EPILEPSY PATIENT FALL DETECTION SYSTEM AND ITS ANALYSIS USING DATA SCIENCE

The Project submitted to

Sant Gadgebaba Amravati University, Amravati

Towards partial fulfilment of the Degree of

Bachelor of Engineering

In

Information Technology

Guided by
Prof. S D Padiya

Submitted by
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DEPARTMENT OF INFORMATION TECHNOLOGY
SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING, SHEGAON (M.S.)

2022- 2023

SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING, SHEGAON

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2022-2023

CERTIFICATE

This is to certify that **Ms. Gauri Sawarkar, Ms. Maithali Kulkarni, Ms. Sayali Marathe, Ms. Anuja Thakre** students of final year B.E. (Information Technology) in the year 2022-2023 of the Information Technology Department of this institute have completed the project work entitled "**Epilepsy Patient Fall Detection System and Its Analysis Using Data Science**" based on syllabus and has submitted a satisfactory account of his/her work in this report which is recommended for the partial fulfilment of the degree of Bachelor of Engineering in Information Technology.

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SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING, SHEGAON

2022-2023

CERTIFICATE

This is to certify that the project work entitled "**Epilepsy Patient Fall Detection System and Its Analysis Using Data Science**" submitted by **Ms. Gauri Sawarkar, Ms. Maithali Kulkarni, Ms. Sayali Marathe, Ms. Anuja Thakre** students of final year B.E. (Information Technology) in the year 2022-2023 of the Information Technology Department of this institute, is a satisfactory account of his work based on the syllabus which is approved for the award of the degree of Bachelor of Engineering in Information Technology.

Internal Examiner

Date:

External Examiner

Date:

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ABSTRACT

There are many health issues today, but the most common and frequent is falling. There is no effective epilepsy patient fall detection system to aware the nearby people and relatives. There is also not any system for the analysis of patient falls as per the various parameters of the doctor. Epilepsy is a neurological disorder marked by the sudden loss of consciousness. To overcome this, we are proposing an “Epilepsy Patient Fall Detection System and its Analysis using Data Science”. For the development of the above-said fall detection system, an accelerometer and gyroscope will be used to detect the human body position across the coordinates (x, y and z) and the body tilt angle of the faller.

The effective epilepsy patient fall detection system will aware nearby people by a sound alert and relatives by a notification on mobile phones. Here, we are proposing data analysis of patient fall as per the various parameters by using data science.

Keywords - Accelerometer, Arduino Nano 33 BLE, Fall Detection, Analysis.

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1. INTRODUCTION

1.1 Preface

The project "Epilepsy Patient Fall Detection System and Its Analysis using Data Science" is mainly for epilepsy patients to reach help faster. The main aim of this project is to help elder people or any person suffering from epilepsy by providing them with attention and help as faster as possible. It is an Android app where a user can set the emergency contact number to whom the alert message would be sent along with his live location. Location helps his relative to reach out faster as compared to just an alert message. Also, an analysis of the patient is provided so that the doctor may analyze how frequently the patient falls and at what particular time the fall has occurred.

Here the user needs to wear a device over his/her body comprised of an Arduino Nano 33 BLE kit and an adapter to provide a power supply to it. This kit has an inbuilt accelerometer which helps in continuous monitoring of the body movements of the user. By this accelerometer readings the fall is detected using the threshold value.

The android app when opened initially the user have two options that is to set emergency contact by selecting this user can set the contact number and another option is fall history where the user will able to view his fall history. Also, here user has one more option to clear history which will clear the fall history till that time. And again, starts showing new fall history when ever occurs.

1.2 Problem Statements

After analyzing many existing systems, we observed many problems to be addressed as follows:

1. Currently there is no effective epilepsy patient fall detection system to aware the nearby people and relatives.
2. There is also not any system for the analysis of patient fall as per the various parameters for the doctor.

1.3 Objectives of Project

The objective of this project is to develop an android app for epileptic patients in order to help them and their relatives reach help faster. So main objective of this project is as follows:

1. To effectively detect the fall of Epilepsy patients to be aware of nearby peopleaby a sound alert and relatives by a notification on mobile phones.
2. To the doctor for treating the patient based on the patient body movement history and its analysis.

1.4 Scope and Limitations of the Project

1.4.1 Scope:

"Epilepsy Patient Fall Detection System and its Analysis Using Data Science" is targeted to each of the individuals who have problems of epilepsy or the elder. So, this can be the project which helps people worldwide.

1. Patients need not do anything for asking help the alert message is sent automatically.
2. Nearby people are also made aware by alert sounds for help.
3. Analysis in the form of fall history is provided.
4. User-friendly application.

1.4.2 Limitations:

This application has some limitations as follows:

1. The device should always be mounted on the body of the user.
2. The device and mobile are connected via Bluetooth so it has very limited area coverage so the mobile and the device must always be kept within the defined Bluetooth coverage.
3. It is not suitable in conditions where mobile generally does not have a network.

1.5 Organization of the Project

The project is organized as follows:

1. Chapter 1 gives Introduction about the project.
2. Chapter 2 gives Literature survey of the project.
3. Chapter 3 provides analysis of project.
4. Chapter 4 provides design phase of project.
5. Chapter 5 provides how project is implemented.
6. Chapter 6 gives conclusion with future scope of the project.

2. LITERATURE SURVEY

There are many health issues in today's time but the most common and frequent is falling. Each year an estimated 6,84,000 individuals die from falls globally of which over 80% are in low and middle-income countries. Epilepsy is mainly caused due to a sudden increase or decrease in heart rate, dizziness, light-headedness, blurred or double vision, and foot pain.

Epilepsy is the second most common and frequently encountered neurological condition that imposes a heavy burden on individuals, families, and also on healthcare systems.

As per a recent study, 70 million people have epilepsy worldwide and nearly 90% of them are found in developing regions.

The study also estimated a median prevalence of 1.54% (0.48-4.96%) for rural and 1.03% (0.28-3.8%) for urban studies in developing countries.

There are more than 12 million persons with epilepsy (PWE) in India, which contributes to nearly one-sixth of the global burden.

There are more than 12 million persons with epilepsy (PWE) in India, which contributes to nearly one-sixth of the global burden.

Patients with newly diagnosed epilepsy who require treatment can be started on standard, first-line AEDs such as carbamazepine, phenytoin, valproic acid, or phenobarbital.

An AED, or automated external defibrillator, is used to help those experiencing sudden cardiac arrest. It's a sophisticated, yet easy-to-use, medical device that can analyze the heart's rhythm.

Between 70% and 80% of individuals are successfully treated with one of the AEDs.

Approximately 30% of people over 65 years of age living in the community fall each year.

Between 5% and 10% of all falls result in a fracture, and up to 90% of all fractures are caused by a fall.

Falls are also the cause of other adverse events, such as long lies with the inability to recover.

Paper 01:

Gulhane, Vijay & Padiya, Sagar. (2022). Eddystone-UID Frame with Data Confidentiality and Integrity for Secured Data Broadcasting by BLE Beacons. 10.21203/rs.3.rs-2095668/v1.

Description:

Beacons are small-sized embedded devices that periodically broadcasts radio frequency (RF) signals without establishing a connection so that any other Bluetooth-equipped device/s in the range can receive the broadcasted data, but some applications desired that data should be observed only by an authenticated receiver. The beacon specification does not have any authentication mechanism, anyone can observe broadcasted information. Beacon has very limited security provisions, as any observer can receive the signal and also easily get the message. This research defined an extension of Google Eddystone-UID for secured data broadcasting without affecting regular operations. The proposed "Extended Eddystone-UID Frame" assures secured broadcasting by performing data cryptography and data integrity. The experiment concluded that the proposed frame does not add any extra bytes, therefore, it does not require any more time and energy, and it is capable to broadcast data securely at the same time and energy as the standard protocol required.

Findings:

This paper presents an extension for Eddystone-UID Frame for secure data broadcasting in the IoT applications which assured the secured broadcasting by BLE Beacon after performing the data cryptography and data integrity methodologies. The proposed frame has a provision to perform encryption of Namespace ID and Instance ID, and also to calculate the hash value based on the Namespace ID and Instance ID. The frame has a provision to include encrypted Namespace ID and x = 10log10 P 1mW ∴ P = 1mW · 10 x 10 Page 15/20 Instance ID (16 bytes), Secrete keys (1 byte) and Hash Value (1 byte). The extended frame has been embedded into the RFU (2 bytes) of an existing Eddystone-URL frame. From the experiment, it is concluded that it does not add any extra bytes for the broadcasting of security keys and hash value, therefore, it

does not require any extra time and power, it is capable to broadcast data securely at the same time and power as the standard protocol required.

Paper 02:

Abdullah, Chowdhury Sayef & Kawser, Masud & Opu, Md & Faruk, Tasnuva & Islam, Md. Kafiul. (2020). IEEE WIECON ECE Presentation on "Human Fall Detection using Built-in Smartphone Accelerometer". 10.13140/RG.2.2.19713.89440.

Description:

Falls represent a significant threat to elderly health and life, especially for those suffering from chronic diseases, e.g. Parkinson's disease or Epilepsy or Dementia. Timely and accurate fall detection can reduce injuries and avoid loss of precious life. Mobile App based health monitoring and event detection utilizing built-in Smartphone sensors has recently become very popular.

Falls are a serious health hazard issue among aged people around the world. It's a common accident for the elderly people living alone. They do a lot of daily activities like sitting, walking, standing, lying, and running. These were collected through accelerometer data. An app was used called Physics Toolbox Sensor Suite to take the data values which consist of an f accelerometer.

Using the Neural Net Pattern Recognition app leads us to solve data classification problem using two-layer feed forward network. Using their data, they trained, validated, and test the data through Neural Network Pattern Recognition, and achieved their classification accuracy to 90.6%. Using 67 data consisting of 26 falls and 41 non-falls. Basically, they classified and predict the data's through offline activity recognition. Once the falling victim is detected his positions along its locations will be tracked. And instantly will send an alert to the caregivers for immediate assistance.

Findings:

In order to reduce injuries and loss of life, accurate fall detection is required. Built-in accelerometer senor (Smartphone) was used for tri-axial data collection. Physics toolbox app was used to collect tri-axial data in .csv format 67 Events related to fall and

non-fall were performed 4 Features used: min, max, mean and variance. Target file consists of 01 as fall and 10 as non-fall class. Overall accuracy is 92.3%.

Paper 03:

A. Gupta, R. Srivastava, H. Gupta and B. Kumar, "IoT Based Fall Detection Monitoring and Alarm System For Elderly," 2020 IEEE 7th Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON), Prayagraj, India, 2020, pp. 1-5, DOI: 10.1109/UPCON50219.2020.9376569.

Description:

This paper presents an IOT based fall detection monitoring and alarm system for the elderly using 3-axis Accelerometer. In elderly, injuries induced by fall, becomes fatal sometimes, if timely medical interventions do not take place. Therefore, they aim to design a system to detect the fall and alert the medical experts about the incidents of distress. In the proposed system for the detection of falling, the elderly patient's acceleration data are continuously acquired by using a wearable sensor and stored on a cloud server, using an IoT board. To access the stored data, an android application is designed for the medical expert to examine the fall in the elderly patient and provide the desired assistance, if needed. A threshold-based approach for the fall detection has been used to get the sensor data and set the threshold on accelerometer readings. A complete algorithm has been designed for the detection of genuine falls.

Findings:

This paper presented the development of a fall detection monitoring and alarm system for the elderly using a 3-axis accelerometer and gyro sensor with Raspberry PI. For the elderly, an android application was developed as a mobile platform for fall detection. Data transmission on the cloud server was performed using AppSheet. These readings can be accessed by any medical expert who has the particular Uniform Resource Locator (URL). The proposed system is used to continually monitor and relay the activities of the individual elderly patient. The cloud-based system continually transmitted the sensor's data via a wireless network. This ensures seamless connectivity

between the patient, doctor and relatives. In the future, by using machine learning and EEG data analysis, falls in the elderly can be prevented at early stages.

Paper 04:

S. S. Fakhrulddin, S. Kamel Gharghan and S. L. Zubaidi, "Accurate Fall Localization for Patient based on GPS and Accelerometer Sensor in Outside the House," 2020 13th International Conference on Developments in eSystems Engineering (DeSE), Liverpool, United Kingdom, 2020, pp. 432-436, DOI: 10.1109/DeSE51703.2020. 9450240.

Description:

Falling of the elderly patients was increased every year and can cause head injury or broken bones. The elderly cannot move or make calls to the medical emergency center by himself after fall, which leads to increase danger of fall injuries. This paper aimed to design and implemented a wearable fall detection system (FDs) which is used for detecting the falling for the elderly and helps them after a fall by making automatic communication between them and caregivers. A proposed system which includes the Bio-sensor, localization module based on GPS, controller unit, and GSM unit will alert the caregivers by sending messages contained his/her health status and geolocation (latitude and longitude coordinates) immediately when he or she passes a selected threshold of falling. The proposed system was validated by using statistical analysis based on mean absolute error. The fall detection system appeared the ability to distinguish between fall and normal daily activities of the elderly with an accuracy of 99.2% based on the proposed algorithm which compared acceleration magnitude and fall threshold values, called the FDB-FTAM algorithm. The result showed, the proposed system was satisfactory performance and more accurate when get the patient location with 1.938×10-5 o, and 1.327×10-5 o of mean absolute error for latitude and longitude information respectively.

The main purpose of the fall detection system (FDs) proposed was to decrease the size, and able wearable it on the upper arm of the body without any effect to the normal activities of the body during daily life's; this means it needs specific electronic

components for designed the prototype of FDs which have some special properties such as lightweight, advanced communication technology, and high accuracy of measurements. It was consisting of a micro-controller, GSM and GPS units, accelerometer (ACCs) sensor, heartbeat (HBS) sensor, and DC power source by using two Lithium-ion battery (3.7V/8400mAh).

Findings:

The proposed FDs was practically design and implemented with small size and more comfortable when using for patient fall detection. Tri-axial ACC (ADXL345) sensor was adopted to interface with microcontroller board based on ATmega 328P. The proposed FDB-FTAM algorithm was achieved 99.2% fall detection accuracy, whereas it performs sensitivity of 98.93% and specificity of 99.3%. The mean absolute error of geolocation of the proposed system was developed to 1.327×10-5 o and 1.938×10- 5 o for longitude and latitude, respectively. The proposed FDs provides good results and can be used for remotely monitoring the vital signs of the elderly such as acceleration, HR, and detection of falling in real-time. In addition, FDs can take decision when the body falls and checking the heartbeat it is normal or not. The future effort will highlight the optimizing of the FDs, using the latitude and longitude obtained from this study, and try to convey the first aid equipment to the location of the patient's fall based on the drone itself without human intervention.

Paper 05:

G. -M. Sung, H. -K. Wang and W. -T. Su, "Smart Home Care System with Fall Detection Based on the Android Platform," 2020 IEEE International Conference on Systems, Man, and Cybernetics (SMC), Toronto, ON, Canada, 2020, pp. 3886-3890, DOI: 10.1109/SMC42975.2020.9283415.

Description:

In this paper, the authors propose a smart homecare system built on an Android smartphone. The database and application programming interface (API) are set up on the server side. The database collects information from various sensors and stores it,

and the API acts as a bridge between the mobile phone and the database. The API prevents the leakage of private data. In the associated Android smartphone app, two functions are provided: instant monitoring based on inhome sensor data and fall detection using the three-axis accelerometer, gyroscope, and orientation sensor inbuilt into the smartphone. When the sensor data are abnormal, the remote controller is notified immediately. Moreover, the remote controller can view real-time images by using an IP camera to guarantee home safety. As for fall detection, given that falls cause severe injuries in elder people and children, the proposed app can detect a fall event, send a help message, and indicate the user's location by using the global positioning system and Google Maps API. According to the simulation results obtained in this study, the proposed system exhibited a fall-detection sensitivity of 92.5% and specificity of 97.6%, thus proving that the system can be effectively used for home care. An SOS function has been designed for the elderly or those with special conditions. This feature includes the options to place emergency calls and the user's medical care settings. The medical card records the user's name, contact number, emergency contact number, and medical history. The user is required to input the contents of the medical card in advance and store it in the local database to prevent unauthorized access to the user's basic information in an environment without a network.

Findings:

The authors proposed a smart home care system based on the Android platform and consisting of a smart home system and a fall detection system. Once a system user is connected to the Internet and logged in to the system through the smartphone application, they can use all the designed functions in the application to control the system. The functions developed for the smart home care system include home monitor, IP camera, communication, GPS positioning, SOS, and fall detection. When a fall event occurs, the system can display the exact location of the user in Google Maps and transmit an emergency message to inform family members. The fall detection system itself is based on three sensors available in smartphones, namely a three-axis accelerometer, gyroscope, and azimuth sensor. According to experimental results, the system proposed in this study provided a good sensitivity of 92.5% and significant

specificity of 97.6% at the threshold SVM of acceleration of 20 m/s2 , threshold SVM of angular velocity of 10 m/s, and threshold SVM of angle of 50°, thus outperforming the existing fall detection systems

Paper 06:

K. Kim, G. Yun, S. -K. Park and D. H. Kim, "Fall Detection for the Elderly Based on 3-Axis Accelerometer and Depth Sensor Fusion with Random Forest Classifier," 2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Berlin, Germany, 2019, pp. 4611-4614, DOI: 10.1109/ EMBC.2019.8856698.

