Software Requirement Specification Document for Smart Movement Recognition

Sara Abdelfattah,Nourhan Ali ,Maha Fayez, Nour Tadros
Supervised by Dr.Mostafa Abdelsallam and Eng. Huda ElTouny

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1 Introduction

1.1 Purpose of this document

The purpose of this Software Requirements document is to present a detailed description of Smart Movement Recognition. In this project, we detect the patients activity as falling and tremor by using the accelerometer sensor. Also, we detect the hand gesture for blind. Every gesture has a related move that will help blind people to deal with things easily. The accelerometer API will have access to the accelerometer using real-time classification for stream data from accelerometer, then according to this classification alert will be sent to doctors/nurses with notifications. The doctor/nurse must accept the notification when they reach the corresponding patient. It will consist of one mobile application accessible with any android phone. Furthermore, this document will illustrate the features and purposes of this project.

1.2 Scope of this document

Smart Movement Recognition system aims to help doctors to detect and predict abnormal behavior the patient will do as falling and tremor. Also, hand gestures is made for blind to help them to deal with things easily.

1.3 Overview

Smart Movement Recognition is to detect patient's activity and helping him rapidly if something went wrong. Detecting the abnormal behavior of patient play a vital role in hospitals and will help doctors and nurses to be more careful to the patients. The project aims to enhance the accuracy of detecting patient abnormal behavior as falling and tremor, through a mobile application using the accelerometer sensor. This sensor will send classified readings to doctors

and nurses if any thing went wrong to help patient.

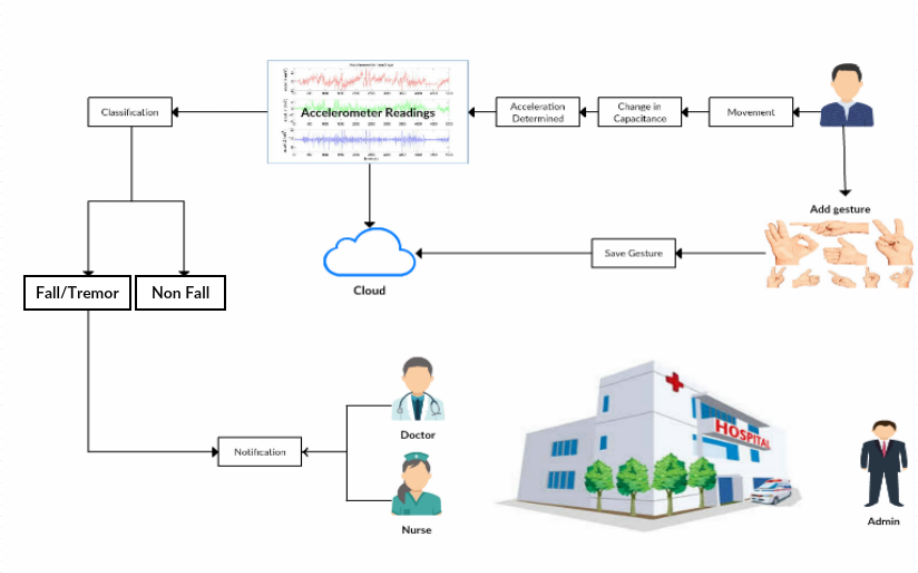
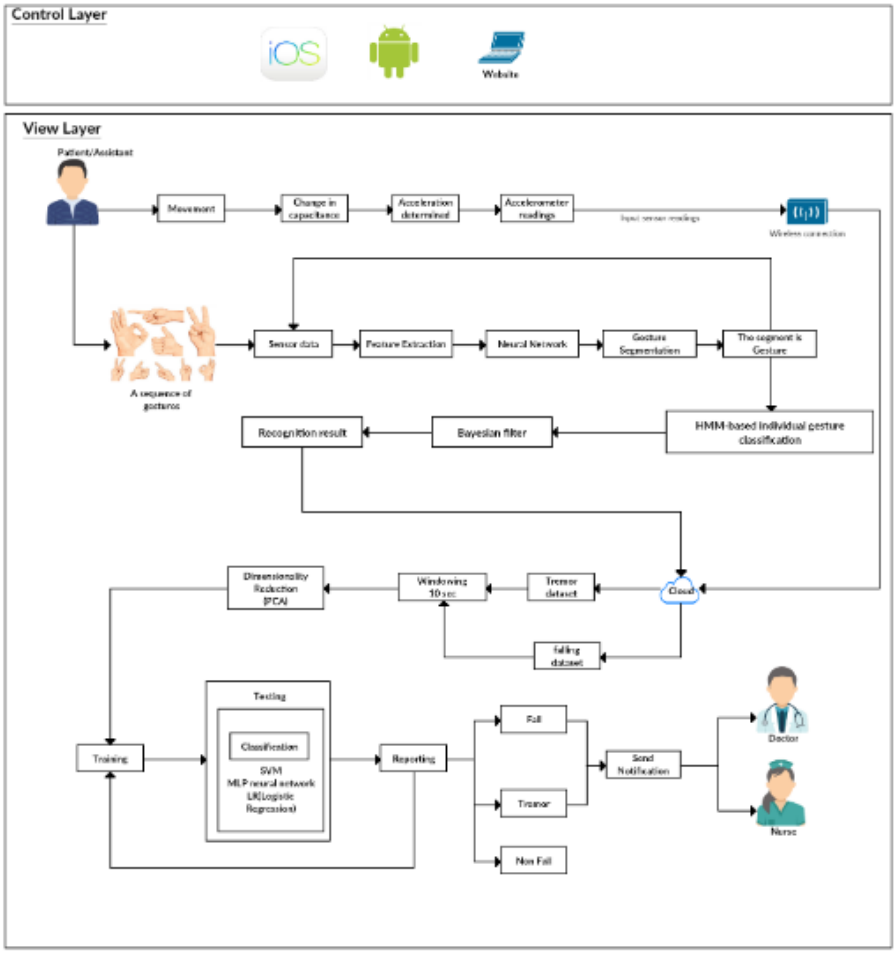


Figure: System Overview.

