Sri Lanka Institute of Information Technology

Elderly Patient Monitoring System

Software Requirements Specification Document

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Declaration

I hereby declare that this project "Elderly Patient Monitoring System" is submitted to the Sri Lanka Institute of Information Technology is a record of an original work done by the group, under the guidance of the Supervisor Mr. Yashas Mallawarachchi and It was not a copy of a document done by any organization, university any other institute or a previous student project group at Sri Lanka Institute of Information Technology and was not copied from the internet or other sources.

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Software Requirement Specification

1. Introduction

The introduction of the Software Requirements Specification (SRS) provides an overview of the entire SRS with purpose, scope, definitions, acronyms, abbreviations, references and overview of the SRS. The aim of this document is to gather and analyze and give an in-depth insight of the complete **Patient Monitoring System** by defining the problem statement in detail. Nevertheless, it also concentrates on the capabilities required by stakeholders and their needs while defining high-level product features. And also, this document will be in the favor of the system engineering, quality assurance engineers for building and maintaining the system. The detailed requirements of the **Elderly Patient Monitoring System** are provided in this document.

1.1 Purpose

The purpose of this document is to provide a detailed description of the requirements for the "Elderly patient Monitoring system". This will also explain the system constraints, interface and interactions with other external applications. 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 intended audience of this document is all of the stakeholders for a project involving the development this system and also this document gives described and a list of abbreviations and definitions.

1.2 Scope

The proposed software system is an elderly patient monitoring system which is useful for the patients who have respiratory problem and this document will describe the functionalities, software requirements, hardware requirements, related research findings and the technological challenges that the system must overcome. And also, it will define the requirements which can meet recommendations by providing accurate, reliable, responsive readings of heart rate, SPO2 and optional respiration rate monitoring, so it may detect respiratory complications earlier and intervene sooner. And this system will be used to get detect the abnormalities in emotions and behaviors of the patients thus bedridden elderly patients have those abnormalities in respiration. If any kind of abnormality of pulse rate, spo2, behaviors or emotions is occurred it will inform to the caregiver or whatever the responsible person of the patient. This system will easier the caregiver's day today life by monitoring the patient at every single minute since anyone at home will be work with this system. 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 functions 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 to inform the caregiver about the detected abnormality and for the drug reminder component.

1.3 Definitions, Acronyms, and Abbreviations

1.3.1 Glossary

Terms	Description
Caregiver	The person which is used to interact with the system
Interface	Use to do communication between user and the system
User	Person who use the system
Stakeholder	Person who has interest on the project but who is not a developer.

Table 1: Glossary

1.3.2 Acronyms

Terms	Description
ELPS	Elderly Patient Monitoring System.
SRS	Software Requirement Specification
GUI	Graphical User Interface
DB	Database.
RAM	Random access memory.
UML	Unified Modeling language.
PC	Personal computer.
QA	Quality Assurance.
IT	Information Technology.
SpO2	Percentage of oxygenate hemoglobin.

Table 2: Acronyms

1.4 References

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

1.5 Overview

In the following, this document discusses the overall description of the system, which includes interface properties, dependencies and functions of the product. Furthermore, it contains functional and non-functional requirements of the system. Description of limitations of the product, addressing the constraints and assumptions can be found. Use case diagram and object class diagram is also included for a better picture during the implementation of the system. These provide necessary support and allows the project team to make sure that goals and functionalities of the system are being met.

1.5.1 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.

1.5.2 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

This section will give an overview of the whole system. The system will be explained in its context to show how the system interacts with other systems and introduce the basic functionality of it. It will also describe what type of users that will use the system and what functionality is available for each type. At last, the constraints and assumptions for the system will be presented.

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

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 capturing of the respiratory sound, 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 is there to perform the task of converting the signal waveform to reduced number of parameters for further analysis and processing. Correlation will be used to identify how similar two signals are for how long they remain similar when one is shifted with respect to the other. 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.

Sensor configuration and anomaly detection via sensor inputs

Most of the time patient and care giver are facing a problem that they can't grab and analyses health of the patient at home. We design and implement health care monitoring system for bedridden patient. We are mainly focused on grab analyses arrhythmia of heart rate (HR) and deviation of peripheral capillary oxygen saturation (SpO2) using pulse rate and SpO2 sensors. Swing protocol use for configure the sensors and arduino.

First the heart rate (HR) and deviation of peripheral capillary oxygen saturation (SpO2) use as the inputs and if that signals have noises, that noises filtering using a filtration technique. Then use time thesis analyses for recognize patterns of that signals. Based on that outputs feature extraction using a machine learning algorithm or neural network. The performance of the sensor inputs (heart rate, spo2) analysis are mainly based on the feature extraction method and finding out the best method is very advantage for get batter outputs. RNM (Remote Neural monitoring), DTW (Dynamic Time Wrapping) can be used to feature extract of

above inputs. If detect abnormal arrhythmia of the heart rate (HR) or deviation of the SpO2, automatically send a message to care giver.

Abnormality detection of behaviors

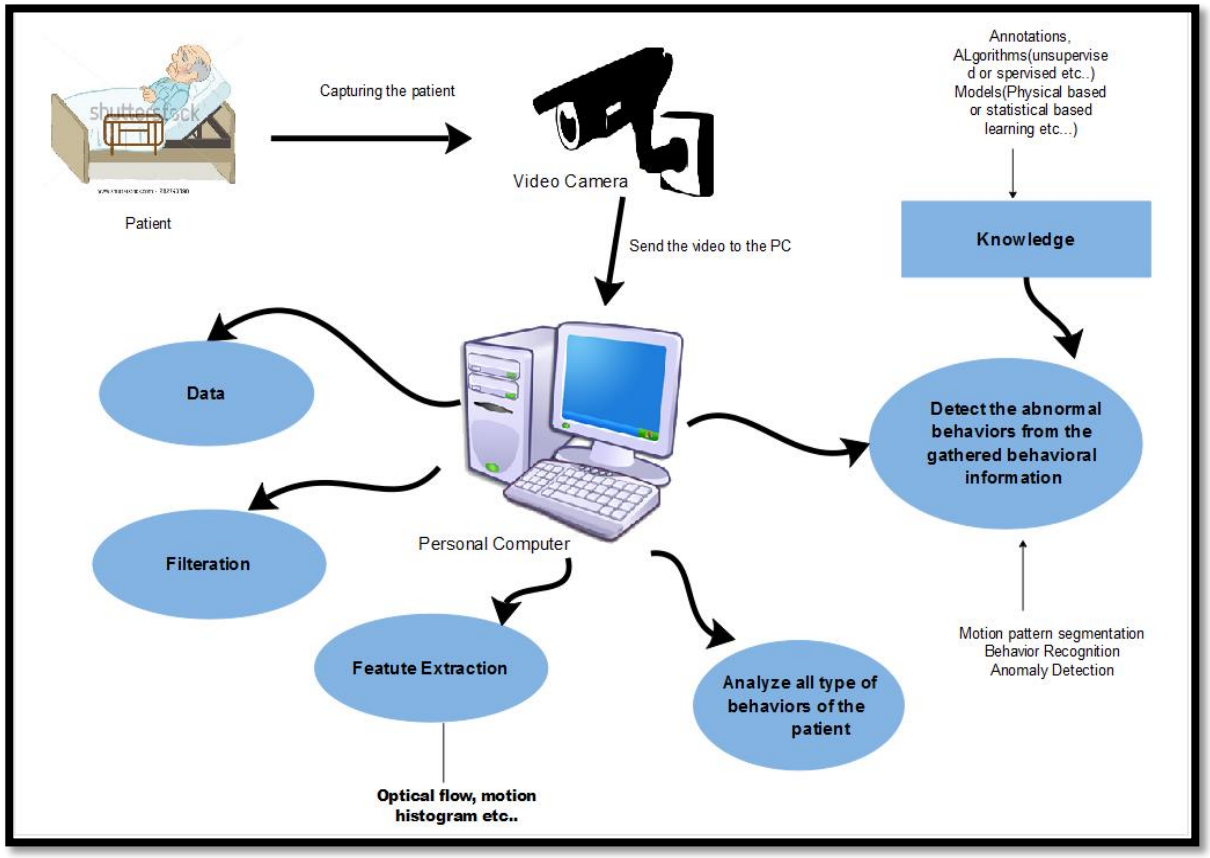

Figure 2.1 Abnormal Behavior Recognition

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.

So, the main task of this function is to identify the abnormality of behaviors of their patient. In here Data of both the normal and abnormal behaviors of patients should be collected. Based on the state of the patient categorize the set of behaviors to create different profiles for patients in different health conditions. And then construct a classification model for detecting the behavioral abnormalities. To detect the abnormality of behaviors of the patient mainly focusing on "Optical Flow Analysis method". Optical flow algorithms generally demand for high computational power and huge storage capacities. On the other hand, the many implementation of optical flow algorithms, are mostly experimental ones with no intent to apply them in ant practical situation requiring outputs at standard video frame-rate. Optical flow consists on the time variations of brightness patterns produced in an image. On living beings with visual ability, this continuously changing image appears in the retina while artificial systems, and it is captured by a light sensor in a camera.

To do this recognition, the camera have to be mounted in the patient's room. The proposed system consists of four modules including face region extraction, multiple hand and leg samples extraction, features extraction, and behaviors analysis. This is based on the histogram of the optical flow orientation descriptor. The details of the histogram of the optical flow are illustrated for describing movement of behaviors of the patient. By SVM (support vector machine) the abnormal events in the current situation can be detect after a learning period characterizing normal behaviors. Then the difference abnormal detection results are analyzed.