Description:

In this paper, authors propose a new fall detection method that combines 3-axis accelerometer and depth sensors. By combining vision and acceleration-derived features they managed to minimize the false detection rate that is considerably higher when the decision is based on just one type of feature. Also, using machine learning has led to good generalization performance. In addition, they newly created fall database that are more realistic than previous ones. Experiment results show that the proposed method can efficiently detect falls.

There has been increasing interest in automatic detection of emergency situations for the elderly such as fall and slip accidents, since it can be closely related to their lives. According to the Center for Disease Control and Prevention (CDC) in the U.S., deaths from unintentional injuries are the seventh leading cause of death among older adults, and falls account for the largest percentage of those deaths. Also, falls are the leading cause of fatal and nonfatal injuries among adults aged ≥ 65 years. For elderly people living alone, therefore, it is very important to detect falls and let their family know it when it occurs through sending messages to their mobile devices, etc. so that they can get help at the right time.

In this paper, they propose a real-time fall detection technology to be used in a robotic system designed to care for the elderly people. The proposed method consists of feature extraction part and classification part. By combining two other types of sensors, they

deal with the previously existing problems. The proposed classification model shows good generalization performance, and can be applied to low performance systems. The rest of the paper is organized as follows.

Findings:

Authors have proposed a new fall detection method that combines 3-axis accelerometer and depth sensors. By combining vision with acceleration data, they improved the false detection problems when the accelerometer is only used and missing problem occurred when the vision sensor is only used. They have shown that the proposed method can efficiently detect falls. Finding the more optimal feature combinations will be one of their future works.

Paper 07:

T. Padma and C. U. Kumari, "Sudden Fall Detection and Protection for Epileptic Seizures," International Conference on Recent Innovations in Electrical, Electronics & Communication Engineering (ICRIEECE), Bhubaneswar, India, 2018, pp. 2334-2336, DOI: 10.1109/ICRIEECE44171.2018.9009317

Description:

An Epileptic Seizure is a sudden and uncontrolled symptom originated in brain. They could be due to abnormal electrical activity start in brain for very brief period and also recurring seizures due to a brain disorder. Therefore during the event there is an effect due to bumps, cuts /bruises are commonly observed occurrences. The effect of injuries is seriously caused due to falling and losing alertness or realization during or after a seizure, for instance a broken bone or injury. This project used an Arduino based airbag protection system for the people suffering from seizures by using an accelerometer, which will detect the fall of the person and triggers the airbag. A push pull solenoid is used to puncture a canister that is present in the airbag. A relay is used to operate the solenoid. When the fall is detected, the Arduino will trigger the airbag.

Electro Cardio Gram (ECG) is measurement of the heart's electrical activity and it's based on WHO (world health organization) survey, the Epilepsy seizure is an ailment

that affects approximately 0.6-0.8 % of the world population, interpreting as the most common neurological disorder. During these sessions, they might fall and they leads to fracture or ligament injuries, or death as shown in Figure1. Moreover these injuries due to fall have severe effects were unable to help themselves. Average, they may laid down helplessly more than 10 minutes after a fall, more than 2 % of non-injured fall may be waiting for more than an hour to get help from others. This leads to hospitalization and a high morbidity mortality rate. The project is designed by a hardware electronic part a compact and wearable system using a microcontroller -Arduino Uno it is well-known for its open-source software platform and ability to create interactive electronic objects efficiently via GPS.

Findings:

This paper has introduced an efficient method to find unrestorable cut sets exhaustively. Although unrestorable cut sets have not gathered much attention in the research community, it is a crucial tool with which to guarantee the restorability of distribution networks. Finding all unrestorable cut sets is a computationally tough problem, but they tackled it with efficient algorithms based on hitting sets and ZDDs; the proposed method first selected a small number of suspicious cut sets from the many ones possible by using hitting sets, and performed feasibility tests against the selected cut sets with ZDD algorithms without complex power flow calculation. Experiments showed the proposed method reduced the number of tests by five orders of magnitude (relative to the naive approach) with no significant false negatives. Each test was executed in just a few seconds in the proposed method. In future work, they will develop an efficient scheme that prevents many unrestorable cut sets by reinforcing a small number of line sections, as discussed in Section IV. They also will consider the significance of each unrestorable cut set; e.g., the number of intact sections that cannot be restored under the cut sets.

Paper 08:

Silvia Deandrea [1], Ersilia Lucenteforte, Francesca Bravi, Roberto Foschi, Carlo La Vecchia, Eva Negri "Risk factors for falls in community-dwelling older people", Lippincott Williams and Wilkins, vol. 21, No.5, September 2010, DOI: 10.1097/EDE. 0b013e3181e89905

Description:

Falls are the main cause of accidental death in persons aged 65 years or older. A total of 74 studies met the inclusion criteria and 31 risk factors were considered, including sociodemographic, mobility, sensory, psychologic, and medical factors and medication use. The strongest associations were found for a history of falls (OR = 2.8 for all fallers; OR = 3.5 for recurrent fallers), gait problems (OR = 2.1; 2.2), walking aids use (OR = 2.2; 3.1), vertigo (OR = 1.8; 2.3), Parkinson disease (OR = 2.7; 2.8), and antiepileptic drug use (OR = 1.9; 2.7). For most other factors, the ORs were moderately above 1. ORs were generally higher for recurrent fallers than for all fallers. For some factors, there was substantial heterogeneity among studies. For some important factors (eg, balance and muscle weakness), they did not compute a summary estimate because the measures used in various studies were not comparable.

In 2003, the National Institute of Clinical Excellence9 provided guidelines for the prevention of falls in older persons. These guidelines included a systematic review of prospective cohort studies published from 1998 through 2002. The mean odds ratio (OR) and relative risk (RR) for 16 risk factors extracted from 28 studies were computed. Factors predictive of falling for community-dwelling older people included a history of falling, gait deficit, balance deficit, mobility impairment, fear of falling, visual impairment, cognitive impairment, urinary incontinence, and home hazards.

Findings:

This meta-analysis provides a comprehensive evidence-based assessment of risk factors for falls in older people, confirming their multifactorial aetiology. Some nonspecific indicators of high baseline risk were also strong predictors of the risk of falling.

Paper 09:

G Peeters, Natasja M van Schoor, Paul Lips "Fall risk: the clinical relevance of falls and how to integrate fall risk with fracture risk", Best Practice Res Clin Rheumatol 2009 Dec 23, DOI: 10.1016/j.berh.2009.09.004

Description:

In old age, 5% - 10% of all falls result in a fracture, and up to 90% of all fractures result from a fall. This article describes the link between fall risk and fracture risk in community-dwelling older persons. Which factors attribute to both the fall risk and the fracture risk? Which falls result in a fracture? Which tools are available to predict falls and fractures? Directions for the use of prediction tools in clinical practice are given. Challenges for future research include further validation of existing prediction tools and evaluation of the cost-effectiveness of treatment after screening

Findings:

In brief, in old age, 5–10% of all falls result in a fracture, and up to 90% of all fractures result from a fall. In community-dwelling older persons, risk factors for both falling and fractures are age, female gender and chronic diseases. Interestingly, the number of overlapping risk factors is small. Although many fall-prediction tools have been developed, there is no consensus on which fall prediction-tool should be used in clinical practice, and most tools have not been validated. For the prediction of fractures, the FRAX tool has very promising features. It would be interesting to examine whether fracture prediction can be improved by adding risk factors for falls to the FRAX tool. Challenges for future research include further validation of existing prediction tools and evaluation of the cost-effectiveness of a treatment after screening.

Paper 10:

Schwickert, Lars; Klenk, Jochen; Zijlstra, Wiebren; Forst-Gill, Maxim; Sczuka, Kim; Helbostad, Jorunn L.; Chiari, Lorenzo; Aminian, Kamiar; Todd, Chris; Becker, Clemens "Reading from the Black Box: What Sensors Tell Us about Resting and

Recovery after Real-World Falls".2018, Gerontology, 64(1), 90–95, DOI:10.1159/ 000478092

Description:

Laying on the floor for a long time after falls, regardless of whether an injury results, remains an unsolved healthcare problem. In order to develop efficient and acceptable fall detection and reaction approaches, it is relevant to improve the understanding of the circumstances and the characteristics of post-impact responses and the return or failure to return to pre-fall activities. Falls are seldom observed by others; until now, the knowledge about movement kinematics during falls and following impact have been anecdotal. Objective: This study aimed to analyse characteristics of the on-ground and recovery phases after real-world falls. The aim was to compare self-recovered falls (defined as returns to standing from the floor) and non-recovered falls with long lies. Data from subjects in different settings and of different populations with high fall risk were included. Real-world falls collected by inertial sensors worn on the lower back were taken from the FARSEEING database if reliable information was available from fall reports and sensor signals.

Findings:

The findings provide new insight into what happens in the seconds and minutes after a fall impact. Based on this information, it was possible to describe the recovery process as non-recovered, directly self-recovered or self-recovered after a period of resting. The presented findings on the post-impact phase have several implications on falls research. Currently, most studies on fall prevention report falls and injurious falls, but not the frequency of unrecovered falls or the resting duration as an outcome. Adding information on post-impact reactions is important as, for example, long lies might result in negative health outcomes. Reliable indicators for long lying may help to better guide emergency measures.

Paper 11:

Wild, D, Nayak, U.S. Isaacs, B. "How dangerous are falls in old people at home?", Br. Med. J. 1981, 282, 266–268, DOI: 10.1136/bmj.282.6260.266

Description:

From a survey of six general practices information was obtained on 125 people aged 65 and over who fell in their own homes. Three fractured their femurs and 15 had other fractures; most of the rest suffered only trivial injuries. Twenty lay on the floor for more than one hour; none were known to have suffered hypothermia. One-quarter of these patients died within one year of the fall, five times as many as in an age- and sex-matched control group; while of those who lay on the floor for more than one hour, half died within six months of the fall. Factors associated with mortality from falls were impaired mobility, abnormal balance, and a disturbed pattern of gait. Much attention has been paid to fractures of the femur in old age resulting from falls; but most old people who fall. Over at home do not break any bones. Some studies have been made, but little is known about the causes of these falls, what can be done to prevent them, what resources are devoted to those who fall, and what happens to them. In an attempt to find answers to these questions, they organized a survey of falls at home in people aged 65 and over in the Birmingham area. A group of persons reporting falls were matched for age and sex with a control group and both were followed for one year after the fall. Falls at home in old age are often indicative of the presence of severe ill health.

Findings:

Falls in old people at home are not usually due to external hazards but reflect instability associated with impaired general health. No doubt many different physiological mechanisms play a part; and retrospective inquiries some days after the occurrence of the fall cannot be expected to identify these. Little evidence was found, however, to support the statements frequently made that falls in old age are often caused by vertebrobasilar ischemia, cervical spondylitis, and the like. It seems much more common for falls to result from errors in environmental perception, slowing of

responses, and weakness of support; but a great deal more needs to be known about the circumstances of the falls before this assertion can be made with confidence.

Paper 12:

Palmerini, L.; Klenk, J.; Becker, C.; Chiari, L, "Accelerometer-Based Fall Detection Using Machine Learning: Training and Testing on Real World Falls", Sensors 2020 Volume 20 Issue 22, 20, 6479, DOI: 10.3390/s20226479

Description:

Falling is a significant health problem. Fall detection, to alert for medical attention, has been gaining increasing attention. Still, most of the existing studies use falls simulated in a laboratory environment to test the obtained performance. They analyzed the acceleration signals recorded by an inertial sensor on the lower back during 143 real-world falls (the most extensive collection to date) from the FARSEEING repository. Such data were obtained from continuous real-world monitoring of subjects with a moderate-to-high risk of falling. They designed and tested fall detection algorithms using features inspired by a multiphase fall model and a machine learning approach. The obtained results suggest that algorithms can learn effectively from features extracted from a multiphase fall model, consistently overperforming more conventional features. The most promising method (support vector machines and features from the multiphase fall model) obtained a sensitivity higher than 80%, a false alarm rate per hour of 0.56, and an F-measure of 64.6%. The reported results and methodologies represent an advancement of knowledge on real-world fall detection and suggest useful metrics for characterizing fall detection systems for real-world use.

Findings:

In this study, they exploited the unique real-world fall data from the FARSEEING fall repository to train and test machine learning algorithms for fall detection based on acceleration signals recorded by a single wearable sensor. The implemented algorithms learn from features based on a multiphase model over-performed algorithms learning

on conventional features. Finally, they provided and suggested useful metrics for characterizing fall detection systems to deploy in the real world.

Paper 13:

Chokemongkol Nadee and Kosin Chamnongthai, "An Ultrasonic-Based Sensor System for Elderly Fall Monitoring in a Smart Room", J Health Eng. 2022; 2022: 2212020. Published online 2022 Nov 7, DOI: 10.1155/2022/2212020.

Description:

To reduce the risk of elderly people falling in a private room without relying on a closed-circuit television system that results in serious privacy and trust concerns, a fall monitoring system that protects privacy and does not monitor a person's activities is needed. An ultrasonic-based sensor system for elderly fall monitoring in a smart room is proposed in this study. An array of ultrasonic sensors, whose ranges are designed to cover the room space, are initially installed on a wall of the room, and the sensors are rotated to transmit and receive ultrasonic signals to measure the distances to a moving object while preventing ultrasonic signal interference. Distance changes measured by ultrasonic sensors are used as time-independent patterns to recognize when an elderly person falls. To evaluate the performance of the proposed system, a sensor system prototype using long short-term memory was constructed, and experiments with 25 participants were performed. An accuracy of approximately 98% was achieved in this experiment using the proposed method, which was a slight improvement over that of the conventional method.

Findings:

To prevent serious risks to elderly individuals after falling in a room, it is necessary to simultaneously monitor elderly behaviours without intruding on their privacy, detect falls, and immediately inform caregivers, when a fall occurs so they can provide urgent assistance. A design method for an ultrasonic sensor-based system is proposed in this study for elderly fall monitoring in a smart room. In this design, ultrasonic sensors are installed as a sensor array on a wall under the condition that the ultrasonic signal covers

the area of the whole room with a limited blind zone. The blind zone is determined in advance to be smaller than the width of the human, and the determined blind zone and average human fall duration are used to calculate the distance between neighbouring ultrasonic nodes and the total number of ultrasonic nodes on a wall. Then, activated ultrasonic nodes are transmitted in a one-by-one manner without interference in a zigzag scanning line, and the ultrasonic signals, which are time-independent, are classified as a fall or a no fall by a time-independent-based classifier, such as LSTM. The performance of the proposed method is confirmed to be effective.

Paper 14:

Abdull Sukor, Abdul Syafiq & Zakaria, Ammar & Abdul Rahim, Norasmadi, " Activity Recognition using Accelerometer Sensor and Machine Learning Classifiers" 2018 IEEE 14th International Colloquium on Signal Processing & Its Applications (CSPA), DOI: 10.1109/CSPA.2018.8368718.

Description:

Activity recognition is considered an important task in many applications, particularly in healthcare services. Among these applications include medical diagnostic, monitoring of users' daily routine and detection of abnormal cases. This paper presents an approach for the activity recognition using an accelerometer sensor embedded in a smartphone. This approach uses a publicly available accelerometer dataset as the raw input signal. The features of the signal are selected based on the time and frequency domain. Then, Principal Component Analysis (PCA) is used to reduce the dimensionality of the features and extract the most significant ones that can classify human activities. A comparison process is performed between the original raw data and PCA-based features and additionally, time and frequency domain features are also compared using several machine learning classifiers. The obtained results show that the PCA-based features obtain higher recognition rate while frequency-domain features have higher accuracy, with the rate of 96.11% and 92.10% respectively. Activity recognition plays a vital role in healthcare services and has been studied as a part of solutions to reduce the costs and workloads currently being placed on professional

caregivers. The capability of performing activities is usually associated with the physical and mental health of people and can be considered as a primary indicator to determine their quality of life.

Findings:

This paper presents an approach for the recognition of activities of daily living based on a publicly available accelerometer dataset. The dataset uses an accelerometer sensor which has been embedded in a smartphone. A number of features from the time-domain and frequency-domain are extracted from the raw accelerometer signal. PCA is performed on the original features to distinguish low and high variances and reduce the dimensionality of data. This approach is evaluated by comparing the precision, recall, F-score and accuracy of four different types of machine learning classifiers.

Paper 15:

K. N. Lavanya, D. R. Shree, B. R. Nischitha, T. Asha and C. Gururaj, "Gesture controlled robot," 2017 International Conference on Electrical, Electronics, Communication, Computer, and Optimization Techniques (ICEECCOT), Mysuru, India, 2017, pp. 465-469, DOI: 10.1109/ICEECCOT.2017.8284549.

Description:

This project is a real-time monitoring system by which humans interact with robots through gestures. This is an immense aid for people for whom mobility is a great challenge. There is a dire need for a vision-based interface over speech recognition as it failed to mandate the robots because of modulation and varying frequency. Gesture recognition consists of three stages: capturing of image, image processing and data extraction. The implementation is achieved by navigation of the robot through various gestures. By the impact of this project, life of physically challenged people becomes less challenging. From further research it will benefit various areas including applications in military and high security bases.

Findings:

They proposed a more efficient and easy way of controlling a robot. They demonstrate the efficiency of the algorithm on the real time images fed to the system which helps in monitoring the robot .This helps in making the disabled person able in performing their task. It has a large development scope where it can be used in a complex model for any advanced robot in performing more complex tasks. They have used limited number of gesture conditions for movement of robot and this can be further developed by adding more gesture and its corresponding commands for higher level performance of the robot. Due to these development scopes and societal needs this project has a great potential. It can be used by the physically challenged person for DOIng their work and used in movement of the robot wirelessly to perform various industrial tasks. As they know that robots have wide range of applications it can be used in remote places where human cannot go. In future with implementation of certain technology and sensors this can be used for metal detection.