1.4 Business Context

Detecting patient abnormal activity and hand gesture for blind are an important researches nowadays, as most of the hospitals need this application to help them to take care of patients by a mobile application instead of continues monitoring the patient. Moreover, most of the housing for the blind need this application to facilitate their life and help them live in easier way.



blockdiagram.PNG
Figure: Block Diagram.

2 General Description

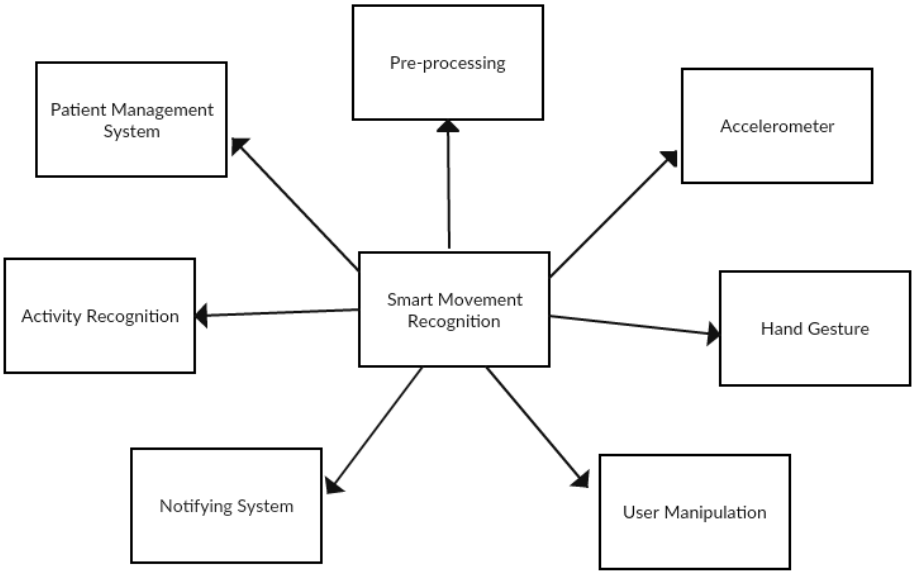


Figure : context diagram

2.1 Product Functions

1- Accelerometer:
-Wearable sensor get the stream of patient movement.
-If detecting any unusual in stream.
-Classify the reading and send notification to doctor/nurse/assitant.
-Blind/elder people make the desired gesture using the wearable sensor.
-After the gesture is added, the person can do the added gesture to reach the action needed.

2-Hand Gesture:
-Person make gesture that relate to the desired action he wants.
-Every person has the ability to has his own gesture to do a certain thing.
-The assistant helps the person in need to add his own gesture or use the generic ones.
The assistant can add/edit/delete/list/search the gestures.

3-User Manipulation:
-Doctor can add patient including(personal data, history health and symptoms).
-Doctor can search for a patient if it is already added.
-Doctor can edit after getting record of patient including(personal data).

-Doctor can delete patient from system.
-admin can add/delete/edit/list/search (doctors/nurses).

4-Notifying System:
-Doctor/nurse receive notification.
-Doctor/nurse accept notification.

5-Activity Recognition:
-Get data from sensor
-Detect and classify patient's activity as falling or non-falling and tremor.

6-Pre-Processing:
-Change in capacitance Acceleration determined Stream produced then take accelerometer readings.

7-Patient Management System:
-Doctor can add patient Data.
-Doctor/Admin can edit/delete/list/search for a patient.

2.2 Similar System Information

The first similar system: In the past years, Activity Recognition Using Sensor And Machine Learning Classifiers[1], publish the detection of normal and abnormal by using Acceleometer sensor places in smart phones. Using publicly available dataset, takes the features of signals based on time and frequency and PCA used to help in ltering features and extract the most signicant ones that detect human activities as falling, abnormality detection and prediction of human behavior. PCA based features obtained higher recognition rate while frequency domain features have higher accuracy with rate 96.11% and 92.10%.GA accuracy 75% BFS.From the overall results, Multi-layer Perceptron Neural Network shown to has the highest accuracy compared to other classifier.
The ssecond similar system: Hand gesture recognition interface for visually impaired and blind people[2], was proposed an easy-learned text input solution that enables visually impaired and blind people to interact with wearable systems. The data was recorded by directly intercepted USB reports. each event is timestaped by the system. In each condition a common processing was done in order to pair a group of changes in X and Y axis. They use WEKA dataset that stores the structure of the sample. Algorithms used are Naive Bayes Algorithm, HMM, Neural Networks, Decision trees, Support-Vector Machines, k-nearest neighbor. The best results based on a SVM with a polynomial kernel and RZR (94.29%).
The third similar system: The last decade has seen a huge interest in classification of time series. Most of this work assumes that the data resides in main memory and is processed offline [3]. time series bitmaps, can be implemented as efficient classifiers which can be updated in constant time and space in the

face of very high data arrival rates. They used robot datasets, The data used to generate the results follow a similar overall trend as the results generated from running our algorithm on a test set 100 times as large and a training set 10 times as large. And the used Beet Leafhopper Behavior Dataset The classification results of the beet leafhopper behavior problem largely agree with expectations and the phloem phase behavior is classified correctly (64.93%) of the time, which is much higher than the phloem phase accuracy of (42.56%). They have demonstrated that an amnesic algorithm can accurately detect complicated patterns in the erratic sensor data from an important entomological problem. the algorithm is fast and accurate. The fourth similar system: Accelerometer and gyroscope could provide information directly fig[7]. Sensor measurements could be used to distinguish a real fall [4]. The wearable device will be mounted on human's waist at first to reflect the motion of human body closely fig[6]. As normal activity of resting also has similar rotation as falling, it may trigger fall alarm when the body hits ground heavily. So the choice of a threshold is quite important to distinguish falling from heavily lying activity. Threshold based fall detection algorithm will be used in this system.

