Mini Project report on

FALL DETECTION AND PREVENTION

Submitted by

ADITHYAN SREEKUMAR
ALEN VINOY
ANAGHA M
ASMA SHERIN

Focus on Excellence

Department of Electronics & Communication Engineering
FEDERAL INSTITUTE OF SCIENCE AND TECHNOLOGY (FISAT)®
Angamaly-683577, Ernakulam

Affiliated to

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Thiruvananthapuram-695016
2024

FEDERAL INSTITUTE OF SCIENCE AND TECHNOLOGY (FISAT) ®

Mookkannoor(P.O), Angamaly-683577

Focus on Excellence

CERTIFICATE

This is to certify that the Mini project report titled **FALL DETECTION AND PREVENTION**submitted by **ADITHYAN SREEKUMAR,ALEN VINOY, ANAGHA M,ASMA SHERIN,** towards partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in Electronics and Communication Engineering is a record of bonafide work carried out by him/her during the academic year 2024.

Project Guide

Head of the Department

Internal Examiner

External Examiner

Place: Mookkannoor

Date:

ACKNOWLEDGEMENT

We take this opportunity to place on record our heartiest thanks to those who have contributed to completion of this project. We express our sincere gratitude towards our mini project guide Pearlsy P V, Assistant Professor, Def Electronicpartment os Communication Engineering, Federal Institute Of Science And Technology,

Angamaly for her advice, support and guidance. Any attempt of gratitude would be incomplete without the mention of the project co-ordinator, Assistant Prof. Nisha PR and Assistant Prof. Binoy, Department of Electronics & Communication Engineering, Federal Institute Of Science And Technology, Angamaly , for his suggestions and solutions during times of dilemma. We also thank all the seniors of Federal Institute Of Science And Technology, Angamaly for their whole hearted support and cooperation. Finally We would like to acknowledge our deep sense of gratitude to all well wishers and friends who helped us directly and indirectly to continue with this work.

Adithyan Sreekumar

Alen Vinoy

Anagha M

Asma Sherin K

ABSTRACT

In the 21st century, the problem of an aging population has become increasingly serious. Unsupervised elderly people frequently fall accidentally. If the rescue is not timely when an elderly person falls, it is likely to cause them physical injury or even psychological injury. Therefore, it is necessary to develop a device that can detect the posture of the elderly in a timely manner.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 the 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 indoors. Current commercialized devices require the user to wear a wireless emergency transmitter in the form of a wristwatch. This method will restrict the user movement and produce a high false alarm due to frequent swinging and movement of the device.In our proposed system if someone falls readings from the sensor taken into microprocessor.If the reading is beyond the threshold value Buzzer sounds and a "fall detected" notification send to mail and connected device. If it is a false alarm, a person can manually press the analog switch then the buzzer stops for 15 seconds and "fallen,but I am okay" notification is sent to mail and connected devices. The person has to return to his normal position otherwise the buzzer will sound again. In case of an occurring fall , the fall is automatically detected and airbag is inflated to prevent damage and reduce impact of fall .

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

IDE	:	Integrated Development Environment
Li-ion	:	Lithium ion
MEMS	:	Micro electro mechanical systems
LBS	:	Location based service
SVM	:	Support vector machine
SCL	:	Serial Clock
SDA	:	Serial Data
I2C	:	Inter integrated circuit
SMS	:	Short Message Service
RAM	:	Random access memory

CONTENTS

Chapter 1

INTRODUCTION

Relevence

The problem of an aging population has become increasingly serious.
Unsupervised elderly people frequently fall accidentally. If the rescue is not timely when an elderly person falls, it is likely to cause them physical injur or even psychological injury. Therefore, it is necessary to develop a device that can detect the posture of the elderly in a timely manner. As a result of the aging population, more and more old people live alone. It is dangerous for the elderly to fall at home. It is important to detect the fall at the earliest in order to cure as fast as we can. Progress of technology brings more possibilities to help us protect the elderly. Low power consumption components make it possible to realize wearable monitoring devices. MEMS sensors have simplified the design and implementation of sensor systems. Location based service (LBS) makes it more convenient to locate the elderly in health monitoring. Beside these, mobile computing makes remote health monitoring easier to realize.