Abnormality detection in emotions

With the pervasive presence of video data, and there is a priority to detect motions such as sports event interpretation, detecting facial expressions, visual surveillance and many more applications via automated analysis and understanding of object motions from large amounts of videos. Now days to detect these types of motions, machine learning is used. Machine learning is a type of artificial intelligence that provides the ability to learn without explicitly programmed. Since many more researches are now based on machine learning and most of them are successfully completed while many researches are still going on, to implement the detection of abnormalities in facial emotions in this proposed component also will use machine learning.

A data set with facial emotions will use for this purpose. Analyzing of facial emotion is done by several steps. Facial emotions will be captured by a high-resolution video camera. Should detect the face of the patient correctly while capturing the video, and send it to a personal computer. If noises have in the capturing video clips, it should be filtered. An average filtration method will be used for this purpose. If the facial expressions cannot be detecting due to not correctly focusing face to the camera, it should be re-oriented. Here, first have to detect the land marks of the face. Then if there is an orientation deviation, detect the locations of the land marks, re-calculate and should make the correct orientation for the emotion detection. Then extract the features of the video to be given as input to the data model. Non- linear classification method like artificial neural network method will be used for the classification purposes. If any abnormality is detected in the patient's face, it will be informed the caregiver by generating a status message.

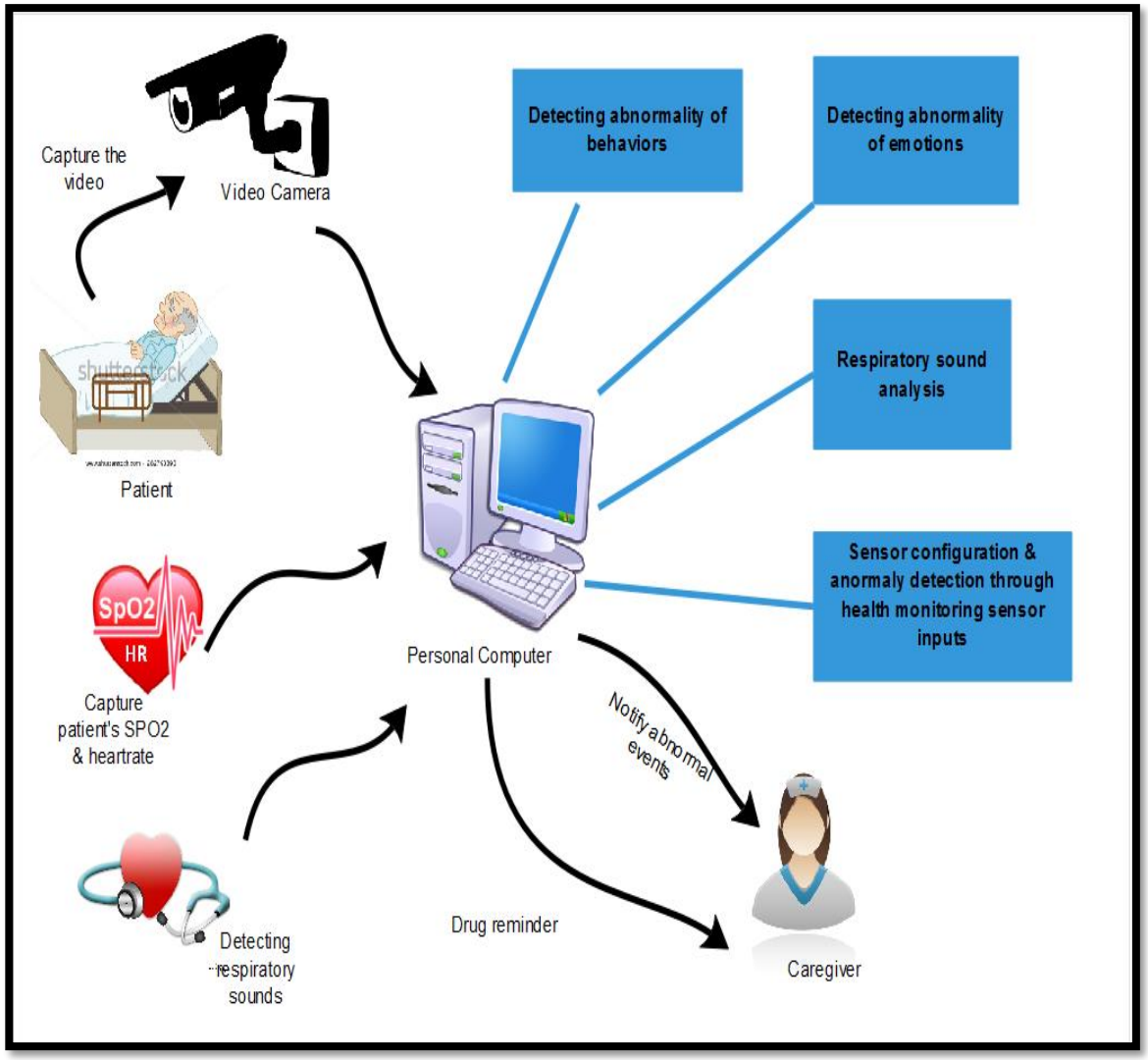

Figure 2.2 High level Architecture of the system

2.1 Product perspective

We are hoping to provide an accurate, reliable, responsive and cost saving patient monitoring system that will give the basement for various products. Before enter the design stage it is more required to conduct a literature survey to study, analyze and identify the existing systems. Therefore, this section will be to compare related researches with the

system we are planning to develop. 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.

State-of-the-art patient monitoring systems shouldn't be reserved for facilities with the most money, leaving smaller clinics and hospitals to use outdated machines or equipment that could potentially fail during a critical procedure. In here we believe everyone should have access to the latest technology without having to exceed their budget. That's why we have dedicated ourselves to developing and distributing new, affordable technology that any clinic, hospital, or medical facility can afford.

The main problem of the existing researches and products they are mainly focusing on normal patients not specified for the ones who's suffering from some kind of special illness or bedridden patients. And also in those they are mainly focusing on the abnormal behaviors related to exercises. That's the main problem of existing products. If some bedridden patient has some regression with breathing by looking at that patient's behaviors can identify that patient has some discomforts. So, it's hard to come up with abnormal behaviors of bedridden patients with these existing systems.

There is a research done by the Christian Thurau Czech University, Faculty of Electrical Engineering Department for Cybernetics on an approach for human detection and simultaneous behavior recognition from images and image sequences [1]. It is done by an action representation is derived by applying a clustering algorithm to sequences of Histogram of Oriented Gradient (HOG) descriptors of human motion images. In this case, they considered 10 different behaviors performed by 9 subjects. The task is to detect the human within the image and to assign the sequence to one of the known categories like Jump, run etc. They detect humans by comparing extracted HOG descriptors to template HOG descriptors of human poses. The templates are automatically clustered from a set of

training sequences. They select the best matching action primitives for a novel image, and thereby create a sequence of action primitive indices. And they express the sequential observation of basic action units using n-grams, a popular representation used in text analysis or bioinformatics. Though they classify behaviors by means of histogram comparison.

Chun-Jun Su has proposed rehabilitation system based on Dynamic Time Warping (DTW) [2]. In this system, a patient is allowed to perform a prescribed behavior with the presence of a professional. The behavior performed will be recorded and evaluated to monitor the rehabilitation behavior at home environment. The outcomes of the evaluation are used to validate the behaviors and to prevent unfavorable events. Further, the system provides the capability to upload the outcomes to a cloud for physician to monitor patient's rehabilitation process and to adjust the prescription. The limitation of the system is that, it is difficult to provide real-time feedback because they used the Dynamic Time Wrapping Algorithm.

Pioggia and his team have proposed a "Healthcare System Focusing on Emotional Aspects using Augmented Reality" [3]. This system is used to cater health problems resulted by negative mentality. This system allows users to interact with 3D objects in real environment to reduce negative emotions. ECG (Electrocardiogram) and EEG (electroencephalograph) sensors detect respiration then decide the mood of the user. Kinect sensor is used to detect movements of the user then user is able to interact with 3D object.

Christopher Richard Wren and his group have proposed a real time tracking of the human body called Pfinder. Pfinder is a real-time system for tracking people and interpreting their behavior. It runs 10Hz on a standard SGI Indy computer, and has performed reliably on thousands of people in many different physical locations. The system uses a multiclass statistical model of color and shape to obtain a 2D representation of head and hands in a wide range of viewing conditions.

JAWBONE is a unique health and fitness tracker, available to individual consumers, combines a wristband monitor that tracks movement and sleep details with a user-friendly mobile app that enables logging of exercise, food and hydration [4].

The company Preventice has been working with the Mayo Clinic to develop comprehensive technology to help monitor chronic or at-risk patients with wearable sensors that collect real-time health data. The device currently on the market is the Body Guardian Remote Monitoring System, which monitors cardiac health using a lightweight wearable sensor. Data is sent to a smartphone and, from there, to the cloud-based Preventice Care Platform, which can be accessed by physicians at any time.

GreatCall is the company behind the popular Jitterbug phone, a cellphone designed to be simple and user-friendly for seniors. Now they offer a touch-screen smartphone, too, with senior-focused health apps that assist with medication management and even provide Urgent Care. GreatCall also offers a standalone emergency response system, 5Star Urgent Response, which uses GPS and wireless cellular technology to connect users with emergency contacts or medical services during an emergency.