Paper 16:

Tianzhang Xing, Qing Wang, Chase Q. Wu, Wei Xi, and Xiaojiang Chen. 2020. dWatch: A Reliable and LowPower Drowsiness Detection System for Drivers Based on Mobile Devices. ACM Trans. Sen. Netw. 16, 4, Article 37 (September 2020), 22 pages. https://DOI.org/10.1145/3407899

Description:

Drowsiness detection is critical to driver safety, considering thousands of deaths caused by drowsy driving annually. Professional equipment is capable of providing high detection accuracy, but the high cost limits their applications in practice. The use of mobile devices such as smart watches and smart phones holds the promise of providing a more convenient, practical, non-invasive method for drowsiness detection. In this article, they propose a real-time driver drowsiness detection system based on mobile devices, referred to as dWatch, which combines physiological measurements with motion states of a driver to achieve high detection accuracy and low power consumption. Specifically, based on heart rate measurements, they design different

methods for calculating heart rate variability (HRV) and sensing yawn actions, respectively, which are combined with steering wheel motion features extracted from motion sensors for drowsiness detection. They also design a driving posture detection algorithm to control the operation of the heart rate sensor to reduce system power consumption. Extensive experimental results show that the proposed system achieves a detection accuracy up to 97.1% and reduces energy consumption by 33%.

Findings:

This article presents dWatch, a real-time driver drowsiness detection system that combines the physiological performance and motion state of the driver. dWatch extracts HRV features related to drowsiness from heart rate data using statistical methods and detects whether the driver yawns through a heart rate sequence yawn matching model (HYM). Then, the data collected by the motion sensor such as an accelerometer is used to track the movement of the driver's hand, which is further used to infer the movement of the steering wheel of the vehicle. The motion data not only assists in detection, but also acts as a starting mechanism for activating the heart rate sensor; hence reducing the power consumption of the system.

3. ANALYSIS

3.1 Detailed Statement of the Problem

Epilepsy is a neurological disorder marked by sudden loss of consciousness. There are many health issues in today's time but the most common and frequent is falling. Each year an estimated 6,84,000 individuals die from falls globally of which over 80% are in low and middle-income countries. Epilepsy is mainly caused due to a sudden increase or decrease in heart rate, dizziness, light-headedness, blurred or double vision, and foot pain.

As per the above-described problem statement, there is no effective epilepsy patient fall detection system to aware the nearby people and relatives. There is also not any system for the analysis of patient falls as per the various parameters of the doctor. Epilepsy is the second most common and frequently encountered neurological condition that imposes a heavy burden on individuals, families, and on healthcare systems. As per a recent study, 70 million people have epilepsy worldwide and nearly 90% of them are found in developing regions.

The study also estimated a median prevalence of 1.54% (0.48-4.96%) for rural and 1.03% (0.28-3.8%) for urban studies in developing countries. There are more than 12 million persons with epilepsy (PWE) in India, which contributes to nearly one-sixth of the global burden. Consequently, efforts are being made for better understanding of the disease and to organize comprehensive services.

Patients with newly diagnosed epilepsy who require treatment can be started on standard, first-line AEDs such as carbamazepine, phenytoin, valproic acid, or phenobarbital. An AED, or automated external defibrillator, is used to help those experiencing sudden cardiac arrest. It's a sophisticated, yet easy-to-use, medical device that can analyze the heart's rhythm. Between 70% and 80% of individuals are successfully treated with one of the AEDs. Approximately 30% of people over 65 years of age living in the community fall each year. Between 5% and 10% of all falls result in a fracture, and up to 90% of all fractures are caused by a fall. Falls are also the cause of other adverse events, such as long lies with the inability to recover.

3.2 Requirement Specifications

In this section we will look towards the Software and Hardware required for the implementation of the project. We have divided the requirements in two parts Software requirement and Hardware requirement.

3.2.1 Software Requirement

- Operating System
- Android Studio
- Arduino IDE
- Eddystone Protocol

3.2.2 Hardware Requirement

- Laptop/PC
- System: Intel Processor i5/above
- Hard Disk: 500GB
- RAM:4-8GB
- Arduino Nano 33 Ble

3.3 Functional Requirements

Functional requirements are the features or functions of software system to accomplish the tasks. It basically explains how the system must work. They are the statements that describe what a system needs to do in order to provide a capability. A description of each major software function, along with data flow (structured analysis) or class hierarchy (Analysis Class diagram with class description for object-oriented system) is presented.

3.3.1 Data Flow Diagram

Figure 3.1: DFD Level 1

DFD level – 1

Here. Figure 3.1 shows DFD level – 1 indicates the basic flow of data in the system. In this system input is given equal importance as that for output.

• Input:

1. Here input required from the Arduino Nano 33 BLE is continuous accelerometer values according to the patient's movement.
2. User must set a mobile number in the android application.

• System: The system detects the fall is occurred or not.

• Output: After fall occurs it sends the alert message and location through SMS and shows the fall history.

Hence, the data flow diagram indicates the visualization of system with its input and output flow.

DFD Level-2

DFD Level – 2 gives more in and out information of the system. Where system gives detailed information of the procedure taking place as shown in Figure 3.2.

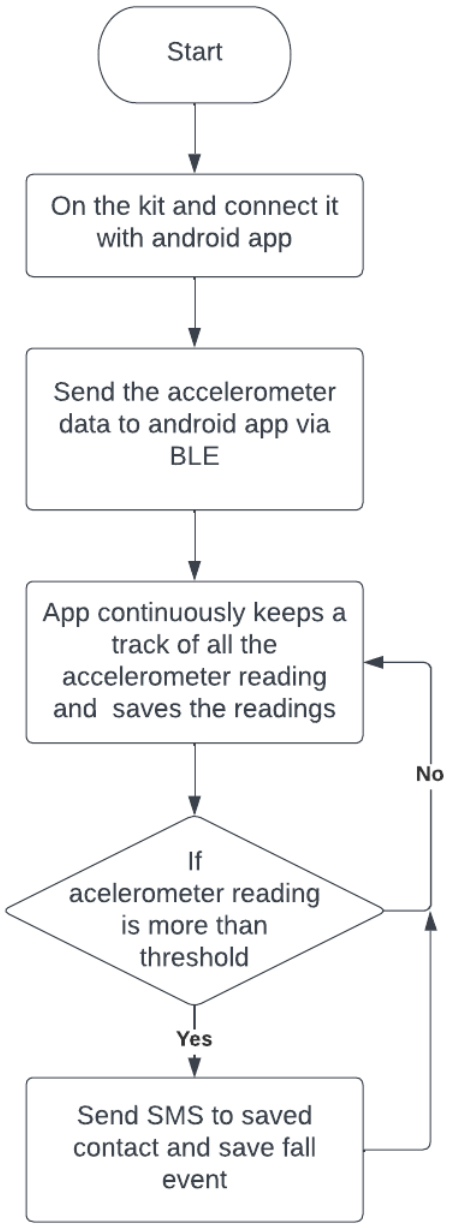


Figure 3.2: DFD Level 2

3.4 Non-Functional Requirement

Non-functional requirements are the software specifications that describe the qualitative aspects of a software. It lists the desired qualitative features of a software or application, which don't fall under the category of any function/use-case. Non-

functional features do not perform any action, instead they help in enhancing the software performance (efficiency).

3.4.1 Supporting Technologies

Implementation should be feasible using technologies that are accessible to the end users.

With the help of embedded C programming language, Arduino ide and java programming language and Android Studio, we developed the fall detection system with android application.

3.4.2 Device Software Compatibility

Minimum requirement of fall detection system for device capability is Android device with android OS and minimum 4GB RAM.

3.4.3 Time Response

Application perform in a proper time constraint that typing speed, motion and obstacles in the internet. Area: Performance Efficiency. Application performance is a response time. In android application, the response time for fall detection is 200ms to 700ms. Response time for saving and retrieving data from database is very low.

3.4.4 Accessibility

The “Fall Detection System” have interactive user interface so that Admin or any new person can easily understand it and able to access the different features of the project.

3.4.5 Maintainability

If some error occurred during execution of system then the system can resolve all error by restarting or debugging of system.

3.4.6 Usability

User has to install the app in their android phone. After installing the application, homepage display. Homepage contain simple module which can access on clicking the buttons. All module are easy to understand and easy to perform many operations.

3.5 Feasibility Study

Feasibility study is an un-biased evaluation of an App idea, conducted for the purpose of determining whether the idea is viable and worth pursuing. The feasibility study is undertaken to determine merits and demerits of each alternative and recommended system that will be most appropriate. All are feasible given unlimited resource and identified infinite, so it is essential to evaluate and estimate the advantage of one system over another.

3.5.1 Market Feasibility

- Assessment of the overall appeal to the market for the Desktop based application.
- Market timeliness: best suitable time for release
- Identification of the target audience
- Comparing with other similar competing applications.
- Past and present supply position.
- Imports and exports
- Structure of competition
- Elasticity of demand
- Administrative, technical and legal constraints
- Cost structure
- Production possibility and constraints
- Consumer behavior, intentions, motivations, attitude, preferences and requirements
- Consumption trends in the past and the present consumption level
- Distributive Channels

3.5.2 Economical Feasibility

- Resource cost is based on the estimated resources within the technical analysis.
- Cost of maintenance of equipment is much less.
- In economic feasibility, we study about cost of developing our system. The software and hardware requirement are at affordable costs. This project is economical feasible.

3.5.3 Product Feasibility

- Considering the major features of the current scope (at a high level) and evaluating if they are feasible.
- New concept: desktop based Application is purely based on new concept
- Low Competition desktop application.
- Product placement
- The Target market
- Marketing and Advertisement
- The Competition
- Pricing strategies

3.5.4 Technical Feasibility

- Experimental features: Identify the features in the design that seem experimental in nature, such as untried or unproven technologies, techniques, perspectives, or other unique ideas.
- Technical feasibility also involves the evaluation of the hardware, software, and other technical requirements of the proposed system.
- To check the selected scale of operation is optimal or not.
- Choose suitable production process.
- Appropriate equipment and machines
- The technology proposed to be employed appropriate from the social point of view
- Provision of auxiliary equipment and supplementary engineering works

- Establishment of the availability of raw material, power, and other inputs
- Provision for the treatment of effluents
- Proper layout of the site, buildings, and plant

3.5.5 Behavioral Feasibility

- Behavioral feasibility refers to the system to see whether the data input is readily available or collectable.
- This project is easily access and for understanding to people.
- System performs all functionality correctly and in a fraction of time.

3.5.6 Operational Feasibility

- Operational feasibility is mainly concerned with issues like whether the system will be used if it is developed and implemented.
- This system interacts with the user and is user-friendly and it will benefit the organization.
- The accessibility of the information will not be lost. User information will be secured and no loss of integrity.

3.6 Use Case Diagrams

The purpose of a use case diagram is to capture the dynamic aspect of a system. Use case diagrams are used to gather the requirements of a system including internal and external influences. These requirements are mostly design requirements. Hence, when a system is analyzed to gather its functionalities, use cases are prepared and actors are identified as shown in Figure 3.3.

In the Unified Modelling Language (UML), a use case diagram can summarize the details of your system's users (also known as actors) and their interactions with the system. To build one, you'll use a set of specialized symbols and connectors. An effective use case diagram can help your team discuss and represent:

- Scenarios in which your system or application interacts with people, organizations, or external systems.

- Goals that your system or application helps those entities (known as actors) achieve.
- The scope of your system.

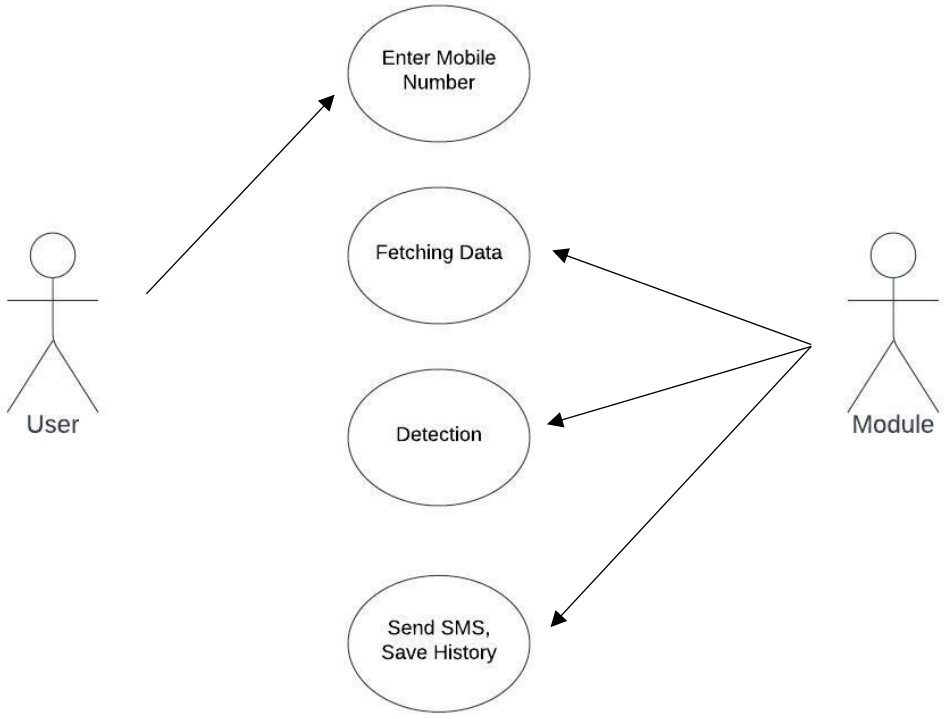


Figure 3.3: Use case View of Epilepsy Patient Fall Detection System

3.7 Use Case Specification

3.7.1 Enter Mobile Number -

In this user have to enter the mobile number upload in the application so that after detection of fall event the SMS is sent to that number only.

3.7.2 Fetching Data –

In this module the data is extracted from the Arduino nano 33 ble for further processing and detecting the fall event. For communication between Arduino and application Eddystone transmitting protocol is used.

3.7.3 Detection -

After getting the data from Arduino the fall is detected if the values goes beyond the threshold and detect whether the fall is occur or not.

3.7.4 Send SMS, Save History -

After detection of the fall event the text message and the user's current location is send to the registered mobile number via SMS. Fall history which itself containing date and time when the event occurred is saved into the memory.

4. DESIGN

4.1 Design Goals

Agile technique of modelling is used for the designing process of the complete application. Agile model believes that every project needs to be handled differently and the existing methods need to be tailored to best suit the project requirements. In Agile, the tasks are divided to time boxes (small time frames) to deliver specific features for a release. Agile methods are being widely accepted in the software world recently. However, this method may not always be suitable for all products. Here are some pros and cons of the agile mode.

The advantages of the Agile Model are as follows -

- A very realistic approach to Software Development.
- Promotes teamwork and cross training.
- Functionality can be developed rapidly and demonstrated.
- Resource requirements are Minimum.
- Suitable for fixed or changing requirements
- Delivers early partial working solutions.
- Good model for environments that change steadily.
- Minimal rules, documentation easily employed.
- Enables concurrent development and delivery within an overall planned context.
- Little or no planning required.
- Easy to manage.
- Gives flexibility to developers.

The complete application has three different design modules which are web application, iOS application and Android application. Web application is designed to ease the use of teacher and administrator

4.2 Design Strategy

Design is a meaningful engineering representation of something that is to be built. It can be traced to a customer's requirements and at the same time assessed for quality against a set of predefined criteria for good design. In the software engineering context, design focuses on four major areas of concern: data, architecture, interfaces, and components. The design process translate requirement into representation of software that can be accessed for a quality before core generation. Design is the process through which requirement are translated to blue print for constructing into software. Initially the blueprint depicts the holistic view of software. This is the design represented at the high level of abstraction. During various stages of system development and design following strategy have been setup for a complete architecture

- Planning
- Analysis
- Design
- Implementation
- Testing
- Deployment

Figure 4.1: SDLC for Epilepsy Patient Fall Detection System

4.3 Module Diagram

Module diagrams are used to show the allocation of classes and objects to modules in the physical design of a system, that is module diagrams indicate the partitioning of the system architecture. Through these diagrams it is possible to understand the general physical architecture of a system. The two essential elements of a module diagram are modules and their dependencies. The first three icons denote files specification and the body icon denote files containing the declaration and definition of entities.

Module diagram defines the logic of the model. The following Figure. 4.2 shows the convolution layers at different stages and how they are concentrated and diverged between different layers.