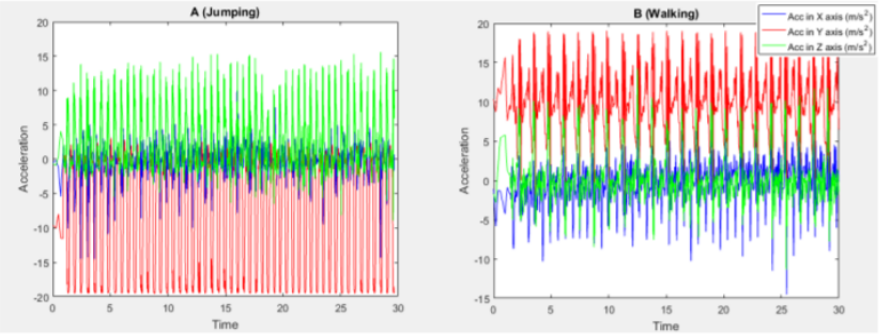
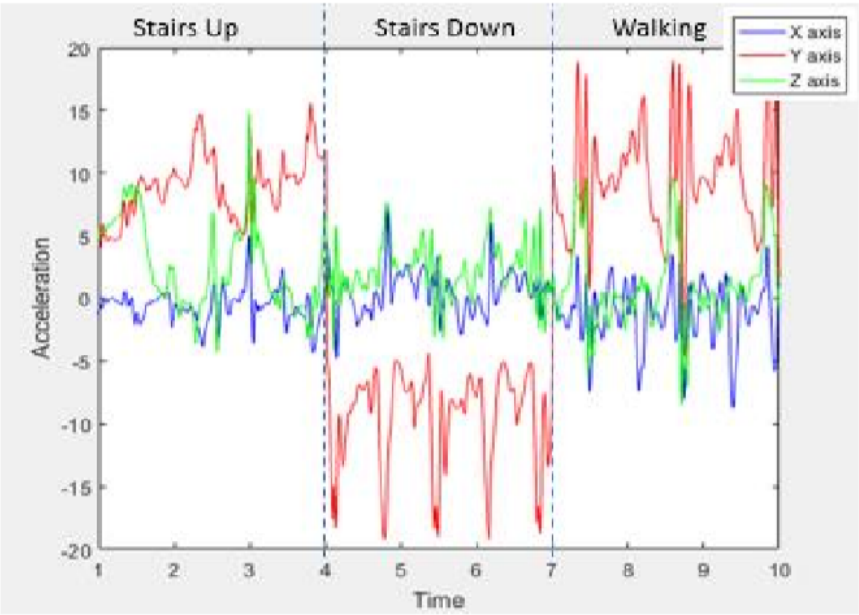
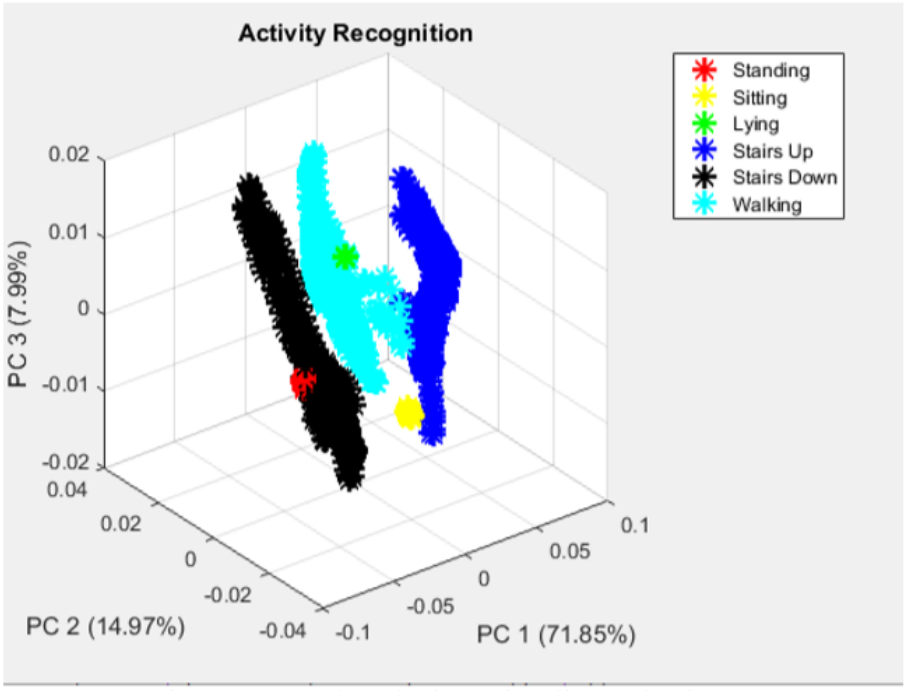


