FALL DETECTION FOR ELDERLY PEOPLE

A Project Report

Submitted in partial fulfillment of the requirement for the award of the degree of

Bachelor of Technology
in
Electronics and Communication Engineering

by

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Under the guidance of

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(Deemed to be University under section 3 of UGC Act, 1956)

April 2018

DECLARATION

I hereby declare that the project work entitled "**Fall Detection of Elderly People**" submitted by me, for the award of the degree of *Bachelor of Technology in Electronics and Communication Engineering* to Vellore Institute of Technology is a record of bonafide work carried out by me under the supervision of **Prof. Abhijit Bhowmick**.

I further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

Place : Vellore **Signature of the Candidate**

Date :

CERTIFICATE

This is to certify that the project work entitled “Fall Detection for Elderly People” submitted by **Sijo Baby Mathews(14BEC0080)**, School of Electronics Engineering, Vellore Institute of Technology, 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 under my supervision, as per the VIT code of academic and research ethics.

The contents of this report have not been submitted and will not be submitted either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university. The report fulfills the requirements and regulations of the institute and in my opinion meets the necessary standards for submission.

Place : Vellore

Date : **Signature of the Guide**

The project work is satisfactory / unsatisfactory

Internal Examiner **External Examiner**

Approved by

Head of the Department
Department of Communication Engineering
School of Electronics Engineering

ACKNOWLEDGEMENT

I have taken efforts in this project fall detection for the elderly people. However, it would not have been possible without the kind support and help of many individuals and organizations. I would like to extend my sincere thanks to all of them.

I am highly indebted to my guide Prof: Abhijit Bhowmick for his guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project.
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I would like to express my gratitude towards my parents & friends for their kind co-operation and encouragement which help me in completion of this project. I would like to express my special gratitude and thanks to ONLINE YouTube channel for giving me valid information and ideas to implement my project.
My thanks and appreciations also go to my colleague in developing the project and people who have willingly helped me out with their abilities.

SIJO BABY MATHEWS

EXECUTIVE SUMMARY

The major cause of injury and accidental deaths in old people is due to unexpected fall. According to recent statistics, majority of serious consequences are not due to direct fall but due to lack of immediate attention and treatment. Post-fall consequences can be reduced if relief personnel are alerted in time. Many modern old people prefer living alone independently after their children have grown up and leave home. It is so common that after a fall an elderly is unable to get up by themselves or contact someone for help. Thus, there is a need for an automated fall detection system such that he or she can summon help when they are unable to get up or is unconscious.

Many algorithms have already been developed but still it is difficult to differentiate real falls from certain activities such as sitting quickly, jumping which results in many false positives, as it uses accelerometer to detect fall with body orientation as ending position is not always horizontal. E.g. fall on stairs.
The fall detection algorithm can be developed is using both accelerometer and gyroscope reducing both false positives and false negatives, while improving fall detection accuracy. It notifies a concern person with SMS either automatic when fall occurs or with a panic button.

With the advancement and development in medical field, resulting in increase in life expectancy. So, demand for health care of elderly rises. As we know that, elderly people are suffering from diseases that require attention and, in most cases, fall leads to many casualties. So, hiring the personal care taker is costly and elderly needs attention in case of medical emergency. The purpose of this project is to design a device which will track the location of patient using Global Positioning System and send the details using wireless network (GSM) and send the detail to their care takers in case of fall. Design consists of sensor like accelerometer, along with pulse sensor to know whether the pulse is normal.

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List of Terms and Abbreviations

3GPP	Third Generation Partnership Project
2G	Second Generation
3G	Third Generation
4G	Fourth Generation
GSM	Global System for Mobile Communications
GPS	Global Positioning System
WAAS	Wide Area Augmentation System
PPS	Standard Positioning Service
SPS	Standard Positioning Service
ANSI	American National Standards Institute
ISO	International Organization for Standardisation
WiFi	Wireless Fidelity

CHAPTER 1

INTRODUCTION

1.1 MOTIVATION

A fall is nothing but “accidentally coming to floor, or some lower level not as an outcome of sustaining a violent blow, loss of awareness, sudden onset of paralysis as in caress or an epileptic attack”.[1] Something like 3% of all fallers stretches out for more than 20 minutes without exterior hold up.[2] The need of support in the case of unconsciousness or extreme injury is the main reasons why elders leave the comfort and privacy of their own home to live in an assisted-care environment (40% of nursing home patient are only because of fall accident).[1] 32% of elderly people aged over 75 years have ever fallen at least once a year, and along with them, 24% have dangerously injured. Fall related injuries are the leading source of death and hospitalization surrounded by the elderly. Falls among older people become a major problem facing hospitals and nursing homes.

People, who have earlier met this kind of accident often fear a lot and wish not to have a new fall accident again and this fear of another fall take them into idleness or a kind of social isolation, many of the times they wish to go out but can’t really go just because of the fear of collapse. We thought of this savour problem and solution which can detect such kind of accidents and generate alert which can help them get immediate assistance. Specifically, fall detectors can have a direct impact on the reduction in the fear of falling and the rapid provision of assistance after a fall. Falls and fear of falling depend on each other: an individual who falls may subsequently develop fear of falling and, vice versa, the fear of falling may increase the risk of suffering from a fall. [4][5]

1.2. BACKGROUND

This fall can be detected by 2 ways:

First method is Visual observation with some visual device which can observe the person continuously and then image analyser which can analyse the fall of the person and generate alarm. These systems use sensors deployed in the environment to detect falls. The main advantage of this system is the person does not need to wear any special device. The scope of this kind of device is limited to monitoring region (Majorly indoors) cannot be carried all the time with the person Information provided by device is quite accurate but such equipment will cost higher. But this kind of system can have some flaws like it will capture all the personal activities. Now a day, Microsoft launched its product the Kinect sensors [3]A that include an IRFF projector and camera, thus this system functionally works as a vision-based sensor under all lighting conditions. It is useful to gathering activity data during all times of the day. Microsoft Kinect camera is enabling to gather information during night times. This is biggest disadvantage of this system. There are many vision based sensor most common is cameras, infrared sensors, microphones, pressure sensors and floor sensors. Video-based systems can be considered as a subcategory in this group as they use computer vision techniques that differ from the rest of the detection methods.

Second method is through sensor to overcome the flaws of visual monitoring equipment we thought of devising electronic sensor which will important to detect fall and send out alert to call for help. If a fallen person is unconscious and unable to call for help it can lead to permanent injure and even death. Therefore, there is a need of self-directed fall detectors that can trigger an alarm automatically without any interference of the victim and transferring this information to a remote site. So that the fallen person should get immediate medical help. Based on these problems, the main aim, of then this system is to build up a small, comfortable, and user-friendly device,

and automatic fall detector system that will help older people to handle this problem. In this paper the fall detector system is a real time working model for detecting the fall, by using accelerometer. It will be accomplished for continuous fall detection and sending an alarm to a remote terminal. It will consist of GSM

attached to this system to transfer the real time condition to the respective places (Care taker, Relatives, Family Doctor etc).

1.3. OBJECTIVE

Accelerometer [7] has been used in various studies and applications to objectively monitor a range of human movement, for example to measure metabolic energy expenditure, physical activity levels, balance and postural sway, gait, and to detect fall. The monitoring system show in figure. These systems having hardware part. It will attachable on the waist of the person and a microcontroller is used for classifying person's actions and detecting any possible falls.

In case of the falls, the system also sends out an alarm to the appropriate response unit. The first part of the system includes a fall-detecting band for extracting and processing signals obtained from the triaxial accelerometer. In this system an accelerometer ADXL335 is used for the fall detection purpose on X, Y and Z axis. Here these sensors will send the analog signal to the microcontroller for its logical manipulation for detecting the real time status of the body to the home server to update the display information. The device also includes an emergency help button display the fall alert and emergency signal. The second part of the system consists of a GSM modem system that will be attached with the microcontroller for sending the message to the respective places along with the location of user. The server first received a fall alert, and then it generates alarm. The third part of the system that will provide the heart rate value at the time of triggering using with the SMS service via gsm module.

In fall detection technique, the values of accelerometer are the input to microcontroller i.e. to Arduino board for computational purpose. The three axes i.e. x, y, z will each produce a different acceleration value, based on these value use stage analyses to evaluate user’s movement signals. Movements of person will be classified into normal movements and abnormal movements. According to acceleration values from accelerometer, normal actions will be continuous and cadent movement signals, while irregular actions shall be recognized as fall signal. In this method check the value of three axes with respective defined threshold. If value is below the threshold then generate alarm. It’s ability to

determine different activities under different environments. Speed up the activity state identification process and lead to faster fall detection.

