Elderly Patient Monitoring System

Project ID: 17-105

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ELDERLY PATIENT MONITORING SYSTEM

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Software Requirement Specification

(Software Requirement Specification Documentation submitted in partial fulfilment of the requirement for the Degree of Science Special (honors) In Information Technology)

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Declaration

I declare that this is my own work and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate is carrying out research for the undergraduate Dissertation under my supervision.

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Table of Content

Contents

Declaration 3
Table of Content 4
1 Introduction 8
1.1 Purpose 8
1.2 Scope 8
1.3 Definitions, Acronyms, and Abbreviations 10
1.4 References 11
1.5 Overview 11
2 OVERALL DESCRIPTION 14
2.1 Product Perspective 18
2.1.1 System interfaces 22
2.1.2 User interfaces 22
2.1.3 Hardware interfaces 25
2.1.4 Software interfaces 27
2.1.5 Communication interfaces 27
2.1.6 Memory constraints 27
2.1.7 Operations 27
2.1.8 Site adaptation requirements 28
2.2 Product functions 28
2.2.1 Use Case Diagrams 29
2.2.2 Use Case Scenarios 29
2.3 User characteristics 34
2.4 Constraints 35
2.5 Assumptions and Dependencies 35
2.5.1 Assumptions 35
2.5.2 Dependencies 35
2.6 Apportioning of Requirements 36
3 System Requirements 37
3.1 External Interface Requirements 37
3.1.1 User Interfaces 37
3.1.2 Hardware Interfaces 38
3.1.3 Software Interfaces 40

3.1.4 Communication Interfaces 41
3.2 Classes/ Objects Diagram 41
3.3 Performance Requirements 42
3.4 Design Constraints 42
3.5 Software system attributes 42
3.5.1 Reliability 42
3.5.2 Availability 42
3.5.3 Security 43
3.5.4 Maintainability 43

List of Figures

List of Tables

Table 2.1 Comparison of Existing Systems 18

1 Introduction

Importance of the Software Requirements Specification (SRS) document is to provide all the necessary information which are related to the requirements of the related system. Detailed description of what the system is about and how to use the system will be included in the SRS document for all the users who are willing to interact with the system. This document will also be in the favor of the software engineers, quality assurance engineers for building and maintaining the system. Vision and the scope of the system will be stated in the SRS document while system overview will describe what the system is all about. For better understanding of the readers, all the functionalities and the user interactions are going to be stated in this document.

1.1 Purpose

The purpose of this SRS document is to identify and analyze the functional and non-functional requirements for the proposed system Patient Monitoring System. Detailed description of the technology and the research background of the system will be provided by this document. It will explain the purpose and the features of the system, the main interfaces of the system, the design processes used, how the users are going to interact with the system and the constraints under which it must operate.

This document is developed after a thorough background study conducted by the project group regarding the requirements of the specified project. The final product of this project will meet the requirements specified in this document. The targeted audience of this document are the end users of patient monitoring system and also the developers who will be engaged in developing and maintaining this system in future.

1.2 Scope

This document covers the requirements for developing a system that is able to help elderly patients who are having respiratory problems. This describes the functionalities, software requirements, hardware requirements, related research findings and the technological challenges that the system must overcome. And also the overview of the project, along with its goals, tasks,

users and research areas. It provides the clear overall design of the system which will provide the basis for developing the final product.

Functional requirements will convey specific functionalities, tasks or behaviors of the system and non-functional requirements will be the constraints, performance factors, etc. The requirements mentioned in this document may change as the project team go through the development process.

Patient Monitoring System consists of four major components such as Respiratory Sound Analysis And drug reminder, sensor configuration and anomaly detection via sensor inputs, abnormality detection of behaviors and abnormality detection in emotions. System will be having a mobile application for the drug reminder component and to inform the caregiver regarding abnormalities of the patient.

This proposed system can be effectively used to monitor multiple necessary facts about the patient's health. There are several computerized monitoring systems available to date, but which are lack of many mandatory features worth to their extreme cost. Therefore proposed system will be ideal solution to monitor the elderly patient who are suffering from respiratory issues. Heart rate or the pulse is a parameter to check the health of a person regardless of age or gender. Monitoring such thing in patients who are having respiratory issues is as much as important due to frequent changes in heart rate. Very low heart rates, frequent fast heart rates or irregularity in heart rate are mostly due to abnormality of the patient's body and caregiver should inform the doctor in case of such incident. Blood oxygen saturation level (Sp02) or the percentage of the oxygen amount in the blood is another health parameter which can be advantageous in monitoring the patients with respiratory issues. It is a must to identify the normal SpO2 level of such patient with the help of a doctor and keep monitoring it to avoid adverse events. Patients with respiratory problems are lacking the ability to take oxygen in to their bodies easily and they are putting extra effort in breathing to gain more oxygen. Therefore component of sensor configuration and anomaly detection via sensor inputs can be used to identify abnormalities in heart rate and the SpO2 level of the patient. Patients with respiratory issues are having restlessness in case of a situation where they need more oxygen. Restless patients tent to change their position in the bed to gain more oxygen in to the body. Even the pose can be changed with amount of the oxygen that

the patient require at the given time. Component abnormality detection of behaviors and abnormality can be used to clarify the normal behaviors and the abnormal behaviors of the patient respective to the time. Unknown observations should be identified as an abnormal behavior. Emotions can state the stress level, anger, sadness and many other feelings which should be classified as normal and abnormal. Therefore caregiver should have the responsibility of focusing on the emotions of the patients in every possible second. With the help of component abnormality detection in emotions, it will be easier to identify any anomalies in the emotions of the patients. Auscultation or the listening to the internal sounds using a stethoscope is an effective way of diagnosing the respiratory sounds and identify related diseases in the respiratory system. But identification of respiratory sounds and separate them as normal and abnormal is not an easy task to perform and it requires a skill level of a well-trained physician. Respiratory Sound Analysis component will be implemented to listen and understand the nature of the respiratory sounds with relevant classification mechanisms. Elderly patients should not be treated with the wrong drugs irrespective of any disease. It will affects the health level of the elderly patient immensely. Therefore drug reminder component will notify the caregiver in order to give the right dose of right drug at the right time.

1.3 Definitions, Acronyms, and Abbreviations

ELPS	Elderly Patient Monitoring System
SRS	Software Requirement Specification
OS	Operating System
PC	Personal Computer
FFT	Fast Fourier Transformation
RAM	Random Access Memory
SVM	Server Vector Machines
IT	Information Technology

QA	Quality Assurance
SpO2	Percentage of oxygenate hemoglobin

1.4 References

The references relevant to the SRS document will be stated at the end of this document.

1.5 Overview

This document is intended to describe about the development of The Patient Monitoring System which will be effective in monitoring the patients with respiratory issues.

Main Goals

- To implement an inexpensive, efficient and a reliable system which can effectively monitor elderly patients who are having respiratory problems and detect anomalies in order to minimize adverse events.

- To eases up the duties of the family caregiver where he/she can manage the day to day work while taking care of the patient and can save the amount of cost which is needed for a separate caregiver or a nurse.

Tasks

- Features will be extracted for classification in order to identify normal and abnormal respiratory sounds.
- Respiratory sounds should be classified.
- Train the module by providing data related to drugs of the patient and notify the responsible person regarding drug taking.
- Setting up suitable sensors according to the physical parameter such as heart rate and spo2 is required.

- Analysis of the heart rate is necessary to monitor the arrhythmia.
- Further analysis on differentiation of the SpO2 is required.
- Anomalies in the heart rate and the SpO2 should be detected according to the analysis using a signal processing technique.
- Features in emotions of the patients should be identified for further extraction.
- Extracted features should be classified in order to detect anomalies.
- Finally the responsible person should be notified in case of an abnormality in emotions.
- Data of both the normal and abnormal behaviors of patients should be collected.
- Categorize the set of behaviors based on the state of the patient in order to create different profiles for patients in different health conditions.
- Construct a classification model for detecting the behavioral abnormalities.

People who are having bedridden patients in their home will be directly benefited with the proposed system. Elder's homes and Elder care agencies will be assisted by the suggested patient monitoring system.

Chapter 1: Explains the purpose of preparing the SRS document. In this chapter, the scope of the project is clearly described indicating what the researchers will do and will not do in the implementation of the system. It also describes the benefits, objectives and the goals of the particular software. The overview explains how the SRS is organized and describes briefly what the rest of the document contains.

Chapter 2: This chapter describes the overall description in a non-technical way focusing the users who has no idea on the technical terms. The purpose is for the users of the system to have a clear understanding what the system is about. This includes the Product Perspectives; under which it identifies whether there any other existing systems available in regard for the developing application, Product Functions; providing a summary of all the major functions of the developing system, User Characteristics; describing the targeted user category, Constraints; describing all conditions that may limit developers‟ options, Assumptions and Dependencies; indicating any assumptions that has been made when designing and implementing the system and Apportioning of Requirements.

Chapter 3: This section describes the developer's point of view of the system. This uses the technical words/phrases understood by the software engineers, developers and maintainers. The main purpose is for any other developers or the maintainers to have a good understanding of this system. External Interface Requirements, Performance Requirements, Design Constraints, Application attributes and other requirements are also explained in advance.

2 Overall Descriptions

Considering the outcome of the literature survey, it is possible to decide the most suitable for the implementation phase. In some cases of design decisions, consider more than one possible technology and take performance and dependencies into consideration. The proposed solution can be divided in to following major parts.