Alarm.com is a system which is Using discreet wireless sensors throughout the client's living area, Wellness tracks activity and wellness indicators, giving caregivers real-time insight into each client's current conditions as well as potential emergent problems.

If we consider about those existing similar systems they all will not provide all the features that our proposed system provides.

Table 2-1 Comparisons of existing Systems

SYSTEM	**RESPIRATORY SOUND ANALYSIS**	**SENSOR CONFIGURATION & ANOMALY DETECTION**	**ABNORMALITY DETECTION OF BEHAVIOURS**	**ABNORMALITY DETECTION IN EMOTIONS**	**ALERTING CAREGIVER**

		VIA SENSOR INPUTS			
PROPOSED SYSTEM	✓	✓	✓	✓	✓
JAWBONE	✗	✗	✓	✗	✗
PREVENTICE SOLUTIONS	✓	✓	✗	✗	✓
GREATCALL	✗	✓	✗	✗	✓
ALARM.COM	✗	✓	✓	✗	✓

2.1.1 **System interfaces**

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

2.1.2 **User interfaces**

Registration

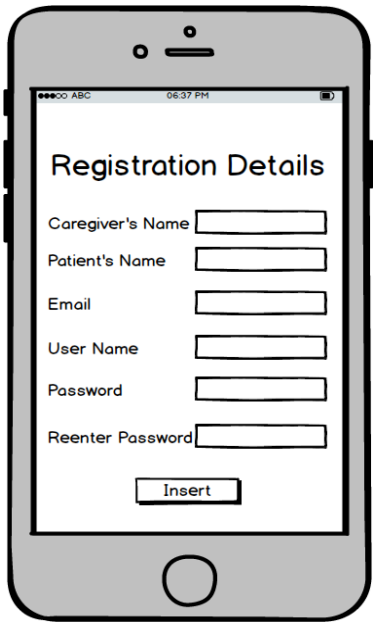

Figure 2.3 Registration

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

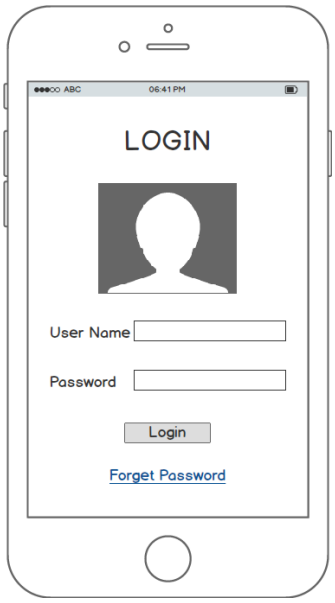

Figure 2.4 Login

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

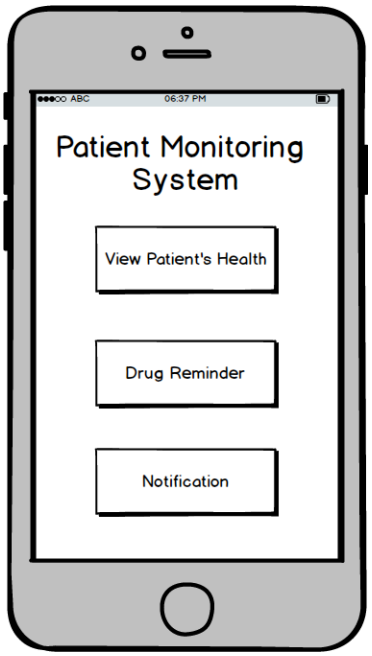

Figure 2.5 Main interface

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 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 for Update Drug Details

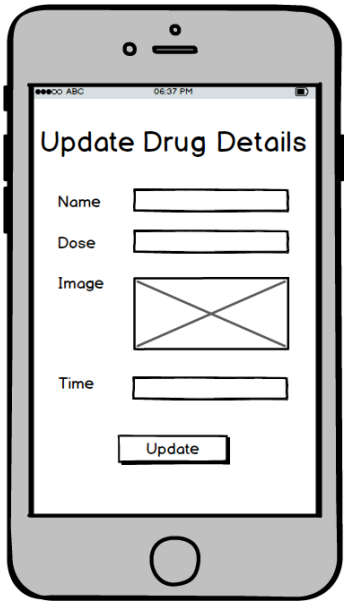

Figure 2.7 Update drug details

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 Personal computer

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 are 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.

2.2.1 **Use case diagram**

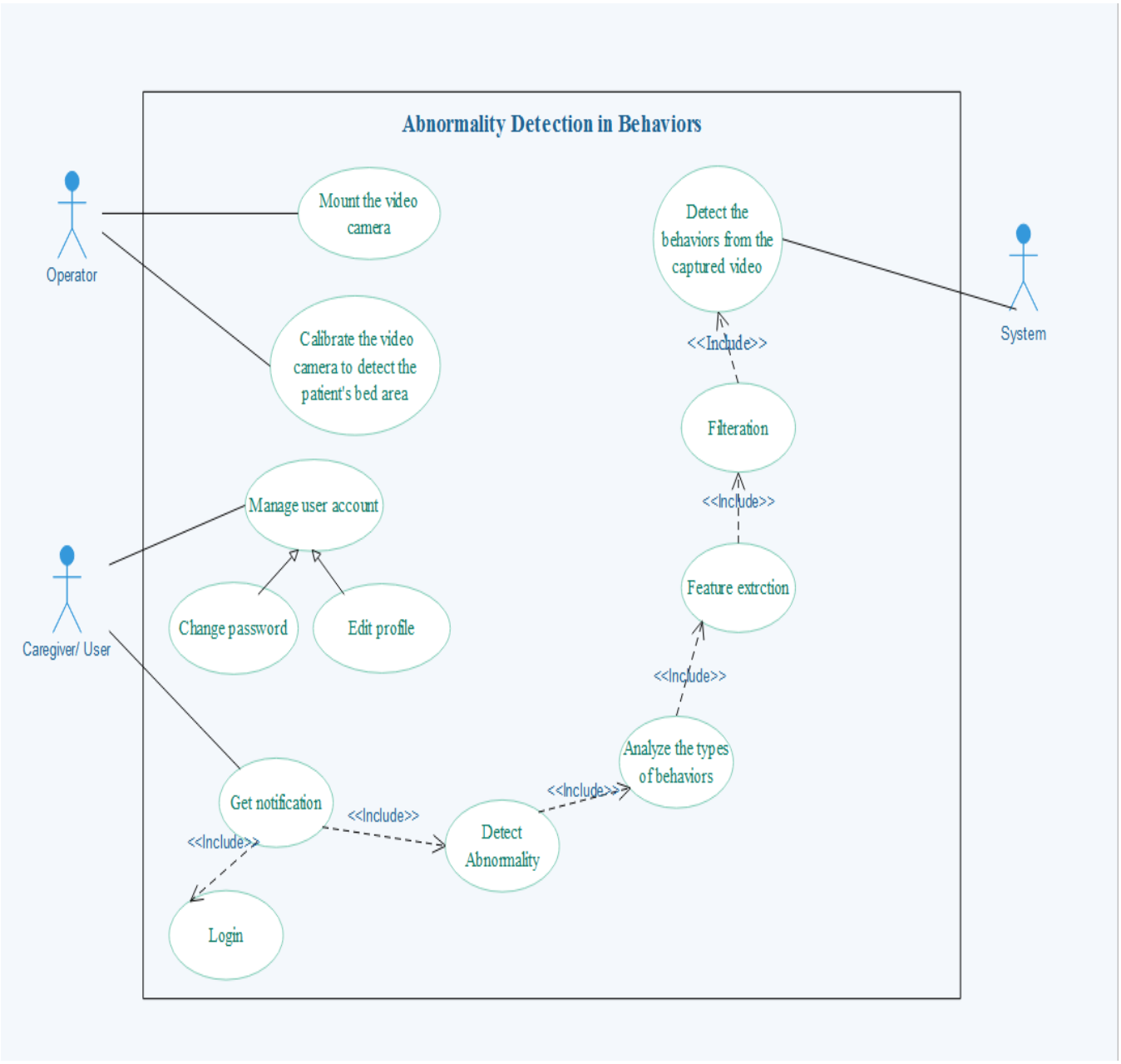

Figure 2.10 Abnormality Detection in behaviors

2.2.2 **Use case scenarios**

Use case 01: Login to the mobile application

Table 2-2 Login

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 Get Notification 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: Abnormal Behavior Recognition

Table 2-4 Abnormal Behavior Recognition

Use case 03	**Abnormal Behavior Recognition**
Description	Analysis of abnormal behaviors in order to detect the anomalies of the patient's behaviors
Primary Actors	System
Pre-conditions	1. Inputs from the video camera (captured video) has to be properly transmitted in to the PC.
Main Success Scenarios	1. Analyze the captured video

	2. Feature extraction. 3. construct a classification model in order to detecting the behavioral abnormalities Filtration. 4. Normal or abnormal event detects.

