ELDERLY PATIENT MONITORING SYSTEM

Project ID: 17-105

Project Proposal Report

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Bachelor of Science Special (Honors) Degree in Information Technology

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(Proposal documentation submitted in partial fulfilment of the requirement for the Degree of Science Special (honors) In Information Technology)

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Sri Lanka

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Declaration

We declare that this is our 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 candidates are carrying out research for the undergraduate Dissertation under my supervision.

Signature of the supervisor: Date:

…… 27/03/2017

Mr. Yashas Mallawarachchi

Dedication

We dedicate this project to especially my parents, our strong pillars, our source of inspiration, wisdom, knowledge and understanding. They have been the source of our strength throughout this project and also dedicate this work to our lecturers, instructors who has encouraged us all the way and whose encouragement has made sure that we give it all it takes to finish that which we have started. To all of our friends who have been affected in every way possible by this quest.

Thank you!

Acknowledgement

The completion of this study would have been not possible if not dependent on the steadfast support and encouragement of our parents. They hence paid equal contribution to the study for which we always feel profound gratitude in our hearts.

We would like to express here the very thanks to our dissertation advisor, Mr. Yashas Mallawarachchi, Sri Lanka Institute of Information Technology, who provided us the opportunity to do such research under his supervision.

Abstract

Declining birth rates and longer living people are major reasons to increase ageing population. Since they need more concerns and treatments on health, it is becoming a problematic scenario to looking after them regularly. Most of the elder people are getting affected by respiratory problems and monitoring of their health conditions has become a must. The purpose of a patient monitoring system is to implement an inexpensive system which can monitor multiple necessary facts about the patient's health along with the observation in patient's behaviors, emotions and respiratory sounds. Computer vision and IOT based approaches are proposed to monitor the patient, identify the anomalies in the patient and finally alert the responsible person with an appropriate alerting system. Process of patient monitoring at the domestic level is hardly been implemented via a proper technological solution. Therefore proposed system will reduce the number of adverse events to improve elderly patient outcomes while saving money at clinics and private hospitals.

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1. Introduction

1.1 Background & Literature Survey

Background

One of the major challenge for future is the ageing of the population, and how the health of old people can be preserved. Since the rate of the growth in ageing population is too high, there should be different ways to tackle the problem. Approximately percentage of older people is projected to be more than double the worldwide over the next half century [1]. With the ageing, older people are restricted to bed due to various kinds of diseases and eventually they are becoming bedridden patients. Majority of the elderly patient are getting directly affected by the air pollution in the domestic environment due to limited outdoor activities. Since the respiratory disorder for elderly people are common, they have been untreated to some extent [2]. Elderly patients who are getting treatments under their own roof need a help of a caregiver to get the attention, care and monitoring. Caregiver's role is to help patients by preventing occurrences of breathing problems. At the same time caregiver need to report the identified problems to doctor in order to ensure the correct directions for the treatments are followed [3]. Caregiver has to monitor elderly patient in few different ways to identify the anomalies in an appropriate manner. 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 tool such as SpO2 can be used to monitor how effectively the body is taking oxygen [4]. Not only the health parameters, but the tracking the behaviors of those patients has significant impact on the monitoring part. 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. Clarifying the normal behaviors and the abnormal behaviors of the patient respective to the time is a responsibility of a caregiver. Unknown observations should be identified as an abnormal behavior. 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. Therefore caregiver should have the responsibility of focusing on the emotions of the patients in every possible second. 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 [5]. But identification of respiratory sounds and separate them as normal and abnormal is not an easy task to perform. It requires a skill level of a well-trained physician to listen and understand the sound for classification. 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. Caregiver has a high responsibility on his/her shoulders where sometimes he/she may forget to give the drugs of the patient in time with the right amount of dose. Therefore

caregiver should be aware of the drug taking of the patient and should adjust his/her schedule according that.