1. Respiratory Sound Analysis and Drug Reminder
2. Sensor configuration and anomaly detection via sensor inputs
3. Abnormality detection of behaviors
4. Abnormality detection in emotions

Respiratory Sound Analysis and Drug Reminder

Auscultation or the listening to the internal sounds using a stethoscope is an effective way of diagnosing the respiratory sounds and identify related diseases in the respiratory system. But identification of respiratory sounds and separate them as normal and abnormal is not an easy task to perform and it requires a skill level of a well-trained physician. Respiratory sounds will be captured using a stethoscope and a microphone. Respiratory Sound Analysis component will be implemented to listen and understand the nature of the respiratory sounds with relevant classification mechanisms. Elderly patients should not be treated with the wrong drugs irrespective of any disease. It will affects the health level of the elderly patient immensely. Therefore drug reminder component will notify the caregiver in order to give the right dose of right drug at the right time.

Machine Learning allows computers to learn in order to achieve specific tasks without being programmed and it is evolving day by day. More information is fed in to existing algorithms to gain more accurate and the maximum outputs. There are so many applications of the Machine leaning techniques in various kinds of fields and the results are proven to be good. Many researches have been successfully implemented using machine learning in past few years and more researches are currently happening over the world. The development of computerized respiratory sound analysis has attracted many researchers in past years which has led to implementation of machine

learning algorithms. Therefore respiratory sound analysis component of the proposed system will be implemented using machine learning.

Data set of patients who are having respiratory problems are required to have prior to analysis. Analysis of the respiratory sounds will be achieved step by step with different processes. After the signal acquisition, FFT has to be applied to convert the signal from its' original domain to frequency domain. Normalization process should be performed in order to remove differences among signals acquired from different subjects at different time points from the same location. Filtration is necessary to cut-off unwanted frequencies such as frequencies coming from heart sounds which are not required. Feature extraction will be achieved by identifying the data points of the power spectrum and the data points will be considered as features. The performance of the respiratory sound analysis is mainly based on the classification method and finding out the best method is very advantageous for better accuracy rate. Artificial Neural Networks (ANN), SVM classifier and K-NN (nearest neighbor) can be used to classify the extracted features.

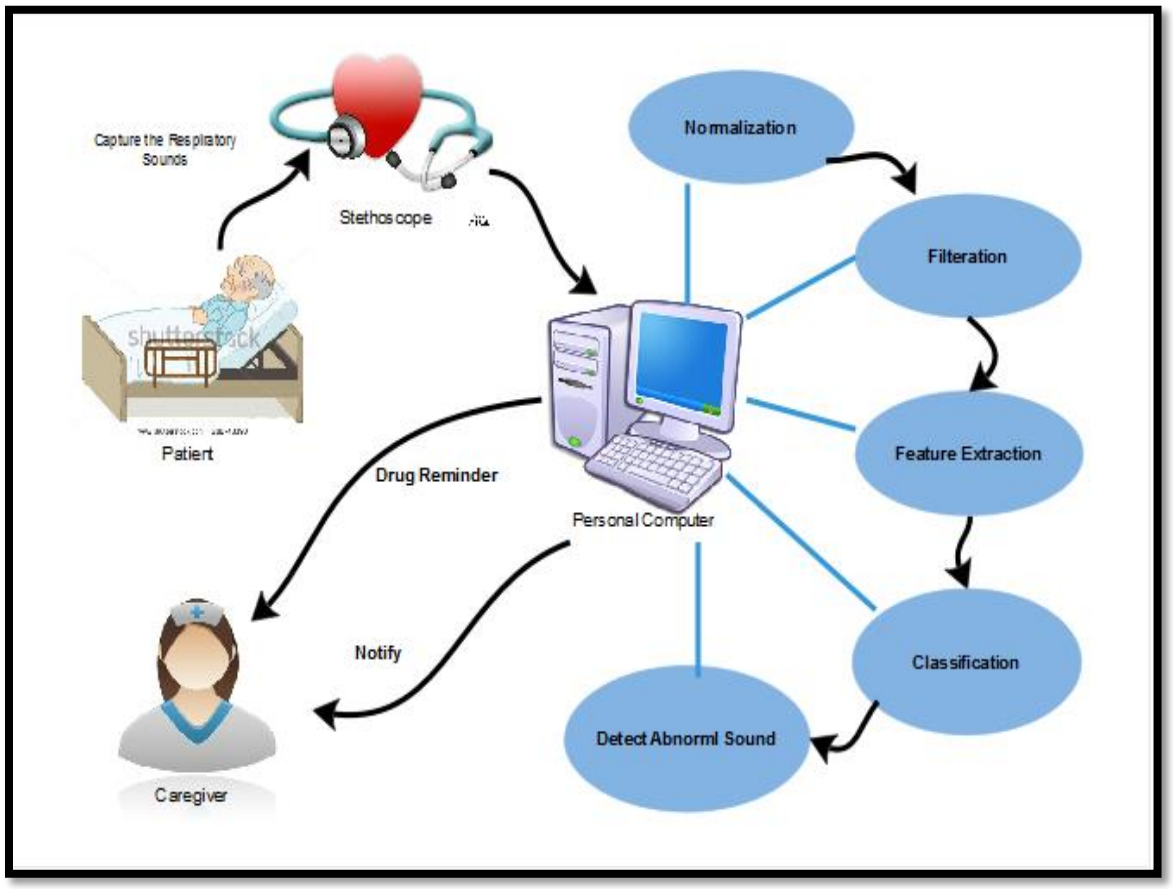

Figure 2.1 Architecture of Respiratory Sound Analysis

Sensor configuration and anomaly detection via sensor inputs

Heart rate or the pulse is a parameter to check the health of a person regardless of age or gender. Monitoring such thing in patients who are having respiratory issues is as much as important due to frequent changes in heart rate. Very low heart rates, frequent fast heart rates or irregularity in heart rate are mostly due to abnormality of the patient's body and caregiver should inform the doctor in case of such incident. Blood oxygen saturation level (Sp02) or the percentage of the oxygen amount in the blood is another health parameter which can be advantageous in monitoring the patients with respiratory issues and those parameters will be captured using pulse rate and SpO2 sensors. It is a must to identify the normal SpO2 level of such patient with the help of a doctor and keep monitoring it to avoid adverse events.

Abnormality detection of behaviors

A behavioral disorder should be included in the differential diagnosis of any patient who presents with repeated complaints, especially fatigue, insomnia, pain or just feeling overwhelmed. For a variety of reasons, this demands that the primary care physician or the caregiver maintain a high index of suspicion for behavioral disturbance in their patients. In here mainly focusing on bedridden patients. The bedridden patients are naturally obstinate in behavior and the face may negatively impact to their health condition due to various kind of accidents. Sleeping sessions, sudden wakeups and falling down will get in to major consideration. Main task of this function is to identify the abnormality of behaviors of their patient. A High resolution camera will be in use to capture the behaviors of the patient.

Abnormality detection in emotions

It is so much tough to find a disease for which emotions are not playing any significant role in identifying abnormalities of the patient. Emotions have a huge impact on understanding the mental status of the patient in order to give more attention and special care. Emotions can state the stress level, anger, sadness and many other feelings which should be classified as normal and abnormal. Facial emotions will be captured by a high resolution video camera.