2.2.3 Activity Diagram

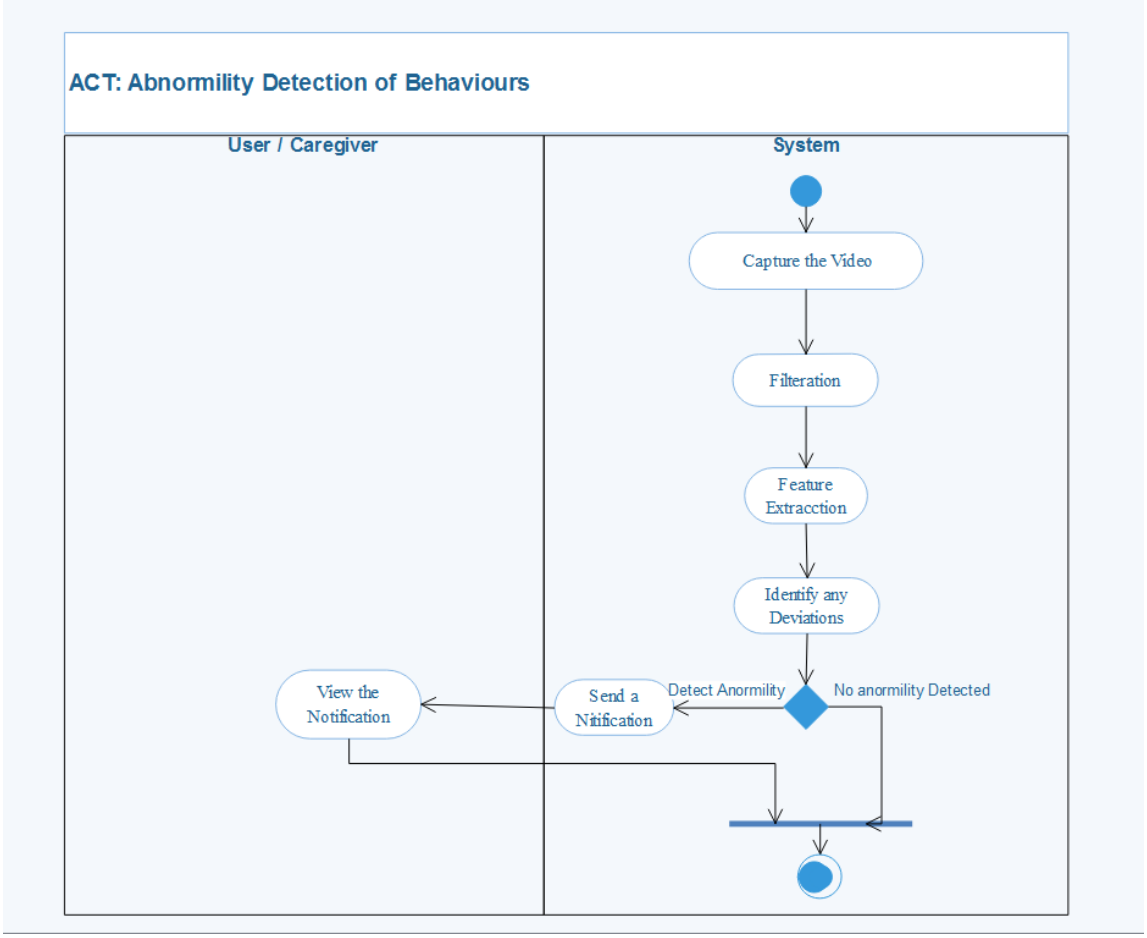

Figure 2.11 Activity Diagram of Abnormality detection of behaviors

2.3 User characteristics

Thus, increased technological improvement, rise in the incidence, globalization and prevalence of some diseases along with increase in aging population, enhanced demand for monitoring in private sectors. Hence the global market for patient monitoring system market is expected to have a healthy growth rate in the forecast period. And to deal with this system no need any additional knowledge or any extra things who have the basic knowledge of a computer and a smart phone can easily work with this easily. And especially this system will be very useful for Homecare settings, Elder Homes, Elder care agencies etc.

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.
- Personal computer 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**

- 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.
- Patient is equipped with the necessary sensors and the stethoscope.
- Patient is living under normal environmental conditions.

2.5.2 **Dependencies**

- The system is immensely depending 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. Specific 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.

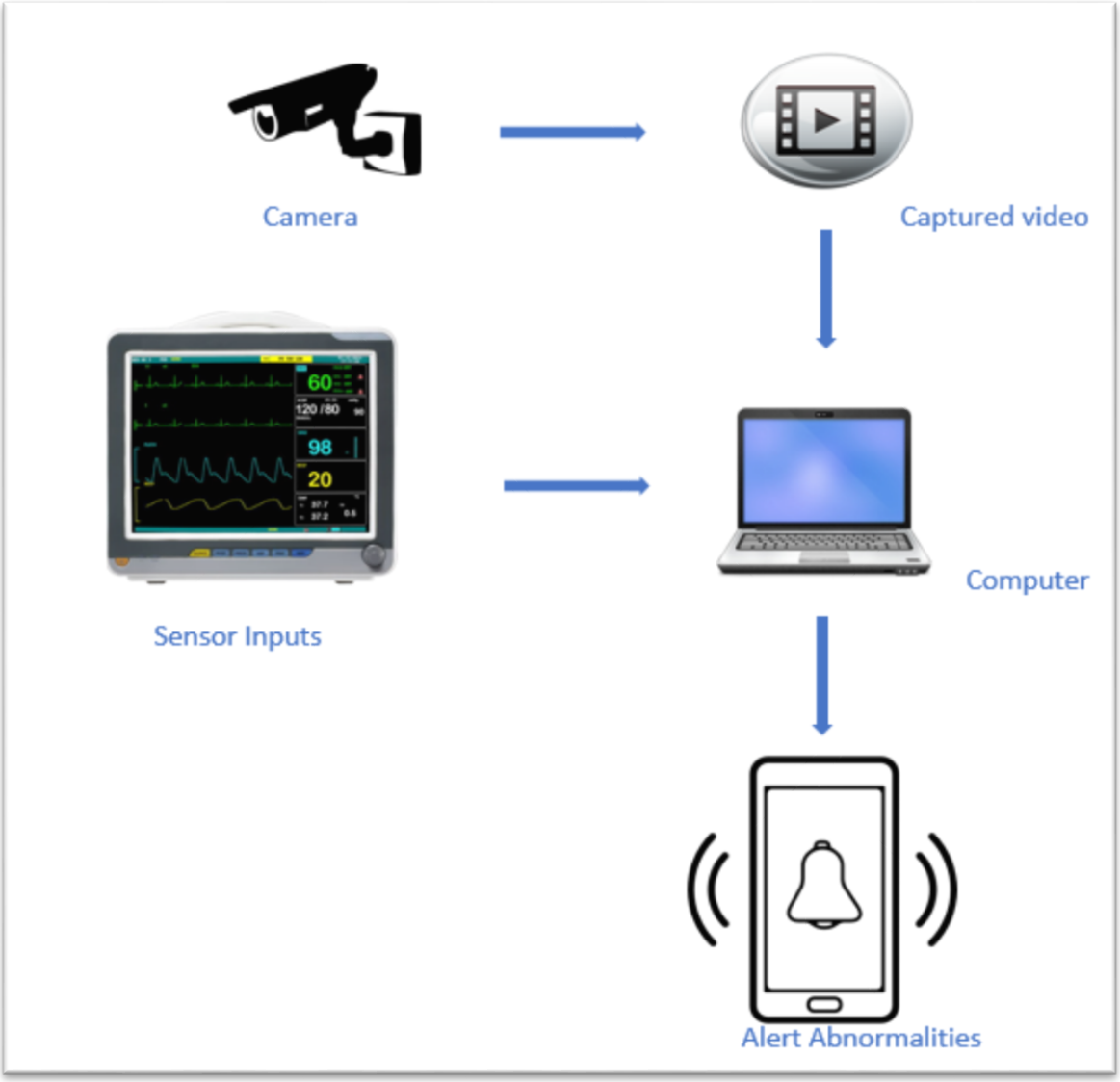

Figure 3.1 Overall description

The captured video from the camera will be send to the computer and it will analyze the video. If some abnormality detects in any sensor inputs, emotions or behavior it will alert to the caregiver via the smart phone.