Developing a system with cost-saving health technologies and bringing it to the market will be helpful to improve prevention, diagnosis, and treatment of disease. Even the promotion process will be easier with the cost-effectiveness of such system. Finally the product can be targeted to different markets which are in need of such a product. 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.

Literature Survey

Electronic Health has been with the people for many years and has been defined as use of Information and Communication Technology. With the arrival of many technologies, concept of the patient monitoring system has emerged. Comparison of existing patient monitoring systems is a must prior to propose a solution for an identified problem.

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. Therefore identification of the solutions for the main components separately will optimize the performance of the system with the newest technologies.

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 [6].

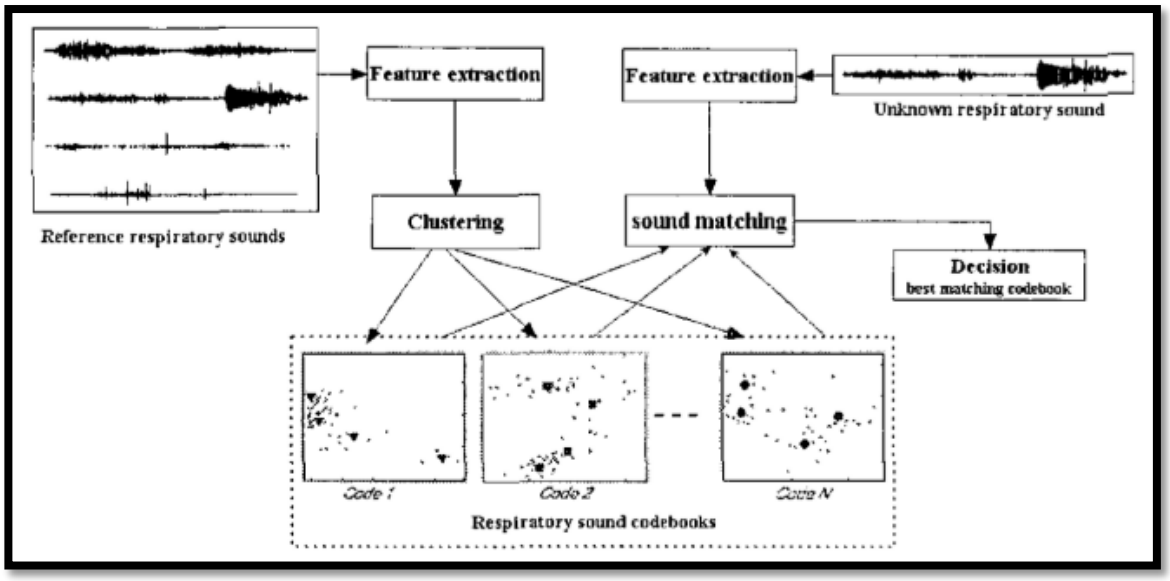


Figure 1.1 Block diagram of the VQ based sound classification

Source: [6]

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 [7].

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 [8].

Figure 1.2 Outer appearance of the device

Source: [8]

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 [9].

Figure 1.3 Set-up used for recording Lung sounds

Source: [9]

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 [10].

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 5kHz range from 10kHz 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 [11].

Variety of respiratory problems have been gotten 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.

When it comes to the process of the respiratory sound analysis, different techniques have been implemented. Feature extraction and the classification are two main parts of the procedure. Many feature extraction methods have extracted more features than required amount. Classification will become harder with larger features where there can be features which quite similar to each other. Therefore finding the best technique out of available feature extraction method is a must. Major section of the analysis process is classification, where it will directly affect to the accuracy of the system. SVM and K-NN classification models have been used in the domain and achieved different accuracy rates where

comparison is bit harder to perform. Artificial Neural Network can be used as a classification model where non-linear classification can be done.

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. 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 [12].

Figure 1.4 For the experiments considering 10 different behaviors performed by 9 subjects to detect the human within the image and to assign the sequence to one of the known behavioral categories

Source: [12]

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) [13]. 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.