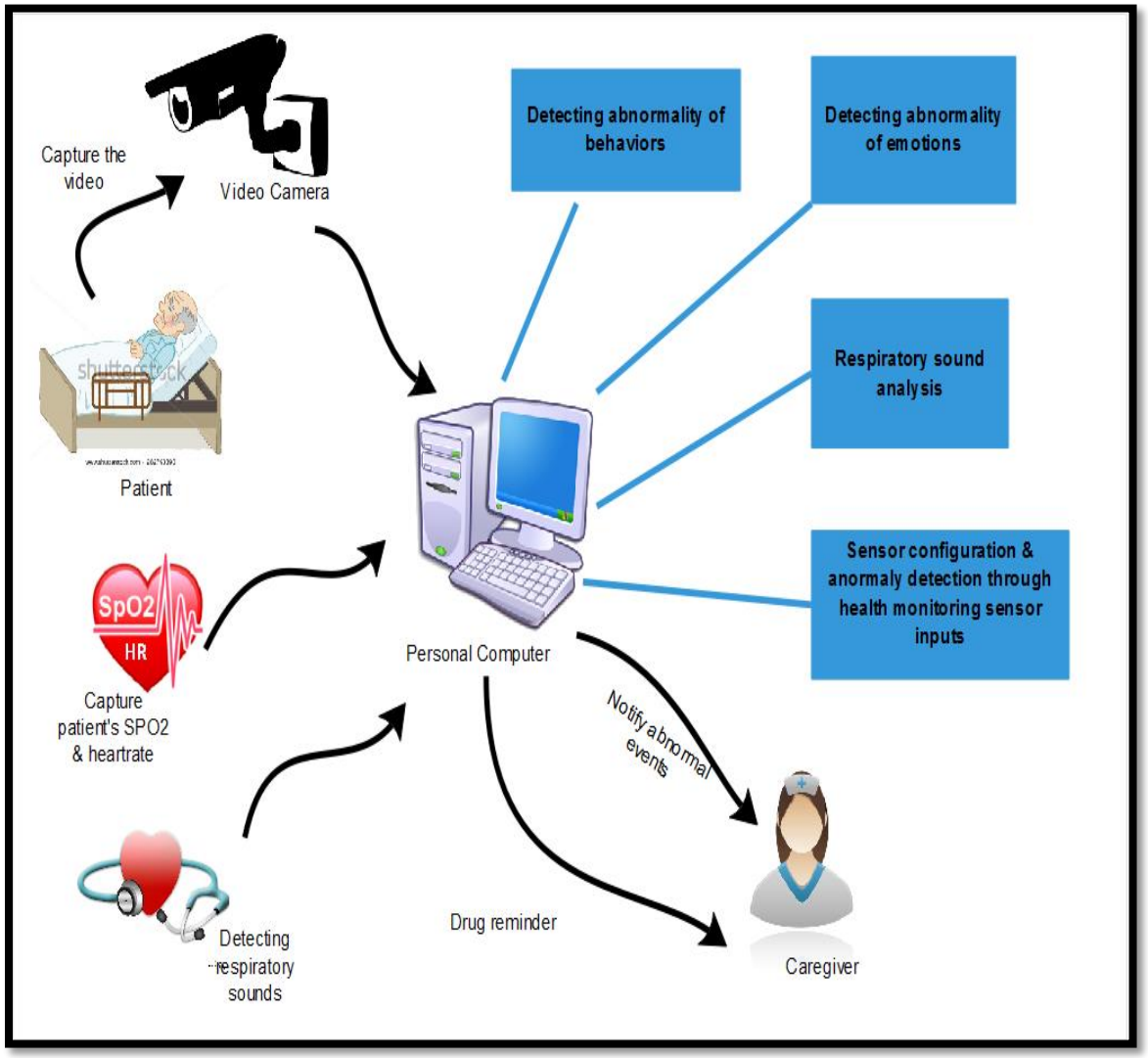

Figure 2.1 High level Architecture of the system

2.1 Product Perspective

Before beginning the design of the system, it is much required to conduct a literature survey to identify, analyze the existing systems. Most of the provided solutions in this domain regardless of respiratory patients have mainly targeted on taking major health parameters of the patient such as heart rate, SpO2, respiratory rate etc. But the requirement of monitoring emotions, behaviors and the inner sounds of the patients have hardly been addressed. Even a proper solution for patients who are having respiratory issues have not been implemented.

Table 2.1 Comparison of Existing Systems

SYSTEM	RESPIRATORY SOUND ANALYSIS	SENSOR CONFIGURATION & ANOMALY DETECTION VIA SENSOR INPUTS	ABNORMALITY DETECTION OF BEHAVIOURS	ABNORMALY DETECTION IN EMOTIONS	ALERTING CAREGIVER
PROPOSED SYSTEM	✓	✓	✓	✓	✓
JAWBONE	✗	✗	✓	✗	✗
PREVENTICE SOLUTIONS	✓	✓	✗	✗	✓
GREATCALL	✗	✓	✗	✗	✓
ALARM.COM	✗	✓	✓	✗	✓

Variety of respiratory problems have been taken in to considering in the existing solutions. Most of the systems are having one specific disease regarding respiration and implemented a solution to get rid of it. But it is necessary to be focused on more respiratory problems rather than two or three. Elderly patients are having various kinds of problems in respiration. Therefore considering on more issues related to respiration will be reliable from the perspective of the patient.

Mohammed Bahoura and Charles Pelletier have conducted a research to introduce a new parameter or an approach called cepstral analysis to classify respiratory sounds. The main objective of the research was to identify the wheeze sounds and the normal respiratory sounds of the patient. Mel-Frequency Cestrum Coefficient (MFCC) had been used to extract the features and Sound signal is divided in to segments and further will be characterized by a reduced number of cepstral coefficients. Classification method is Vector Quantification and two phases of the classification process was training and recognition of the respiratory sounds. In the training phase, an acoustical model (codebook) is constructed for each class of respiratory sound and the models are stored in a database. In the recognition phase, the unknown respiratory sound is analyzed and the best matching model is searched from the database. Higher classification rate was shown for the extracted features based on cepstral analysis but the researches have not done a comparison between other existing classification methods [1].

Rajkumar Palaniappan and K. Sundaraj have conducted a research on Respiratory Sound Classification using Cepstral Features and Support Vector Machine. Research is mainly based on distinguishing between normal, airway obstruction pathology and parenchymal pathology using respiratory sound recordings. Sound recordings had been gathered through RALE database which is having a respiratory sound database for research purposes. Preprocessing had been added to eliminate unwanted noises within the respiratory sounds. Mel frequency cepstral coefficient (MFCC) is used to extract the features in respiratory sounds with the normalization process. SVM one-against-one approach has been used to classify sounds and the MFCC feature vector feeds to the SVM classifier to distinguish normal, airway obstruction and parenchymal pathological condition. Confusion metrics is used to evaluate the performance of the algorithm. The mean classification accuracy has been shown as 90.77% which is very acceptable in respiratory sound analysis [2].

Group of researchers Khalid Badi-uz-zama, Abhishek Attal and Abhijit Verma presented a device capable of extracting, processing, displaying and storing sound data gathered from the patient's body with the help of chest piece diaphragm. Designed handheld device also has the capability of analyzing the sounds and give relevant warnings based on unhealthy situations of the patient.

Raspberry pi single board computer is used to data collection, amplification and recording. Electronic noise made by the microphone and unwanted frequencies coming from outside has to be eliminated to amplify the captured sound. After the amplification, plotted signal can be displayed on the screen of the device in order to identify the pattern, frequency and the time differences between systolic and diastolic strokes. Fourier transformation function has been used to frequency matching as a technique along with some more techniques. None of the techniques are able to match the sample files with the data set. Sample dataset has been too small to compare the data set with the sample files. Research is mainly focused on identifying the anomalies in the heart sounds without considering about respiratory sound analysis. Device is feasible enough to for patients to get the warnings and doctors to identify the problem [3].

Sibghatuallah I. Khan, Naresh P. Jawarkar and Vasif Ahmed have investigated a research on Cell phone based Remote Early Detection of Respiratory Disorders for Rural Children using Modified Stethoscope. Lung sounds of children have been recorded at different chest locations by modified stethoscope and cell phone. Recorded lung sounds are sent to the relevant healthcare center for further analysis. The proposed method for lung sound analysis is based on MFCC analysis of lung sounds and classification using feed forward neural network using Error back propagation algorithm at the health care server. Results have been checked with two different set of features and accuracy rate of 92.5% have been shown. Proposed system need set of health workers, technical man power as well as volunteers to achieve the expected outcome [4].

A research paper presented by Achmad Rizal, Risanuri Hidayat and Hanung Adi Nugroho describe lung sound signal analysis using first order statistic texture analysis on the spectrogram. The spectrogram technique is used to convert the signal from time domain to time-frequency domain. Scaling process has been used to spread the value of the spectrogram to the range of 0-255 due to wide range of values in spectrogram. Texture analysis method is used by considering mean, variance, skewness, kurtosis, and entropy to extract the features properly. K- Nearest Neighbor method has been manipulated to classify the extracted features. Validation of the classification results are tested by three-fold validation method where data set is divides in to three parts. One data set is for testing data and other two data sets are for training module. Accuracy of 96.33 % has been achieved by the classification method after taking the average accuracy out of three. But

the accuracy of the system is always depending on the parameters used by the spectrogram. Pre-processing techniques can be applied to increase the performance of the system [5].

R. Palaniappan, K. Sundaraj and C. K. Lam have proposed a method to classify respiratory pathology from breath sound signals. Data has been gathered as normal, wheeze, rhonchi, fine and coarse crackles. Pre-processing has been added to sample the breath sounds to 5 kHz range from 10 kHz original range. Breath sounds were filtered from noise and segmented into breath cycles followed by feature extraction. AR Coefficients and Mel Frequency Cepstral Coefficients (MFCC) features were extracted from breath sound cycles. Extracted features has been classified using SVM classifier. The SVM classifier was used to distinguish normal, wheeze, rhonchi, fine and coarse crackles. Reliability of the classification method has been evaluated using confusion matrix. The mean classification accuracy obtained using the proposed method was 88.72% and 89.68% for AR coefficients and MFCC features respectively. Since the number of features which was extracted is too high, feature reduction algorithm should be implemented to increase the rate of accuracy and reliability through high classification [6].

2.1.1 System interfaces

In the proposed system there is no requirement for specific system interfaces.

2.1.2 User interfaces

Registration

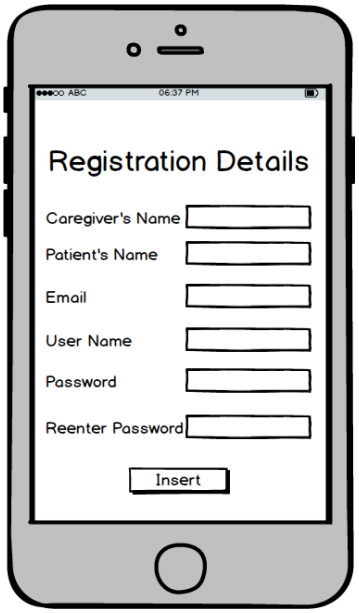

Figure 2.3 Interface of Registration

Once the User Clicks on Sign Up button, it will display above interface for registration of the caregiver. User will have to give required details and click the insert button in order to save all the details in the database server.

Login

Figure 2.4 Interface of Login

User has to give username and the password in order to log into the system and validation process will be done after user clicks on the Login Button. There is the option of forget password in the interface where will be receiving an email to reset the password.

