects using various widgets we provide.

Blynk Server - responsible for all the communications between the Smartphone and hardware.

Blynk Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and out coming commands.

Features

- Similar API & UI for all supported hardware & devices
- Connection to the cloud using:
- WiFi
- Bluetooth and BLE
- Ethernet
- USB (Serial)
- GSM
- Set of easy-to-use Widgets
- Direct pin manipulation with no code writing
- Easy to integrate and add new functionality using virtual pins
- History data monitoring via SuperChart widget
- Device-to-Device communication using Bridge Widget
- Sending emails, tweets, push notifications, etc.

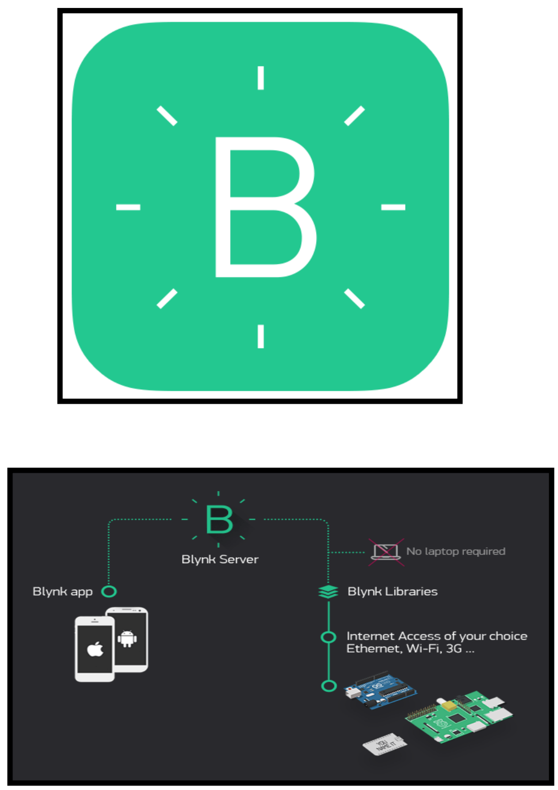


Figure 26: Blynk application