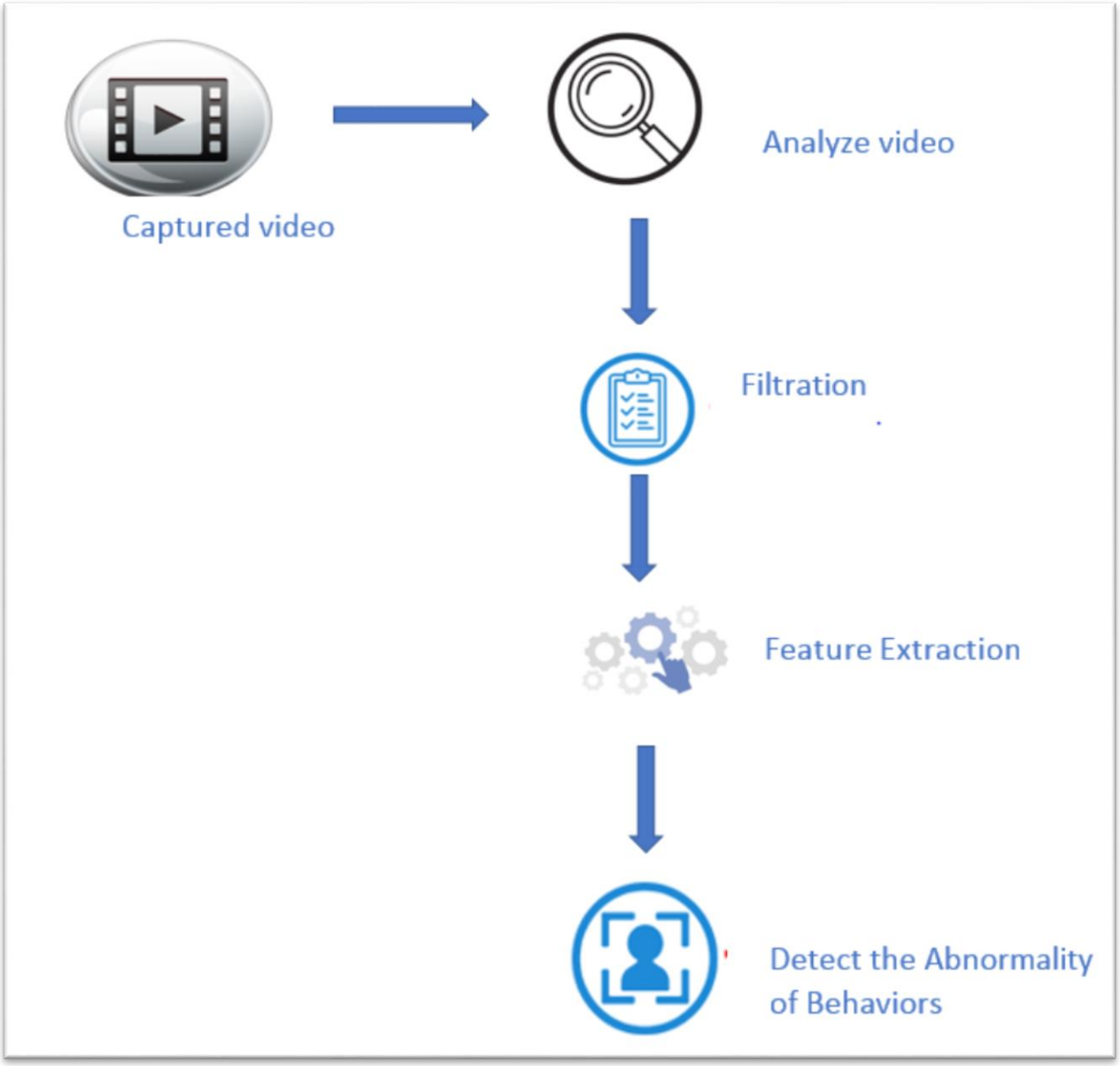

Figure 3.2 Detect Abnormal behaviors

The captured video is analyzed by the system and using some feature extraction methods it will detect are there any abnormality in patient's behaviors.

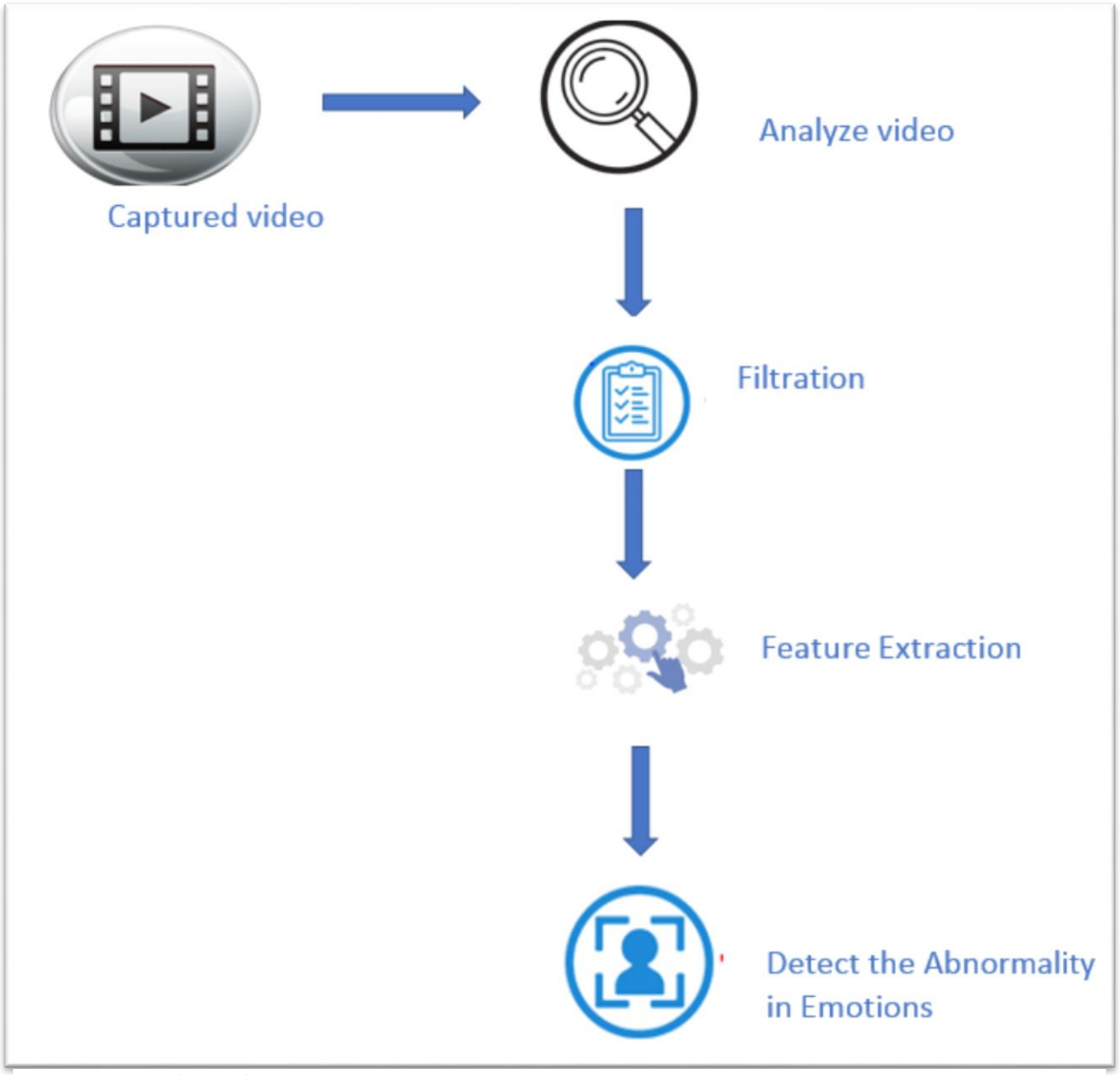

Figure 3.3 Detect Abnormal emotions

As the same by analyze the captured video it will check are there any abnormality in emotions.