Main Interface

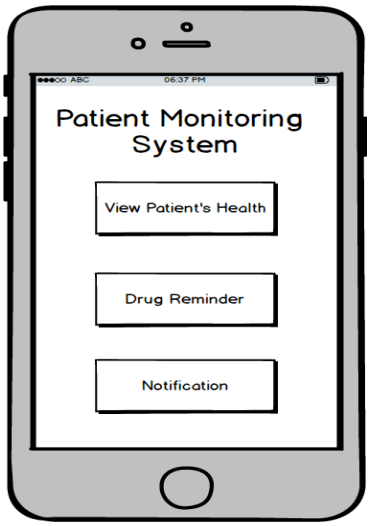

Figure 2.5 Main Interface of the System

Once the user log into the system, there are few options to choose from. Selecting the relevant button will load the application in to relevant interfaces. As an example, clicking on Drug Reminder Button, user can manage the drug taking of the patient.

User Interface of Adding Drug details

Figure 2.6 Interface of Adding Drug details

In order to manage the drug taking of the patient in an efficient way, user has to add all the necessary details of the drugs along with an image of the drug for better identification.

User Interface of Updating Drug details

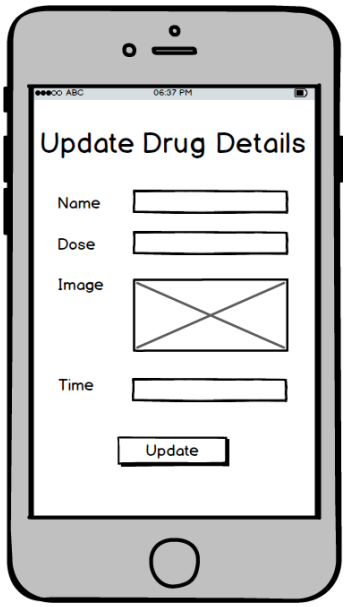

Figure 2.7 Interface of Updating Drug details

User will have the option of changing drug taking details of the patients as soon as the doctor make any change to the drugs of the patient.

2.1.3 Hardware interfaces

In the proposed system there is a requirement of product specific hardware along with specific hardware interfaces for the user.

Mobile Phone

Mobile Application will be developed to notify the caregiver regarding the abnormalities of the patient. Therefore it is a major hardware requirement to have a mobile phone with installation of the mobile application related to proposed system.

Figure 2.8 Mobile Phone

Personal Computer / Laptop

All the necessary processing related to proposed system will be done in the personal computer and it is mandatory to have a PC or a Laptop with specified requirements.

Figure 2.9 Laptop

2.1.4 Software interfaces

Mobile Application

Mobile Application should be installed on the caregiver's mobile phone in order to get necessary notifications and the alarms related to drug reminder. Mobile is required to fulfill mandatory specifications.

2.1.5 Communication interfaces

GSM - 3G or 4G LTE connection of the mobile phone will be used for data transmission between the mobile app and the web server.

Wi-Fi - If the mobile data is not available, user can connect to an available Wi-Fi router to get the internet connection in order to use the application. And this will also be used for data transmission between the mobile app and the web server. Required Connection bandwidth might differ time to time. Since large data load is travelling through the network, having a high bandwidth internet connection will help a lot for the users to use the application with ease.

2.1.6 Memory constraints

For the mobile application to run a minimum 1024 MB of memory will be required and a 100 MB of secondary memory as well.

All the processing will be done in the PC and it requires minimum of 2GB of RAM and free space of at least 10 GB.

2.1.7 Operations

This section describes what operations should be or can be performed by user in order to use the services of the system.

- Create profile - User should provide related details with unique username and password when registering with the mobile application.

- Log in to profile - User should provide user name and password in order to login to the application.
- View and edit profile - User can view the profile and update necessary information.
- Add drug details – User should add drug taking details of the patients.
- Upload images of the drugs - User should upload valid images of the drugs to the system in order to maximize the identification purpose of the relevant drug.

System Administrator is capable of following operations.

- Login - Admin can provide user name and password in order to login to the application.
- Manage the user details- Has the privilege to manage user details.

2.1.8 Site adaptation requirements

There is no such site adaptation requirements at the implementation of the ELPS. But necessary adaptation requirements are needed to mount the camera in the room of the patient. Mounting of the camera has to be done in a way that bed area of the patient will be covered and the more focus will be on the face of the patient.

2.2 Product functions

Here below is a detailed description of the Patient Monitoring System and UML designs has been used in order to give a clearer idea on what happens and how it happens in the system.

Patient Monitoring System, as stated above is mainly focused on elderly patient who are suffering from respiratory issues. System will analyze the respiratory sounds of the patients in order to identify any abnormalities. Since internal sounds or respiratory sounds are effective in addressing issues in respiration, it will be helpful to caregiver to identify problems of the patient prior to meet the doctor for further monitoring. Drug taking process of the patient can be optimized through the system where it will notify the caregiver before the exact drug taking time with the relevant descriptions.

The caregiver can add relevant drugs of the patients to the system with the availability of the update and delete options. Prior to right drug taking time, caregiver will be alarmed through the mobile application which is installed on caregiver's mobile phone.

2.2.1 Use Case Diagram

The following Use Case diagram describes respiratory sound analysis and drug reminder component of the EPMS.

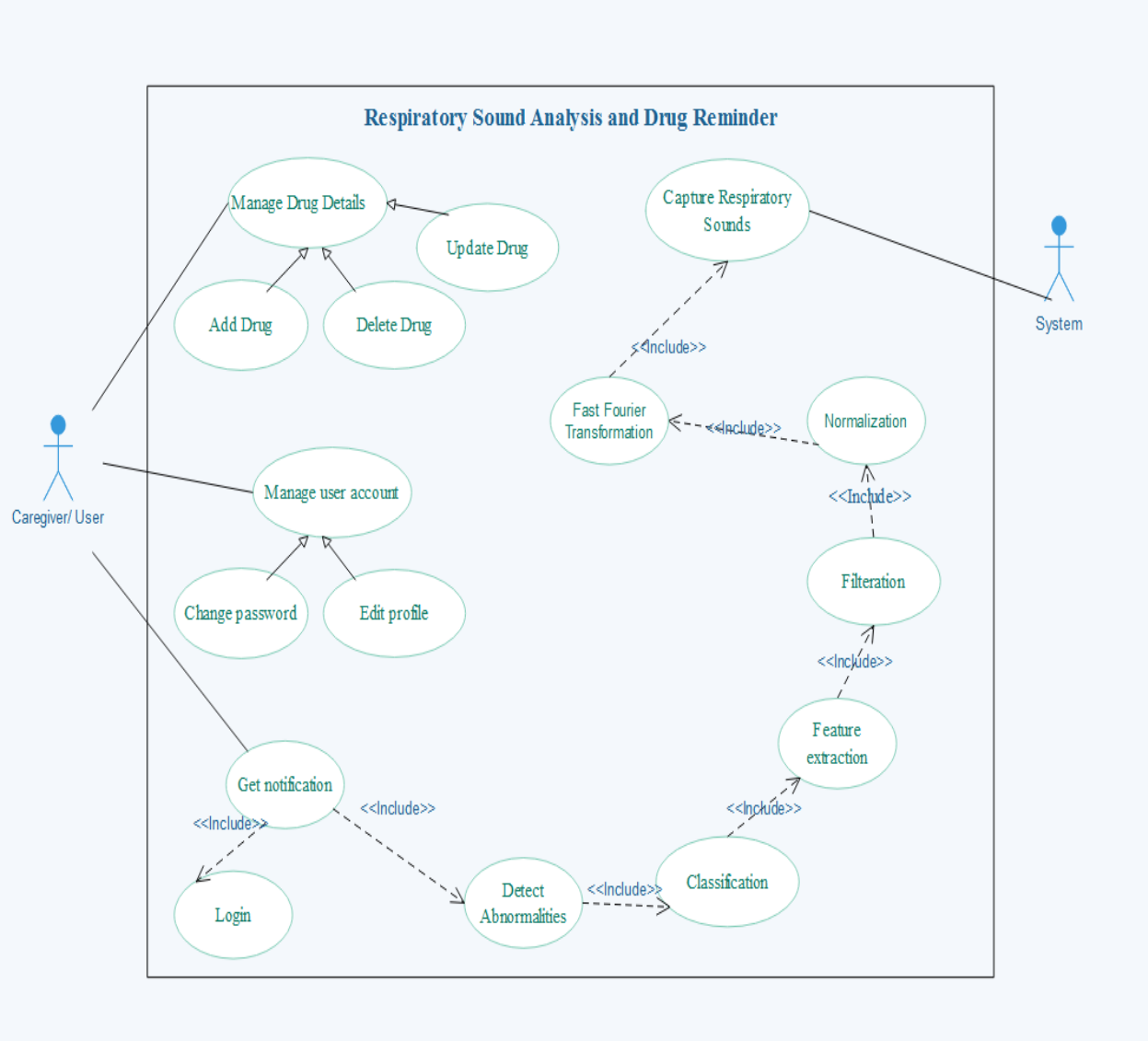

Figure 2.10 Use Case Diagram of Respiratory Sound Analysis and Drug Reminder

2.2.2 Use Case Scenarios

Use case 01: Login to the mobile application

Table 2.2 Use Case Scenario for Login of the mobile application

Use case 01	Mobile Application Login
Description	Login to the mobile application by providing the user name and password
Primary Actors	Caregiver
Pre-conditions	1. The mobile application is up and running. 2. Mobile data is turned on. 3. User has already registered.
Main Success Scenarios	1. User enters the user name and password. 2. User select the login button 3. System validates the user name and password. 4. The main window is displayed to the patient.
Extensions	1a. If the username or/and password is invalid, display an error message and prompt the patient to enter the user name and password again.