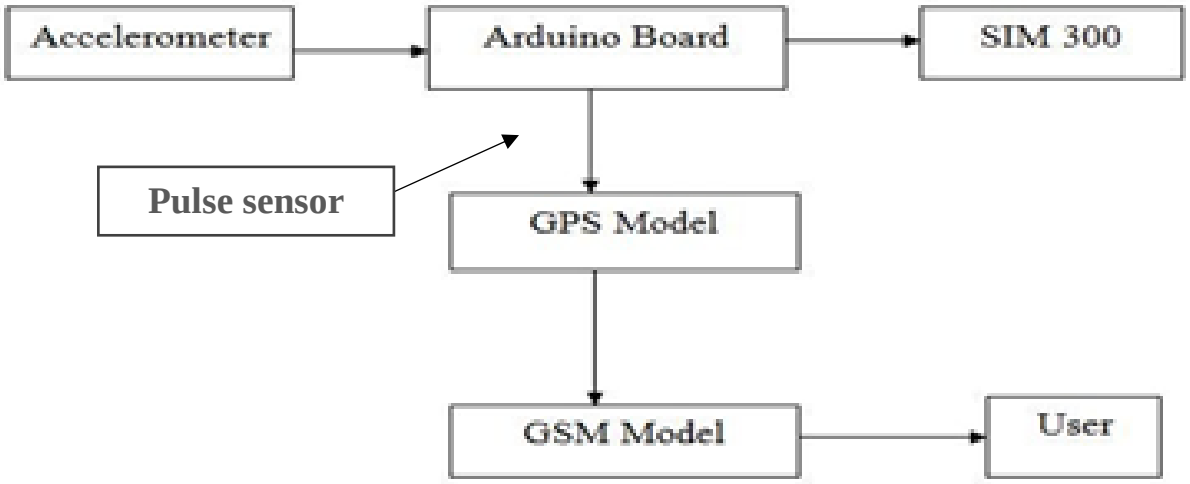


Fig 1.3 Architecture of fall detection model

1.4. ORGANIZATION OF THE REPORT

This report is organized into various sections that helps one understand and grasp the full knowledge of the hardware project on fall detection of the elderly people living independently, using hardware components like mems sensor, Arduino uno, gsm and gps module and pulse sensor.

The report starts with the introduction and the motivation behind why the particular project was selected. It is followed by backgrounds regarding the work. The technical specifications along with description and goals have been mentioned in detail.

The design feature and approach are discussed in brief. The schedule, task and milestones regarding my project work is tabulated along with conclusion and references have also been given in detail. The cost analysis is also tabulated with the approximate cost for implementing this project.

1.5 LITERATURE REVIEW

TOPIC: Fall Detection Algorithm Based on Triaxial Accelerometer and Magnetometer

AUTHOR'S: Tianjiao Shi, Xingming Sun, Zhihua Xia, Leiyue Chen, and Jianxiao Liu

DESCRIPTION : Fall is a precipitous drop from a height, or from a higher position, which may be accompanied by injuries. This is one of the most dangerous and fearful situation in the elderly living. This is the reason, fast and early detection of the fall is very important to save and rescue the people and avoid the badly prognosis. In this article we are presenting a thresholdbased fall detection algorithm that processes data from common sensors in modern smart phones, such as triaxial accelerometer and magnetometer in order to detect falls. The algorithm uses Signal Vector Magnitude (SVM) peak value, base length and post-impact velocity to distinguish falls from most of daily activities. However, the SVM curve in a period produced by running is similar to a fall (a running curve can be regarded as the combination of multiple fall curves). Accordingly, residual movement is taken into account to identify running and fall. In addition, the vertical acceleration is observed to increase detection accuracy. In the experiments, the data are collected by simulating fall in four directions: forward, backward, left and right. The simulations are conducted by young people. The final experiment includes data from 120 simulated falls and 150 daily activities. Compared with previous methods, the proposed method achieves higher sensitivity and specificity.

TOPIC: Fall Detection Using Single Tri-Axial Accelerometer

AUTHOR'S: Suleman Belal Kazi, Sherjeel Sikander, Sadia Yousafzai

DESCRIPTION: This paper describes a mobile phone based system which implements a fall detection algorithm using a mobile phone's built-in accelerometer which can detect falls with a high degree of accuracy. The application developed can then notify predefined guardians or emergency services with the victim's GPS coordinates displayed on a map for timely delivery of medical help. The algorithm has been tested on human subjects, and the results are also included in this paper.

TOPIC : Fall Detection System for Elderly Person Monitoring Using GSM Network

AUTHOR'S : S. Manigandan and Suresh R. Norman

DESCRIPTION : The World Health organization (WHO) indicated that falls are the second leading cause of unintentional injury, deaths for those over 65 years old worldwide. Non-fatal injurious falls can not only cause disability or functional impairment, but also have psychological effects that reduce the range of Activities of Daily Living (ADLs).A combination of sensors such as accelerometer and ultrasonic sound sensor is a cost efficient method for fall detection. Arduino boards are used to detect the fall events based on threshold values. A pair of RF transmitter and receiver is used for wireless communication. Moreover in case of emergency sending an alert to the caregiver would help in timely medical aid. When the microcontroller in the Arduino board senses drastic changes from the threshold values of the sensors outputs, an emergency alert is sent as SMS to the caregiver through a GSM.

CHAPTER 2

PROJECT DESCRIPTION AND GOALS

The main objectives of this work are:

(1) To design a fall detection system using low cost fall detector sensors,

(2) To develop an algorithm that can identify the body position of the elderly people whether it is in falling tendency, and

(3) To construct a system that can send an Emergency SMS to the contact person (e.g. next-of-kin or close relatives) stored in the system.

(4). To connect a pulse sensor

Falling Scenario

The workflow of the system is as follows:

- The elderly people wear the falling detection sensor devices on their waist.
- The sensor device runs an algorithm embedded with it to detect and measure the body position of the users.
- If the sensor devices detect the body position in falling mode, the system will trigger the GSM.
- To prevent false positive, happen, if threshold conditions are not achieved within 10 seconds by the user, the system will not send an emergency SMS to the contact person. Thus it increases efficiency of system.

The story board of falling until an ambulance is informed is presented in Figure below

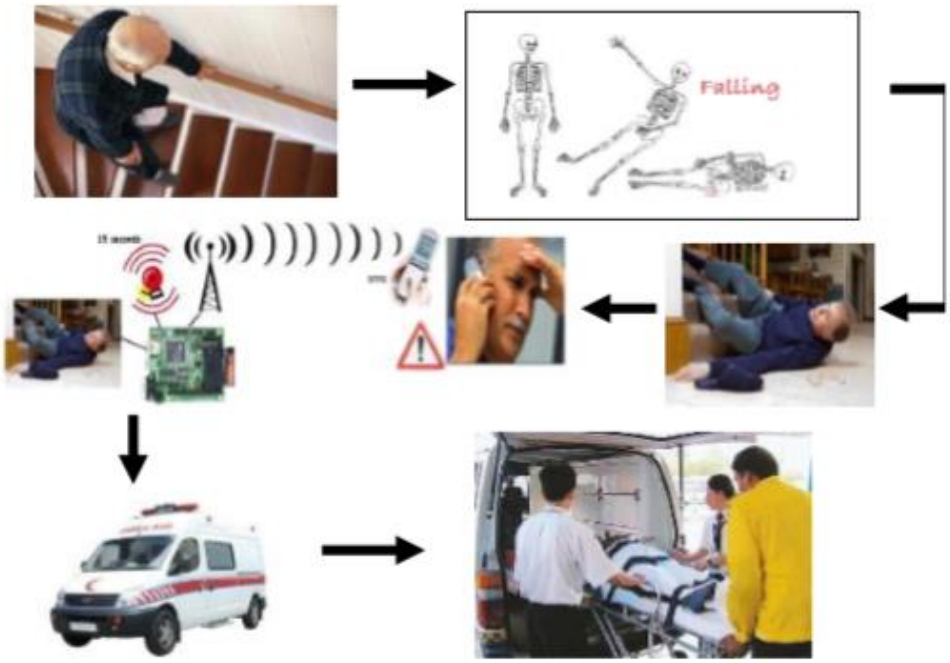


Fig 2. Workflow of fall scenario.