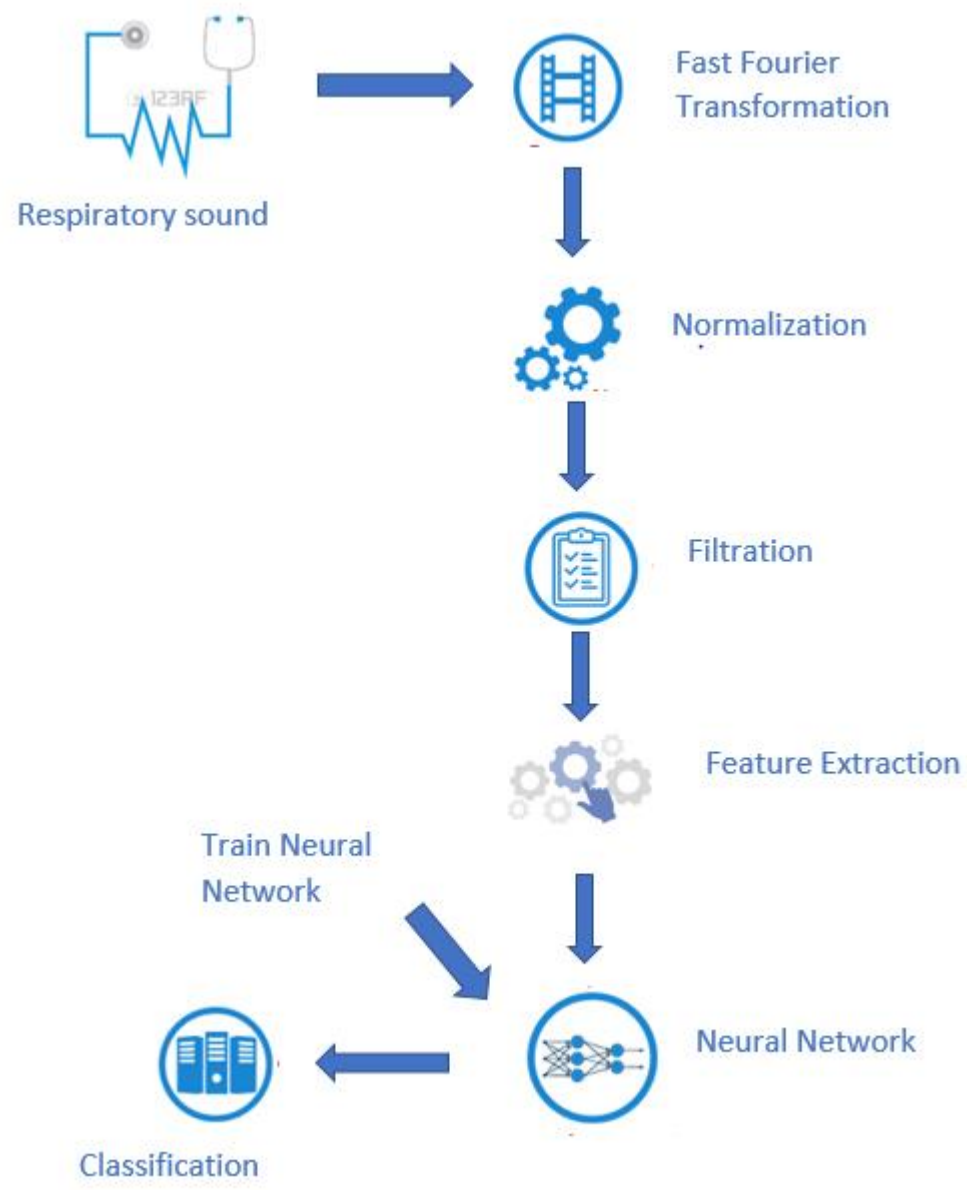

Figure 3.4 Respiratory Sound Analysis

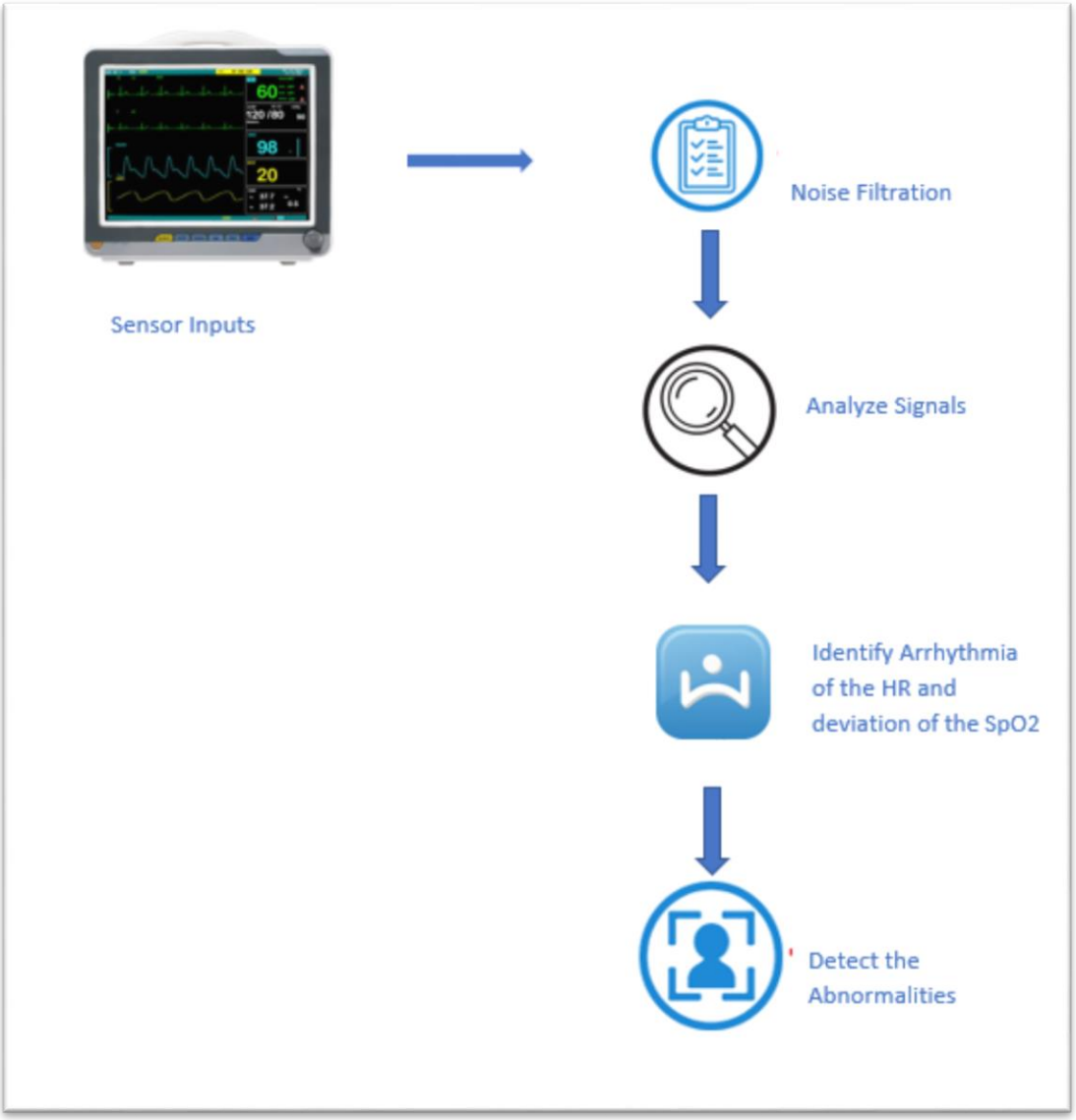

Figure 3.5 Sensor input abnormality

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 3.6 Arduino Uno 3

Pulse SpO2 Sensor

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

Figure 3.7 Pulse SpO2 Sensor

Web Camera

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

Figure 3.8 Web Camera

Bluetooth Module

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

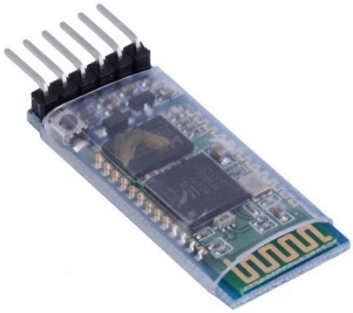

Figure 3.9 Bluetooth Module

Stethoscope

Stethoscope will be in use to capture the respiratory sounds.

Figure 3.10 Stethoscope

Microphone

Figure 3.11 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

3.3 Performance requirements

An internet connection with an average downlink speed of 400 kbps will allow an uninterrupted service. The product will be based on web and has to be run from a web

server. 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 one second. Data should be secured and backed up every quarter hour.

And in this system Power supply have a backup and a disaster recovery plan. System will be operable 24 hours a day and accessible in real-time.

3.4 Design constraints

During the design stage the major constraint will be facing is the limitation of available time. System design will be prepared and it helps to specify the requirements and helps to define the overall system architecture. Before start developing our system, we have to design a layered architecture of the core framework. The main components are included in this core service framework that required running the system.

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. Thus, system should be reliable enough because it has to produce accurate suggestions.

Elderly Patient Monitoring System 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 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. Ratio should be a higher value to achieve high availability of the system. Elderly Patient Monitoring System 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. Elderly Patient Monitoring 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. 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.

4. References

[1] Christian Thurau ” Behavior Histograms for Action Recognition and Human Detection” Czech Technical University, Faculty of Electrical Engineering Department

for Cybernetics, Center for Machine Perception 121 35 Prague 2, Karlovo n´amˇest´ı, Czech Republic.

[2] Chuan-Jun Su, “Personal Rehabilitation Exercise Assistant with Kinect and Dynamic Time Warping,” International Journal of Information and Education Technology, Vol. 3, No. 4, pp. 448-454, August 2013.

[3] Somchanok Tivatansakul and Michiko Ohkura, “Healthcare System Focusing on Emotional Aspects using Augmented Reality,” International Conference on Biometrics and Kansei Engineering ‘5-7, July, 2013, pp. 218–222.