Use case 02: Get Notification on abnormal situations of the patient.

Table 2.3 Use Case Scenario for Get Notifications on abnormal situations

Use case 02	Get Notifications
Description	Get Notifications on abnormal situations of the patient.

Primary Actors	Caregiver
Pre-conditions	1. The mobile application is up and running. 2. Mobile data is turned on. 3. User has already registered. 4. User has already logged in to the mobile application.
Main Success Scenarios	1. User taps on the notifications.

Use case 03: Respiratory Sound Analysis

Table 2.4 Use Case Scenario for Respiratory Sound Analysis

Use case 03	Respiratory Sound Analysis
Description	Analysis of Respiratory sounds in order to detect the anomalies of the patient.
Primary Actors	System
Pre-conditions	1. Inputs from the stethoscope has to be properly transmitted in to the PC.
Main Success Scenarios	1. FFT applies to the captured signal. 2. Normalization process. 3. Filtration. 4. Feature extraction. 5. Classification. 6. Normal or abnormal event detects.

Extensions	1a. If FFT is not properly applied, it will be hard to analyze the sounds further. 3a. If filtration is not properly done, it will be hard to extract the real features.

Use case 04: Add Drug details.

Table 2.5 Use Case Scenario for Adding Drug details

Use case 04	Add Drug details
Description	Adding Drug details of the patient in order to get daily alerts of the drug taking.
Primary Actors	Caregiver
Pre-conditions	1. The mobile application is up and running. 2. Mobile data is turned on. 3. User has already registered. 4. User has already logged in to the mobile application.
Main Success Scenarios	1. User selects the ‘Add Drug Details’ button. 2. User adds necessary details related to drug taking. 3. User Uploads an image of the drug. 4. User Clicks on ‘Submit’ button.
Extensions	2a. If user unable to provide all the details, it will not be possible to add the drug details in to the system. 3a. If user unable to upload an image of the drug, it will not be further processed.

Use case 05: Update Drug details.

Table 2.6 Use Case Scenario for Updating Drug details

Use case 04	Update Drug details.
Description	Updating Drug details of the patient whenever a change has been made by the doctor on drugs of the patient.
Primary Actors	Caregiver
Pre-conditions	1. The mobile application is up and running. 2. Mobile data is turned on. 3. User has already registered. 4. User has already logged in to the mobile application.
Main Success Scenarios	1. User selects the 'Edit Drug Details' button. 2. User edits necessary updated details related to drug taking. 3. User Clicks on 'Submit' button.
Extensions	2a. If user unable to provide all the details, it will not be possible to add the drug details in to the system.

2.2.3 Activity Diagram

Activity diagram can be effective in illustrating activities as the operations of the system and following is the Activity diagram of respiratory sound analysis and drug reminder component.

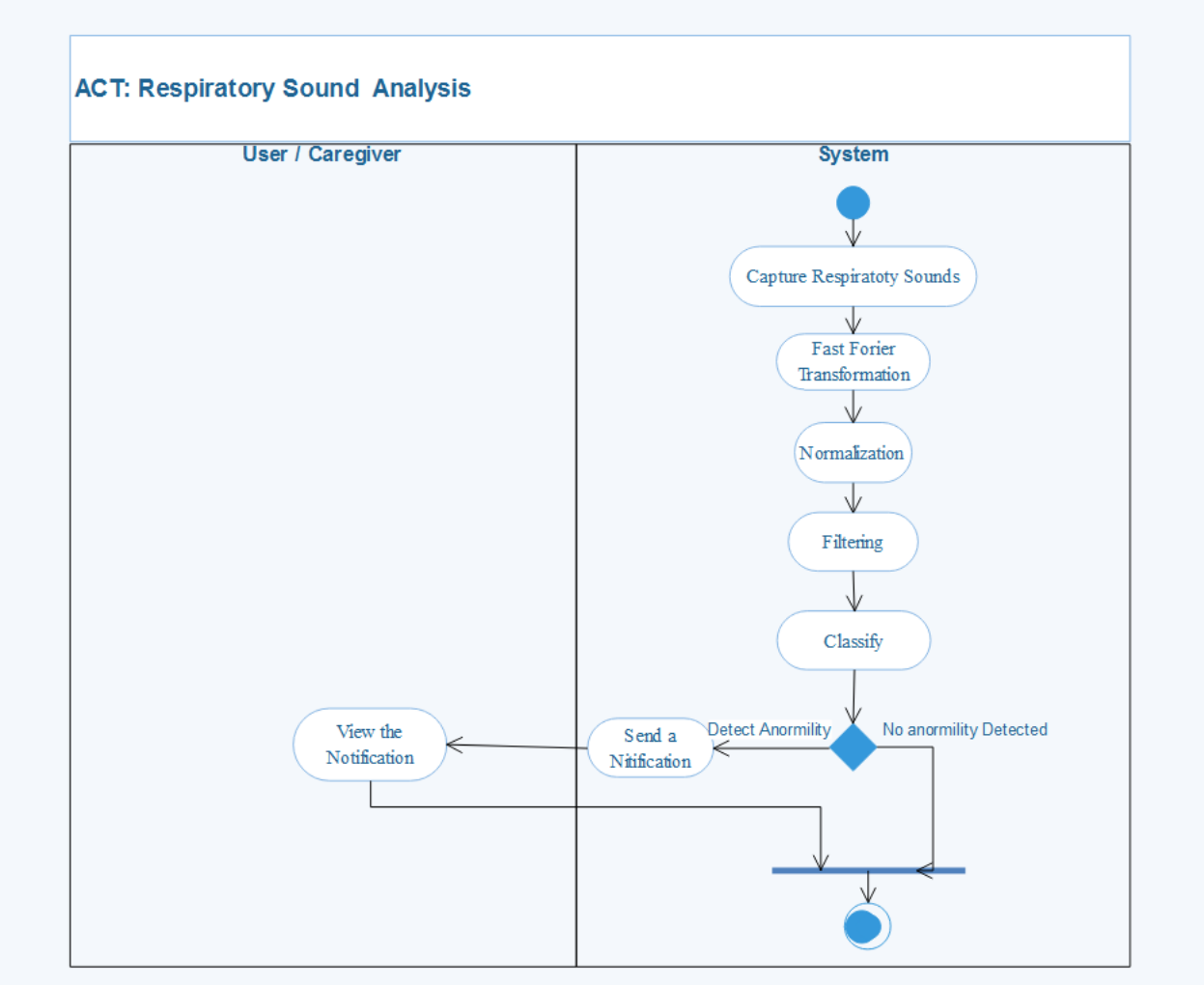

Figure 2.11 Activity Diagram for respiratory Sound Analysis and Drug Reminder

2.3 User characteristics

The software is intended for use by the caregiver or the parties who are having elderly patients with respiratory issues in their domestic arena. Elder's homes and Elder care agencies can be effectively assisted by this system, if there are patients who are suffering from respiratory problems and responsible persons of those places will eventually become users of the system.

The other category of user is the Administrator who is responsible for configuring the system.

2.4 Constraints

- Mobile application consumes the battery power for internet connectivity and for the processing in the mobile application. So the operation time of the mobile application has limited to several hours.
- PC is compulsory for the system.
- Necessary sensors and the stethoscope have to be equipped to the patient.
- High resolution web camera should be set on top of patient's bed covering the bed area while more focusing on the face.

2.5 Assumptions and Dependencies

2.5.1 Assumptions

- Patient is equipped with the necessary sensors and the stethoscope.
- Patient is living under normal environmental conditions.
- Most users have Smart mobile phones.
- Users who interact with the system have at least a slight knowledge about handling smart phones.
- The OS runs in the mobile devices are android version 2.3 or above.
- The mobile devices have mobile data turned on when running the application.

2.5.2 Dependencies

- The system is immensely depend on the hardware, because data transmitted from the sensors and the stethoscope are essential for the analysis process.

2.6 Apportioning of Requirements

In the section 1.5, it describes the overview of the proposed system and the section 2 provides the overall detailed description about the system and its requirements. The section 3 contains the requirements in detail that should be followed while designing the above mentioned requirements. The methodology of the implementation of the system might have slight differences from the contents described in this document. During the system designing, the requirements specified will not change and the system that is to be released will contain its purposes and the objectives as mentioned in the document.

3 System Requirements

3.1 External Interface Requirements

3.1.1 User Interfaces

Chapter 2 describes the user interfaces from the front end for any kind of stakeholder who is interested in understanding the functionalities of the system. In this section we will describe the backend of the system in order of clear clarification of the requirements for the related professionals with IT knowledge like developers, QA engineers and etc.