1. An elderly people is walking down on a stair.
2. He misses the steps on the stairs and falling from the stairs to the floor.
3.Fall detection sensor system will detect the falling, through the algorithm system and then trigger GSM and send a short-message (i.e., SMS) to the contact person stored in the system. The contact person will track the falling location and contact ambulance for medical help.
4.Ambulance department will receive the call from the contact person and then send an ambulance car to that location of the victim.

CHAPTER 3

TECHNICAL SPECIFICATION

SYSTEM REQUIREMENTS

- ARDUINO UNO
- ACCELEROMETER
- GPS
- GSM
- POWER SUPPLY UNIT
- PULSE SENSOR

SOFTWARE TOOLS

- ARDUINO IDE
- EMBEDDED C

3.1 HARDWARE SPECIFICATION

3.1.1 ARDUINO

DESCRIPTION

Arduino is an open source, computer hardware and software company, project, and user community that designs and manufactures Single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world.

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards can read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online.

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

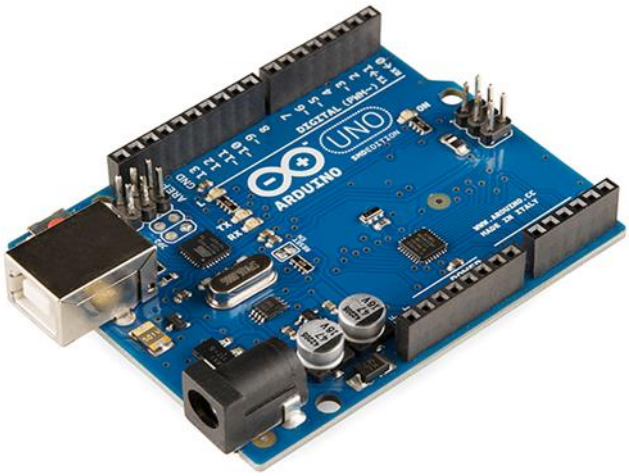


Fig 3.1.1.a ARDUINO UNO

Arduino is an open-source project that created microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices. The project is based on microcontroller board designs, produced by several vendors, using various microcontrollers. These systems provide sets of digital and analog input/output (I/O) pins that can interface to various expansion boards (termed shields) and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development

environment (IDE) based on a programming language named Processing, which also supports the languages C and C++.

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter. Arduino Uno has several facilities for communicating with a computer, another Arduino board, or other microcontrollers.

FEATURES

- Microcontroller: ATmega328P
- Operating voltage: 5V
- Input voltage: 7-12V
- Flash memory: 32KB
- SRAM: 2KB
- EEPROM: 1KB

APPLICATIONS

- Real time biometrics
- Robotic applications
- Academic applications

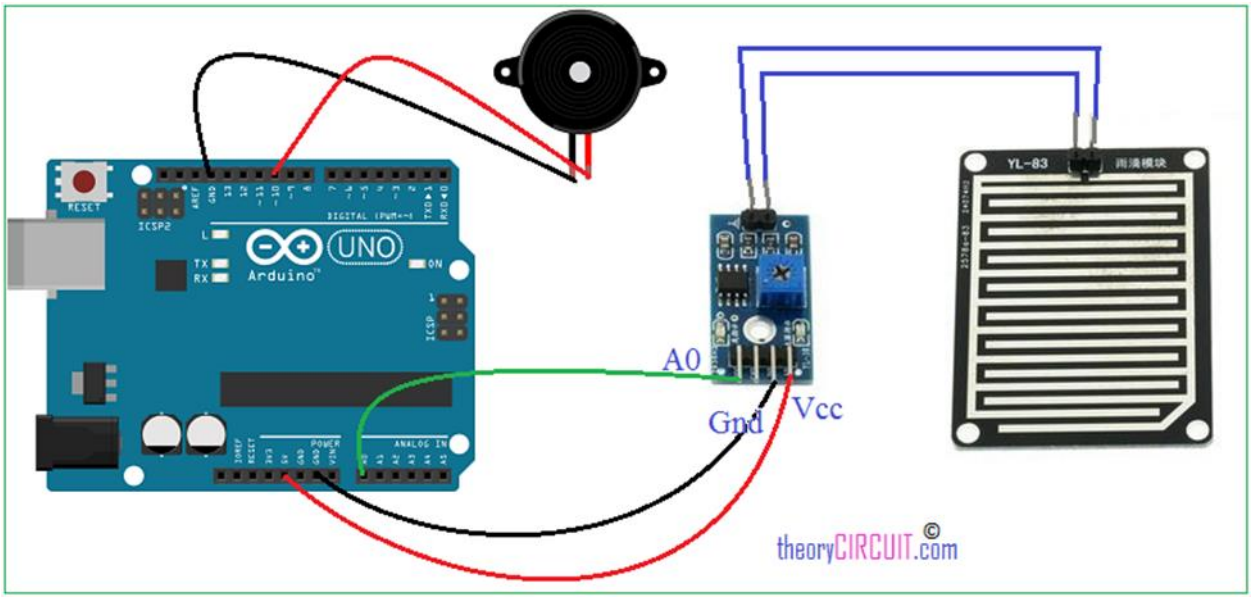


Fig 3.1.1.b sensor interfacing with Arduino uno example

I/O PORTS

DESCRIPTION

Input/output port. Alternatively referred to as I/O address, I/O ports, and I/O port address, the input/output port is what allows the software drivers to communicate with hardware devices on your computer. In your computer there are 65,535 ports that are numbered from 0000h to FFFFh

General-purpose input/output (GPIO) is a generic pin on an integrated circuit or computer board whose behaviour including whether it is an input or output pin is controllable by the user at run time.

ANALOG PIN DETAILS

GPIO pins have no predefined purpose and go unused by default. The idea is that sometimes a system integrator who is building a full system might need a handful of additional digital control lines and having these available from a chip avoids having to arrange additional circuitry to provide them. For example, the Realtek ALC260 chips (audio codec) have 8 GPIO pins, which go unused by default. Some system integrators (Acer Inc. laptops) use the first GPIO (GPIO0) on the ALC260 to turn on the amplifier for the laptop's internal speakers and external headphone jack.

GPIO capabilities may include

- GPIO pins can be configured to be input or output
- GPIO pins can be enabled/disabled
- Input values are readable (typically high or low)
- Output values are writable/readable
- Input values can often be used as IRQs (typically for wakeup events)

GPIO peripherals vary widely. In some cases, they are simple a group of pins that can switch as a group to either input or output. In others, each pin can be set up to accept or source different logic voltages, with configurable drive strengths and pull ups/downs. Input and output voltages are typically though not always limited to the supply voltage of the device with the GPIOs and may be damaged by greater voltages.

A GPIO pin's state may be exposed to the software developer through one of several different interfaces, such as a memory mapped peripheral, or through dedicated IO port instructions. Some GPIOs have 5 V tolerant inputs: even when the device has a low supply voltage (such as 2 V), the device can accept 5 V without damage.