Figure 1. Raw Signal Captured by Accelerometer

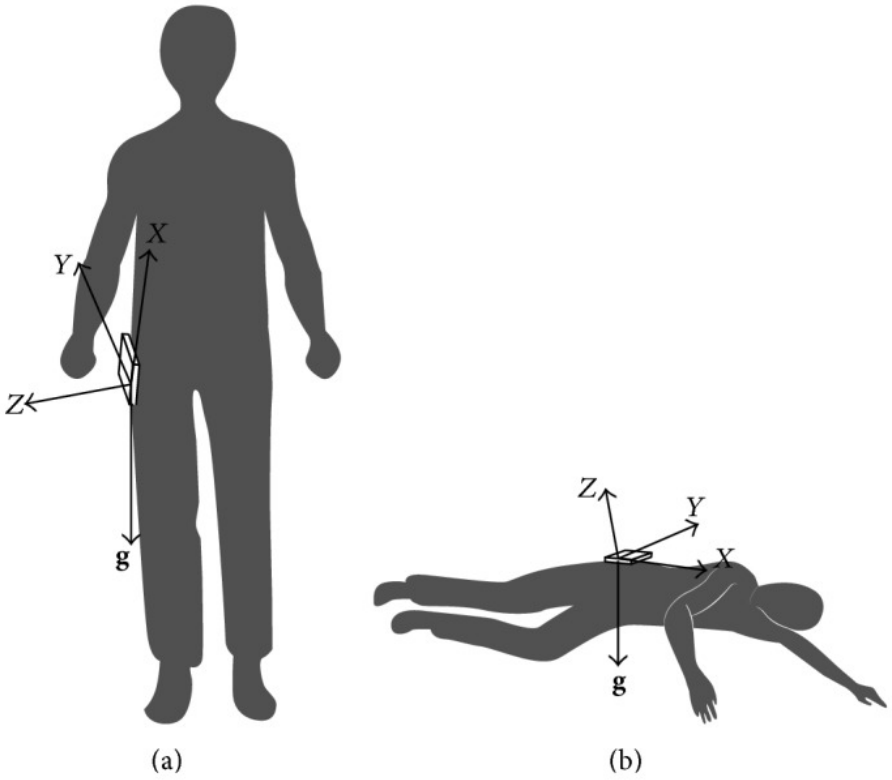
fig[1]



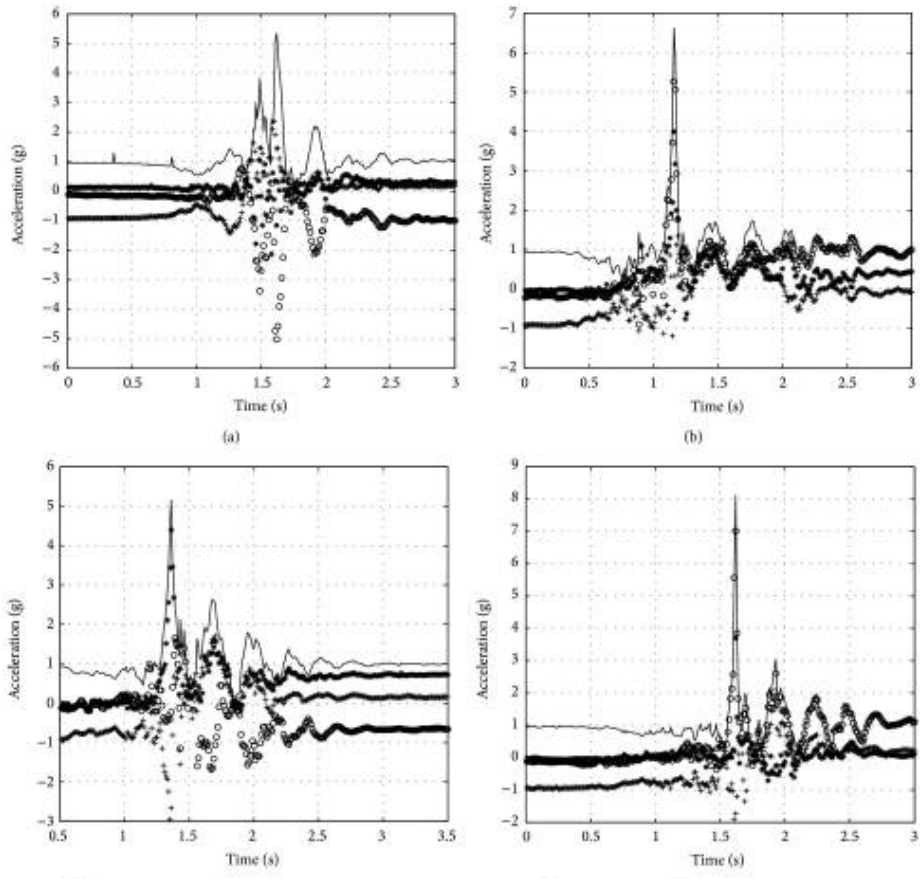
fig[2] Hand gesture recognition interface for visually impaired and blind people[2], was proposed hand gesture recognition interface to ease interaction with visually impaired and blind people. They use WEKA dataset that stores the structure of the sample. The best results based on a SVM with a polynomial kernel and RZR (94.29%).


Activity Recognition
Standing
Sitting
Lying
Stairs Up
Stairs Down
Walking
PC 3 (7.99%)
0.02
0.01
0
-0.01
-0.02
PC 2 (14.97%)
0.04
0.02
0
-0.02
-0.04
PC 1 (71.85%)
-0.1
-0.05
0
0.05
0.1

fig[3]



fig[6]



fig[7]

2.3 User Characteristics

1. Doctor: should have the basic knowledge of using android devices and web browsers.
2. Admin/Nurse: should have the basic knowledge of using android devices and web browsers.
3. Assistant: should have the basic knowledge of using mobile phones.

2.4 User Problem Statement

Differentiate between each abnormal activity characteristics. Discriminate between falls, non-fall and tremor.Enhance the accuracy of identifying and detecting falling and tremor. Hand Gesture differentiate between hand gesture and enhance the accuracy of identifying and detecting gesture of each activity.

2.5 User Objectives

Detecting and identifying patients falling and tremor activities and hand gestures.

2.6 General Constraints

Mobile application applicable for android mobile devices only.

3 Functional Requirements

3.1 User class: Doctor

3.1.1 LoginUser

Description Each user logs into his account.	
Action	Checks if all elds are lled and if so compares data entered to that in the database records.
Input	Email and password.
Output	The homepage is previewed and log in successful message or error message upon validating elds.
Precondition	User is already registered in the database.
Post-condition	Redirected to the homepage.
Dependencies	User Added.
Priority	10/10.