Existing methods

Several kinds of fall detection methods have been developed or applied in our life. One of them is a computer vision based method. Cameras are distributed at limited space to offer pictures or videos of human activities to implement fall detection algorithms. External supports such as motion sensors could be used to enhance computer vision based fall detection method, and a data fusion algorithm can operate the validation and correlation among the two subsystems to raise robust performance of fall detection. These computer based methods work effectively in an indoor environment, but they are hard to realize in an outdoor environment as the deployment of cameras is always limited.

Motion sensor-based method is also commonly used. Accelerometer and gyroscope could provide linear and angular motion information directly. Sensor measurements or their proper fusion could be used to distinguish a real fall. There are

several kinds of detection methods which differ in the constitution of motion sensors and detection algorithms. The first kind of detection method is using an accelerometer. A single triaxial accelerometer can provide object's accelerations in three directions which include the influence of gravity. A coordinate will be built when the accelerometer is fixed on the human's body. The influence of gravity or dynamic acceleration is available by using a low pass filter or a high pass filter. Some kinds of angular movement information can also be calculated based on the relationship between acceleration components and their vector sum. The second kind of detection method is based on both an accelerometer and gyroscope. Gyroscopes can offer angular velocity and the
An accelerometer could offer linear motion information. The third kind of detection

method also uses a magnetometer. A triaxial magnetometer can detect magnetic strength in three directions, and it can also provide angular motion information in the horizontal plane. But the environment magnetic field may disturb the geomagnetic field which reduces the reliability of the magnetometer outputs, for instance, in some steel structure architecture or near some objects with strong electromagnetism. As angular information can also be extracted from accelerometer measurements, a state space filter such as the Kalman filter is a commonly used technique to combine angular motion information. Beside these, sensors such as barometers can also assist pure motion sensors at human gait recognition.

But, in fact, using more sensors means more power consumption, and it is a challenge to design a proper algorithm to fuse different kinds of sensors. A single triaxial accelerometer is quite enough for human fall detection as sufficient information could be extracted from its measurements. Besides this, the accelerometer coordinate does not have to be fixed if only the magnitude of the sum vector is needed, and that is quite convenient for wearable applications. In this paper, a fall detection system based on a wearable device is developed. The hardware and software realization of the device is mainly based on a single triaxial accelerometer and blynk . The device uses an efficient fall detection algorithm with less resource and power consumption, which means that it is a proper design for outdoor application.

Chapter 2

LITERATURE REVIEW

DESIGN AND DEVELOPMENT OF FALL DETECTOR AND PREVENTION SYSTEM FOR PARKINSON'S PATIENTS

Author: Syeda Sheema Faheem, Qazi Bilal Ahmed, Aisha Nazir, M.Faris Iqbal

Department of Bio-Medical Engineering Faculty of Engineering Science and Technology,Hamndar University,Karachi

- proposed a system for fall detection using mpu6050 sensor,arduino microcontroller etc.
- The fall detection is done on the basis of body movement detection using the sensors accelerometer and gyroscope .
- It consist of a push buttons that are connected to an arduino microcontroller and set the threshold values of both sensors .
- Preventive measures include inflating an airbag to protect against head injuries and activating an alarm buzzer
- Real time accelerometer and gyroscope values are displayed on an LCD screen ,facilitating threshold adjustments based on the patient's specific movements.
- the system also employs GSM for wireless communication to send alert message to concerned people.
- This system aims to provide timely intervention and minimize injuries resulting from falls.