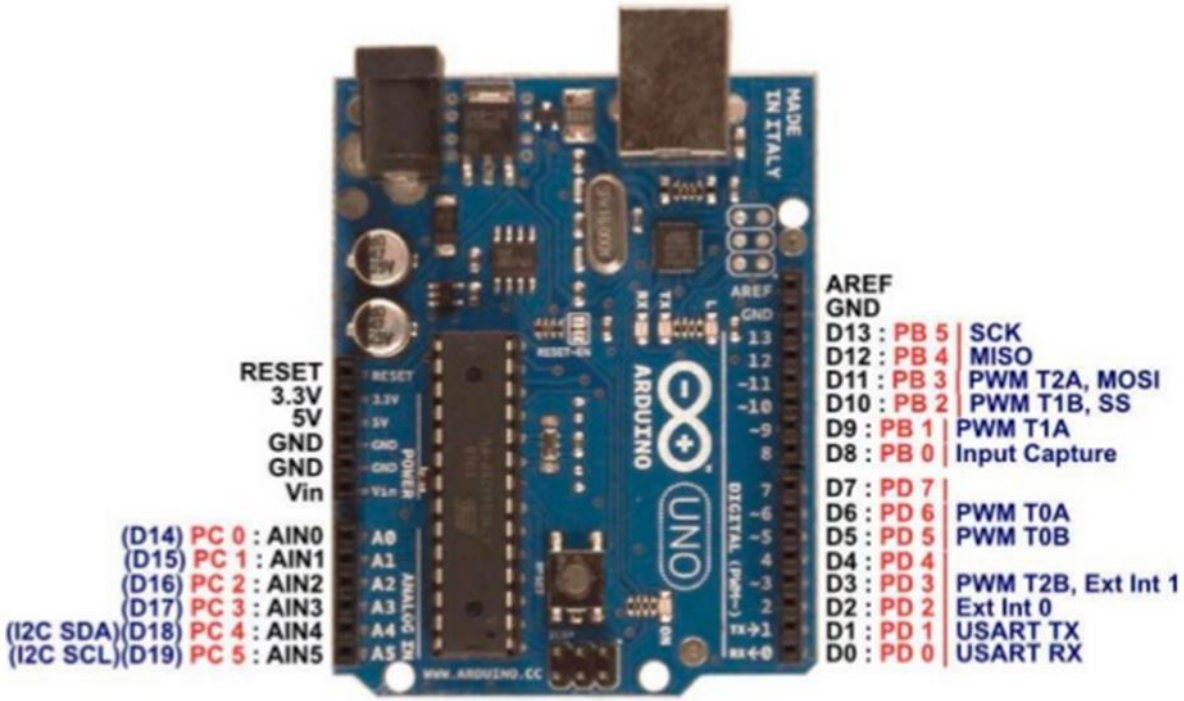


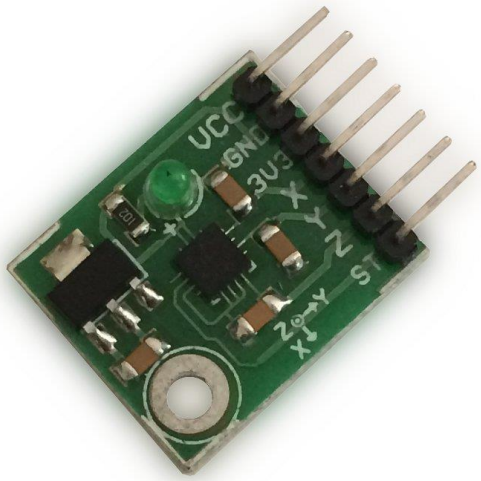
Fig 3.1.1.c Port representation in Arduino uno

3.1.2 MEMS SENSOR

DESCRIPTION

Microelectromechanical system (MEMS, also written a micro-electro-mechanical, Microelectromechanical or microelectronic and microelectromechanical system and the related micro mechatronics) is the technology of microscopic devices, particularly those with moving parts.

The accelerometer is a low power, low profile capacitive micro machined Accelerometer featuring signal conditioning, a 1-pole low pass filter, temperature Compensation, self-test, 0g-Detect which detects linear freefall, and g-Select Which Allows for the selection between 2 sensitivities Zero-g offset and sensitivity is Factory set and requires no external devices. This includes a Sleep Mode that makes it ideal for handheld battery powered electronic device



. Fig 3.1.2.a MEMS sensor

You can use an accelerometer's ability to sense acceleration to measure variety of things that are very useful to electronic and robotic projects and designs:

- Acceleration
- Tilt and tilt angle
- Incline
- Rotation
- Vibration
- Collision
- Gravity

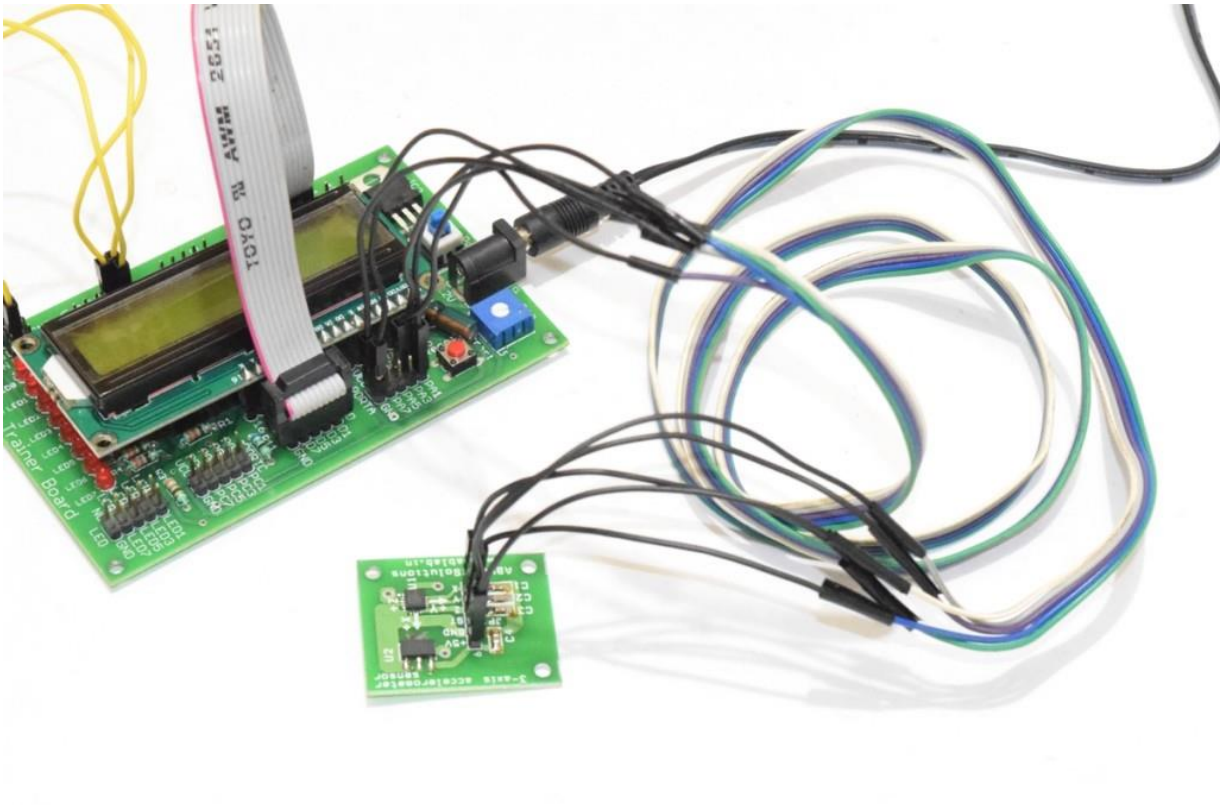


Fig 3.1.2.b MEMS INTERFACE WITH CONTROLLER

Acceleration is a measure of how quickly speed changes. Just as a speedometer is a meter that measures speed, an accelerometer is a meter that measures acceleration. Accelerometers are useful for sensing vibrations in systems or for orientation applications. Accelerometers can measure acceleration on one, two, or three axes. 3-axis units are becoming more common as the cost of development for them decreases. You can use an accelerometer's ability to sense acceleration to measure a variety of things that are very useful to electronic and robotic projects.

FEATURES

- Low Current Consumption: 400 mA
- Sleep Mode: 3μA
- Low Voltage Operation: 2.2 V – 3.6 V
- High Sensitivity (800 mV/g @ 1.5g)
- Selectable Sensitivity (±1.5g, ±6g)
- Fast Turn on Time (0.5 ms Enable Response Time)
- Self-Test for Freefall Detect Diagnosis

APPLICATIONS:

- Self-balancing robots
- Tilt-mode game controllers
- Model airplane auto pilot
- Car alarm systems
- Crash detection/airbag deployment

3.1.3 GPS MODULE

DESCRIPTION

The Global Positioning System (GPS), originally Navstar GPS, is a space-based radio navigation system owned by the United States government and operated by the United States Air Force. It is a global navigation satellite system that provides geo location and time information to a GPS receiver anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.

The GPS system does not require the user to transmit any data, and it operates independently of any telephonic or internet reception, though these technologies can enhance the usefulness of the GPS positioning information. The GPS system provides critical positioning capabilities to military, civil, and commercial users around the world. The United States government created the system, maintains it, and makes it freely accessible to anyone with a GPS receiver.

Fig 3.1.3.a GPS module.

The Global Positioning System (GPS) is a global navigation satellite system that provides location and time information in all weather conditions. The GPS operates independently of any telephonic or internet reception, though these technologies can enhance the usefulness of the GPS positioning information. GPS

satellites transmit signal information to earth. This signal information is received by the GPS receiver to measure the user's correct position.