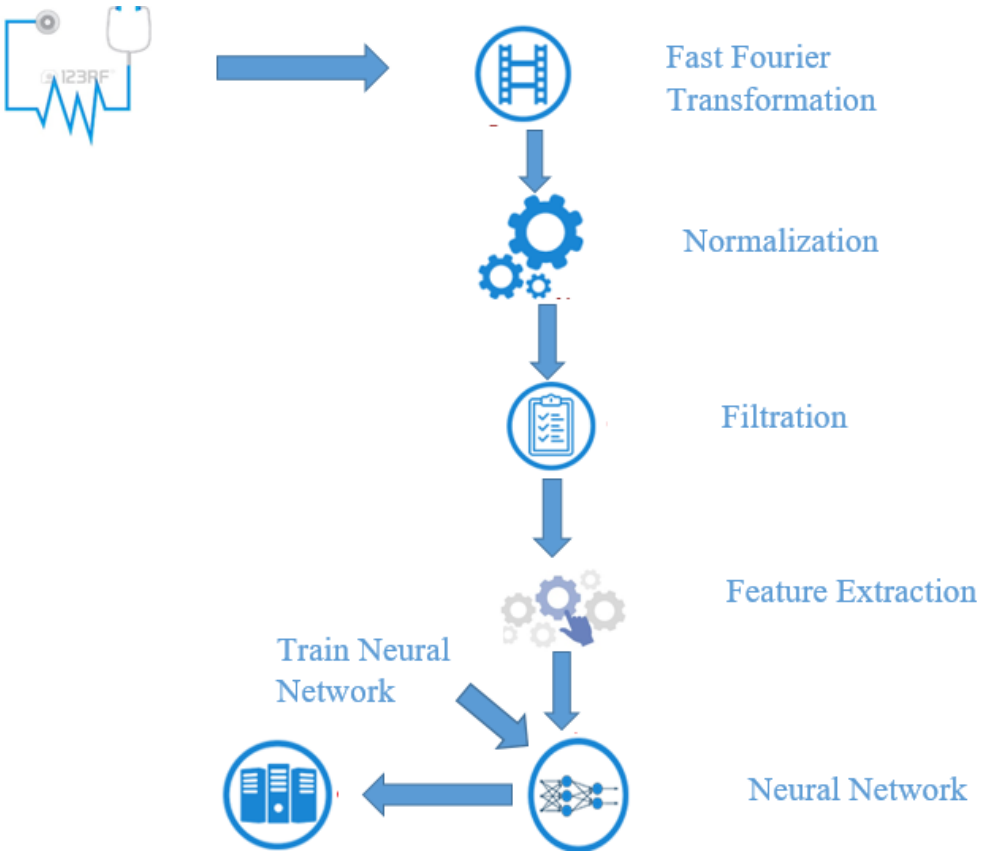

Figure 3.1 Developer Perspective Diagram for Respiratory Sound Analysis

3.1.2 Hardware Interfaces

This section shows the necessary hardware interfaces which will be used by the developer in order to produce the proposed system.

Arduino Uno 3

Since it is not possible to send serial inputs straight away in to the PC, Arduino Board will be used as controller.

Figure 3.2 Arduino Board

Pulse SpO2 Sensor

Pulse SpO2 Sensor will be used to detect heart rate and the oxygen percentage of the blood.

Figure 3.3 Pulse SpO2 Sensor

Web Camera

Web Camera will be in use to detect the emotions and the behaviors of the patient.

Figure 3.4 Web Camera

Bluetooth Module

Bluetooth Module will be used to transfer the data to the PC which will be captured by the Arduino Board.

Figure 3.5 Bluetooth Module

Stethoscope

Stethoscope will be in use to capture the respiratory sounds.

Figure 3.6 Stethoscope

Microphone

Microphone will be used to record the captured signal in order to send to the PC.

Figure 3.7 Microphone

3.1.3 Software Interfaces

For the implementation of the EPMS, developer will have to utilize different software interfaces.

- OpenCV library – For behavior recognition and emotion recognition purposes.
- Dlib library – For face detection.
- MATLAB – For signal processing.
- Apache HTTP Server – As the web server of the system.
- MYSQL – As the Database Management System of the EPMS.

3.1.4 Communication Interfaces

To communicate between knowledge base and mobile application and also to communicate between web application and mobile application HTTP protocol will be used.

Once the necessary values from the sensors are obtained by the main board they had to be transmitted to the PC for the necessary processing to take place. Therefore Bluetooth will be one of the major communication interface.

3.2 Classes/ Objects

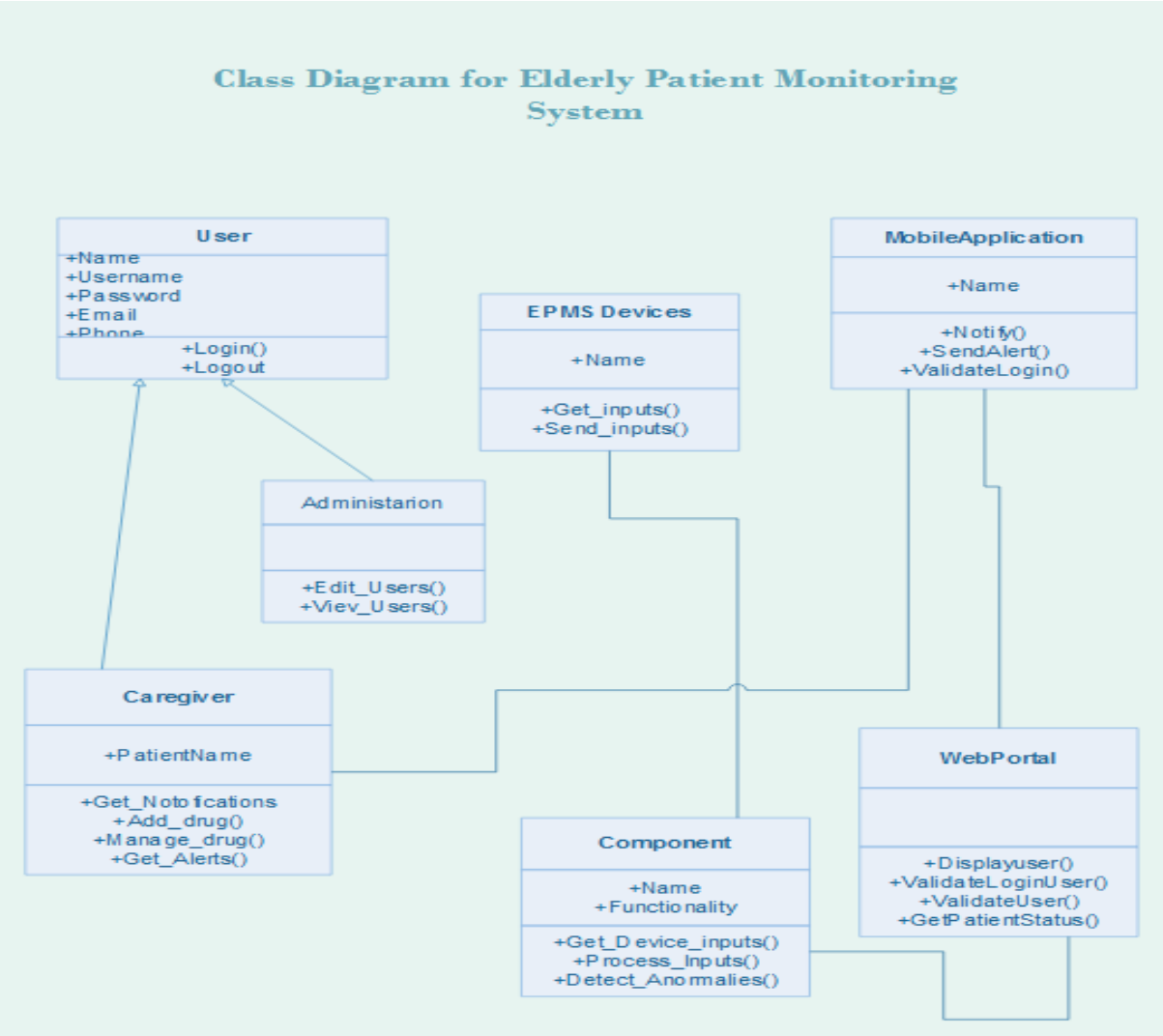

Figure 3.8 Class Diagram for Overall System

3.3 Performance Requirements

Real Time Monitoring will be achieved through EPMS. The system will take initial load time depending on internet connection strength which also depends on the media from which the product is run. And 95% of the detected abnormalities are processed in less than five seconds.

3.4 Design Constraints

Since the mobile application is used by caregivers who are fairly computer illiterate, the GUIs will be designed as very simple and self-evident interfaces.

3.5 Software system attributes

3.5.1 Reliability

Reliability is an Ability of a computer program to perform its intended functions and operations in a system's environment, without experiencing failure (system crash). Reliability is measured as the probability that a system will not fail and that it will perform its intended function for a specified time interval [7]. Thus system should be reliable enough because it has to produce accurate suggestions. EPMS will be able to work with sensors and other hardware parts without leading the whole system crash.

3.5.2 Availability

The system could be accessed whenever in need and availability is the ratio of time a system or component is functional to the total time it is required or expected to function [8]. Ratio should be a higher value to achieve high availability of the system. EPMS will be implemented with high availability and necessary testing will be done to check whether high availability has maintained or not.

3.5.3 Security

Security is the protection of the data against unauthorized access [9]. EPMS will be and exposing health values of the patient and those are confidential information, the security of those data has to be considered. Those data have only to be visible for the intended parties. Ethical issues which might arise from this kind of system have to be considered. To achieve those goals password usage is more important.

3.5.4 Maintainability

Maintainability is defined as the probability of performing a successful repair action within a given time. In other words, maintainability measures the ease and speed with which a system can be restored to operational status after a failure occurs [10]. The system should be modularized in order to achieve good maintainability. The sensors should be able to replace individually without replacing the whole system. The application design also needs to facilitate maintainability.