FALL DETECTION AND PREVENTION FOR THE ELDERLY: A REVIEW OF TRENDS AND CHALLENGES

Author:Nashwa El-Bendary, Qing Tan , Athabasca University, University Drive,

- Trends and challenges in fall detection and prevention for the elderly
- Falls are a common occurrence among the elderly and can lead to serious injuries
- Various practical solutions for detecting falls and triggering notification alarms to call for
- help
- Use of fall likelihood prediction systems based on medical and behavioral history to prevent falls.
- Highlighting the need for automatic monitoring and fall detection systems
- Systems should be able to call for help even if the patient is unconscious or unable to get up after a fall

AIRBAG PROTECTION AND ALERTING SYSTEM FOR ELDERLY PEOPLE

Author: Mariam Ibrahim,Shuruq Shawish

Department of Mechatronics Engineering, German Jordanian University

- Development of a wearable airbag for fall injury prevention
- Utilizes fall-detection system triggered by acceleration and angular velocity signals
- Detection algorithm created with thresholding technique by using accelerometer and gyro sensor
- Can detect signals 300 ms before a fall
- There will be a inflating mechanism.inflates a 2.4 L capacity airbag upon detection

- ➢ Fall detection and prevention are crucial for the elderly
- ➢ Hip Protect is currently the leading device in fall prevention.

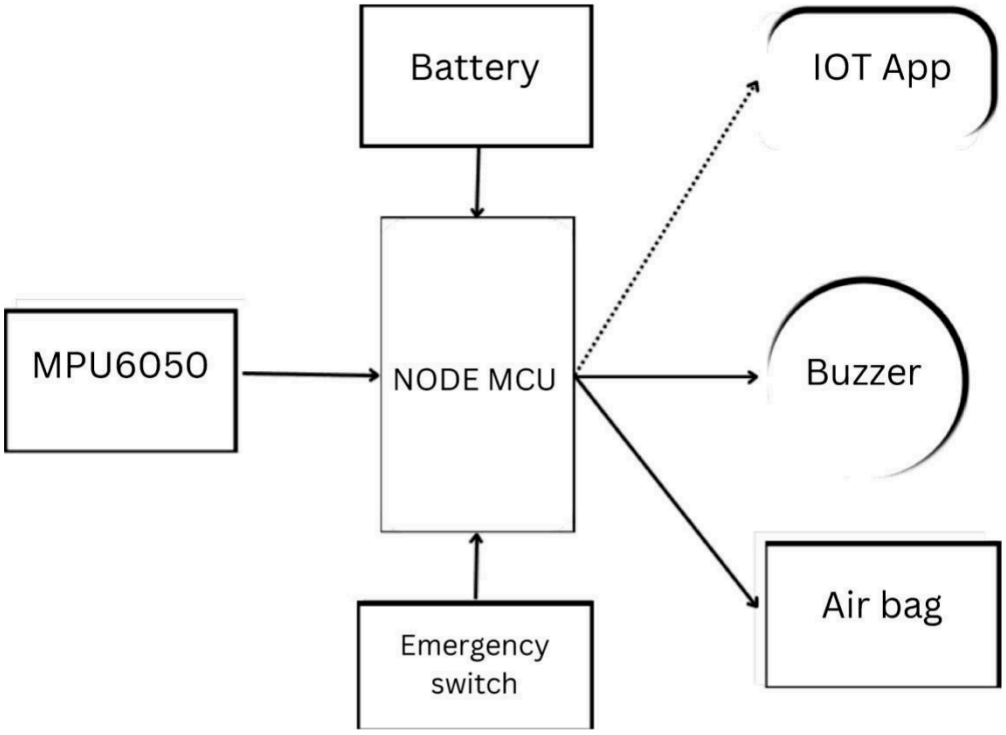
A WEARABLE AIRBAG TO PREVENT FALL INJURIES

Author: Toshiyo Tamura, Senior Member, IEEE, Takumi Yoshimura, Masaki Sekine,Member, IEEE, Mitsuo Uchida, and Osamu Tanaka