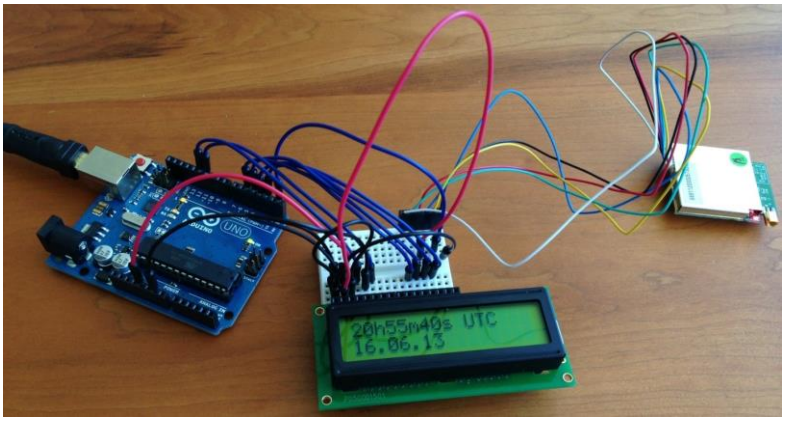


Fig 3.1.3.b GPS MODULE INTERFACE WITH ARDUINO

The GPS concept is based on time and the known position of specialized satellites. GPS satellites continuously transmit their current time and position. A GPS receiver monitors multiple satellites and solves equations to determine the precise position of the receiver and its deviation from true time. At a minimum, four satellites must be in view of the receiver for it to compute four unknown quantities.

Each GPS satellite continually broadcasts a signal (carrier wave with modulation) that includes a pseudorandom code (sequence of ones and zeros) that is known to the receiver and a message that includes the time of transmission (TOT) of the code epoch and the satellite position at that time.

FEATURES

- Supply voltage: 12v DC
- Interface: UART RS232
- Optional T-TL uart also available
- Precision: 5 meters
- Automatic antenna switching function

APPLICATIONS

- GPS trackers
- Automated vehicle
- Robotics
- Fleet tracking

3.1.4 GSM MODEM

DESCRIPTION

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. This tutorial will explain how to interface a GSM modem with Toradex modules.

Fig 3.1.4 GSM MODEM.

SIMCom Wireless Solutions is a subsidiary of SIM Technology Group Ltd (stock code: 2000. H.K). It is a fast-growing wireless M2M company, designing and offering a variety of wireless modules based on GSM/GPRS/EDGE, WCDMA/HSDPA and TD-SCDMA technical platforms By partnering with third parties, SIMCom Wireless provides customized design solutions in M2M, WLL, Mobile Computing, GPS and other applications. SIMCom Wireless also provides ODM services for customers. According to ABI Insight report, SIMCom Cellular

Module was number two provider of wireless modules worldwide in 2008 with 20% acquisition of global market share

This GSM Modem can accept any GSM network act as SIM card and just like a mobile phone with its own unique phone number. Advantage of using this modem will be that you can use its RS232 port to communicate and develop embedded applications. The SIM900A is a complete Dual-band GSM/GPRS solution in a SMT module featuring an industry-standard interface; the SIM800 delivers GSM/GPRS 900/1800MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mm x 24mm x 3 mm, SIM800 can fit almost all the space requirements in your applications, especially for slim and compact demand of design.

FEATURES

- High Quality Product
- RS232 interface @ RMC Connector for direct communication with computer or MCU kit
- Configurable baud rate
- SMA connector with GSM Antenna.
- SIM Card holder.
- Built in Network Status LED
- Inbuilt Powerful TCP/IP protocol stack for internet data transfer over GPRS.
- Audio interface Connector
- Normal operation temperature: -20 °C to +55 °C
- Input Voltage: 4.5V-12V DC

APPLICATIONS

- Short Message Service(SMS)
- Internet
- Incoming /outgoing calls

3.1.5 PUSH BUTTON

A push-button (also spelled pushbutton) or simply button is a simple switch mechanism for controlling some aspect of a machine or a process. Buttons are typically made out of hard material, usually plastic or metal. The surface is usually flat or shaped to accommodate the human finger or hand, so as to be easily depressed or pushed. Buttons are most often biased switches, although many un-biased buttons (due to their physical nature) still require a spring to return to their un-pushed state. Terms for the "pushing" of a button include pressing, depressing, mashing, hitting, and punching.

The "push-button" has been utilized in calculators, pushbutton telephones, kitchen appliances, and various other mechanical and electronic devices, home and commercial.

In industrial and commercial applications, push buttons can be connected by a mechanical linkage so that the act of pushing one button causes the other button to be released. In this way, a stop button can "force" a start button to be released. This method of linkage is used in simple manual operations in which the machine or process has no electrical circuits for control.

Red pushbuttons can also have large heads (called mushroom heads) for easy operation and to facilitate the stopping of a machine. These pushbuttons are called emergency stop buttons and for increased safety are mandated by the electrical code in many jurisdictions. This large mushroom shape can also be found in buttons for use with operators who need to wear gloves for their work and could not actuate a regular flush-mounted push button

3.1.6 PULSE SENSOR

The Pulse Sensor is a plug-and-play heart-rate sensor for Arduino. It can be used by students, artists, athletes, makers, and game & mobile developers who want to easily incorporate live heart-rate data into their projects. It is an integrated optical amplifying circuit and noise eliminating circuit sensor. Clip the Pulse Sensor to your earlobe or fingertip and plug it into your Arduino, you can ready to read heart rate.

Fig 3.1.6 Ear clip pulse sensor

3.2 SOFTWARE IMPLEMENTATION

3.2.1 ARDUINO IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them. Programs written using Arduino Software (IDE) are called **sketches**. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

Before uploading your sketch, you need to select the correct items from the **Tools > Board** and **Tools > Port** menus. The boards are described below. On the Mac, the serial port is probably something like **/dev/tty.usbmodem241** (for an Uno or Mega2560 or Leonardo) or **/dev/tty.usbserial-1B1** (for a Duemilanove or earlier USB board), or **/dev/**tty.USA19QW1b1P1**.1** (for a serial board connected with a Keyspan USB-to-Serial adapter). On Windows, it's probably COM1 or COM2 (for a serial board) or COM4, COM5, COM7, or higher (for a USB board) - to find out, you look for USB serial device in the ports section of the Windows Device Manager. On Linux, it should be **/dev/ttyACMx** , **/dev/ttyUSBx** or similar. Once you've selected the correct serial port and board, press the upload button in the toolbar or select the **Upload** item from the **Sketch** menu. Current Arduino boards will reset automatically and begin the upload. With older boards (pre-Diecimila) that lack auto-reset, you'll need to press the reset button on the board just before starting the upload. On most boards, you'll see the RX and TX LEDs blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is complete or show an error.

When you upload a sketch, you're using the Arduino **bootloader**, a small program that has been loaded on to the microcontroller on your board. It allows you to upload code without using any additional hardware. The bootloader is active for a few seconds when the board resets; then it starts whichever sketch was most recently uploaded to the microcontroller. The bootloader will blink the on-board (pin 13) LED when it starts (i.e. when the board resets).

3.2.2 EMBEDDED C

Embedded C is a set of language extensions for the C programming language by the C Standards Committee to address commonality issues that exist between C extensions for different embedded systems.

Embedded C is a set of language extensions for the C programming language by the C Standards Committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed point arithmetic, multiple distinct memory banks, and basic I/O operations.

An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today. Ninety-eight percent of all microprocessors are manufactured as components of embedded systems.

Examples of properties of typical embedded computers when compared with general-purpose counterparts are low power consumption, small size, rugged operating ranges, and low per-unit cost. This comes at the price of limited processing resources, which make them significantly more difficult to program and to interact with. However, by building intelligence mechanisms on top of the hardware, taking advantage of possible existing sensors and the existence of a

network of embedded units, one can both optimally manage available resources at the unit and network levels as well as provide augmented functions, well beyond those available. For example, intelligent techniques can be designed to manage power consumption of embedded systems.

Modern embedded systems are often based on microcontrollers (i.e. CPU's with integrated memory or peripheral interfaces), but ordinary microprocessors (using external chips for memory and peripheral interface circuits) are also common, especially in more-complex systems. In either case, the processor(s) used may be types ranging from general purpose to those specialized in certain class of computations, or even custom designed for the application at hand. A common standard class of dedicated processors is the digital signal processor (DSP).

Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

Embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, and largely complex systems like hybrid vehicles, MRI, and avionics. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

CHAPTER 4

DESIGN APPROACH AND DETAILS

4.1 DESIGN APPROACH

Accelerometer has been used in various studies and applications to objectively monitor a range of human movement, for example to measure metabolic energy expenditure, physical activity levels, balance and postural sway, gait, and to detect falls. The monitoring system show in figure. These systems having hardware part. It will attachable on the waist of the person and a microcontroller is used for classifying person's actions and detecting any possible falls.

In case of the falls, the system also sends out an alarm to the appropriate response unit. The first part of the system includes a fall-detecting band for extracting and processing signals obtained from the triaxial accelerometer. In this system an accelerometer ADXL335 is used for the fall detection purpose on X, Y and Z axis. Here these sensors will send the analog signal to the microcontroller for its logical manipulation for detecting the real time status of the body to the home server to update the display information. The device also includes an emergency help button display the fall alert and emergency signal. The second part of the system consists of a GSM modem system that will be attached with the microcontroller for sending the message to the respective places along with the location of user. The server first received a fall alert, and then it generates alarm.

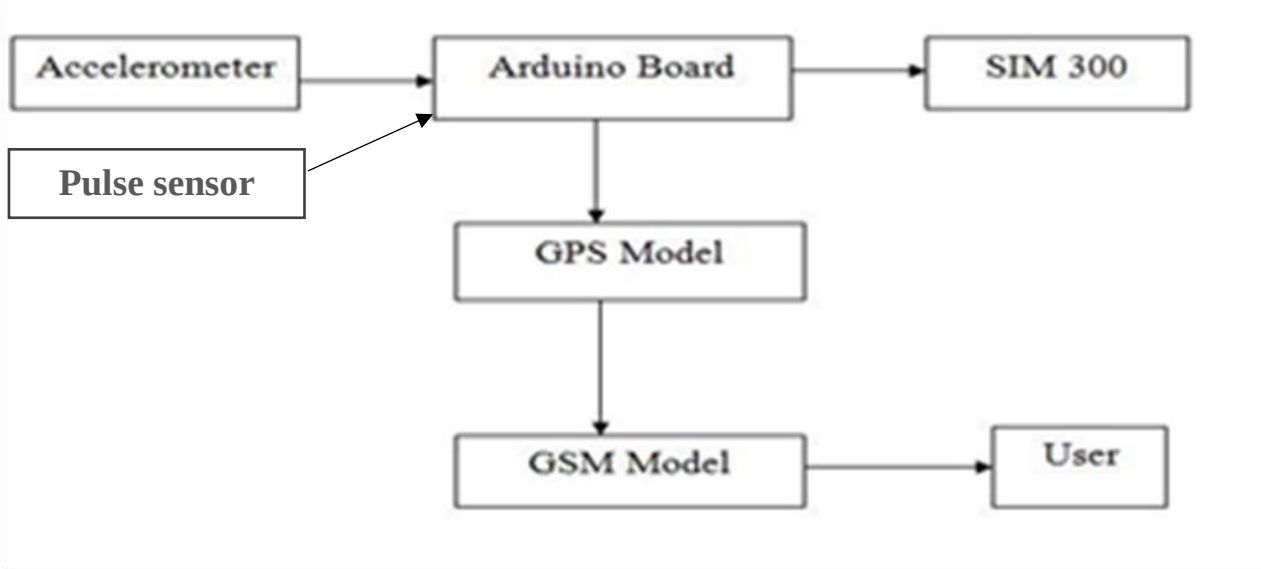


Fig 4.1.a Block Diagram representation

In fall detection technique, the values of accelerometer are the input to microcontroller i.e. to Arduino board for computational purpose. The three axes i.e. x, y, z will each produce a different acceleration value, based on these value use stage analyses to evaluate users' movement signals. Movements of person will be classified into normal movements and abnormal movements. According to acceleration values from accelerometer, normal actions will be continuous and cadent movement signals, while irregular actions shall be recognized as fall signal. In this method check the value of three axes with respective defined threshold. [7] If value is below the threshold then generate alarm as an SOS message. It's ability to determine different activities under different environments. Speed up the activity state identification process and lead to faster fall detection.

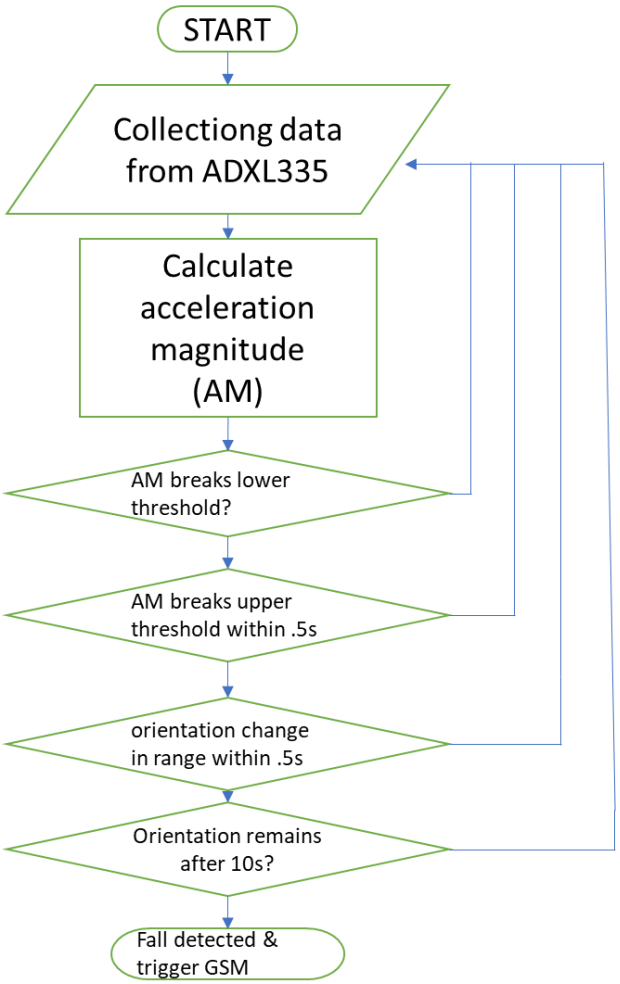


Fig 4.1.b Working principle flowchart

My algorithm is based off the concept that during a fall, a person experiences a momentary freefall or reduction in acceleration, followed by a large spike in acceleration, then a change in orientation. The flowchart for Algorithm is given below. We see the algorithm checks to see if the acceleration magnitude (AM) breaks a set lower threshold. If this lower threshold is broken, the algorithm then checks to see if AM breaks a set upper threshold within 0.5s. If this upper threshold is broken, the algorithm then checks to see if the person's orientation has changed in a set range within 0.5s, which would indicate a person has fallen or toppled over. If the person's orientation has changed, the algorithm then

examines to see if that orientation remains after 10s, which would indicate the person is immobilized in their fallen position on the ground. If this holds true, the algorithm recognizes this as a fall. A failure of any of the intermediate decision conditions would reset the triggers and send you back to the start. The strength of this algorithm is that it requires an activity to break two AM thresholds and have an orientation change. [7] Ideally this additional lower threshold would reduce the number of false positives.

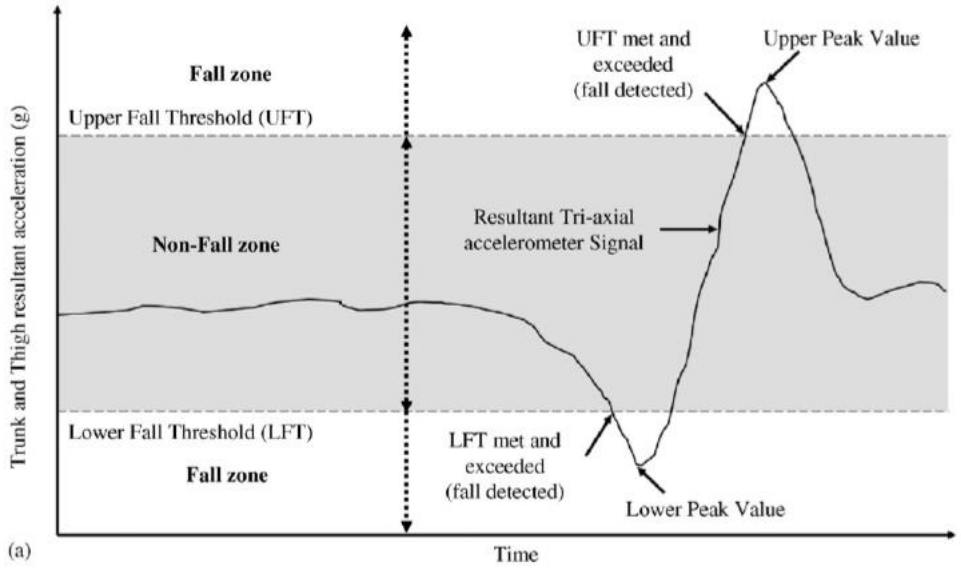


Fig. 4.1.c graph of accelerometer signal during a fall.