3.1.2 recieveNotification

Description	The doctor receives notification when there is an abnormal activity from the patient.
Action	The system should alert the doctor about the patient's current medical status.
Input	accelerometer vector readings (x,y,z).
Output	Alert the doctor with a notication about a specific patient due to his abnormal activity.
Precondition	Patient's medical history.
Post-condition	Accept the notification.
Dependencies	.
Priority	10/10.

3.1.3 acceptNotification

Description	The doctor accepts the notification when the doctor reaches to the needed patient.
Action	Sends conrmation of request acceptance to the doctor, and retrieves the patients location details.
Input	None.
Output	Patients location details.
Precondition	At least one patient has a classified abnormal behavior to send and receive the notification.
Post-condition	None.
Dependencies	recieveNotification.
Priority	10/10.

3.1.4 CRUD Patient

Description	This function is responsible for the user manipulation (Name, Age, Gender, Telephone, User Type(patient), Previous Diseases, Current Disease, Symptoms). The CRUD includes(add,edit,delete,search and list).
Action	Check if all the fields are filled correctly and pass them as new record in the database accordingly.
Input	Name, Age, Gender, Telephone, User Type(patient), Previous Diseases, Current Disease, Symptoms.
Output	Confirmation message or errors message if something went wrong.
Precondition	None.
Post-condition	Database is updated with patient's information.
Dependencies	None.
Priority	10/10.

3.2 User class: Nurse

3.2.1 recieveNotification

Description	The nurse receives notification when there is an abnormal activity from the patient.
Action	The system should alert the nurse about the patient's current medical status.
Input	accelerometer vector readings (x,y,z).
Output	Alert the nurse with a notication about a specific patient due to his abnormal activity.
Precondition	Patient's medical history.
Post-condition	Accept the notification.
Dependencies	.
Priority	10/10.

3.2.2 acceptNotification

Scope	
Description	The nurse accepts the notification when the doctor reaches to the needed patient.
Action	Sends conrmation of request acceptance to the nurse, and retrieves the patients location details.
Input	None.
Output	Patients location details.
Precondition	At least one patient has a classified abnormal behavior to send and receive the notification.
Post-condition	None.
Dependencies	recieveNotification.
Priority	10/10.

3.3 User class: Admin

3.3.1 CRUD Doctor

Description	This function is responsible for the user manipulation (Name, Age, Gender, Telephone, User Type(doctor). The CRUD includes(add,edit,delete,search and list).
Action	Check if all the fields are filled correctly and pass them as new record in the database accordingly.
Input	Name, Age, Gender, Telephone, User Type(doctor).
Output	Confirmation message or errors message if something went wrong.
Precondition	None.
Post-condition	Database is updated with doctor's information.
Dependencies	None.
Priority	10/10.

3.3.2 CRUD Nurse

Description	This function is responsible for the user manipulation (Name, Age, Gender, Telephone, User Type(nurse).
Action	Check if all the fields are filled correctly and pass them as new record in the database accordingly.
Input	Name, Age, Gender, Telephone, User Type(nurse).
Output	Confirmation message or errors message if something went wrong.
Precondition	None.
Post-condition	Database is updated with nurse's information.
Dependencies	None.
Priority	10/10.

3.3.3 deletePatient

Scope	
Description	The admin deletes a patient's account from the system.
Action	Checks for the selected patient's record in the database to be deleted.
Input	Patient's name.
Output	Conrmation message or error message if something went wrong upon removing the patient from the system.
Precondition	Desired patient is already registered in the database.
Post-condition	Desired patient's record is removed from the database.
Dependencies	addPatient.
Priority	9/10.

3.3.4 listingPatients

Scope	
Description	The admin lists all the patients found in the system.
Action	Retrieves information about the patients registered from the database.
Input	User Type.
Output	All patients registered with their information are shown.
Precondition	At least one patient is registered in the database.
Post-condition	None.
Dependencies	addPatient.
Priority	8/10.

3.3.5 searchingPatient

Description	The admin searches for a desired patient.
Action	Retrieves information about the patient, whose name has been entered by the admin, from the database.
Input	Patient's name.
Output	The desired patient's information is shown.
Precondition	Desired patient is already registered in the database.
Post-condition	None.
Dependencies	addPatient.
Priority	8/10.

3.4 User class: Assistant

3.4.1 addGesture

Description	The assistant helps the person to add gesture to the system.
Action	Check if the gesture is done correctly and filled with it's action and added in the database accordingly.
Input	Gesture movement and gesture name.
Output	Confirmation message or error message if something went wrong.
Precondition	None.
Post-condition	Database is updated with person's gesture information.
Dependencies	None.
Priority	10/10.

3.4.2 StartGesture

Description	The assistant press start which allows the person to make his own gesture.
Action	The person starts the motion of his own gesture.
Input	Accelerometer vector reading(x,y,z).
Output	The readings of the gesture from accelerometer.
Precondition	Personal profile.
Post-condition	Press end button to stop taking readings from accelerometer.
Dependencies	addGesture.
Priority	10/10.

3.4.3 EndGesture

Description	The assistant press end gesture after the person make the gesture.
Action	The person stops the gesture motion .
Input	None.
Output	The gesture from the person.
Precondition	Starting the gesture motion.
Post-condition	Gesture is added.
Dependencies	StartGesture.
Priority	10/10.

3.4.4 submitGesture

Description	The desired gesture is uploaded in the database.
Action	The desired gesture after the movement been made is uploaded and saved in the database.
Input	Gesture.
Output	The gesture is saved.
Precondition	The person's movement is made.
Post-condition	Gesture's name is added.
Dependencies	addGesture.
Priority	10/10.