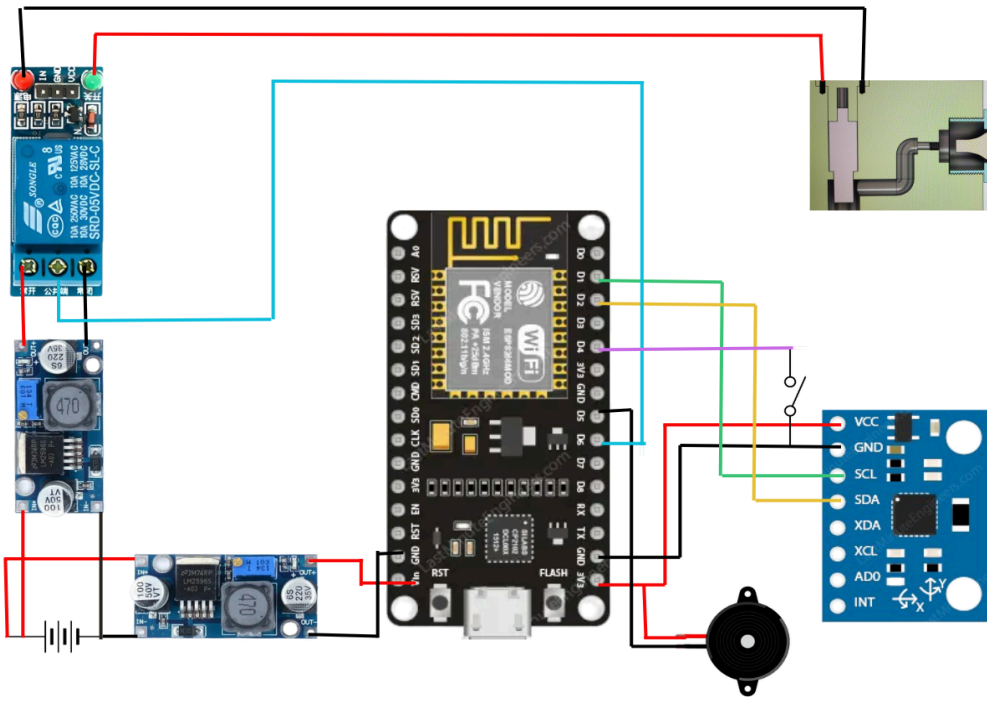
- ➢ Development of a wearable airbag for fall injury prevention
- ➢ Utilizes fall-detection system triggered by acceleration and angular velocity signals
- ➢ Detection algorithm created with thresholding technique by using accelerometer and
- ➢ gyro sensor
- ➢ There will be a inflating mechanism.inflates a 2.4 L capacity airbag upon detection
- ➢ Fall detection and prevention are crucial for the elderly
- ➢ Hip Protect is currently the leading device in fall prevention.

Chapter 3

BLOCK DIAGRAM



CIRCUIT DIAGRAM



WORKING

The system is intricately designed to provide comprehensive fall detection and response mechanisms. At its core, a rocker switch serves as the initiator, channeling power from the batteries to the LM2596S DC Buck converter upon activation. This converter plays a crucial role in voltage regulation, stepping down the input voltage from approximately 7.2 V to a stable 5V output, thereby optimizing performance for the NodeMCU Board.

Further enhancing its functionality, the system integrates an MPU6050 accelerometer, which continuously monitors acceleration in both the X and Y coordinates. This data is then transmitted to the NodeMCU, enabling real-time analysis of motion patterns. Upon detecting a fall that surpasses the programmed threshold, the NodeMCU swiftly triggers a series of actions. Firstly, it activates a linear actuator through the D6 pin, initiating the release of gas from a CO2 cartridge into an airbag, thereby cushioning the impact of the fall. Concurrently, a signal is relayed to a piezo buzzer via the D5 pin, prompting a 15-second audible alert to notify nearby individuals of the fall incident.

In addition to these immediate response measures, the system also incorporates long-term communication protocols. Upon detecting a fall, the NodeMCU not only sends an email to a designated address but also issues a notification labeled "fall" to the relevant device, ensuring prompt awareness of the situation. Following the initial alert phase, the MPU6050 accelerometer rechecks the coordinates; if no change indicative of recovery is detected, the buzzer resumes its beeping sequence, providing ongoing assistance until help arrives.

To minimize the risk of false alarms and ensure the accuracy of fall detection, the system features a toggle switch button connected to the D4 pin of the NodeMCU. This button allows users to confirm a fall manually, thereby activating the system to send a follow-up email and notification with the content "Fall_but_ok" to the appropriate contact. By incorporating this multifaceted approach, the system not only enhances the reliability of fall detection but also ensures that appropriate response mechanisms are deployed in a timely manner, ultimately contributing to the safety and well-being of individuals in need.