4.2 CODES AND STANDARDS

- IEEE STANDARDS
- GSM standards
- ETSI standards
- GPS standards
    - WAAS
    - PPS
    - SPS

- ISO standards

- ANSI standards

4.3 CONSTRAINTS, ALTERNATIVES AND TRADE OFFS

CONSTRAINTS

- Constraints include the low signal availability for the GSM when in rural area/out of coverage area.

- The fall detection can be wrong at times due to motion similar to falling from the user of this device.

ALTERNATIVES AND TRADE OFFS

- the usage of pulse sensor has improved the efficiency of system because from SMS received one can make sure that fall is true from the abnormal value of pulse sensor.

- This can be done alternative means using IOT device NODEMCU instead GSM and GPS system.

- An alternative way is to develop a mobile application to detect fall with their phone.
  Smartphones already have built-in accelerometer and gyroscope (motion sensor), along with GSM and GPS module and even has pulse sensor with certain gadgets , thus my prototype can be implemented directly on to phone and it can monitor the person throughout his daily activities.

- The trade off with the project being done with NODEMCU is that it requires stable
  Internet connection using WiFi router. It can be compromised with a GPS and GSM which makes system portable and doesn't require internet connection.

CHAPTER 5

SCHEDULE, TASK AND MILESTONES

TABLE 5. SCHEDULE AND TASKS

Sr No.	Duration	Review	Outcomes
1	December	Zeroth review	• Deciding the area of project • Literature Survey • Coming up with a topic and problem statement • Learning Arduino programming • Knowledge about various components
2	February	First Review	• Deciding to implement the project with GSM and GPS as nodemcu output is not obtained. • Including pulse sensor to get more accurate result.
3	April	Final Review	• Report submission • poster design • presentation preparation

MILESTONES

- working with sensors
- Arduino programming
- Learnt about embedded C coding
- Detailed knowledge about MEMS sensor and utilizing it to build a fall detection device

CHAPTER 6

PROJECT DEMONSTRATION

This chapter deals with the working model of the project along with images explaining the results and summarize the output from the hardware components.

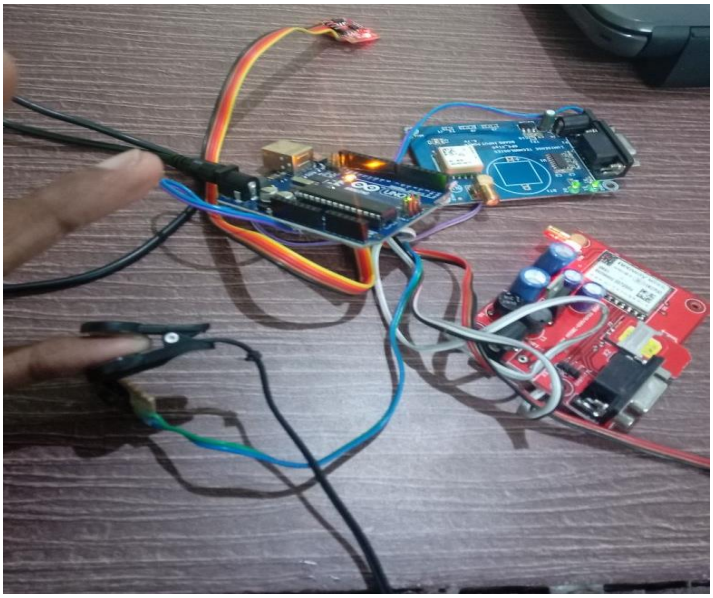


Fig 6. Hardware Setup

SCENARIO 1

- When the fall occurs, and it is detected by the device.

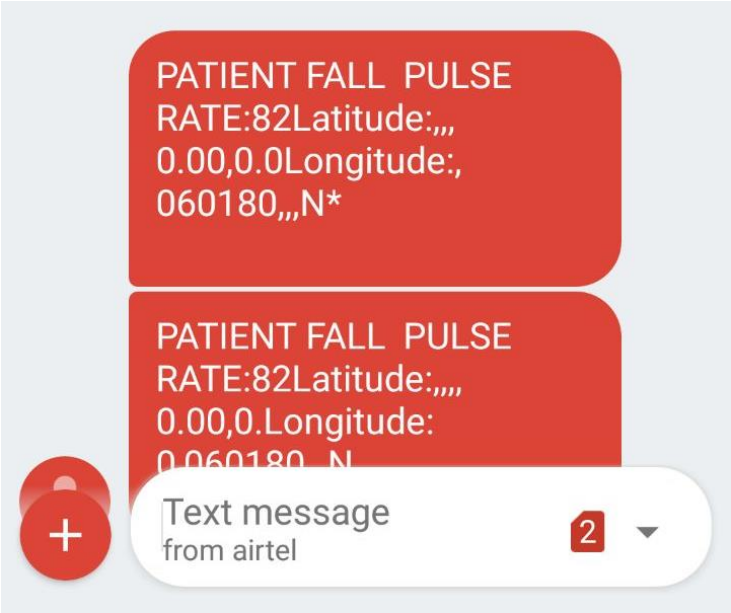


Fig. 6.a SMS received automatically when fall occurs

SCENARIO 2

- When the person presses panic button and need immediate attention from care taker.

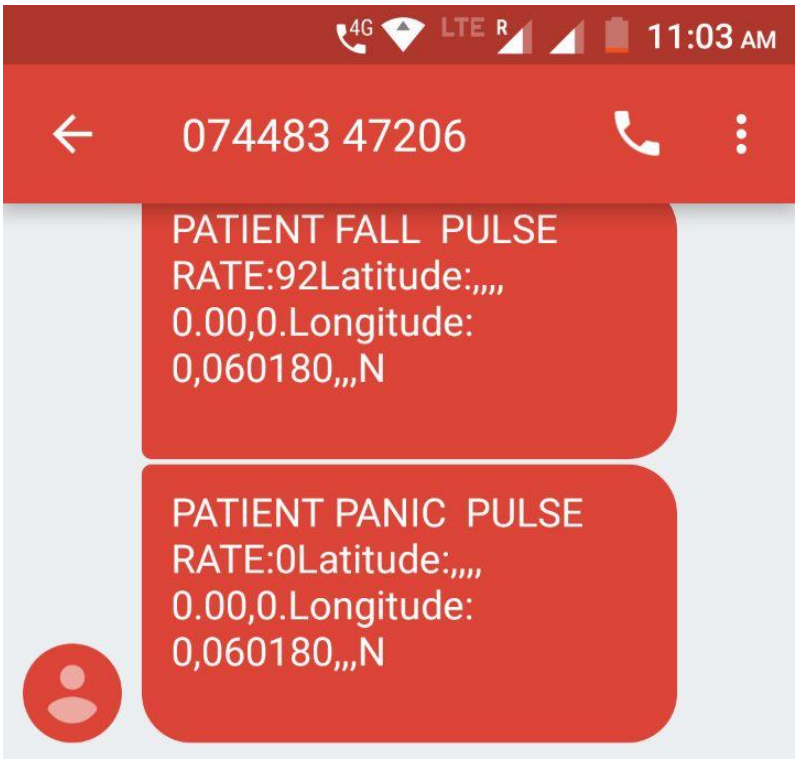


Fig 6.b SMS received with panic button

Here the two scenarios are shown in above fig 6.a and fig 6.b.
The output message comprises of:

1. Alert whether it's a fall or panic.

2. Pulse rate at that moment of fall or panic sent via SMS.

3. GPS output of latitude and longitude is sent via SMS.

4. Message is sent to the care-taker.

CHAPTER 7

COST ANALYSIS

This project was done using ARDUINO IDE software and in real time it requires components
which can cost as follows:

TABLE 7. COST ANALYSIS

Serial no.	Component	Specifications	Cost(Rs)	Quantity	Price
1	Arduino Uno	UNO	300	1	300
2	GSM module	Neoway m590e (SIM 900)	1000	1	800
3	GPS module	Neoway	900	1	800
4	Pulse sensor	Ear clip type	300	1	200
5	Push button	normal	10	1	10
6	accelerometer	ADXL 335	100	1	100
7.	Wires	Soldering and connecting	50	As many as required	50

the overall cost for the components for developing this device is approximately around Rs 2200/-

CHAPTER 8

CONCLUSION

The capstone final year project titled “fall detection for elderly people” has been developed using hardware components such as Arduino Uno, accelerometer, gsm module, gps module, pulse sensor etc. The Arduino was programmed using ARDUINO IDE using embedded C as programming language.