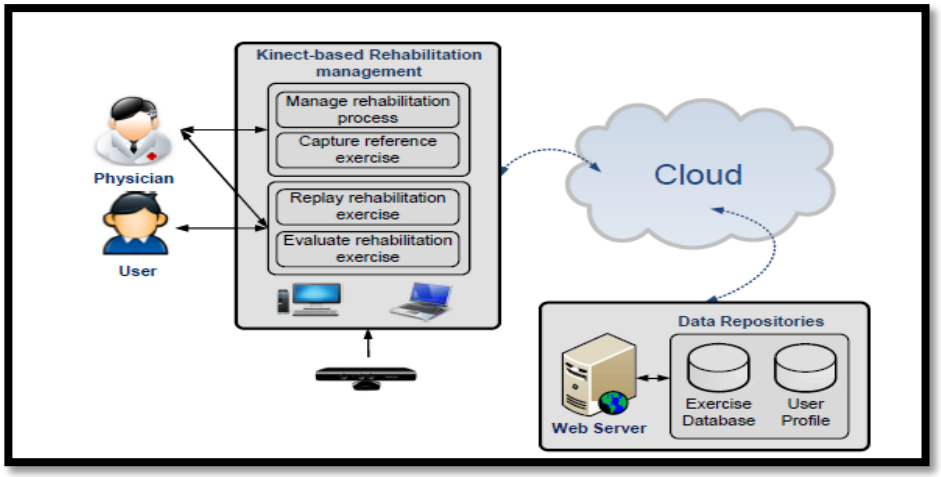


Figure 1.5 Rehabilitation system based on Dynamic Time Warping-architecture

Source: [13]

Pioggia and his team have proposed a “Healthcare System Focusing on Emotional Aspects using Augmented Reality” [14]. 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.

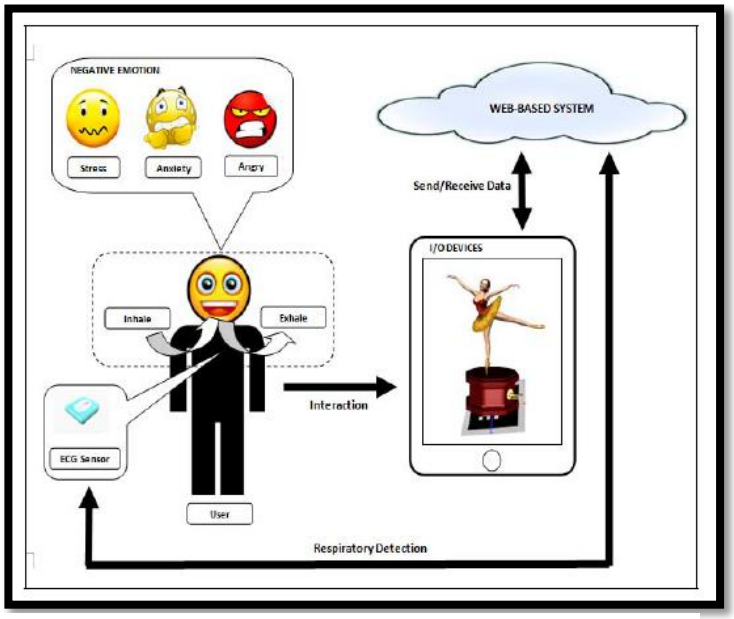


Figure 1.6 Healthcare system focusing on emotional aspects- architecture.

Source: [14]

Norbert GAL and his colleagues have proposed “A Kinect based intelligent e-rehabilitation system in physical therapy”[15]. In In there the Kinect can detect the posture and motion of the patients while the fuzzy inference system can interpret the acquired data on the cognitive level. Using the exercise descriptors, the fuzzy inference system can track the patient and deliver real-time feedback to maximize the efficiency of

the rehabilitation if the patient does not follow the exercise pattern than the system displays a message from the patient to correct the movement. End of each exercise set the system displays the current status of the patients' progress, evaluate the progress from the last session and predicts a final result.