3.4.5 editGesture

Description	The assistant helps the person to edit his gesture to the system.
Action	The information changed and updated to the corresponding attribute in the person's record in the database.
Input	Any of the following: Gesture Name or movement.
Output	Confirmation message or error message if something went wrong in updating corresponding doctor's attribute.
Precondition	Desired person's information is already registered in the database.
Post-condition	Desired person's record in the database is updated with the new information.
Dependencies	addGesture.
Priority	9/10.

3.4.6 deleteGesture

Description	The assistant deletes a gesture's account from the system.
Action	Checks for the selected gesture's record in the database to be deleted.
Input	Person's profile.
Output	Conrmation message or error message if something went wrong upon removing the gesture's information from the system.
Precondition	Desired gesture is already registered in the database.
Post-condition	Desired gesture's record is removed from the database.
Dependencies	addGesture.
Priority	9/10.

3.4.7 listingGesture

Description	The assistant lists all the gestures of the person found in the system.
Action	Retrieves information about the gestures registered from the database.
Input	Profile ID.
Output	All gestures registered with their information are shown.
Precondition	At least one gesture is registered in the database.
Post-condition	None.
Dependencies	addGesture.
Priority	8/10.

3.4.8 searchingGesture

Description	The assistant searches for a desired gesture.
Action	Retrieves information about the person's profile, whose information has been entered by the assistant, from the database.
Input	Gesture Name.
Output	The desired gesture's information is shown.
Precondition	Desired gesture is already registered in the database.
Post-condition	None.
Dependencies	addGesture.
Priority	8/10.

3.4.9 showProfile

Description	The assistant of the person opens his personal dataset with his personal information.
Action	The assistant opens the profile to add,edit,delete,show or search for specific gesture.
Input	Profile ID Number.
Output	The profile is fully shown.
Precondition	Personal information and gestures are already added in the database.
Post-condition	All personal information and dataset are shown.
Dependencies	addGesture, editGestue, deleteGesture, listGestures, searchGesture.
Priority	10/10.

3.5 System Requirements

3.5.1 Classify

Scope	
Description	Classifying the dataset
Action	the Logistic Regression, Linear SVM and MLP Neural Network algorithms to classify accelerometer readings.
Input	Array(x,y,z).
Output	Classified dataset.
Precondition	None.
Post-condition	None.
Dependencies	None.
Priority	10/10.

3.5.2 Encryption

Scope	Non-Functional
Description	This function is to encrypt our data to keep it secured.
Action	Encrypt data using algorithm.
Input	String.
Output	String.
Precondition	Data is raw.
Post-condition	Data is encrypted.
Dependencies	All inherited classes.
Priority	9/10.

3.5.3 Decryption

Scope	Non-Functional
Description	This function is to decrypt our data to keep it secured.
Action	Decrypt data using algorithm.
Input	String.
Output	String.
Precondition	Data is encrypted.
Post-condition	Data is back to normal string.
Dependencies	All inherited classes.
Priority	9/10.

3.5.4 updateNotification

Description	This function is used to update the notification with the information.
Action	Notification is updated with information.
Input	Information of the person in need.
Output	The notification window with the information.
Precondition	Person in need with accelerometer classifying abnormal reading.
Post-condition	Doctors/Nurses recieve the notification with the information.
Dependencies	Classify.
Priority	9/10.

4 Interface Requirements

4.1 User Interfaces

4.1.1 GUI

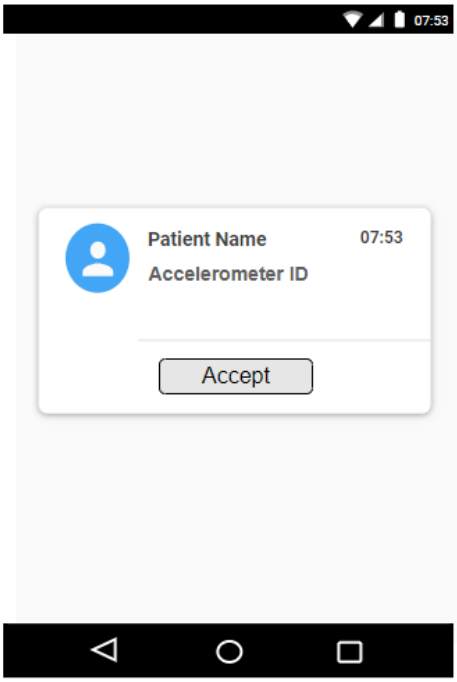


Figure Notification received to doctor.

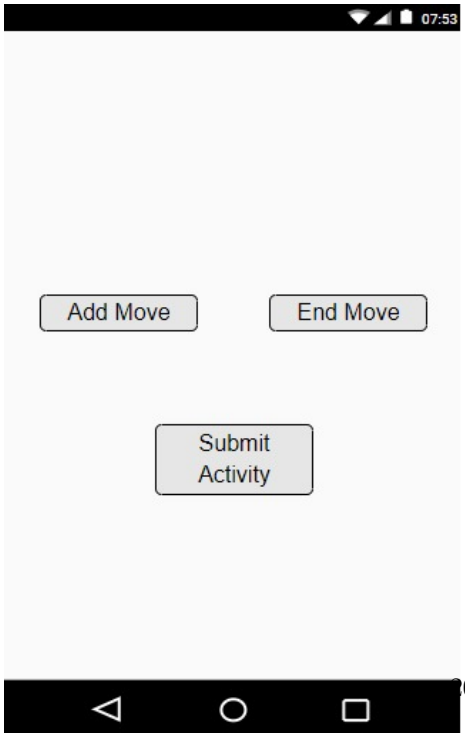


Figure Create new Gesture.