The results of the project is satisfactory with desired output of fall detection of a person, even in stairs.The output comprises of an SMS to caretaker confirming the fall detection, along with the pulse rate during that fall and the latitude and longitude location of the victim. The pulse rate value is an advantage if it is abnormal then we can make sure the situation of the user is bad and can take immediate action to help that person. There is also a panic push button, in case of emergency ,the user can press and notify the caretaker that he is not well and require assistance.

CHAPTER 9

REFERENCE

[1] World Health Organisation. Global report on falls prevention in older age. World Health Organisation,2007.
[http://www.who.int/ageing/publications] Falls_prevention7March.pdf]

[2] Bergland, A., and TB Wyller. "Risk factors for serious fall related injury in elderly women living at home." Injury Prevention (2004): doi:10.1136/ip.2003.004721.

[3] Yardley, Lucy, and Helen Smith. "A Prospective Study of the Relationship Between Feared Consequences of Falling and Avoidance of Activity in Community-Living Older People." Gerontologist (2002) .

[4] Bueno-Cavanillas, A., F. Padilla-Ruiz, J. J. Jiménez-Moleón, C. A. Peinado-Alonso, and R. Gálvez-Vargas. "Risk Factors in Falls Among the Elderly According to Extrinsic and Intrinsic Precipitating Causes." European Journal of Epidemiology, 2000. doi:10.1023/A:1007636531965.

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[7] Bourke, A. K., J. V. O'Brien, and G. M. Lyons. "Evaluation of a threshold-based tri-axial accelerometer fall detection algorithm." Gait & Posture (2007): doi:10.1016/j.gaitpost.2006.09.012

APPENDIX

ARDUINO CODE:

```
#include<Wire.h>
const int MPU_addr=0x68;  // I2C address of the accelerometer
int16_t AcX,AcY,AcZ,Tmp,GyX,GyY,GyZ;
float ax=0, ay=0, az=0, gx=0, gy=0, gz=0;

//int data[STORE_SIZE][5]; //array for saving past data
//byte currentIndex=0; //stores current data array index (0-255)
boolean fall = false; //stores if a fall has occurred
boolean trigger1=false; //stores if first trigger (lower threshold) has occurred
boolean trigger2=false; //stores if second trigger (upper threshold) has occurred
boolean trigger3=false; //stores if third trigger (orientation change) has occurred

byte trigger1count=0; //stores the counts past since trigger 1 was set true
byte trigger2count=0; //stores the counts past since trigger 2 was set true
byte trigger3count=0; //stores the counts past since trigger 3 was set true
int angleChange=0;


void setup(){
  Wire.begin();
  Wire.beginTransmission(MPU_addr);
  Wire.write(0x6B);  // PWR_MGMT_1 register
  Wire.write(0);     // set to zero (wakes up the accelerometer)
  Wire.endTransmission(true);
  Serial.begin(9600);

  pinMode(11, OUTPUT);
  digitalWrite(11, HIGH);
}
void loop(){
```

```
  mpu_read();
  //2050, 77, 1947 are values for calibration of accelerometer
  ax = (AcX-2050)/16384.00;
  ay = (AcY-77)/16384.00;
  az = (AcZ-1947)/16384.00;

  //270, 351, 136 for gyroscope
  gx = (GyX+270)/131.07;
  gy = (GyY-351)/131.07;
  gz = (GyZ+136)/131.07;
  // calculating Amplitute Factor for 3 axis
  float Raw_AM = pow(pow(ax,2)+pow(ay,2)+pow(az,2),0.5);
  int AM = Raw_AM * 10;  // as values are within 0 to 1, I multiplied
                  // it by for using if else conditions

  Serial.println(AM);
 //Serial.println(PM);
  //delay(500);
  if (trigger3==true){
    trigger3count++;
    //Serial.println(trigger3count);
    if (trigger3count>=10){
      angleChange = pow(pow(gx,2)+pow(gy,2)+pow(gz,2),0.5);
      //delay(10);
      Serial.println(angleChange);
      if ((angleChange>=0) && (angleChange<=10)){ //if orientation changes
remains between 0-10 degrees
          fall=true; trigger3=false; trigger3count=0;
          Serial.println(angleChange);
            }
       else{ //user regained normal orientation
         trigger3=false; trigger3count=0;
         Serial.println("TRIGGER 3 DEACTIVATED");
       }
```

```
}
  }
 if (fall==true){ //in event of a fall detection
   Serial.println("FALL DETECTED");
Serial.print("AT");
   Serial.write(0X0D);
   Serial.write(0X0A);
   delay(500)
    Serial.print("AT+CMGF=1");
    Serial.write(0X0D);
    Serial.write(0X0A);
     delay(500);
     Serial.print("AT+CSCS=\"");
     Serial.print("GSM");
     Serial.println("\"");
    Serial.write(0X0D);
   Serial.write(0X0A);
       delay(500);
  Serial.print("AT+CMGS=\"");
  Serial.print("9944828266");              ///9944828266 caretaker's contact no.
  Serial.println("\"");
  Serial.write(0X0D);
  Serial.write(0X0A);
  delay(500);
      Serial.print("PATIENT FALL  ");
      Serial.print("PULSE RATE:");
      Serial.print(hb);
      Serial.print("Latitude:");
      Serial.print(n);
      Serial.print("Longitude:");
```

```
      Serial.print(m);
     Serial.write(0X0A);
     delay(500);
    Serial.write(0x1A);
   Serial.write(0X0A);
   delay(5000);
     Serial.write(0X0D);
     Serial.write(0X0A);
  digitalWrite(11, LOW);
  delay(20);
  digitalWrite(11, HIGH);
  fall=false;
 // exit(1);
  }
 if (trigger2count>=6){ //allow 0.5s for orientation change
  trigger2=false; trigger2count=0;
  Serial.println("TRIGGER 2 DECACTIVATED");
  }
 if (trigger1count>=6){ //allow 0.5s for AM to break upper threshold
  trigger1=false; trigger1count=0;
  Serial.println("TRIGGER 1 DECACTIVATED");
  }
 if (trigger2==true){
  trigger2count++;
//angleChange=acos(((double)x*(double)bx+(double)y*(double)by+(double)z*(d
ouble)bz)/(double)AM/(double)BM);
  angleChange = pow(pow(gx,2)+pow(gy,2)+pow(gz,2),0.5);
Serial.println(angleChange);
  if (angleChange>=30 && angleChange<=400){ //if orientation changes by
between 80-100 degrees
    trigger3=true; trigger2=false; trigger2count=0;
    Serial.println(angleChange);
    Serial.println("TRIGGER 3 ACTIVATED");
```

```
      }
    }
  if (trigger1==true){
    trigger1count++;
    if (AM>=12){ //if AM breaks upper threshold (3g)
      trigger2=true;
      Serial.println("TRIGGER 2 ACTIVATED");
      trigger1=false; trigger1count=0;
      }
    }
  if (AM<=2 && trigger2==false){ //if AM breaks lower threshold (0.4g)
    trigger1=true;
    Serial.println("TRIGGER 1 ACTIVATED");
    }
//It appears that delay is needed in order not to clog the port
  delay(100);
}
void mpu_read(){
  Wire.beginTransmission(MPU_addr);
  Wire.write(0x3B);  // starting with register 0x3B (ACCEL_XOUT_H)
  Wire.endTransmission(false);
  Wire.requestFrom(MPU_addr,14,true);  // request a total of 14 registers
  AcX=Wire.read()<<8|Wire.read();
  AcY=Wire.read()<<8|Wire.read();
  AcZ=Wire.read()<<8|Wire.read();
  Tmp=Wire.read()<<8|Wire.read();
  GyX=Wire.read()<<8|Wire.read();
  GyY=Wire.read()<<8|Wire.read();
  GyZ=Wire.read()<<8|Wire.read();
}
```

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