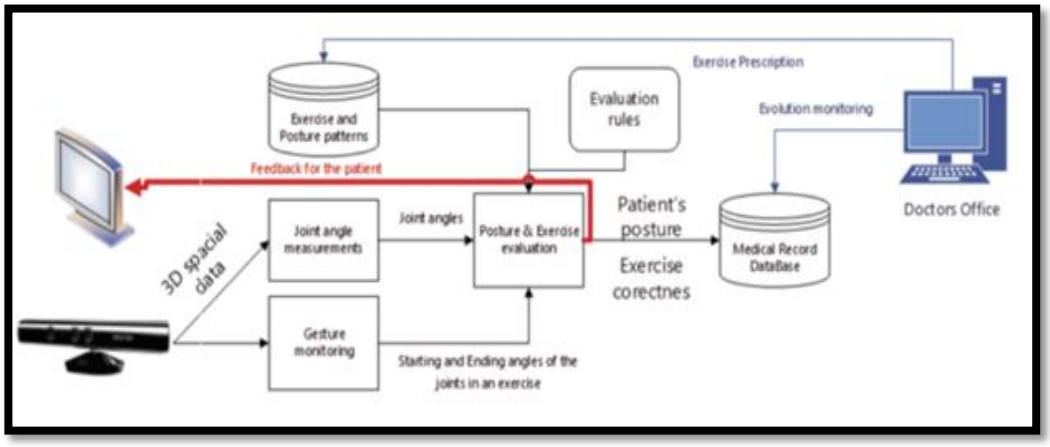


Figure 1.7 intelligent tele rehabilitation system in physical therapy-architecture

Source: [15]

W. Zhao and his team demonstrated a rehabilitation behavior monitoring and guidance system [16] based on the Kinect sensor. Since they used virtual reality techniques to illustrate the movements, they used the Unity game engine because its simplicity. To assess the movements of the patient, they have used a rule-based approach. In their system, they have used two 3D avatars: one avatar demonstrates the correct pre-recorded movements and the second avatar demonstrates the actual movements of the patient.

Figure 1.8 Behavior monitoring and guidance system - architecture

Source: [16]

The system asses the movements of the patient and give real time feedback based on a set of correctness rules. The system assesses the movements for both quantitative and qualitative. Quantitative in the sense the correct number of repetitions. To implement the rules, they have used XML. The rules are loaded at runtime so that the exercise for each person can be modified without having to recompile the code. However, the system is limited only to monitor the angles between the active joints. The system has not considered about the positions of the other joints during the exercise.

Baihua Li and his colleagues have proposed "Development of Exergame-based Virtual Trainer for Physical Therapy" [17]. In their research they used Microsoft Kinect to capture gestures. In their system, there are two user play roles as physiotherapist and patient. In the physiotherapist mode, a physiotherapist can personally perform prescription movements and postures. These movements are recorded and can be played back through a 3D on-screen avatar, so that the physiotherapist can check and edit before storing them

in an exercise database. In the patient mode, the user can preview the movement, know what to expect and then follow the coach to exercise. The user's exercise is captured by Kinect and displayed on the user's avatar during exercise. Compare the patient's gestures with therapist's one and by online motion analysis module analyze and give feedback.