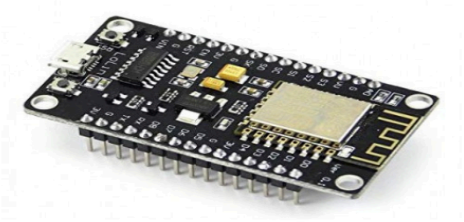
Chapter 4

COMPONENTS IN DETAILS

Hardware details

NodeMCU ESP8266 12E Wifi development board

The NodeMCU ESP8266 development board comes with the ESP-12E module containing ESP8266 chips having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160MHz adjustable clock frequency. NodeMCU has 128 KB RAM and 4MB of Flash memory to store data and programs. Its high processing power with in-built Wi-Fi / Bluetooth and Deep Sleep Operating features make it ideal for IoT projects.

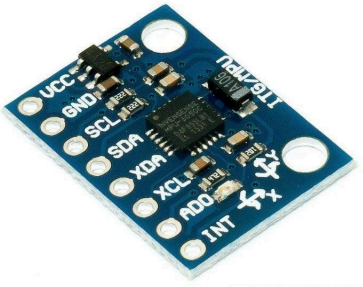


MPU6050 Accelerometer and Gyroscope Sensor

MPU6050 sensor module is a complete 6-axis Motion Tracking Device. It combines a 3-axis Gyroscope, 3-axis Accelerometer and Digital Motion Processor all in a small package.

Also, it has the additional feature of on-chip Temperature sensor. It has an I2C bus interface to

communicate with the microcontrollers.It has Auxiliary I2C bus to communicate with other sensor devices like 3-axis Magnetometer, Pressure sensor etc.If a 3-axis Magnetometer is connected to the auxiliary I2C bus, then MPU6050 can provide complete 9-axis Motion Fusion output.

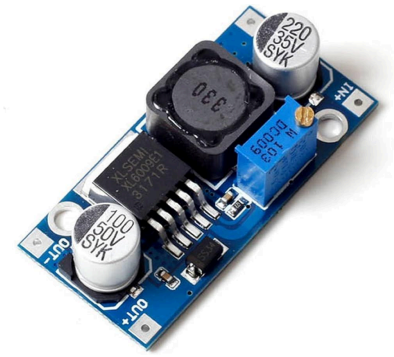


LM2596S DC-DC Buck Converter

DC-DC Buck Converter Step Down Module LM2596 Power Supply is a step-down(buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. The LM2596 series operates at a switching frequency of 150kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

Voltage Booster

It is also known as a step-up converter, is a device that increases the voltage level from its input to its output. It's commonly used in applications such as power supplies for electronics, LED drivers, or renewable energy systems like solar panels.



Linear Actuator

Linear actuators are devices that convert rotational motion into linear motion.

They're commonly used in various applications such as robotics, automotive systems

Relay Module

A relay module is an electronic device used to control high-power electrical devices with low-power signals. They're commonly used in automation, robotics, and IoT

projects for tasks like controlling lights, motors, and other electrical devices.

Co2 Catridge

A 12g CO2 cartridge is typically used in airguns, paintball guns, and other devices requiring compressed air. It provides a consistent and reliable source of compressed

air for powering various devices.

Piezo Buzzer

In simplest terms, a piezo buzzer is a type of electronic device that's used to produce a tone, alarm or sound. It's lightweight with a simple construction, and it's typically a low-cost product. Yet at the same time, depending on the piezo ceramic buzzer specifications, it's also reliable and can be constructed in a wide range of sizes that work across varying frequencies to produce different sound outputs.

Toggle Switch

A toggle switch is to switch the circuit by turning the switch handle to make the circuit on or off. The commonly used varieties of toggle switches include single-pole double-position, single-pole three-position, double-pole double-position, and double-pole three-position, etc. They are generally used in low-voltage circuits and have the characteristics of flexible slider action and stable and reliable performance

Tactile Push Button Switch

A “tactile switch” is one type of widely used switch that completes an electrical circuit typically when pressure is applied to the device by the user, which then gives the user a perceptible “click” or haptic bump in response, indicating current flow. Current flow is turned off when the switch is released.