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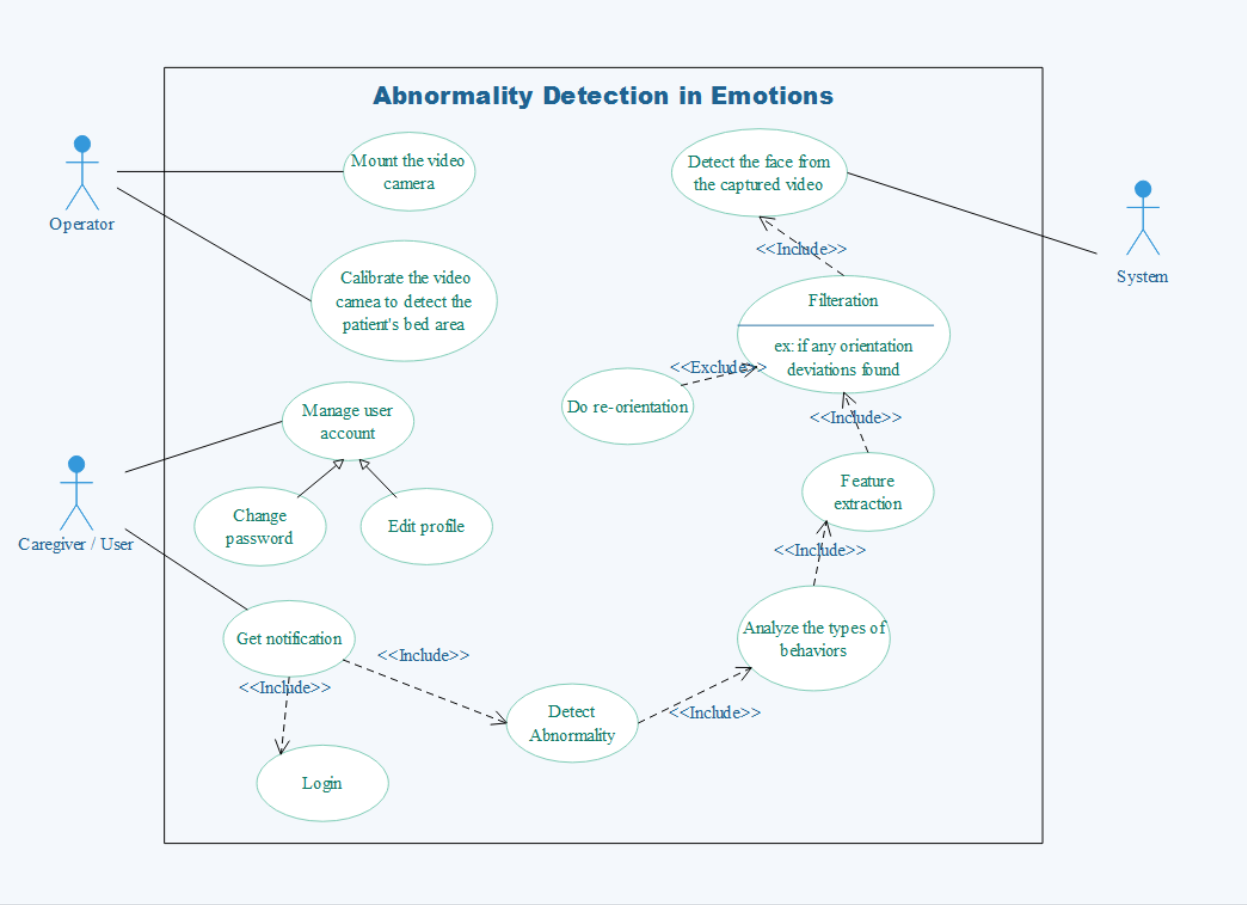
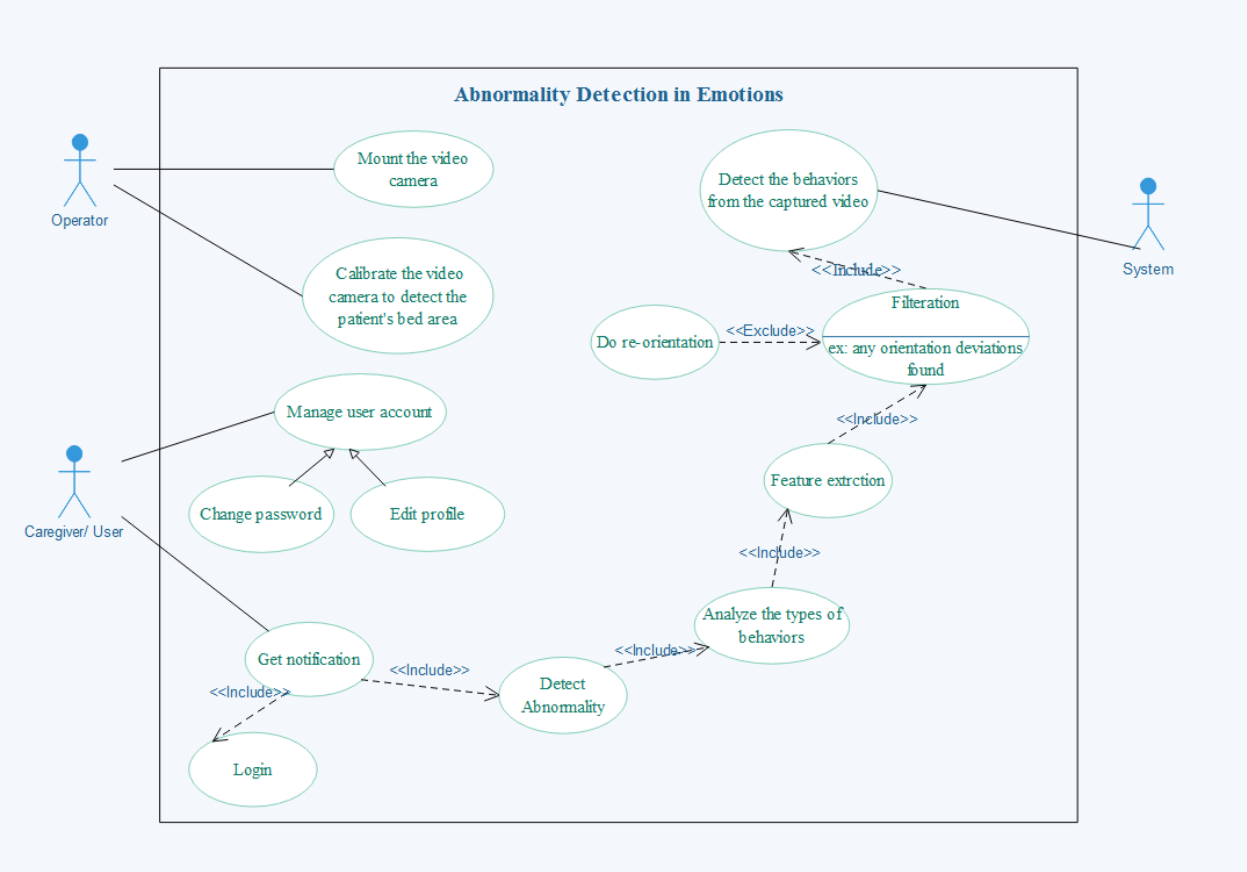
Appendices