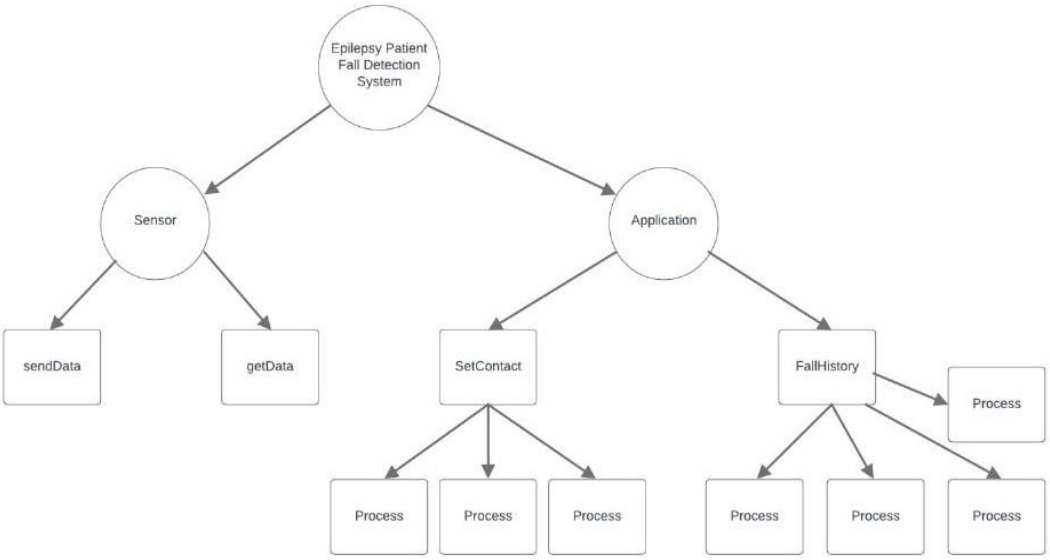


Figure 4.2: Module Diagram for Epilepsy Patient Fall Detection System

4.4 Architecture diagram

Architecture Diagram Definition - On Dragon an Architecture Diagram is: A graphical representation of the concepts, their principles, elements and components that are part of Architecture. Architecture is a coherent set of concepts for a structure these concepts are often visualized at four levels of abstraction. These are

- Conceptual Level-showing an overview of concepts
- Logical Level showing a logical design of one or more concepts, containing at least the key elements of concepts and showing the principles of the concepts (i.e. how the concepts work)
- Physical Level - showing a component design depicting the elements
- Implementation Level - showing the vendors and products with which the components will be implemented.

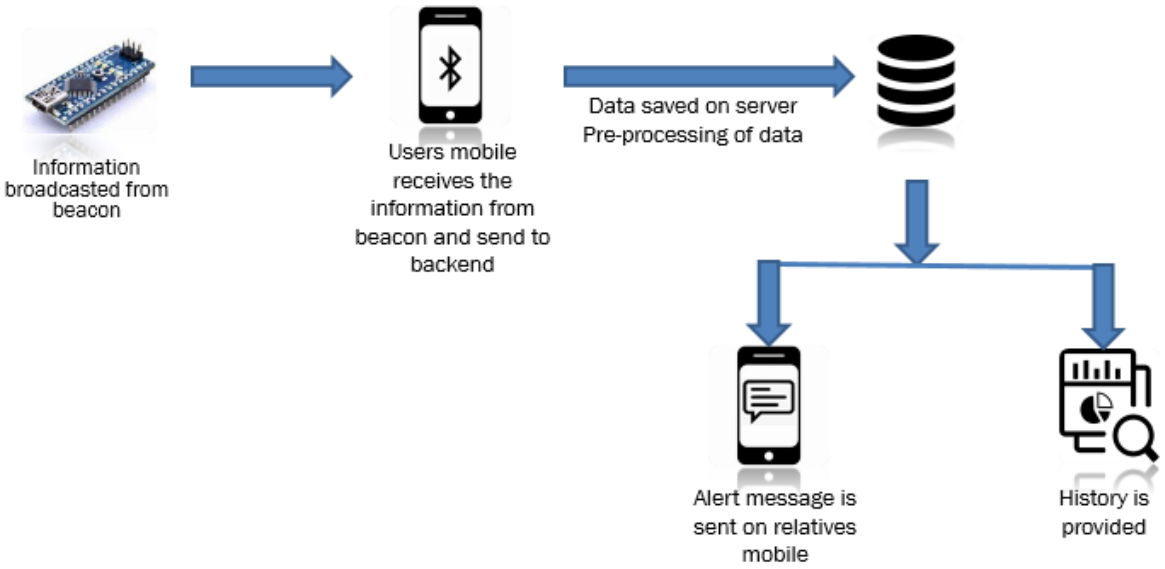


Figure 4.3: Architecture Diagram for Epilepsy Patient Fall Detection System

4.5 Class Diagram

The class diagram is a static diagram. It represents the static view of an application. Class diagram is not only used for visualization describing and documenting different aspects of a system but also for constructing executable code of the software application. The class diagram describes the attributes and operations of the class and also the constrain imposed on the system. The class diagrams are widely used in the modelling of the object oriented system because they are the only UML diagram which can be mapped directly with object oriented languages. UML provides mechanism to represent class members, such as attributes and method and additional information about them.

Purpose of Class Diagrams

The purpose of class diagram is to model the static view of an application. Class diagrams are the only diagrams which can be directly mapped with object-oriented languages and thus widely used at the time of construction.

UML diagrams like activity diagram, sequence diagram can only give the sequence flow of the application, however class diagram is a bit different. It is the most popular UML diagram in the coder community.

The purpose of the class diagram can be summarized as −

- Analysis and design of the static view of an application.
- Describe responsibilities of a system.
- Base for component and deployment diagrams.
- Forward and reverse engineering

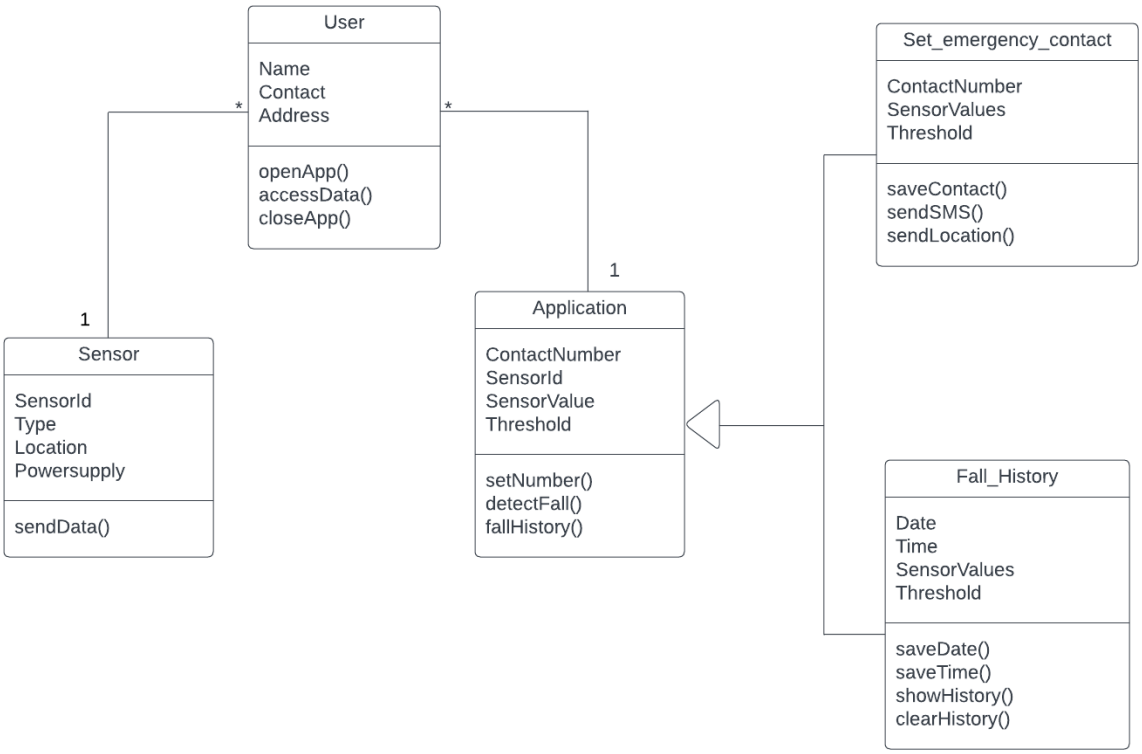


Figure 4.4: Class Diagram for Epilepsy Patient Fall Detection System

4.6 Sequence Diagram

In this sequence diagram, the Epilepsy Patient falls and triggers the Fall Detection System. The system then determines the location of the patient and alerts nearby people and relatives.

The nearby people and relatives confirm the alert and the system checks their status. Finally, the system checks the status of the Epilepsy Patient to ensure they are okay.

Sequence diagrams are a popular dynamic modeling solution in UML because the specifically focus on lifelines, or the processes and objects that live simultaneously, and the messages exchanged between them to perform a function before the lifeline ends. They are the most commonly used Interaction diagrams. The sequence diagram represents the flow of messages in the system and is also termed as an event diagram. It helps in envisioning several dynamic scenarios. It portrays the communication between any two lifelines as a time-ordered sequence of events, such that these lifelines took part at the run time. In UML, the lifeline is represented by a vertical bar, whereas the message flow is represented by a vertical dotted line that extends across the bottom of the page. It incorporates the iterations as well as branching.

Purpose of Sequence Diagrams

- To model high-level interaction among active objects within a system.
- To model interaction among objects inside a collaboration realizing a use case.
- It either models generic interactions or some certain instances of interaction

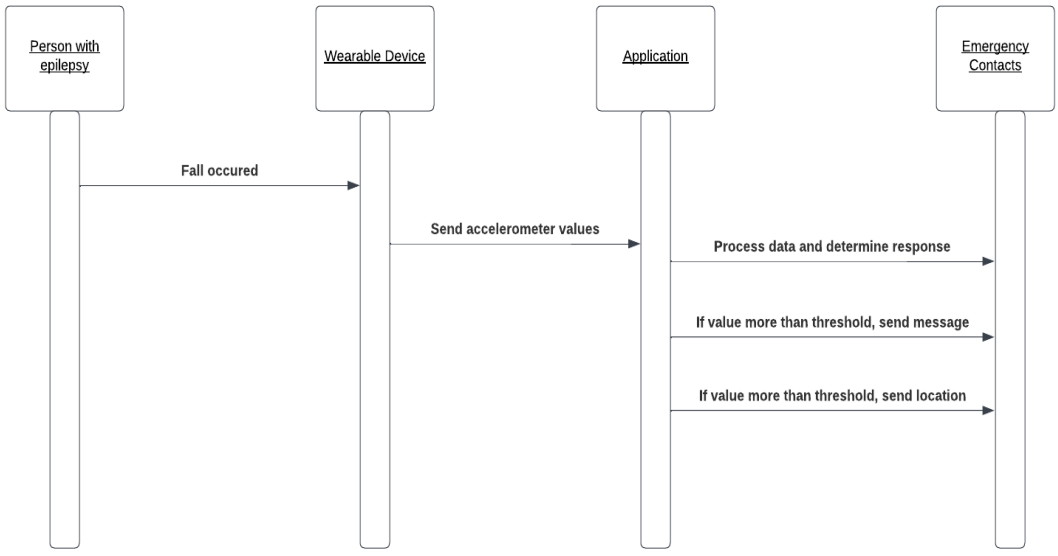


Figure 4.5: Sequence Diagram for Epilepsy Patient Fall Detection System

4.7 Collaboration Diagram

The collaboration diagram shows the interactions between different components of the system. The Monitoring component continuously monitors the user's movements using sensors.

If a fall is detected, the Fall Detection component confirms the fall and sends a signal to the Alerting component. The Alerting component then sends alerts to nearby people and relatives, waiting for an acknowledgment response.

Once an acknowledgment response is received, the Alerting component sends a signal to the Fall Detection component, which then sends a signal to the Monitoring component to stop the alerts. If no acknowledgment response is received, the alerts continue until a timeout is reached.

The collaboration diagram shows that the different components of the system work together to detect a fall, confirm it, and notify nearby people and relatives.

Purpose of Collaboration Diagrams

- The collaboration diagram is also known as Communication Diagram.
- It mainly puts emphasis on the structural aspect of an interaction diagram, i.e., how lifelines are connected.
- The syntax of a collaboration diagram is similar to the sequence diagram; just the difference is that the lifeline does not consist of tails.
- The messages transmitted over sequencing is represented by numbering each individual message.
- The collaboration diagram is semantically weak in comparison to the sequence diagram.
- The special case of a collaboration diagram is the object diagram.
- It focuses on the elements and not the message flow, like sequence diagrams

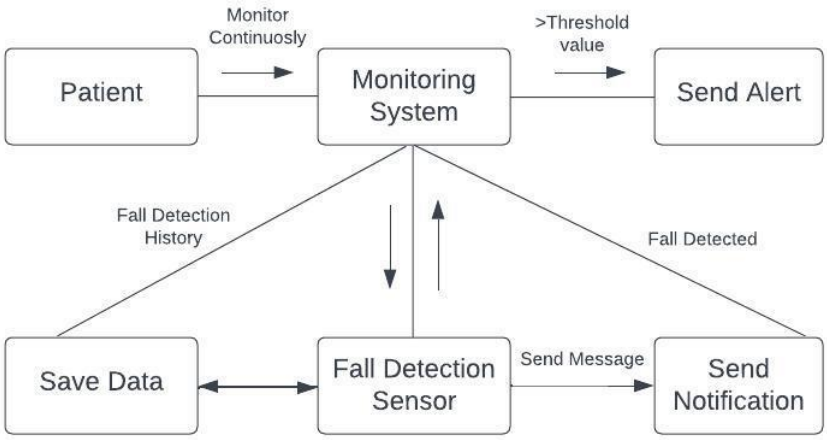


Figure 4.6: Collaboration Diagram for Epilepsy Patient Fall Detection System

4.8 State Chart Diagram

The system starts in the Monitoring state, where it continuously monitors the user's movements using sensors. If a fall is detected, it transitions to the Fall-down Detection state, where it confirms the fall by analyzing the user's movements and posture.

Once the system has confirmed a fall, it transitions to the Alerting state, where it sends alerts to nearby people and relatives to notify them of the fall. The system waits for an Acknowledged Response from any of the notified people. If an acknowledgment is received, it transitions to the Notification Acknowledged state, where it notifies the user that help is on the way.

If no acknowledgment is received, the system continues to send alerts until someone acknowledges the alert or until the system reaches a timeout. Once the system reaches the timeout, it transitions to the idle state, where it waits for the next event to occur. If the user gets up and resumes their normal activity, the system will transition back to the Monitoring state.

Purpose of State Chart Diagrams

State chart diagram is one of the five UML diagrams used to model the dynamic nature of a system. They define different states of an object during its lifetime and these states are changed by events. State chart diagrams are useful to model the reactive systems.

Reactive systems can be defined as a system that responds to external or internal events. State chart diagram describes the flow of control from one state to another state. States are defined as a condition in which an object exists and it changes when some event is triggered. The most important purpose of State chart diagram is to model lifetime of an object from creation to termination.

State chart diagrams are also used for forward and reverse engineering of a system. However, the main purpose is to model the reactive system.

Following are the main purposes of using State chart diagrams –

- To model the dynamic aspect of a system.
- To model the life time of a reactive system.
- To describe different states of an object during its life time.
- Define a state machine to model the states of an object.

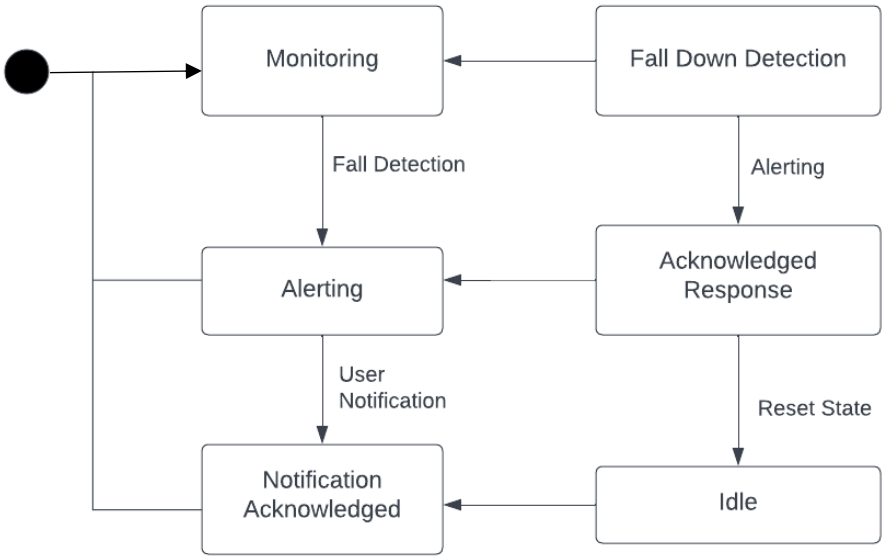


Figure 4.7: State Chart Diagram for Epilepsy Patient Fall Detection System

4.9 Activity Diagram

The activity diagram starts with the Monitoring state, where the system continuously monitors the user's movements. If a fall is detected, the system transitions to the Fall Detected state.

Once a fall is detected, the system transitions to the Alerting state, where it sends alerts to nearby people and relatives to notify them of the fall. The system waits for an acknowledgment response from anyone who received the alert.

If an acknowledgment response is received, the system transitions to the Notification Acknowledged state, where it notifies the user that help is on the way. Once help arrives, the system transitions to the Help Arrives state, where the user receives assistance.

After the user receives assistance, the system transitions back to the Monitoring state to continue monitoring the user's movements. If no acknowledgment response is received, the system continues to send alerts until it reaches a timeout or until someone acknowledges the alert.

Purpose of Activity Diagrams

The basic purpose of activity diagrams is similar to other UML diagrams. It captures the dynamic behavior of the system. Other UML diagrams are used to show the message flow from one object to another but the activity diagram is used to show message flow from one activity to another. Activity is a particular operation of the system.

Activity diagrams are not only used for visualizing the dynamic nature of a system, but they are also used to construct the executable system by using forward and reverse engineering techniques. The only missing thing in the activity diagram is the message part.