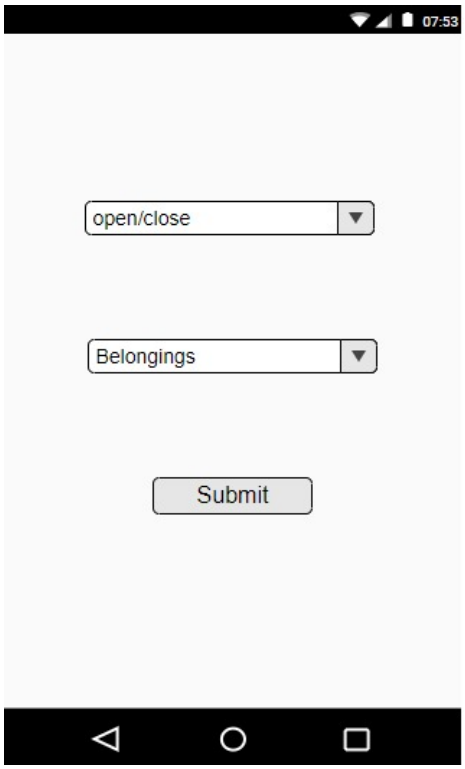


Figure Submit gesture.

4.1.2 API

1. Pandas(0.23.4)
2. Sklearn(0.0)
3. Numpy(1.15.4)
4. Matplotlib(3.0.2)
5. Accelerometer
6. Google Login API

4.2 Hardware Interfaces

Accelerometer which is a sensor for measuring the acceleration of moving or vibrating body.

4.3 Communications Interfaces

Cloud Storage is the storage of data online in the cloud. Data is stored in and accessible from multiple distributed and connected resouces.

4.4 Software Interfaces

Sign in using google API. Google API is a set of application programming interfaces (APIs) developed by Google which allow communication with Google Services and their integration to other services.

5 Performance Requirements

Short response time, notification must be exactly after the detection which is between 3 to 10 seconds.

6 Design Constraints

This system needs to be user friendly to ease the process of achieving the required tasks by the doctors as a result of their lack of professional computer skills.

6.1 Software Limitations

The application runs on android.

7 Other non-functional attributes

7.1 Security

Data of the patient is encrypted. Also, the profile of each person's dataset is encrypted.

7.2 Reliability

The readings of Accelerometer sensor should have high accuracy.The system's performance would be high and aims to detect commands on real-time processing.

7.3 Usability

The system can be used by specified consumers to achieve quantified objective with effectiveness.The patients/blind/elder people will not interact with the system, they will have the wearable accelerometer that would be classified according to their activities or gestures. However, the doctor/nurse/assistant are the ones who would interact with the system as the system have understandable and few buttons to help them know which button to press at the moment.

7.4 Maintainability

The system maintainability should be easy so, the system could be improved by different developers and in this project we using MVC to ensure the maintainability.

7.5 Portability

The system can be deployed on supported android systems.

8 Preliminary Object-Oriented Domain Analysis

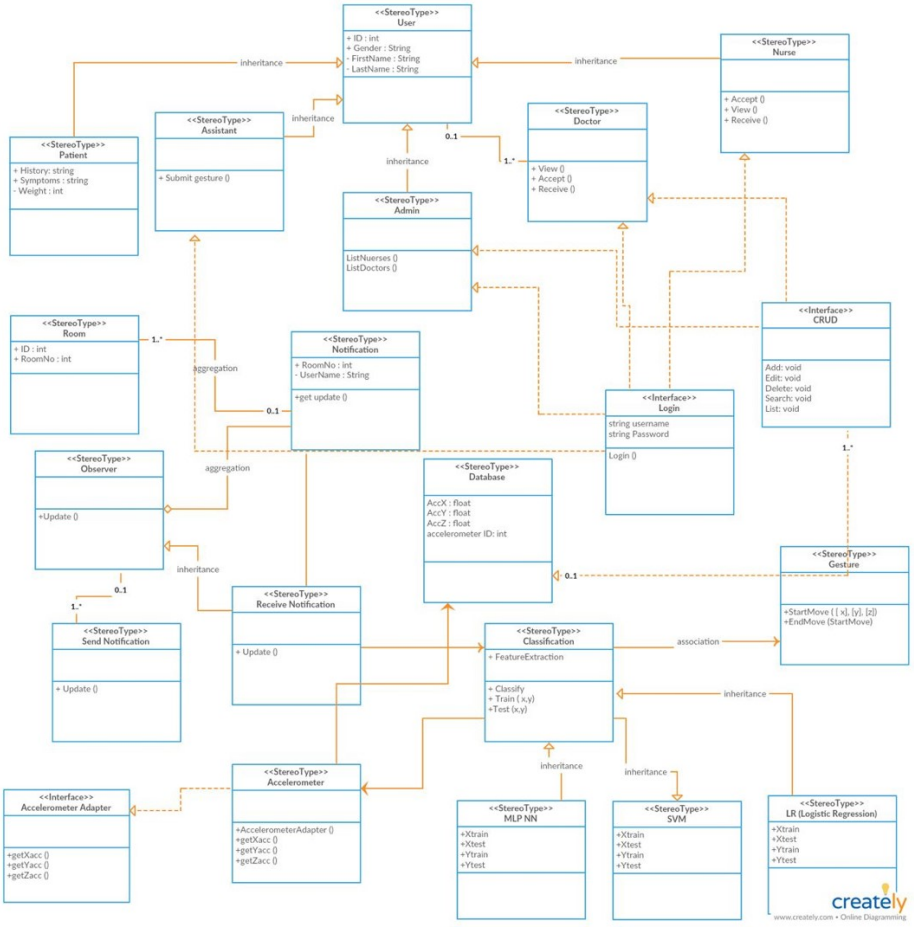
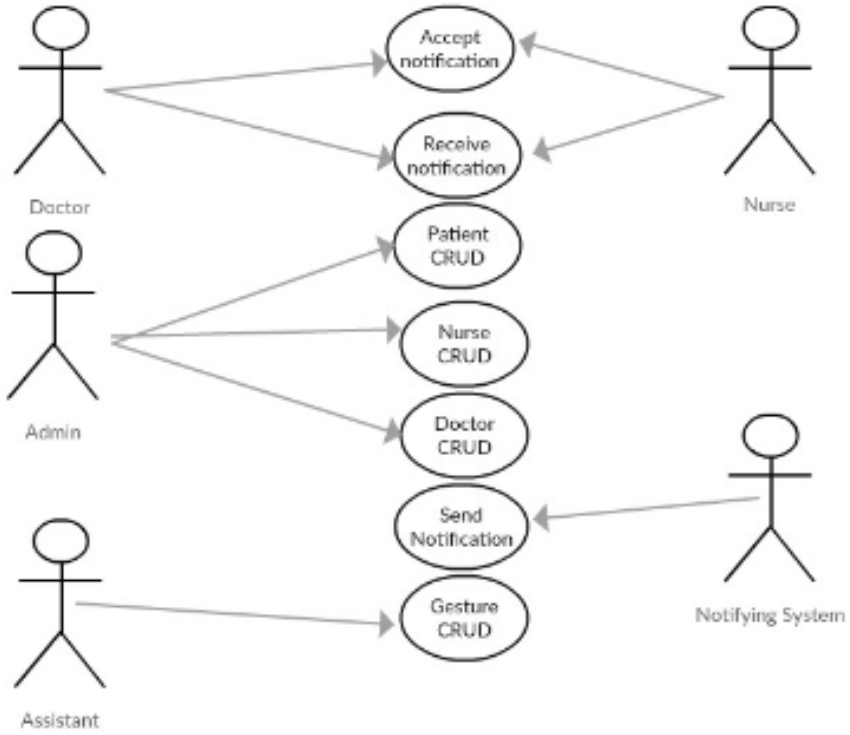