Lithium ion Batteries 3.7V/2600mAh 18650 Type

For powering up the robot we are using 18650 3.7v Li-ionrechargeable batteries. It is capable of supplying very high current . It can supply this much current upto one hour , after thatwe can recharge these batteries

Chapter 5

SOFTWARE DETAILS

Arduino IDE

Arduino Ide is an open source software that is mainly used for writing and compiling the code into the Arduino Module.It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process.It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more.Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board.The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module.This environment supports both C and C++ languages

Blynk

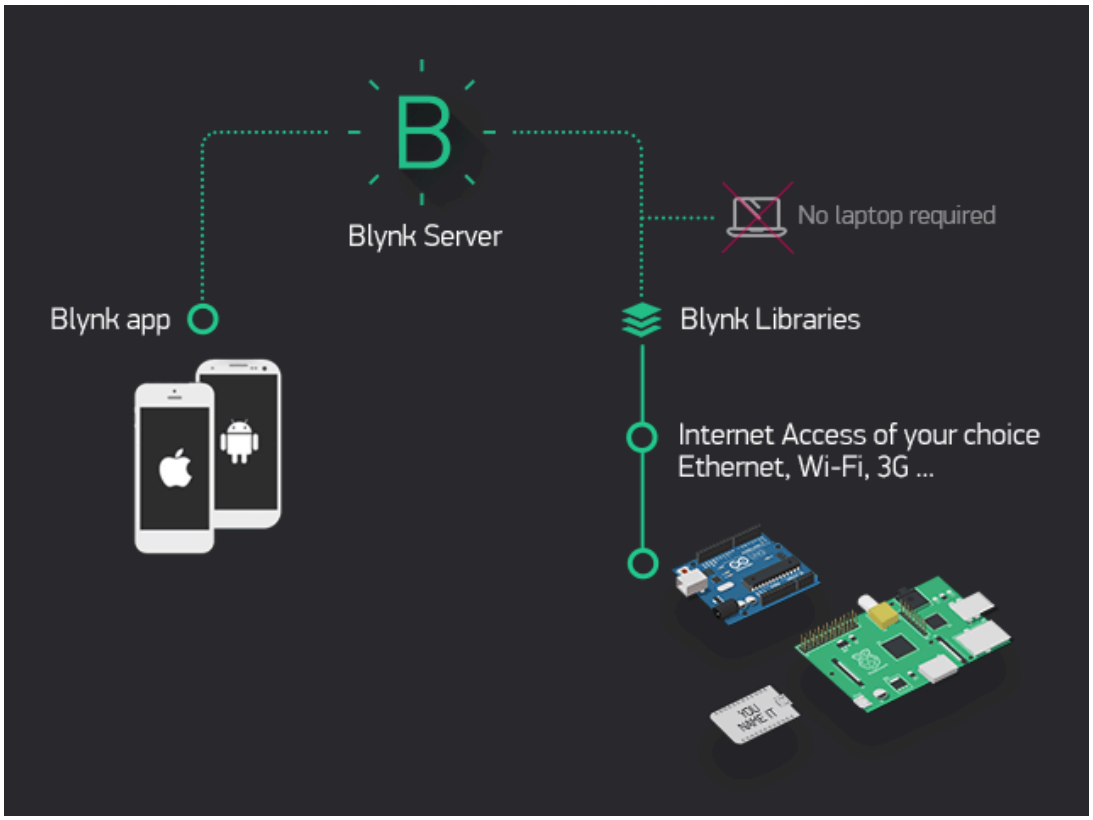
Blynk is a new platform that allows you to quickly build interfaces for controlling and monitoring your hardware projects from your iOS and Android device. After downloading the Blynk app, we can create a project dashboard and arrange buttons, sliders, graphs, and other widgets onto the screen. Using the widgets, you can turn pins on and off or display data from sensors. There are likely hundreds of tutorials that make the hardware part pretty easy, but building the software interface is still difficult. With Blynk, though, the software side is even easier than the hardware. Currently, Blynk supports most Arduino boards,

Raspberry Pi models, the ESP8266, Particle Core, and a handful of other common microcontrollers and single-board

computers, and more are being added over time. Arduino Wi-Fi and Ethernet shields are supported, though we can also control devices plugged into a computer's USB port as well.