It does not show any message flow from one activity to another. Activity diagram is sometimes considered as the flowchart. Although the diagrams look like a flowchart, they are not. It shows different flows such as parallel, branched, concurrent, and single.

The purpose of an activity diagram can be described as:

- Draw the activity flow of a system.
- Describe the sequence from one activity to another.
- Describe the parallel, branched and concurrent flow of the system

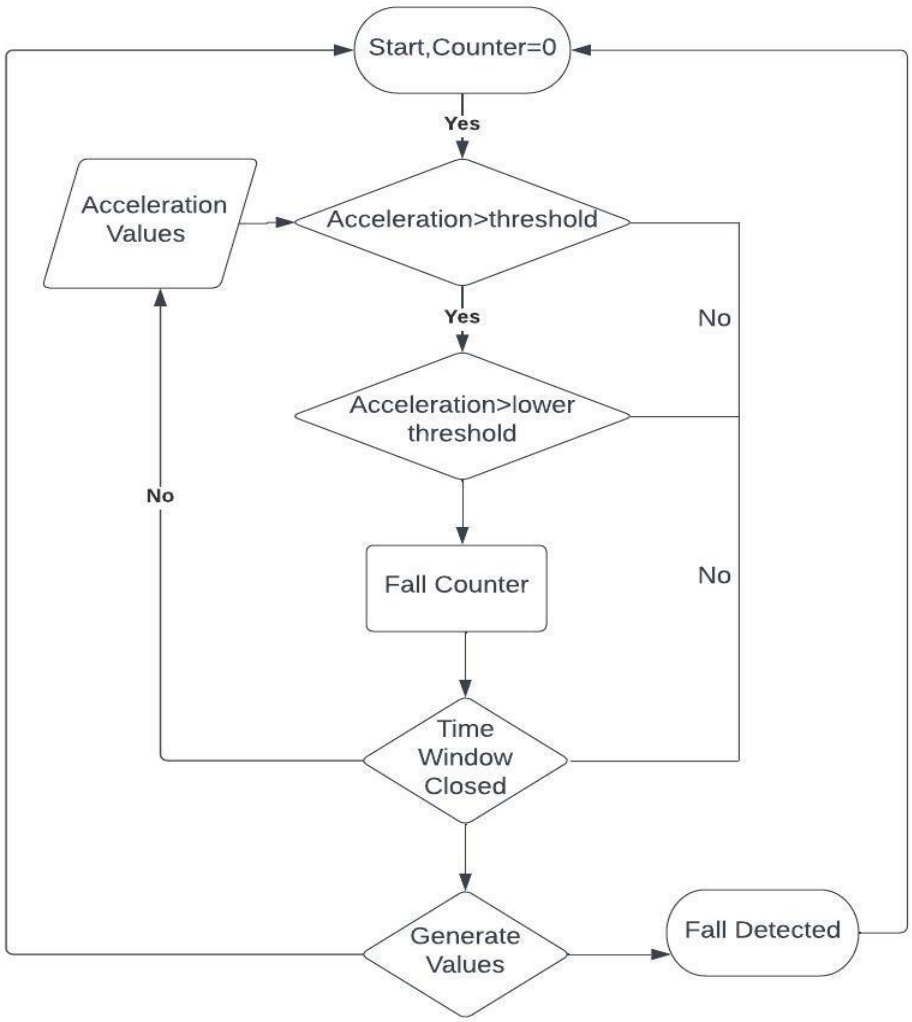


Figure 4.8: Activity Diagram for Epilepsy Patient Fall Detection System

5. IMPLEMENTATION

5.1 Implementation Strategy

There are many systems that have such type of facility which alerts the person on detection of fall but these systems need to be accurate and reliable. In order to build such a system their need to be certain strategy while making it. Planning plays an important role while building any project and the second most important thing comes is the execution of the same. If execution does not go in correct way, then there is possibility that the project would not finish successfully. So here we are using an agile technique which is an iterative approach to project management and software development that helps team to deliver value to their customers faster and with fewer headaches. Basically, the project can be divided into three main parts: Hardware part that is the Arduino related part, second comes the user interface the android app and finally combining both the parts so that the project gets complete expected output.

5.2 Hardware Platform Used

For making this project we need many hardware platforms without which this project is impossible. Main role plays here is the sensors required for the detection purpose.

- Laptop/PC
- System: Intel Processor i5/above
- Hard Disk: 500GB
- RAM:4-8GB
- Arduino Nano 33 Ble

5.3 Software Platform Used

- Operating System
- Android Studio
- Arduino IDE
- Eddystone Protocol

5.4 Deployment Diagram

Deployment diagrams are used to visualize the topology of the physical components of a system, where the software components are deployed as shown in below Figure. Deployment diagrams are used to describe the static deployment view of a system. Deployment diagrams consist of nodes and their relationships.

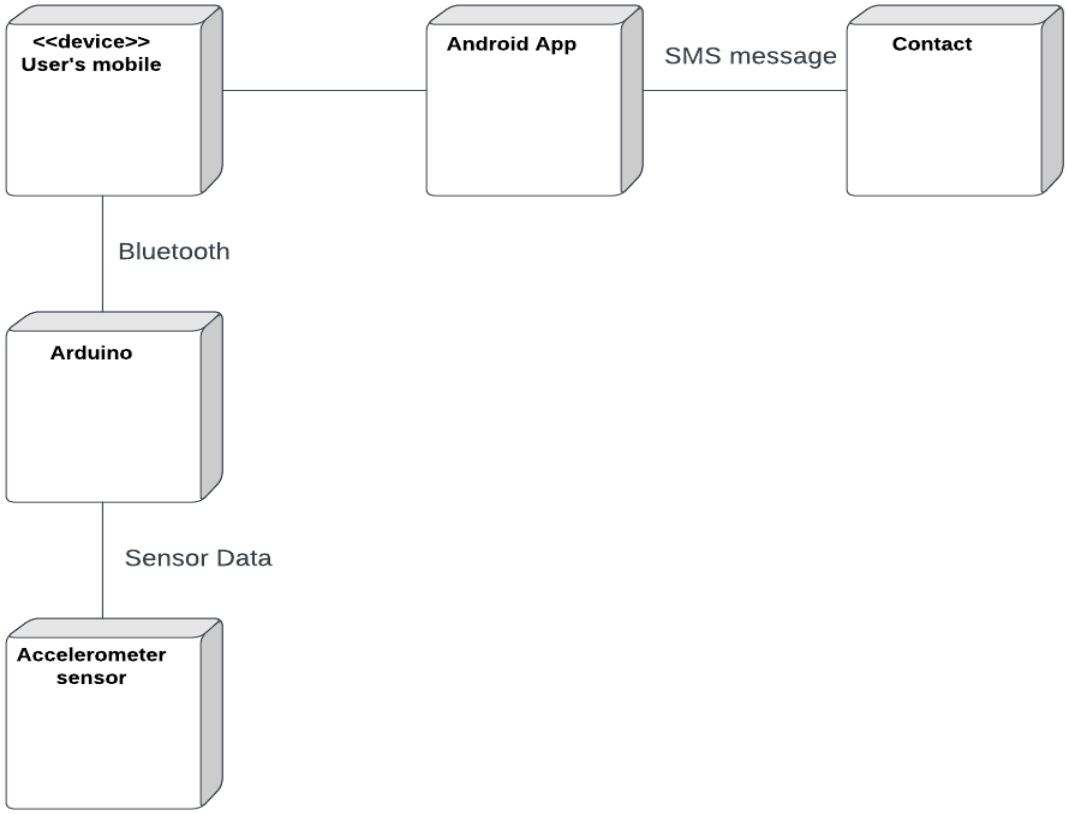


Figure 5.1: Deployment Diagram of Epilepsy Patient Fall Detection System

5.5 Implementation Level Details

5.5.1 Technology Used:

5.5.1.1 Android:

This is the must thing required for this project to be successful. The overall working of the system depends on the mobile device. And we have worked upon the android

operating system devices only as it is the most commonly used. Android is an open source and Linux-based Operating System for mobile devices such as smartphones and tablet computers. Android was developed by the *Open Handset Alliance*, led by Google, and other companies.

Android offers a unified approach to application development for mobile devices which means developers need only develop for Android, and their applications should be able to run on different devices powered by Android.

The first beta version of the Android Software Development Kit (SDK) was released by Google in 2007 where as the first commercial version, Android 1.0, was released in September 2008.

Figure 5.2: Features of Android

Android has various reasons that is features as follows:

1. Beautiful UI: Android OS basic screen provides a beautiful and intuitive user interface.
2. Connectivity: GSM/EDGE, IDEN, CDMA, EV-DO, UMTS, Bluetooth, Wi-Fi, LTE, NFC and WiMAX.
3. Storage: SQLite, a lightweight relational database, is used for data storage purposes.

4. Media support: H.263, H.264, MPEG-4 SP, AMR, AMR-WB, AAC, HE-AAC, MP3, MIDI, Ogg Vorbis, WAV, JPEG, PNG, GIF, and BMP.
5. Messaging: SMS and MMS
6. Web browser: Based on the open-source WebKit layout engine, coupled with Chrome's V8 JavaScript engine supporting HTML5 and CSS3.
7. Multi-touch: Android has native support for multi-touch which was initially made available in handsets such as the HTC Hero.
8. Multi-tasking: User can jump from one task to another and same time various application can run simultaneously.
9. Resizable widgets: Widgets are resizable, so users can expand them to show more content or shrink them to save space.
10. Multi-Language: Supports single direction and bi-directional text.
11. GCM: Google Cloud Messaging (GCM) is a service that lets developers send short message data to their users on Android devices, without needing a proprietary sync solution.
12. Wi-Fi Direct: A technology that lets apps discover and pair directly, over a high-bandwidth peer-to-peer connection.
13. Android Beam: A popular NFC-based technology that lets users instantly share, just by touching two NFC-enabled phones together.

Android Application:

Android applications are usually developed in the Java language using the Android Software Development Kit.

Once developed, Android applications can be packaged easily and sold out either through a store such as Google Play, SlideME, Opera Mobile Store, Mobango, F-droid and the Amazon Appstore.

Android powers hundreds of millions of mobile devices in more than 190 countries around the world. It's the largest installed base of any mobile platform and growing fast. Every day more than 1 million new Android devices are activated worldwide.

Categories of Android Applications:

- Music

- Sports
- News
- Lifestyle
- Multimedia
- Food & Drink
- Travel
- Weather
- Books
- Business
- Reference
- Navigation
- Social media
- Utilities
- Finance

For making android applications usually android studio is used.

5.5.1.2 Android Studio:

- Android Studio is the official integrated development environment (IDE) for developing Android applications. It was developed by Google and is based on the IntelliJ IDEA platform. Android Studio provides a comprehensive set of tools and features for developers to build, test, and deploy Android applications.
- Android Studio includes a code editor with syntax highlighting, code completion, and debugging tools, as well as an emulator to simulate the Android environment for testing applications. It also includes a visual layout editor for creating user interfaces, and tools for managing dependencies, building and signing APKs, and integrating with version control systems like Git.
- Overall, Android Studio provides a powerful and efficient development environment for creating high-quality Android applications, and it is widely used by developers around the world.

- It supports Java, Kotlin and C++ programming languages for developing Android applications. Kotlin is the recommended language for Android development as it is more concise and expressive than Java.
- It also provides a rich set of templates for creating new Android projects, including templates for building apps with different architectures such as MVVM, MVP, and MVC.
- Android Studio includes an advanced code

5.5.1.3 Arduino IDE

Arduino IDE is an open-source software, designed by Arduino.cc and mainly used for writing, compiling & uploading code to almost all Arduino Modules.

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 available for all operating systems i.e. MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role in debugging, editing and compiling the code.

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.

5.5.1.4 Bluetooth

Bluetooth is a wireless technology standard that allows electronic devices to communicate with each other over short distances using radio waves. It was first developed by Ericsson in 1994, and has since become a widely used technology for connecting devices such as smartphones, laptops, headphones, and smartwatches. Bluetooth uses radio waves to transmit data over short distances, typically up to 10 meters (33 feet) but this range can vary depending on the version of Bluetooth being used. It operates in the 2.4 GHz frequency band, which is an unlicensed band that is also used by other wireless technologies such as Wi-Fi and microwave ovens.
There are several versions of Bluetooth, with the latest being Bluetooth 5.2. Each new version of Bluetooth usually comes with improvements in data transfer speed, range, and power consumption. Bluetooth technology can be found in a wide range of devices, from consumer electronics to industrial equipment and medical devices.

Some common uses of Bluetooth include:

- Wireless audio streaming: Bluetooth-enabled speakers, headphones, and car audio systems can receive audio wirelessly from a smartphone or other device.
- Data transfer: Files, photos, and other data can be transferred between devices wirelessly using Bluetooth.
- Wireless input: Bluetooth keyboards, mice, and other input devices can be used with a computer or other device without the need for wires.
- Smart home automation: Bluetooth can be used to connect smart home devices such as lights, locks, and thermostats to a smartphone or hub.

Overall, Bluetooth technology has become an essential part of our modern-day communication and connectivity, providing a reliable and convenient wireless connection between devices.

5.5.1.5 BLE

What is a Beacon?

A beacon in wireless technology is the concept of broadcasting small pieces of information. The information may be anything, ranging from ambient data (temperature, air pressure, humidity, and so forth) to micro-location data (asset tracking, retail, and so forth) or orientation data (acceleration, rotation, and so forth). The transmitted data is typically static but can also be dynamic and change over time. With the use of Bluetooth low energy, beacons can be designed to run for years on a single coin cell battery.

Bluetooth low energy

BLE stands for Bluetooth Low Energy (Bluetooth LE, and marketed as Bluetooth Smart).Bluetooth Low Energy (BLE) is a form of wireless communication designed especially for short-range communication. BLE is very similar to Wi-Fi in the sense that it allows devices to communicate with each other. However, BLE is meant for situations where battery life is preferred over high data transfer speeds. For example, say you want to broadcast a marketing campaign close to a newly launched headphone. The amount of data you need to transfer to a visitor's smartphone is minimal; hence Bluetooth LE compatible beacons do the job quickly without draining the battery. Today, most smartphones and tablets are BLE compatible, which means they can seamlessly communicate with Bluetooth-enabled wireless headphones, digital signage, car stereos, fitness trackers, smart watches, and hardware devices like beacons.

A Bluetooth low energy device can operate in four different device roles. Depending on the role, the devices behave differently. The first two roles are connection-based:

- A Peripheral device is an advertiser that is connectable and can operate as a slave in a connection. This could, for example, be a health thermometer or a heart rate sensor.
- A Central device scans for advertisers and can initiate connections. It operates as a master in one or more connections. Good examples are Smartphones and

computers. This means that the device roles used for established connections are the Peripheral and the Central roles.

- The other two device roles are used for one-directional communication:
  - A Broadcaster is a non-connectable advertiser, for example, a temperature sensor that broadcasts the current temperature, or an electronic tag for asset tracking.

    An Observer scans for advertisements, but cannot initiate connections. This could be a remote display that receives the temperature data and presents it, or tracking the electronic tag. The two obvious device roles for beacon applications are Peripheral and Broadcaster. Both of them send the same type of advertisements with the exception of one specific flag that indicates if it is connectable or non-connectable.
  - A Peripheral device that implements a GATT Server (GATT is an architecture for how data is stored and exchanged between two or more devices) can be branded as a Bluetooth low energy device. So a Bluetooth low energy branding indicates that the device is a connectable Peripheral device that has data, which could be interacted with.

How does BLE technology work?

BLE data transfer is essentially one-way communication. Let's take an example of BLE beacons trying to communicate with a smartphone nearby – a Bluetooth beacon device broadcasts packets of data at regular intervals. These data packets are detected by app/pre-installed services on smartphones nearby. This BLE communication triggers actions such as pushing a message or promoting an app.

To save energy and provide higher data transfer speed, the entire Bluetooth BLE communication framework consists of 40 frequency channels, separated by 2MHz. 3 of these channels are the primary advertisement channels, while the remaining 37 channels are secondary, known as data channels. The Bluetooth communication starts with the 3 primary advertisement channels and then offloads to the secondary channels.

Uses

1. Advertising -

   Bluetooth beacons can be used to send a packet of information that contains a Universally Unique Identifier (UUID). This UUID is used to trigger events specific to that beacon. In the case of Apple's iBeacon the UUID will be recognized by an app on the user device that will trigger an event. This event is fully customizable by the app developer but in the case of advertising the event might be a push notification with an ad However, with a UID based system the user's device must connect to an online server which is capable of understanding the beacons UUID. Once the UUID is sent to the server the appropriate message action is sent to a user's device.

   Other methods of advertising are also possible with beacons, URI Beacon and Google's Eddystone allow for a URI transmission mode that unlike ibeacons UID doesn't require an outside server for recognition. The URI beacons transmit a URI which could be a link to a webpage and the user will see that URI directly on their phone.

2. Notification and interaction -

   Beacons can be associated with the art pieces in a museum to encourage further interaction. For example, a notification can be sent to user's mobile device when user is in the proximity to a particular art piece. By sending user the notification, user is alerted with the art piece in his proximity, and if user indicates their further interest, a specific app can be installed to interact with the encountered art piece. In general, a native app is needed for a mobile device to interact with the beacon if the beacon uses iBeacon protocol; whereas if Eddystone is employed, user can interact with the art piece through a physical web URL broadcast by the Eddystone.