Figure: Class Diagram for the system.

9 Operational Scenarios



Use Case Diagram for System

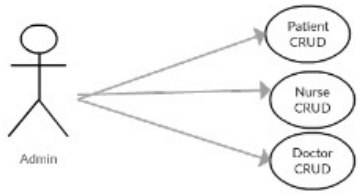
First, The admin opens a form which can add doctor/patient/nurse by filling a form and check that all data is filled correctly then show the added data. This data can be edited by editing the desired fields or deleted by searching for desired person and delete his account from system. Secondly, doctor and nurse accept notification which means that a certain doctor or nurse going to help a certain patient. Also, they receive notification about patient's status and The notifying system send notifications to the Doctors and nurses. Thirdly, the assistant who helps the blind person or elderly person to add his own gesture to help him in doing a certain things. The assistant also can help him to edit the added gesture or delete it. Furthermore, the assistant can search for a desired gesture or list all gestures.

9.1 Scenario

Here will be illustrated some of the scenarios that are shown in the systems use case diagram.

9.1.1 Scenario 1: Admin

The user included in this scenario is the admin. The admin is in control of all users manipulation in the system. The admin can add doctor/patient/nurse information. This information can be edited or deleted. Also, the admin lists all users and search for a desired person.



Use Case Diagram for Admin.

9.1.2 Scenario 2 : Doctor

The user included in this scenario is the doctor and nurse. The doctor/nurse receives a notification sent after the classification of accelerometer about an abnormal behavior of a patient and by accepting it, the application shows the room number and information about the patient.

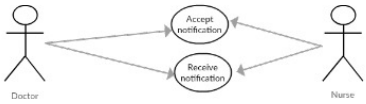


Figure: UseCase Diagram for Doctors and Nurses.

9.1.3 Scenario 3: Assistant

The use included in this scenario is the Assistant. The assistant helps the blind person or elderly person to add his own gesture to do specific movement. This gesture can be edited or deleted. Moreover, assistant can list all gestures and search for a desired one.

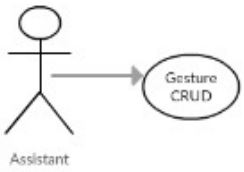


Figure: Use Case Diagram for Nurses.

9.1.4 Scenario 3: Notifying System

The use included in this scenario is the Notification system,it sends notifications to the doctors and nurses then they receive accept it.

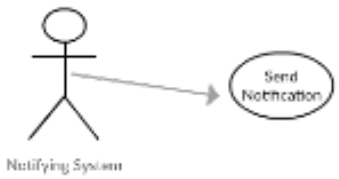


Figure: Use Case Diagram for the Notifying System.

10 Preliminary Schedule Adjusted

Name of Task	Start	End
Project Idea	15/8/2018	2/9/2018
Public Survey	20/9/2018	24/9/2018
Proposal Document	20/9/2018	27/9/2018
Proposal Presentation	26/9/2018	4/10/2018
SRS Document	1/11/2018	11/11/2018
SRS Presentation	20/11/2018	29/11/2018
Survey Paper	30/11/2018	3/12/2018
Implementation	1/12/2018	1/4/2019
SDD Document	15/1/2019	2/2/2019
SDD Presentation	10/12/2018	15/2/2019
Submit Survey Paper	1/12/2018	1/1/2019
Application Implementation	9/1/2019	25/4/2019
Thesis Paper	1/6/2019	25/6/2019
Final Presentation	25/6/2019	27/6/2019

Figure: Time Schedule.

11 Preliminary Budget Adjusted

Item	Quantity	Price
Accelerometer	1	1,000 LE
AWS lambda cloud storage	Per GB	$0.00001667

Figure: Initial Budget.

12 Appendices

12.1 Definitions, Acronyms, Abbreviations

1. The Accelerometer API - provides access to the acceleration data measured by the hardware sensor.

2. PCA - Principal component analysis.

3. GA - Generic Algorithm.

4. BFS - Breadth-first search.

5. HMM - Hidden Markov models.

6. SVM - Support vector machine.

7. MVC - Model View Controller.

8. CRUD - ADD/EDIT/DELETE/SEARCH/LIST

13 References

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