[4] http://www.aplaceformom.com/blog/2014-6-1-cutting-edge-products-for-seniors/

5. Supporting information

5.1 Appendices

Appendix A: Use Case Diagrams

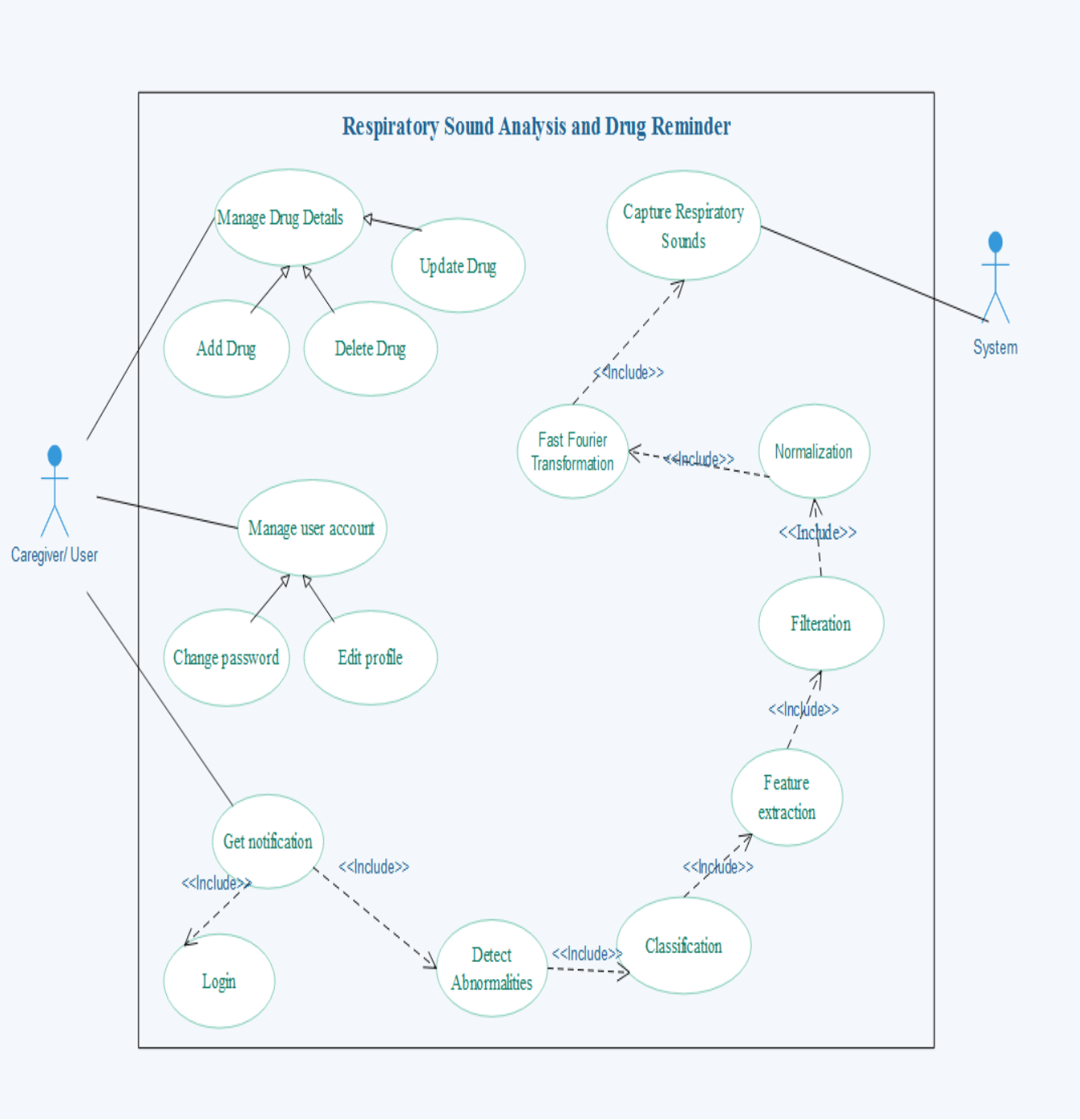

Figure:23

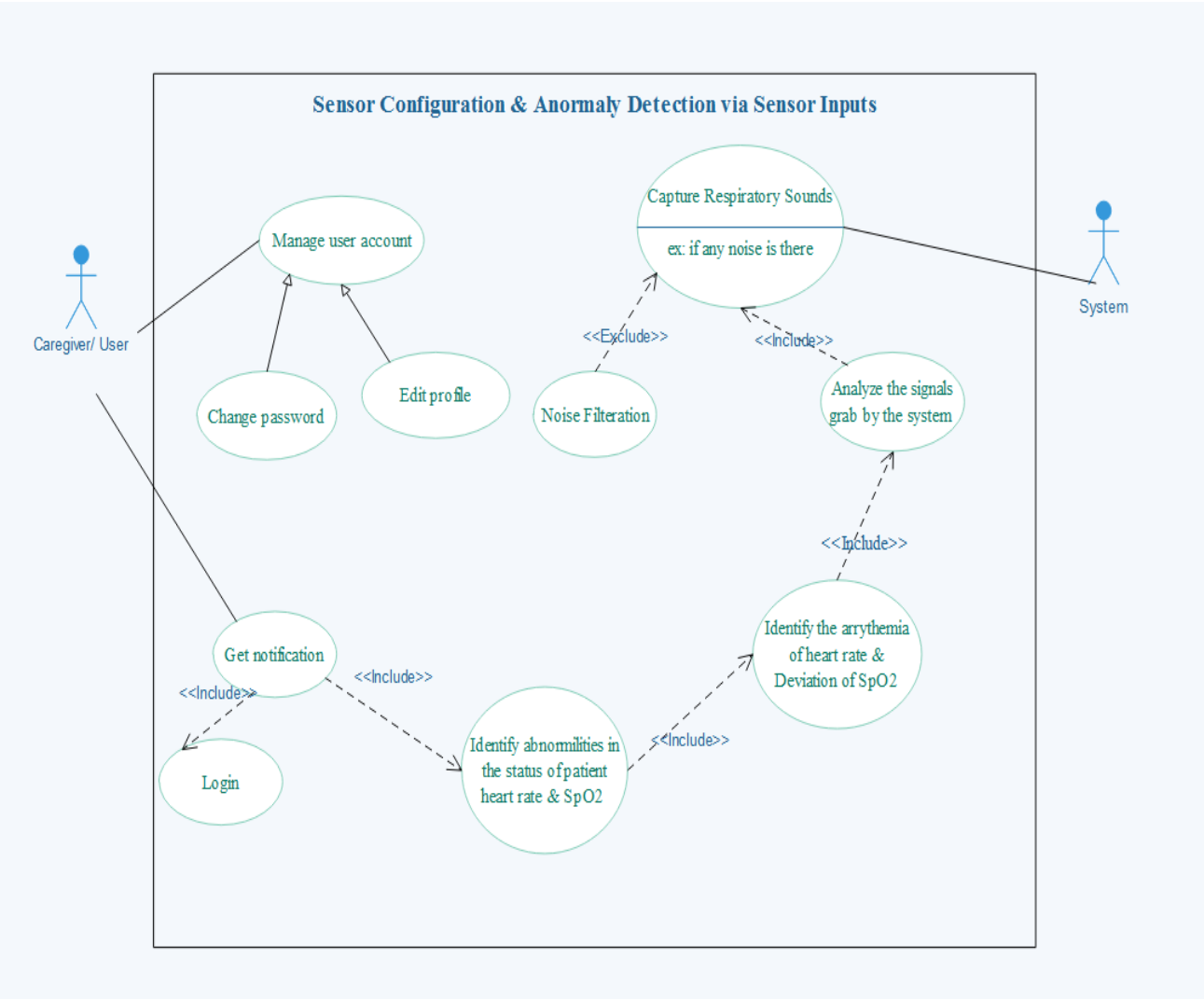

Figure:24

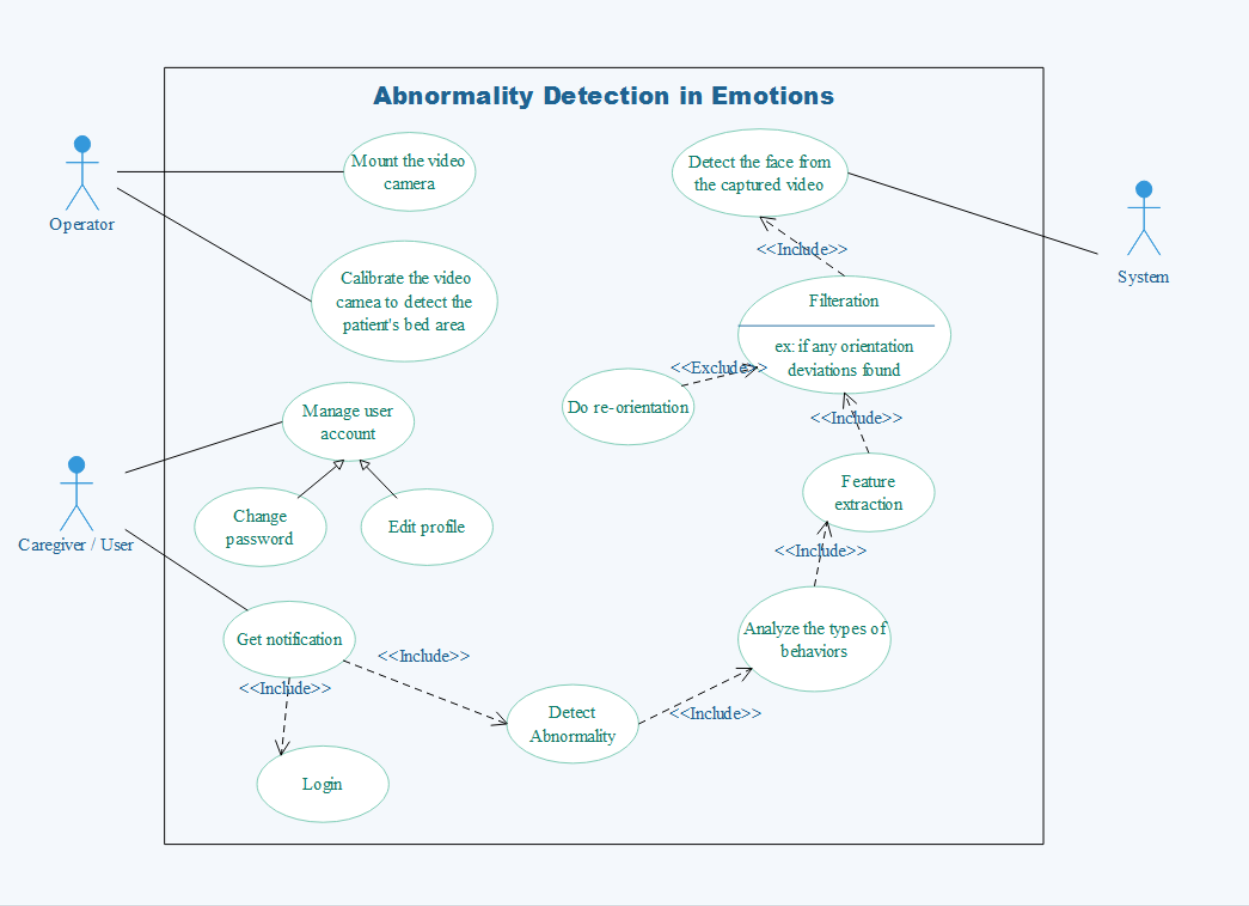
Abnormality Detection in Emotions
Operator
Caregiver / User
System
Mount the video camera
Calibrate the video camea to detect the patient's bed area
Manage user account
Change password
Edit profile
Get notification
Login
Detect the face from the captured video
<<Include>>
Filteration
ex: if any orientation deviations found
<<Exclude>>
Do re-orientation
<<Include>>
Feature extraction
<<Include>>
Analyze the types of behaviors
<<Include>>
Detect Abnormality
<<Include>>
<<Include>>