3. Healthcare -

   Using the device tracking capabilities of Bluetooth beacons, in-home patient monitoring is possible. Using bluetooth beacons a person's movements and

activities can be tracked in their home.[17] Bluetooth beacons are a good alternative to in house cameras due to their increased level of privacy. Additionally bluetooth beacons can be used in hospitals or other workplaces to ensure workers meet certain standards. For example, a beacon may be placed at a hand sanitizer dispenser in a hospital – the beacons can help ensure employees are using the station regularly.

4. Tracker -

   One use of beacons is as a "key finder" where a beacon is attached to, for example, a keyring and a smartphone app can be used to track the last time the device came in range.

   Another similar use is to track pets, objects (e.g. baggage) or people. The precision and range of BLE doesn't match GPS, but beacons are significantly less expensive. Several commercial and free solutions exist, which are based on proximity detection, not precise positioning. For example, Nivea launched the "kid-tracker" campaign in Brazil back in 2014.

5. Home Automation Systems -

   Reminders if some devices (like stoves or ovens) are turned off, Remote control (360-camera), Smart Locks, Sensors (water, fire, motion, light). It can be controlled and operated by Bluetooth smart ready gadgets that can receive and transmit Bluetooth signals.

6. Smart Kitchen -

   Culinary space has many quirky but useful inventions that use BLE technology. The smart fork helps to monitor and track the eating habits to support weight loss. A smart frying pan is a gadget that checks the temperature inside your food and lets you know when it’s done without needing to stick a fork in it.

5.5.1.6 Eddystone

Eddystone is a protocol specification for proximity beacon messages; it describes four types of frames for the variety of applications that may be used individually or in combinations. Each frame has a different format for the BLE advertising. Every time beacon devices advertise the same packets on all three advertising channels so that every BLE packet scanner can pick that packet easily.

Eddystone beacon conFigureuration includes things like power levels and broadcast intervals. You can use Eddystone- EID or go with Eddystone-UID for the advertisement of data or attachments. This is where you also control beacon access

Eddystone Protocol Specification

Every Eddystone frame type must contain the following PDU data types:

The Complete List of 16-bit Service UUIDs as defined in The Bluetooth Core Specification Supplement (CSS) v5, Part A, § 1.1. The Complete List of 16-bit Service UUIDs must contain the Eddystone Service UUID of 0xFEAA. This is included to allow background scanning on iOS devices.

The Service Data data type, Ibid. § 1.11. The Service Data - 16 bit UUID data type must be the Eddystone Service UUID of 0xFEAA.

The specific type of Eddystone frame is encoded in the high-order four bits of the first octet in the Service Data associated with the Service UUID.

Types of Eddystone Frames

There are four types of frames in eddystone

1. Eddystone-URL -

   This frame's main purpose is to offer a way to transmit a URL for it to be detected and discovered by a Bluetooth Low Energy scanner device. The BLE device will then link received and present the right webpage for users. What happens is that Eddystone-URL sends a compressed Uniform Resource Locator of a given site within the beacon transmission allowing mobile devices like Smartphone's auto-open the web address in a browser right after sensing the beacon packet. The Eddystone-URL frame offers web content bases on proximity without requiring an app for different mobile platforms. Chrome for

iOS already supports this Eddystone feature. By utilizing Chrome Today Widget, users are capable to access web content relevant to the vicinity. So they use to receive notifications when encountering beacons.

The URLs have to be very short due to the limited space in the packets.The frame also offers power a calibration field similar to that of the UID.

2. Eddystone-UID -

   This is the main Eddystone frame comprising of three fields, namely Namespace identifier (10 bytes), and Instance identifier (6 bytes), and power calibration (1 byte). It'll help conFigure the field directly into the BLE beacon. The instance identifier is meant to uniquely represent a beacon since they have different instance IDs. The power calibration field is used to help calculate the distance between a mobile device and the Eddystone beacon based on the RSSI (Received Signal Strength Indicator).

   The namespace portion uses for grouping a particular set of beacons. On the other hand, the instance ID is helpful to identify individual devices in the whole group. In addition to this, the division of ID into instance components and namespace facilitates to optimize of BLE scanning strategies.

3. Eddystone-TLM -

   It's meant to supplement the URL frame or the UID frame. Due to the timelines of information provided by TLM being less important, it's not transmitted frequently. The main importance of the Eddystone-TLM frame is to give a full report on the health status of the Eddystone Bluetooth beacon. This includes the Beacon's Version, the current temperatures, the current battery level, the Uptime (seconds which the beacon has been powered), and the PduCount (the number of advertising packets the beacon has deployed after being last powered).

4. Eddystone-EID -

   This is the frame responsible for the security and privacy of a gadget. During a deployment phase, the Ephemeral ID changes time after time. EID is in some way similar to the Eddystone-UID, but they differ due to EID having a single 8-byte AES-encrypted identifier. This identifier rotates at regular intervals depending on the Eddystone beacon conFigureuration. For your BLE beacon to transmit EID, you have to register with Google's Proximity Beacon API.

   It uses ephemeral identifiers to enhance the security of the beacons. This frame broadcasts an encrypted ephemeral identifier. This identifier changes periodically during the initial registration at a rate determined with a web service.

5.5.1.6 Arduino Nano 33 BLE –

It is a small and powerful development board designed for Internet of Things (IoT) applications. It is based on the nRF52840 microcontroller, which is part of the Nordic Semiconductor nRF52 series of devices. The board includes a wide range of features, making it ideal for applications such as environmental monitoring, fitness tracking, and home automation.

The microcontroller on the Arduino Nano 33 BLE runs at 3.3V, which means that you must never apply more than 3.3V to its Digital and Analog pins. Care must be taken when connecting sensors and actuators to assure that this limit of 3.3V is never exceeded. Connecting higher voltage signals, like the 5V commonly used with the other Arduino boards, will damage the Arduino Nano 33 BLE.

To avoid such risk with existing projects, where you should be able to pull out a Nano and replace it with the new Nano 33 BLE we have the 5V pin on the header, positioned between RST and A7 that is not connected as default factory setting. This means that if you have a design that takes 5V from that pin, it won't work immediately, as a precaution we put in place to draw your attention to the 3.3V compliance on digital and analog inputs.

5V on that pin is available only when two conditions are met: you make a solder bridge on the two pads marked as VUSB and you power the Nano 33 BLE through

the USB port. If you power the board from the VIN pin, you won't get any regulated 5V and therefore even if you do the solder bridge, nothing will come out of that 5V pin. The 3.3V, on the other hand, is always available and supports enough current to drive your sensors. Please make your designs so that sensors and actuators are driven with 3.3V and work with 3.3V digital IO levels. 5V is now an option for many modules and 3.3V is becoming the standard voltage for electronic ICs.

Here are some of the key features and specifications of the Arduino Nano 33 BLE:

- Microcontroller: Nordic nRF52840 with ARM Cortex-M4F core running at 64 MHz
- Flash memory: 1 MB
- SRAM: 256 KB
- Bluetooth: Bluetooth Low Energy (BLE) 5.0 with built-in antenna
- Other wireless connectivity: 802.15.4 (Thread, Zigbee), NFC-A tag
- Operating voltage: 3.3 V
- Input voltage: 5 V via USB or Vin pin, or 3.3 V via 3V3 pin
- Digital I/O pins: 14 (with 12 PWM outputs)
- Analog input pins: 8 (12-bit ADC)
- UART, SPI, I2C, PWM, and other communication interfaces
- Integrated IMU (Inertial Measurement Unit) with 9 degrees of freedom (3-axis accelerometer, 3-axis gyroscope, 3-axis magnetometer)
- Built-in temperature sensor

One of the main advantages of the Arduino Nano 33 BLE is its wireless connectivity, which allows it to communicate with other devices over Bluetooth, Thread, Zigbee, or NFC. This makes it ideal for IoT projects that require remote sensing, control, or data exchange. The onboard IMU and temperature sensor also enable applications such as motion tracking, orientation sensing, and environmental monitoring.

Another advantage of the Arduino Nano 33 BLE is its small size (45x18 mm), which makes it easy to integrate into compact devices or wearables. The board can be powered by a USB connection, a battery, or an external power source, depending on the application requirements.

The Arduino Nano 33 BLE is compatible with the Arduino IDE, a popular open-source software development environment for writing, compiling, and uploading code to Arduino boards. The IDE includes a library of pre-written functions and examples that simplify programming tasks, even for beginners.

Overall, the Arduino Nano 33 BLE is a versatile and powerful development board that offers a wide range of features and capabilities for IoT and other applications. Its compact size, wireless connectivity, and integrated sensors make it a popular choice among makers, hobbyists, and professionals alike.

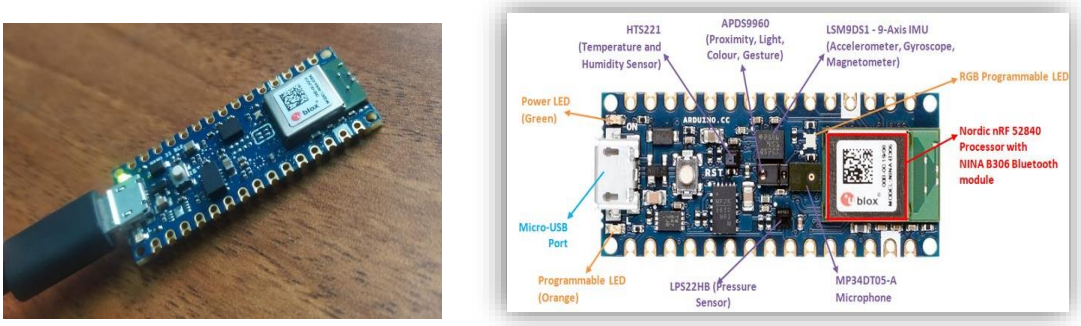


Figure 5.3: Arduino Nano 33 BLE Circuit

Key features of the Arduino Nano 33 BLE include:

- Processor: The board is powered by the Nordic nRF52840 processor, which is a powerful Cortex-M4F based microcontroller.
- Bluetooth Low Energy: The board includes a built-in Bluetooth Low Energy module, which allows for wireless communication with other BLE devices.
- Size: The Nano 33 BLE is a small board, measuring just 45mm x 18mm.
- Connectivity: The board includes a micro-USB port for programming and power, as well as a built-in voltage regulator.
- Sensors: The board includes a 9-axis IMU (Inertial Measurement Unit) that includes an accelerometer, gyroscope, and magnetometer.
- GPIO: The board includes 19 digital input/output pins and 8 analog inputs.

- Power Consumption: The board is designed to be low power, with a consumption of around 1.6mA when in sleep mode and up to 23mA when active.
- Compatible with Arduino IDE: The board can be programmed using the Arduino IDE, making it easy to get started with development.
- Additional Features: The Nano 33 BLE also includes a built-in temperature sensor, a reset button, and an LED for status indication.

5.5.1.7 Accelerometer –

Epilepsy is a neurological disorder characterized by recurrent seizures. These seizures can lead to falls, which can cause serious injuries, especially for older adults. Therefore, developing a fall detection system that can identify falls related to epilepsy is crucial to help prevent injury and provide timely medical attention. One technology that can be used for fall detection is the accelerometer.

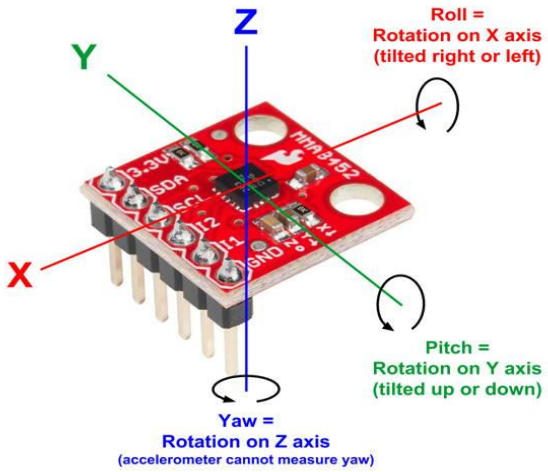


Figure 5.4: Accelerometer Circuit with Possible Directions

What is an accelerometer?

An accelerometer is a device that measures the acceleration of an object. It works by measuring changes in the object's velocity, which are caused by forces acting upon the object. Accelerometers can measure both static and dynamic acceleration, and they are

commonly used in many different applications, such as aerospace, automotive, and consumer electronics.

In consumer electronics, accelerometers are commonly found in smartphones and fitness trackers. These devices use accelerometers to detect changes in movement and orientation, which allows them to perform functions such as screen rotation and step counting.

How can accelerometers be used for fall detection -

Accelerometers can be used for fall detection by measuring the acceleration of a person's body during a fall. When a person falls, their body experiences a sudden acceleration, followed by a deceleration when they hit the ground. By measuring these accelerations, an accelerometer can detect a fall and trigger an alarm or call for help.

There are different ways to use accelerometers for fall detection. One method is to attach an accelerometer to the person's body, such as a wrist-worn device or a belt clip. The accelerometer continuously measures the person's acceleration and sends the data to a processing unit, which analyzes the data for fall events.

Another method is to use a network of accelerometers placed around the person's environment, such as in their home or assisted living facility. These accelerometers can detect falls based on changes in the acceleration patterns of the person's environment. For example, a sudden change in acceleration in a room could indicate a fall.

Challenges of using accelerometers for epilepsy fall detection –

Using accelerometers for epilepsy fall detection presents several challenges. First, there is a high degree of variability in the acceleration patterns of falls related to epilepsy. Unlike typical falls, which have a consistent acceleration pattern, falls related to epilepsy can have varying acceleration patterns depending on the severity of the seizure and the person's position at the time of the fall.

Second, there is a risk of false positives and false negatives. False positives occur when the accelerometer detects a fall event that did not occur, such as when the person drops their phone or stumbles but does not fall. False negatives occur when the accelerometer

fails to detect a fall event, such as when the person falls but the accelerometer is not sensitive enough to detect the acceleration.

Third, there is a need for real-time monitoring and quick response times. Epilepsy falls can result in serious injury or even death, so it is crucial that the fall detection system can quickly detect falls and trigger an alarm or call for help.

Potential solutions to these challenges –

One potential solution to the variability in acceleration patterns is to use machine learning algorithms to analyze the data from the accelerometer. These algorithms can learn the patterns of falls related to epilepsy and adjust the sensitivity of the accelerometer to reduce false positives and false negatives.

Another potential solution is to combine the accelerometer with other sensors, such as gyroscopes and magnetometers. Gyroscopes can measure the rotation of the body during a fall, while magnetometers can detect the orientation of the body. By combining these sensors, the fall detection system can more accurately detect falls related to epilepsy.

To reduce the risk of false positives and false negatives, the fall detection system can be programmed to use a combination of acceleration thresholds and other criteria, such as the duration of the fall and the absence of movement after.

5.5.2 Detail description of project setup:

5.5.2.1 Installation of Extended Eddystone Frame into Arduino Nano 33 BLE for broadcasting accelerometer values

1. Install the ArduinoBLE library: Open the Arduino IDE and go to Sketch -> Include Library -> Manage Libraries. In the Library Manager window, search for "ArduinoBLE" and click "Install" to install the library.
2. Connect the Arduino Nano 33 BLE to your computer using a USB cable.
3. Open the Arduino IDE and select the Arduino Nano 33 BLE board from the Tools -> Board menu.
4. Copy and paste the sample code provided in the previous answer into the Arduino IDE.

5. Verify and upload the code to the Arduino Nano 33 BLE board by clicking on the "Upload" button or by pressing Ctrl + U.
6. Once the code is uploaded, open the Serial Monitor by clicking on the magnifying glass icon in the top right corner of the Arduino IDE. The Serial Monitor will display a message confirming that the BLE Accelerometer service has started.
7. Use a BLE scanner app on your smartphone to search for available BLE devices. The Arduino Nano 33 BLE should appear as "Accelerometer".
8. Connect to the Arduino Nano 33 BLE from the BLE scanner app.

The accelerometer values will be displayed in the BLE scanner app. The Extended Eddystone frame will be used to broadcast these values to nearby BLE devices.

5.5.2.2 Android Application development for receiving broadcasted Accelerometer values by Arduino Nano 33 BLE

To develop an Android app that receives broadcasted accelerometer values from a BLE 33 device, you can follow these general steps:

1. Set up the BLE connection between the Android device and the BLE 33 device. This involves discovering and connecting to the device using Bluetooth Low Energy (BLE) APIs provided by Android.
2. Define the GATT (Generic Attribute Profile) service and characteristic that the BLE 33 device uses to broadcast accelerometer data. You can find this information in the device documentation or by using a BLE scanner app.
3. Implement a callback method to handle notifications from the BLE 33 device when new accelerometer data is available. This involves subscribing to the characteristic notification using the Android BLE API and then implementing the onCharacteristicChanged() method to receive the data.
4. Parse the received data into the appropriate format (e.g., float values for x, y, and z acceleration). You may need to refer to the BLE 33 device documentation to determine the format of the data.

Figure 5.5: Logo of Android Application

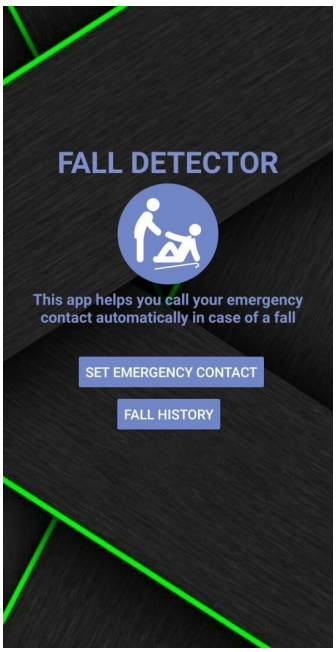


Figure 5.6: Homepage of Application

5.5.2.3 Contacting support for Epilepsy Fall Detection System

When setting up an epilepsy fall detection system, it's important to also set up emergency contacts in case of an emergency. These contacts will be notified automatically in case the system detects a fall or any other emergency situation.