Appendix A: Use Case Diagrams

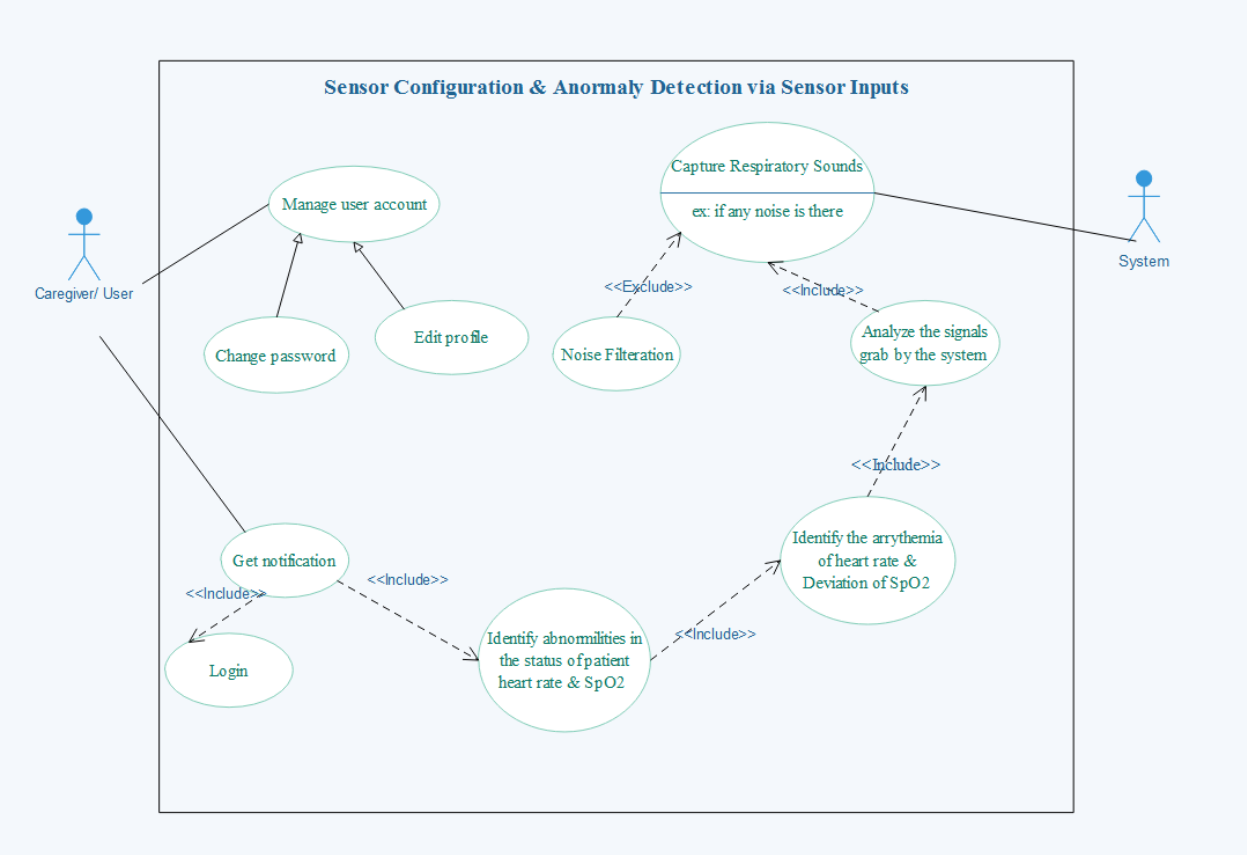
Abnormality Detection in Behaviors



Abnormality Detection in Emotions

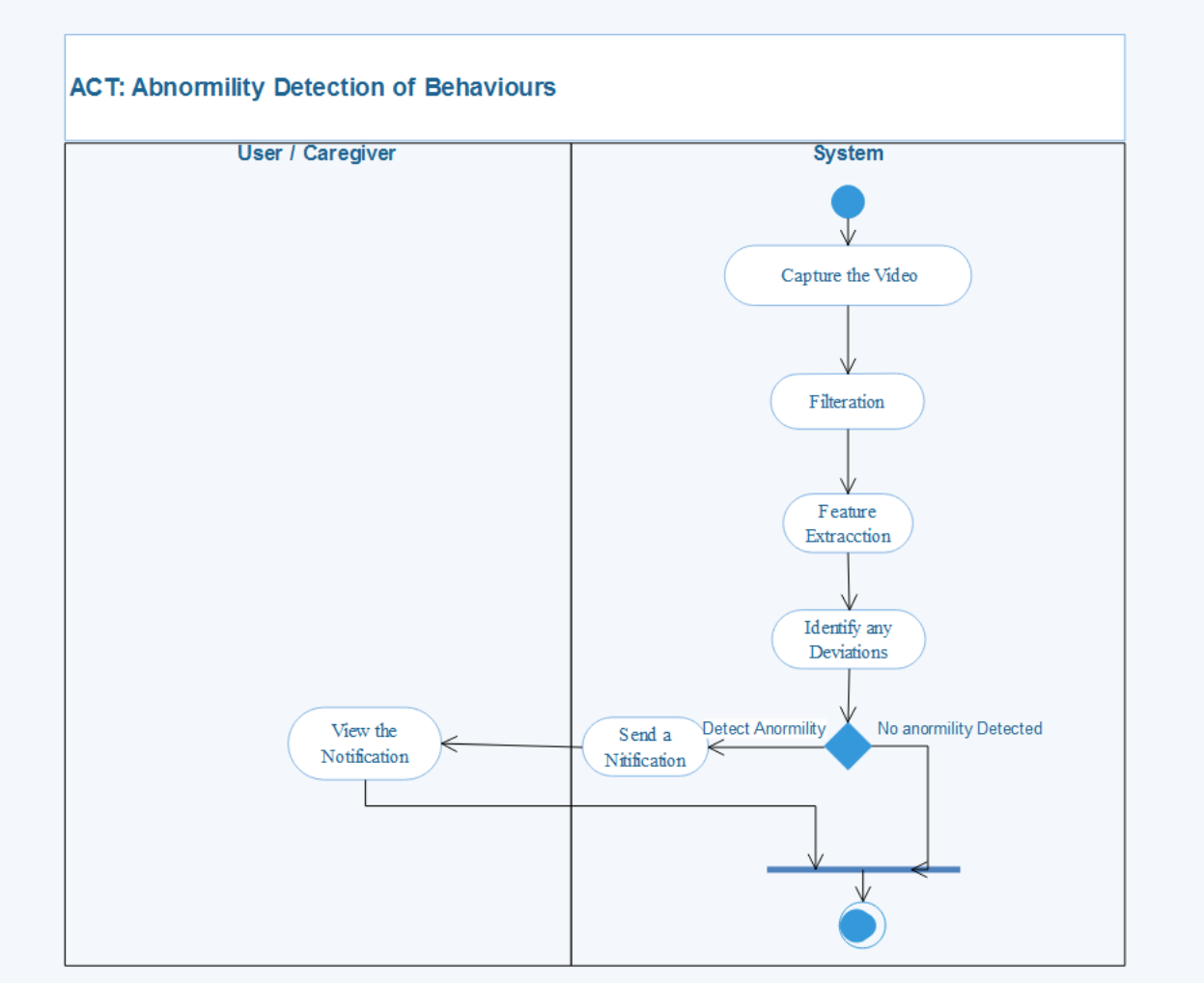


Sensor Configuration & Anomaly Detection via Sensor Inputs

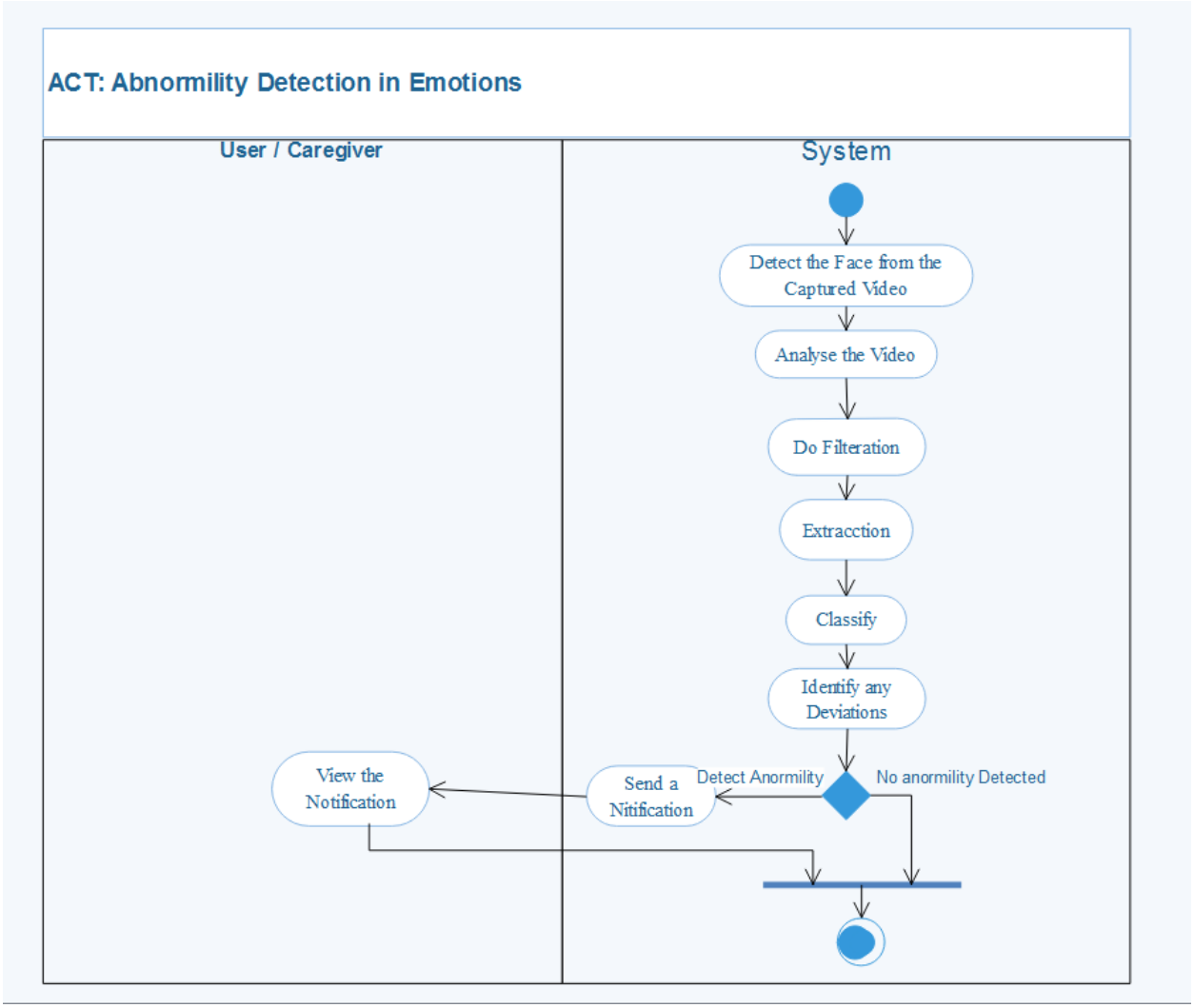


Appendix B: Activity Diagrams

Abnormality Detection in Behaviors



Abnormality Detection in Emotions



Sensor Configuration & Anomaly Detection via Sensor Inputs