There are three major components in the platform:

- Blynk App - allows creating interfaces for projects using various widgets.
- Blynk Server - responsible for all the communications between the smartphone and hardware. We can use the Blynk Cloud or run your private blynk server locally. It's open-source, could easily handle thousands of devices and can even be launched on Raspberry Pi
- Blynk Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and outcoming commands.



Chapter 6

COST OF THE PRODUCT

COMPONENTS	QUANTITY	PRICE
MPU6050	1	450
Node MCU	1	325
LM2596S	1	200
Solenoid valve	1	520
Push Button	1	10
Piezo buzzer	1	20
Toggle switch	1	50
Lithium Batteries	1	150
CO2 Catridge	1	1500
Wires/other material	1	1000
Air bag material	1	100
TOTAL		**4325/-**

Chapter 7

APPLICATIONS

Fall detection and prevention systems for elders have several valuable applications:

Emergency Response: These systems can automatically detect falls and immediately alert emergency services or caregivers, ensuring prompt medical attention.

Remote Monitoring: Caregivers or family members can remotely monitor the elder's activity and receive alerts if a fall or potential fall risk is detected, providing peace of mind.

Preventive Measures: Some systems can identify potential fall risks in the environment and provide recommendations for modifications to reduce the risk of falls, such as removing obstacles or installing handrails.

Health Tracking: They can track the elder's movements and activity levels, providing valuable insights into their health and mobility patterns over time.

Promoting Independence: By providing a safety net, these systems can help elders maintain their independence by allowing them to live at home longer without constant supervision.

Data Analysis: The data collected by these systems can be analyzed to identify trends and patterns, enabling caregivers and healthcare professionals to tailor interventions and support to individual needs.

Overall, fall detection and prevention systems play a crucial role in ensuring the safety and well-being of elders, allowing them to age in place with dignity and independence.

Chapter 8

CONCLUSION

Designed and developed a fall detection system based on a single triaxial accelerometer based wearable device. The system has low power consumed hardware design and highly efficient algorithms which could extend the service time of the wearable device. Both the hardware and software designs are suitable for wearable and outdoor applications. As normal activity of resting also has a similar rotation as falling, it may trigger fall alarm when the body hits the ground heavily. Then we can switch off the alarm using a tactile push button switch. So the choice is quite important to distinguish falling from heavily lying activity. Sufficient sample numbers collected from subjects with different age and gender will improve the reliability and robustness of the threshold.Development of a automatic inflating airbag is then used to reduce the impact of the fall In case of real emergency a message in form of SMS is passed to their Emergency contacts.

FUTURE SCOPE

The fall detection system can be further enhanced to include a low cost safety airbag system to reduce the impact of sudden fall on to the ground. Now the existing airbag systems are very expensive and can’t afford by normal people. A lightweight protective covering can be implemented to protect the system from breaking and damaging while falling.Inorder to provide much more comfort to wear and carry for old people, we are looking for a more compact design. For example, we can implement the system on back pain relief belts for light weight. Also we can include a GPS tracker in it.

Chapter 9

REFERENCES

1.J. Y. Hwang, Y. W. Jang, and H. C. Kim,
"Development of novel algorithm and real-time monitoring ambulatory system using Bluetooth module for
fall detection in the elderly, " in Proc Annu. Int. Conf. IEEE Eng. Med. Biol.
Soc., Sep. 2004, vol. 26, no. 3, pp. 2204–2207.

2.M. K. Karlsson, H. Magnusson, T. von Schewelov, and B. E. Rosengren,
"Prevention of falls in the elderly—a review,
" Osteoporosis International,
vol. 24, no. 3, pp. 747–762, 2013.

3.G. Shi, C.-S. Chan, Y. Luo, G. Zhang, W. J. Li, P. H. W. Leong, and K.-S. Leung,
"Development of a human airbag system for falling protection using
MEMS motion sensing technology,
" in Proc. 2006 IEEE/RSJ Int. Conf.
Intell. Robots Syst., pp. 4405–4410.