Here are the steps to set up emergency contacts for an epilepsy fall detection system:

1. Click on the Set Emergency Contact of the homepage of application
2. Enter the contact information for your emergency contacts, including phone number.
3. Save the contact information.

It's important to choose emergency contacts who can be reached easily and who are familiar with patient condition and medical needs.

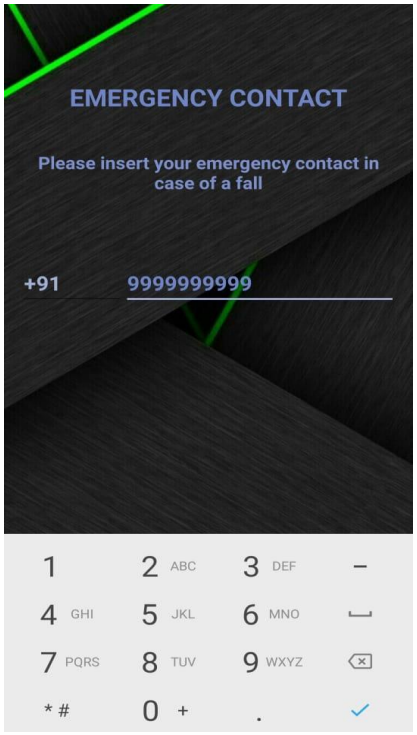


Figure 5.7: Set Emergency Contact

5.5.2.4 Analysis of received accelerometer values for the desired action

Here are the steps to analyze accelerometer readings and identify falls in an Android application programmed using Java and XML:

1. Collecting data: Collect the accelerometer readings by using an accelerometer sensor. This can be done using the SensorManager class in Android.
2. Cheking Fall Threshold Values: Check the collected accelerometer values with the define threshold values.
3. Action on detection: Once a fall is detected, trigger the desired action within the Android application. This could include sounding an alarm, sending an alert message to a caregiver, and saving date and time.
4. Testing: Test the system by simulating a fall and ensuring that the algorithm accurately detects the fall and triggers the desired action.

5.5.2.4 Sending message notification as per analysis of Accelerometer values

To implement message notification based on analysis of accelerometer values, you can follow these general steps:

1. Collect Accelerometer Data: The first step is to collect accelerometer data from the device's accelerometer sensor. You can use a mobile application or a microcontroller board to record the data.
2. Analyze the Accelerometer Data: Next, you need to analyze the accelerometer data to detect patterns that indicate certain events. For example, you can analyze the data to detect when the device is being shaken or moved in a particular direction.
3. Determine the Threshold Values: Once you have analyzed the data, you need to set threshold values for each event. These values will be used to trigger the message notification. For example, you can set a threshold value for the amount of movement required to trigger the message notification.
4. Define the Notification Message: Once the threshold values are defined, you need to decide on the notification message that will be displayed when an event is detected. For example, you can create a message that says "You have reached your daily step goal!" when the device detects a certain amount of movement.
5. Implement the Notification System: Finally, you need to implement the notification system that will display the notification message when an event is detected. This can be done using a mobile application or by integrating the notification system with other software and hardware.

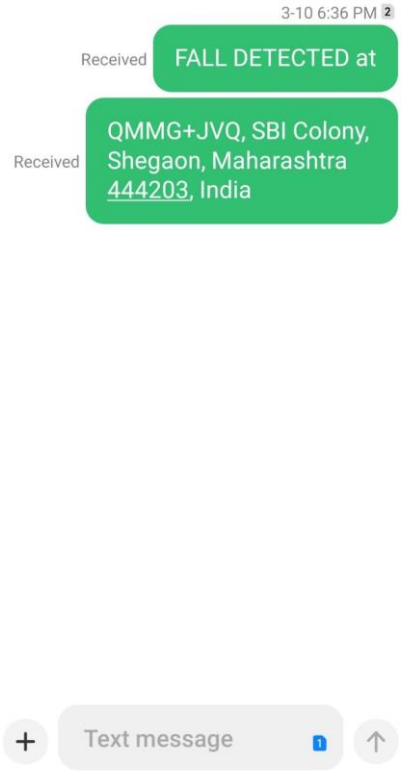


Figure 5.8: Sending Message

5.5.2.5 Tracking Fall History

Fall history is an important aspect of understanding the patient's condition and developing an appropriate fall detection system.

Here are some key steps to consider -

1. Gather medical history: Collecting the patient's medical history, including any past seizures or falls, is important to understand their condition and potential risk factors for falls.
2. Assess fall risk: Assess the patient's fall risk based on factors such as age, mobility, medication use, and comorbidities.
3. Implement a fall detection system: Consider implementing a fall detection system that uses sensors or wearable technology to detect falls and alert caregivers or emergency responders.
4. Once a fall detection system is in place, generating reports can help track the patient's progress and identify any potential issues. Record fall events: Record the date and time of any falls that are detected by the fall detection system.

Overall, fall history and report generation are critical components of a comprehensive epilepsy patient fall detection system. By understanding the patient's condition and tracking their progress, caregivers can provide better care and reduce the risk of falls.

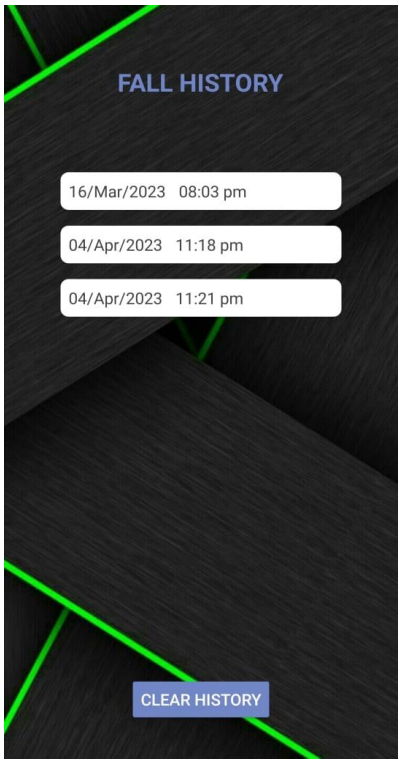


Figure 5.9: Fall History

5.6 Testing

Software testing can be stated as the process of verifying and validating whether a software or application is bug-free, meets the technical requirements as guided by its design and development, and meets the user requirements effectively and efficiently by handling all the exceptional and boundary cases.

The process of software testing aims not only at finding faults in the existing software but also at finding measures to improve the software in terms of efficiency, accuracy, and usability. It mainly aims at measuring the specification, functionality, and performance of a software program or application.

Software testing can be divided into two steps:

1. **Verification**: it refers to the set of tasks that ensure that the software correctly implements a specific function.

2. **Validation**: it refers to a different set of tasks that ensure that the software that has been built is traceable to customer requirements.

When the project is done and is in working stage the project is to be tested before bringing it into practice. So, for this there are various testing technique as shown below:

5.6.1 Unit Testing

Unit Testing is a type of software testing where individual units or components of a software are isolate a section of code and verify its correctness. A unit may be an individual function, method, procedure, module, or object. Unit tests are automated and are run each time the code is changed to ensure that new code does not break existing functionality. Unit tests are designed to validate the smallest possible unit of code, such as a function or a method, and test it in isolation from the rest of the system. This allows developers to quickly identify and fix any issues early in the development process, improving the overall quality of the software and reducing the time required for later testing. In SDLC, Unit testing is the first level of testing technique that is usually performed.

Objective of Unit testing:

- ⇒ To isolate a section of code.
- ⇒ To verify the correctness of the code.
- ⇒ To test every function and procedure.
- ⇒ To fix bugs early in the development cycle and to save costs.
- ⇒ To help the developers to understand the code base and enable them to make changes quickly.
- ⇒ To help with code reuse.

Advantages of Unit Testing:

1. Early Detection of Issues

2. Improved Code Quality
3. Faster Development
4. Better Documentation
5. Facilitation of Refactoring
6. Reduced Time and Cost

Disadvantages of Unit Testing:

1. The process is time-consuming for writing the unit test cases.
2. Unit testing will not cover all the errors.
3. Unit testing is not efficient for checking the errors in the UI.
4. It requires more time for maintenance when source code is changed frequently.
5. Difficulty in testing complex units.

5.6.2 Regression Testing

Tests the software after changes or modifications have been made to ensure the changes have not introduced new defects. Regression testing is a black box testing technique. It is used to authenticate a code change in the software does not impact the existing functionality of the product. Regression testing is making sure that the product works fine with new functionality, bug fixes, or any change in the existing feature. Regression testing is a type of software testing. Test cases are re-executed to check the previous functionality of the application is working fine, and the new changes have not produced any bugs.

Regression testing can be performed on a new build when there is a significant change in the original functionality. It ensures that the code still works even when the changes are occurring. Regression means Re-test those parts of the application, which are unchanged. Regression tests are also known as the Verification Method. Test cases are often automated. Test cases are required to execute many times and running the same test case again and again manually, is time-consuming and tedious too.

Advantages of Regression Testing:

1. Regression Testing increases the product's quality.

2. It ensures that any bug fix or changes do not impact the existing functionality of the product.
3. Automation tools can be used for regression testing.
4. It makes sure the issues fixed do not occur again.

Disadvantages of Regression Testing:

1. Regression Testing should be done for small changes in the code because even a slight change in the code can create issues in the existing functionality.
2. If in case automation is not used in the project for testing, it will time consuming and tedious task to execute the test again and again.

5.6.3 Integration Testing

Tests the integration of different components of the software to ensure they work together as a system. Integration testing is the second level of the software testing process comes after unit testing. In this testing, units or individual components of the software are tested in a group. The focus of the integration testing level is to expose defects at the time of interaction between integrated components or units. Unit testing uses modules for testing purpose, and these modules are combined and tested in integration testing. The Software is developed with a number of software modules that are coded by different coders or programmers. The goal of integration testing is to check the correctness of communication among all the modules. Once all the components or modules are working independently, then we need to check the data flow between the dependent modules is known as integration testing**.** Integration testing is a software testing technique that focuses on verifying the interactions and data exchange between different components or modules of a software application. The goal of integration testing is to identify any problems or bugs that arise when different components are combined and interact with each other.

Advantages of Integration Testing:

1. It is convenient for small systems.
2. Simple and straightforward approach.
3. Can be completed quickly.
4. Does not require a lot of planning or coordination.
5. May be suitable for small systems or projects with a low degree of interdependence between components.

Disadvantages of Integration Testing:

1. There will be quite a lot of delay because we have to wait for all the modules to be integrated.
2. High-risk critical modules are not isolated and tested on priority since all modules are tested at once.
3. Not good for long projects.
4. High risk of integration problems that are difficult to identify and diagnose.
5. Can lead to system downtime and increased development costs.
6. Can lead to decreased efficiency and productivity.

5.6.4 System Testing

Tests the complete software system to ensure it meets the specified requirements. System testing is a type of software testing that evaluates the overall functionality and performance of a complete and fully integrated software solution. It tests if the system meets the specified requirements and if it is suitable for delivery to the end-users. This type of testing is performed after the integration testing and before the acceptance testing. System Testing is a type of software testing that is performed on a complete integrated system to evaluate the compliance of the system with the corresponding requirements. In system testing, integration testing passed components are taken as input. The goal of integration testing is to detect any irregularity between the units that are integrated together. System testing detects defects within both the integrated units and the whole system. The result of system testing is the observed behaviour of a component or a system when it is tested. System Testing is carried out on the whole

system in the context of either system requirement specifications or functional requirement specifications or in the context of both. System testing tests the design and behaviour of the system and also the expectations of the customer.

System Testing Main Focus Areas:

- Hardware Interfaces: System interfaces like software connectivity with USB port, reading DVDs, etc. are working fine in a system.
- Complex functionalities: System is behaving as expected for complex functions like output to a file in desired format, etc.
- System Security: System integrated as a whole is secured enough and allows intended users to access the system functionalities assigned to user.
- Disaster Recovery / COB Testing: How long a system DOIng to take to recover from outage or disaster without impacting the continuity of business.
- Performance Testing: Performance testing is done to make sure system is able to withstand the unexpected load or request without breakdown.
- User Interface: How easily system is responding to user interface for request like AJAX call, button click, file upload, etc.
- Install ability: How easy the software is to get installed without much effort or knowledge needed.
- Documentation: How efficiently use manual is documented to use software by end user.
- Usability: How easy the system software is designed so that it can be put into use by naïve user.
- Load or stress testing: This testing define the maximum load capacity of the system software before it could breakdown or crash.
- Back-activity Compatibility: If a new version of software is developed, new system should make sure that it supports all the existing interfaces and

Advantages of System Testing:

1. Testers do not require more knowledge of programming.
2. It will test the entire product or software so that we will easily detect the errors.

3. Testing environment is similar to that of the real time production.
4. It checks entire functionality of the system with different test cases.
5. After this testing, the product will almost cover all the possible bugs or errors and hence the development team will confidently go ahead with acceptance testing.

Disadvantages of System Testing:

1. This testing is time consuming process than others.
2. The cost for the testing will be high since it covers the testing of entire software.
3. It needs good debugging tool otherwise the hidden errors will not be found.

5.6.5 Functional Testing

Checks an application, website, or system to ensure it's DOIng exactly what it's supposed to be DOIng. Functional testing is the process of validating functionality of a software application. Pass or fail is the result of a functional test, because either a feature works as designed or it does not.

The purpose of functional testing is to validate that the requirements of the software application have been met. It is important because functional testing assesses an application's fitness to be released to end users. While software engineering has evolved in the past decade, functional testing remains a core part of quality testing.

Advantage of Functional Testing:

1. It helps to identify any issues with the system's functionality before they become too much of a problem.
2. It can be used to verify that required features are working as expected and that the system is able to cope with unexpected conditions.
3. It can help to ensure that the product meets customer expectations and is bug-free.
4. It is an effective way to test the system under a variety of conditions and in a variety of scenarios.
5. It can be used to track progress and revise testing plans as needed.

Disadvantages of Functional Testing:

1. Functional testing is slow - Because functional testing is a detailed process, it can take a long time to complete. This can be a problem if you need to test a new feature quickly.
2. Functional testing is less accurate - Functional testing is less reliable than other types of tests because it relies on the actual function of the software being tested. This means that it can be difficult to find bugs that occur during normal usage.
3. Functional testing can be tedious - Because functional testing is focused on the actual functionality of the software, it can be tedious to conduct. This can lead to slow test times and missed bugs.
4. Functional testing is more expensive -functional testing is more expensive than other types of tests because it requires more time and effort to complete.

6. CONCLUSION

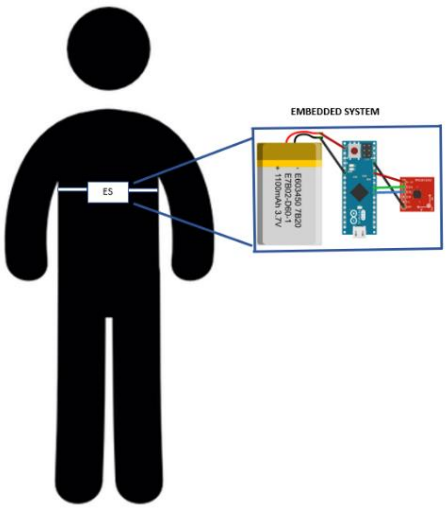
After the overall analysis, we identified the issue which was the problem faced by epileptic patients to get immediate help. Due to this the number of deaths and injuries have been recorded at a higher rate. In this condition, the patient is not in a situation where he/she can ask for help. So, we have worked on a system that could help such people. We have successfully developed a system in which the user needs to wear a kit that helps in the detection of fall events by providing an accelerometer reading. The app installed within the user's mobile sends an alert message to the relative and alerts nearby people by an alert sound. This eventually helps the patient to gain the attention of nearby people and get help faster. Also, along with the alert message location of the user is being shared with the relative to reach out faster. Finally, the system also provides the analysis in the form of accurate date and time which ultimately helps the doctor treat the patient in a much better way.

FUTURE WORK

- Machine learning algorithms can be trained to recognize patterns in sensor data that indicate a fall has occurred.
- Wearable technology: The fall detection system would need to be wearable and unobtrusive, so that epilepsy patients can go about their daily activities without interference.
- Future work could focus on attaching sensors which provide medical data for doctor's help.
- To reduce the response time.

USER MANUAL

Arduino Nano 33 BLE is a very small kit as shown in the following Figure so it can be worn anywhere, we wish to, here for getting a more efficient system with accurate detection so the user needs to wear it in the user's pocket.

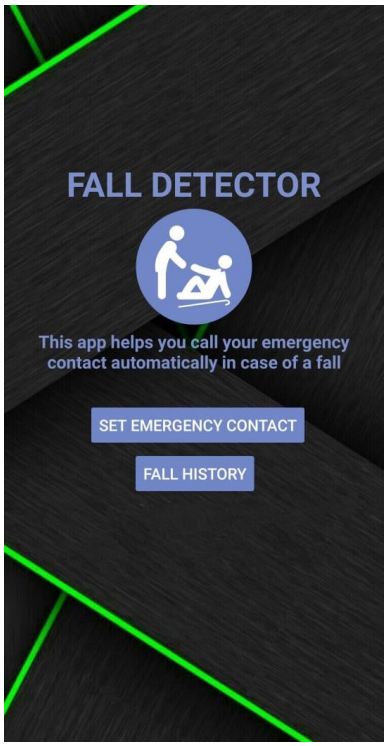


Our UI that is an android app called "Fall Detector" can be divided into the above 4 parts:

Beginning with the user needs to install and open our app in his/her mobile and also turn on mobile's Bluetooth. Here is the icon of our app.