Figure:25

Appendix B: Activity Diagrams

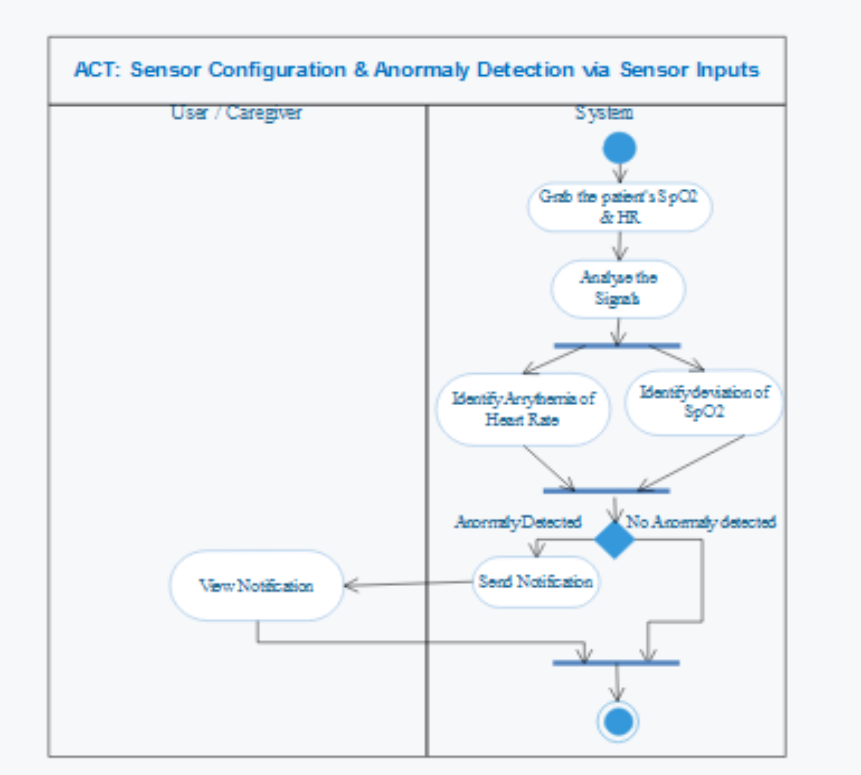

Figure:26

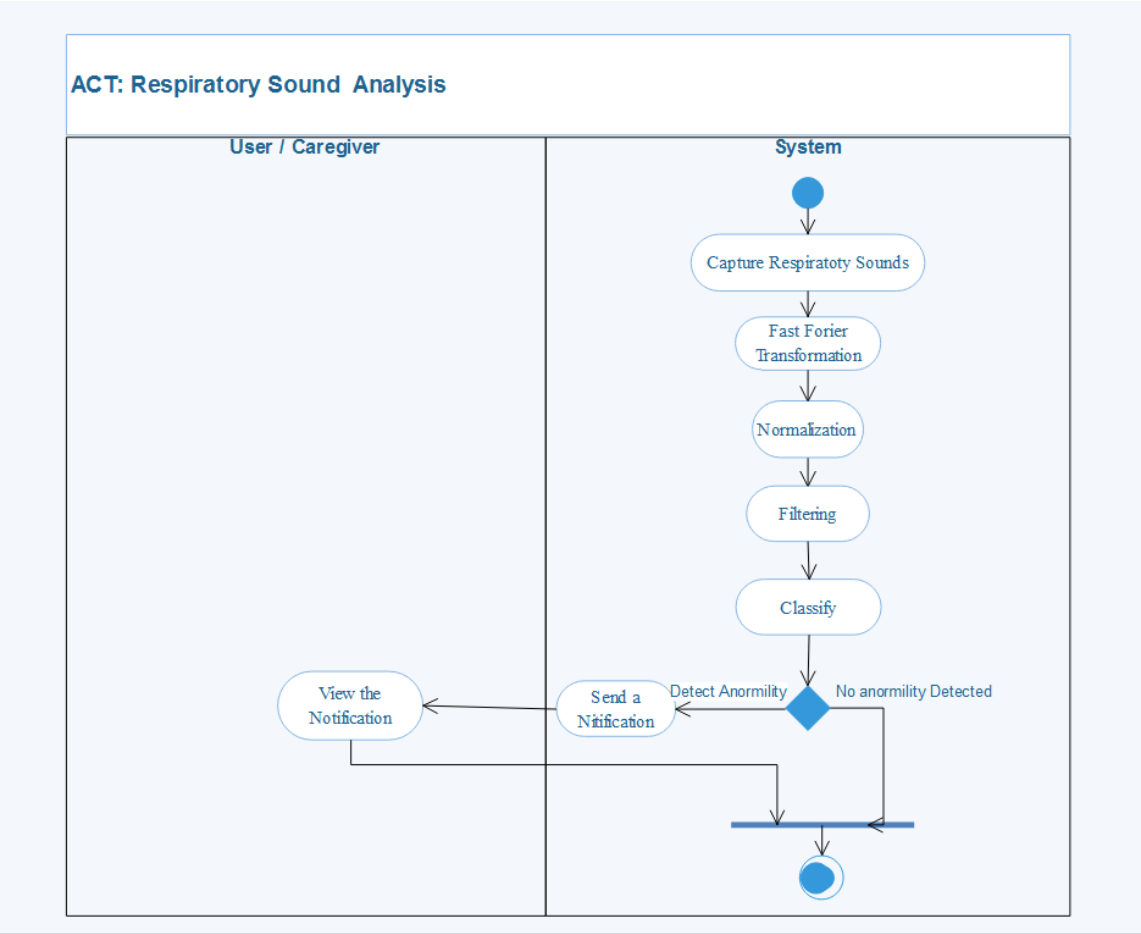
ACT: Respiratory Sound Analysis
User / Caregiver
System
Capture Respiratoty Sounds
Fast Forier Transformation
Normalization
Filtering
Classify
Detect Anormility
No anormility Detected
Send a Nitification
View the Notification

Figure:27

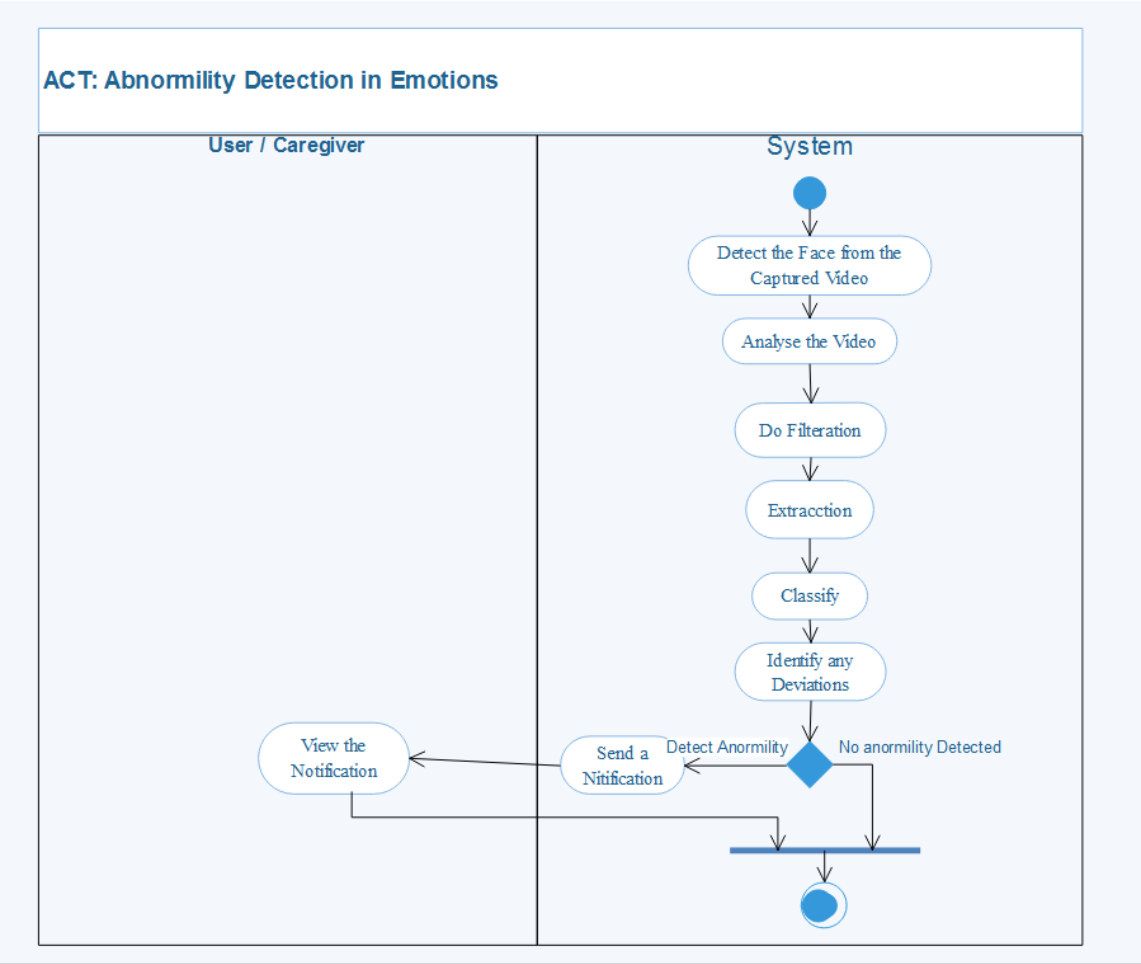
ACT: Abnormility Detection in Emotions
User / Caregiver
System
Detect the Face from the Captured Video
Analyse the Video
Do Filteration
Extracction
Classify
Identify any Deviations
Detect Anormility
No anormility Detected
Send a Nitification
View the Notification

Figure:28