Then follow the steps given below to know how the app works:

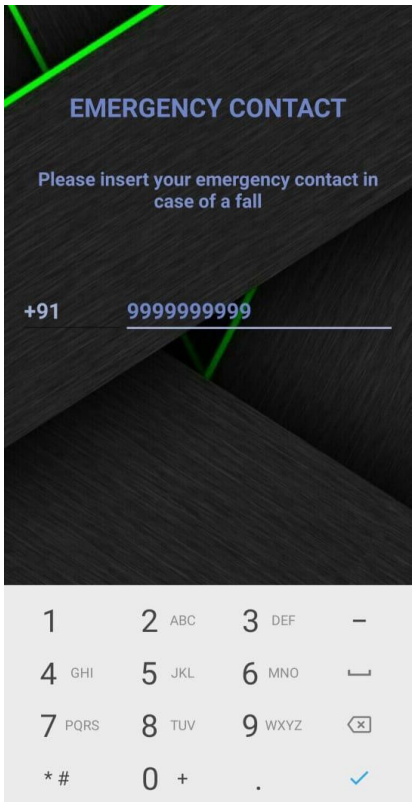
1) **Homepage of the app**: Home page consists of two options for user:-



- Set Emergency Number → The number on which the user wants the emergency message to be sent must be set to function properly.
- Fall History → This option can be helpful for patient as well as doctor with the help of which they may see the fall history of the patient (user) and can be treated accordingly.

Now first let's set the emergency number as it is must for the app to work:

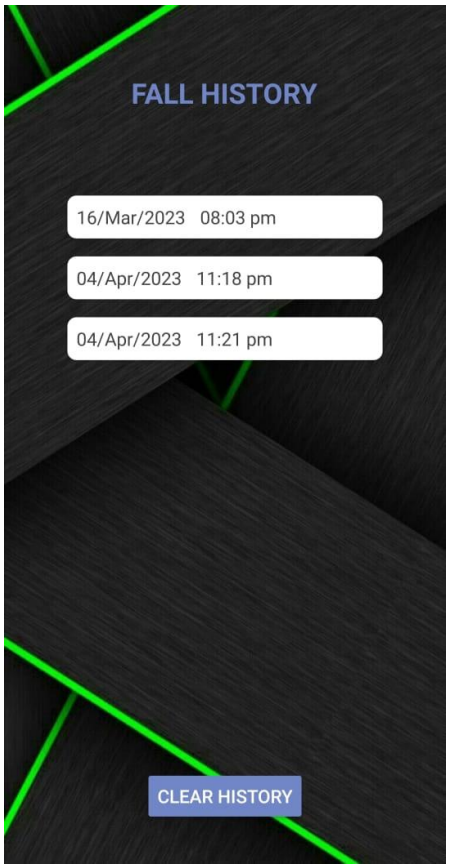
2) **Set Emergency Number**: Allows user to enter and set the number.



Once the user selects the option of set emergency contact, user views the second screen wherein one can set the emergency contact number on which the alert and location must be sent.

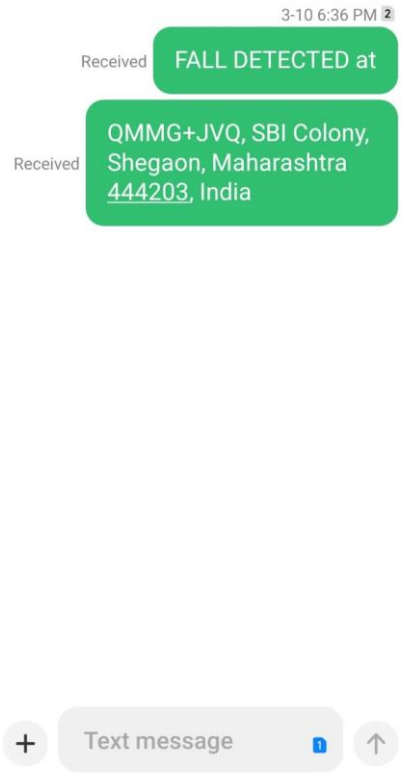
Here user have to enter the contact number and click on “Save” button below and the message will popup that the contact number has been saved.

3) **Fall History**: Displays the fall history of the patient.



- To help in better treatment of the patient it is necessary for a doctor to know how frequently a patient has a fall and the interval between each fall occurred so this fall history shows the time and date of the patient's fall for the ease of doctor.
- Here user can view his/her fall history in form of date and time.
- And if user wants to delete previous history than user just need to press the clear history button and all the data will be cleared.

On the other side the one whose number has been set as emergency contact will receive the message of alert as follows:



- The message is sent using the user's mobile's message inbuilt facility to the already set number whenever the fall is detected.
- Also the location of the user is sent to the care taker along with the alert message so as to get the help faster.

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Dissemination of Work

1) Review Paper - Journal of Advanced Research in Science, Communication and Technology

Title ***: Analysis of Accelerometer Applications***

Authors : Gauri Sawarkar, Maithali Kulkarni, Sayali Marathe, Anuja Thakare

Journal : IJARSCT | ISSN 2581-9429 (online), 1-5

Date : 25th April 2023

DOI : 10.48175/IJARSCT-943

2) Competition – IEEE Technovation 2023 Division 6

Title **: *Epilepsy Patient Fall Detection System and its Analysis Using Data Science***

Members : Gauri Sawarkar, Maithali Kulkarni, Sayali Marathe, Anuja Thakare

Date : 8th April 2023

Certificate of Participation

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Analysis of Accelerometer Applications

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Abstract: *An accelerometer is a digital tool that measures modifications in velocity, acceleration, or vibration of a bodily object. It is typically used in various packages, along with smartphones, vehicles, aerospace, and healthcare. The accelerometer measures the acceleration of the object via detecting modifications within the capacitance, piezoelectric impact, or other phenomena resulting from the motion of the item. Here we have studied and analysed various accelerometer applications to identify their capabilities and usability, based on this we have concluded that accelerometer can be used for the design and development of an Epilepsy Patient Fall Detection and Alert System using Accelerometers.*

Keywords: accelerometer, ardunio Nano 33 BLE, applications

I. INTRODUCTION

An accelerometer is a digital tool that measures modifications in velocity, acceleration, or vibration of a bodily object. It is typically used in various packages, along with smartphones, vehicles, aerospace, and healthcare. The accelerometer measures the acceleration of the object via detecting modifications within the capacitance, piezoelectric impact, or other phenomena resulting from the motion of the item.

Acceleration has two factors; one is static pressure and the other is a dynamic force. Static force is the pressure appearing on an object (consisting of friction or gravity) and dynamic force is the pressure acting on an item at one-of-a-kind speeds (including vibration or the pressure implemented to the cue ball). In billiard video games, this is why accelerometers are used.

For example, in the prevention and protection of car accidents. When a strong force is applied to the vehicle, the accelerometer detects acceleration and sends an electrical signal to the trip computer, which then activates the airbags. There are three different types of accelerometers, and each one of them is designed to work well in a specific condition.

When two or more accelerometers are connected, they provide a different measurement of the required acceleration. Gravity pulls them apart, especially in space, the gradient of the gravity field. The gravitational force is the weak force that relies upon the gravity of the Earth. This is very different, so a gravity gradiometer is used.

Accelerometers are electronic devices that are used to measure acceleration. Acceleration can be resulting from various factors, consisting of gravity, changes in motion, or external forces. These forces can be static like gravity, or it can detect vibration and motion like many mobile phones.

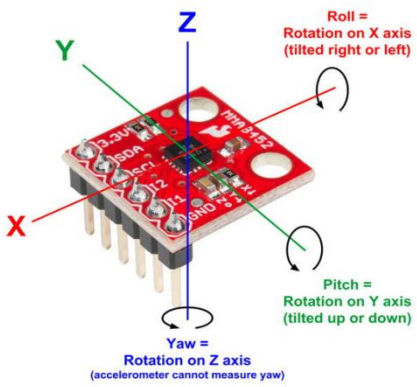

Fig .1: Accelerometer Circuit with Possible Directions

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II. ACCELEROMETER WORKING

Accelerometer can be used as a "level" that will provide information about the board's position. With this application, we will be able to know what is the relative position of the board and also the degree by tilting the board up, down, left or right.

2.1 Accelerometer Uses

Accelerometer sensors are broadly used in diverse digital devices, phones and wearables, and many others may be used in many methods. Accelerometers are sometimes used as part of energy harvesting systems, whereby the motion of an object is converted into electrical energy as it moves, for example, in the case of small sensors powered by vibrations of machinery. Accelerometers are also utilized in biomedical packages where biomedical accelerometer subject sensors are often used for step counting, interest monitoring or dynamic control, these sensors are even used to monitor important signs in heart assault issues.

2.2 Accelerometer Advantages

- High impedance.
- It offers higher sensitivity.
- Easily integrated interface and robust design.
- High-frequency response.
- Due to advances in the MEMS era, it decreased itscost.
- It uses a built-in signal conditioning circuit for the measurement of capacitance.

2.3 Accelerometer Disadvantages

- **Limited accuracy:** Accelerometers are fantastically correct, but they may be now not ideal, and their measurements can be suffering from outside elements inclusive of temperature, vibration, and electromagnetic interference.
- **Confined range:** Accelerometers have a confined size variety, which means that they cannot degree extraordinarily high or low degrees of acceleration or vibration.
- **Sensitivity to noise:** Accelerometers may be touchy to noise, which can influence the accuracy and reliability of their measurements

III. APPLICATIONS

A. Gesture-Controlled Robot

The accelerometer sensor, specifically the ADXL-335 accelerometer sensor is used to move the robot in each direction. In this basically, the accelerometer is placed on the hand and when the hand is tilted in front of the robot, the robot starts to move forward until another movement is given. [1]

As a result of this project, the life of physically disabled people becomes less demanding. The main goal is to provide the user with a reliable and more natural technique for navigating the wireless robot in the environment using gestures. The proposed system will provide an intelligent system that can be controlled by hand gestures, an accelerometer works on the device, which has a transmitter and a receiver.

B. Emotion Detection

Emotion detection the use of an accelerometer is an era that makes use of records from an accelerometer to apprehend and classify emotional states based on the movement styles of the body. This era has potential applications in the diffusion of fields, consisting of intellectual health, human-pc interplay, and gaming. The accelerometer measures adjustments in acceleration and orientation of the tool or frame element and uses machine mastering algorithms to investigate this information and hit upon patterns which might be associated with unique feelings as instance, moves that are greater jittery or erratic can be related to anxiety, at the same time as slower moves can be associated with sadness or despair. [2]

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Here, the researchers tried to effectively detect emotions using a gaming application that many companies can benefit from for their advertising purposes. Researchers also consider certain assumptions, but they are not always true.

C. Enriching Heart Monitoring

Huge volumes of medical facts from frame sensors and advanced medical equipment must be processed and analysed by way of green structures. Consequently, they request to enhance the present ECG sign to add important information to the interpreter including ECG and accelerometer data. The accelerometer facts processing plan presents data about the affected person's pastime in addition to ECG records. [3]

It is an optional item that shows the relationship between actual and predicted position, and activity. It also provides the user with additional real-time information for better interpretation of ECG data. The model is suitable for users who use less strength like extra low-power sign processors or low-power radio communications with smartphones, such as personal devices.

D. Image Stabilization

The photograph stabilization machine makes use of algorithms to analyze the facts collected through the accelerometer and regulate the movement of the digital camera's photo sensor or lens to counteract any movement brought about by blur or distortion. While the digicam is moving, the digicam will pause vibrations to take a photograph. When the digicam continues to be, the picture is captured. The application of picture stabilization is glogger VS2.[4]

In this project, the researchers used high-precision gyroscopes inside the electronic photo stabilization device, not simplest solving the complex problem of the use of the movement vector size algorithm in digital photograph stabilization, however additionally may be universally prolonged. In addition, strong accuracy can be substantially expanded. All in all, it is a worthwhile endeavor.

E. Accelerometer and Surround Sound Technology: Making Touch Screen Mobile Devices Accessible

We discover the concept of the use of a mixture of surround sound and accelerometer era to allow blind

Customers to efficiently manipulate touch display screen gadgets. They discussed the challenges concerned with representing icons and the usage of sound and offered a layout framework that helps solve some of those issues. [5]

It is very useful for the blind to use the mobile touch screen effectively and this device also reduces reliance on others.

F. Drowsiness Detection System

A drowsiness detection gadget in an accelerometer is a generation that makes use of an accelerometer to hit upon while a driver is becoming drowsy or falling asleep while driving. The device works by using reading the movement facts accumulated by using the accelerometer and the use of algorithms to locate patterns which can be indicative of drowsiness. They used an accelerometer and a gyroscope.[6]

The principal gain of this tool is low energy intake and high accuracy. This also allows for lowering the demise price going on because of site visitor accidents that motivate drowsy drivers.

G. Human Activity Recognition

Activity popularity has received popularity in the field of wearable applications. Some of the regions which have benefited from the development of interest recognition are scientific fitness and tracking. The goal of the researchers become to recognize the consumer's interest in using a tool worn at the wrist. Human pastime popularity using an accelerometer is a technology that uses facts from an accelerometer to stumble on and perceive the sortof physical interest being completed by way of a person. This generation is commonly utilized in wearable gadgets, consisting of health trackers and smart watches, to tune and monitor bodily activity carried out via the purchaser. As soon as the activity is anticipated, it calculates the corresponding calories burned in keeping with interest.[7]

This tool could be very convenient for docs to constantly reveal sufferers. It facilitates to better hit-upon and screen sports which include strolling, brisk on foot, strolling and jumping. Additionally, the accuracy furnished by this device is better compared to others.

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IV. POSSIBLE APPLICATIONS

Epilepsy is a set of neurological proceedings considered via Epileptic Seizures; it is far experienced by means of 1% to 2% of the global population. 30% of the instances do now not reply to medications or surgeries. Therefore, the ability of an epilepsy-affected person calls for continuous monitoring with seizure detection methods. The first step in improving epilepsy treatment is to do a precise analysis, considering that epilepsy isn't the simplest ailment with one motive and one treatment, but as an alternative a ramification of diseases with one-of-a-kind treatments that specify themselves as epileptic crises.

There are many health issues in today's time but the most common and frequent is falling. Each year an estimated 6,84,000 individuals die from falls globally of which over 80% are in low and middle-income countries.

Epilepsy is mainly caused due to a sudden increase or decrease in heart rate, dizziness, light-headedness, blurred or double vision, and foot pain. As per the above-described problem statement, there is no effective epilepsy patient fall detection system to aware the nearby people and relatives. There is also not any system for the analysis of patient falls as per the various parameters of the doctor. Epilepsy is a neurological disorder marked by the sudden loss of consciousness.

To overcome this, it is possible to design and develop an "Epilepsy Patient Fall Detection System using an Accelerometer" for the development of the above-said fall detection system, an accelerometer and gyroscope can be used to detect the human body position across the coordinates (x, y and z) and the body tilt angle of the faller. By coupling the accelerometer with the gyroscope, the accuracy of the system can be improved.

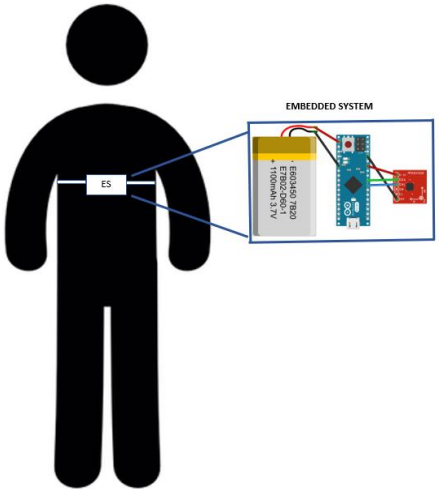

Fig.2: Person with Accelerometer

V. CONCLUSION

In this study, we have understood basic information about an accelerometer and analyzed various applications of an accelerometer. The analysis discussed the various application possibilities by using an accelerometer. This study and analysis motivate us to select an accelerometer for the development of the "Epilepsy Fall Detection System."

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PSY PATIENT FALL DETECTION SYSTEM AND
ITS ANALYSIS USING DATA SCIENCE
Shri Sant Gajanan Maharaj College of Engineering, Shegaon
Department of Information Technology
Background
There are many health issues in today's time but the most common and frequent is falling. Each year an estimated 6,84,000 individuals die from falls globally of which over 80% are in low and middle-income countries.
Problem Statement
Currently there is no effective epilepsy patient fall detection system to aware the nearby people and relatives.
There is also not any system for the analysis of patient fall as per the various parameters for the doctor.
Aurdino Nano 33 BLE
User Interface
Flow Chart
Objectives
To overcome above stated problem we are proposing the system which will help .
To effectively detect the fall of epilepsy patient to aware nearby people by a sound alert and relatives by a notification on mobile phones.
To doctor for treating the patient based on the patient body movement history and
Expected Outcome
An accelerometer-based fall detection system to alert the nearby by an alarm, and send an alert and location details to the caretakers by sending a notification.
Analysis of fall history for a better understanding of the patient's medical condition, to treat effectively.
Under the Supervision of
Prof. S. D. Padiya

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