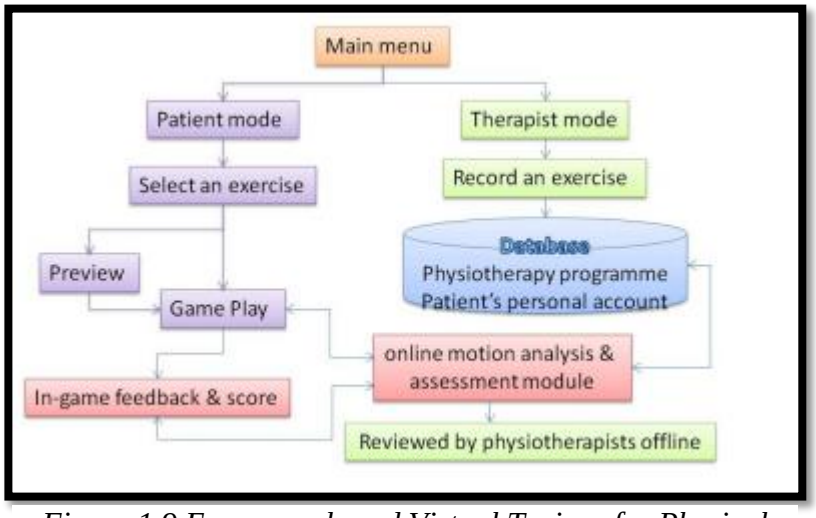


Figure 1.9 Exergame-based Virtual Trainer for Physical Therapy- architecture

Source: [17]

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 those above 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. But in here we are planning to cover those areas.

Rekha Chandra R, Safeer K P and Srividya P has done a research on "design and development of miniaturized pulse oximeter for continuous SpO2 and HR monitoring with wireless technology". The Saturation of blood (SpO2) and Pulse Rate are the two important parameters for monitoring patient's health condition. They use photo-plethysmo-graphy(PPG) to measure pulse rate. Their System consist of fingertip sensor, Analog device, 8 bit Atmel Microcontroller circuit and display unit (PC).The (SPO2) calculate by measuring intensities of red and infrared lights operating at different wavelengths of 660nm and 940nm. The pulse rate calculated by measuring the peaks of IR signal between the elapsed time. Then they are measured all these parameters and transferred to PC via Bluetooth for displaying the results [18].

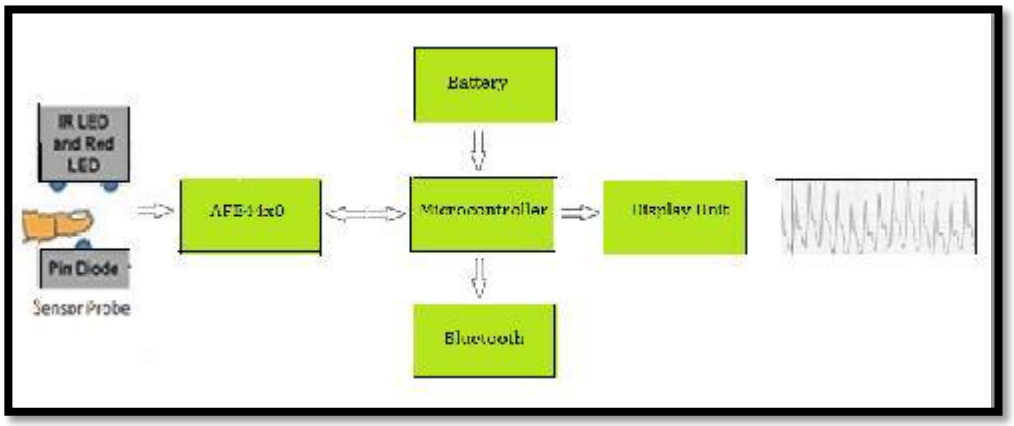


Figure 1.10 Block diagram of SpO2 and Pulse rate measurement

Source: [18]

There is a research done by PG Scholar and 2Assistant Professor, Department of Electronics and Communication Engineering, AVS college of Technology. They proposed an "Advanced Mobile Health Care Monitoring System Using Temperature sensor and Heart beat Rate sensor Method". They use wireless body sensors and smart phones to monitor the well-being of the elderly. When an emergency detection is the smart phone alarm automatically pre people who could be family and friends, the elderly, and to call the ambulance to the emergency call center. It also acts as the personal health information system and he medical advice that provides a platform for communication and the medical knowledge base, so that the family and friends of people served with doctors can work together by him / her to take care. It also acts as the personal health information system and he medical advice that provides a platform for communication and the medical knowledge base, so that the family and friends of people served with doctors can work together by him / her to take care [19].

Their system design describes about the a new approach advanced health monitoring using Arduino Uno is divided into two parts

- Hardware implementation
- Software implementation

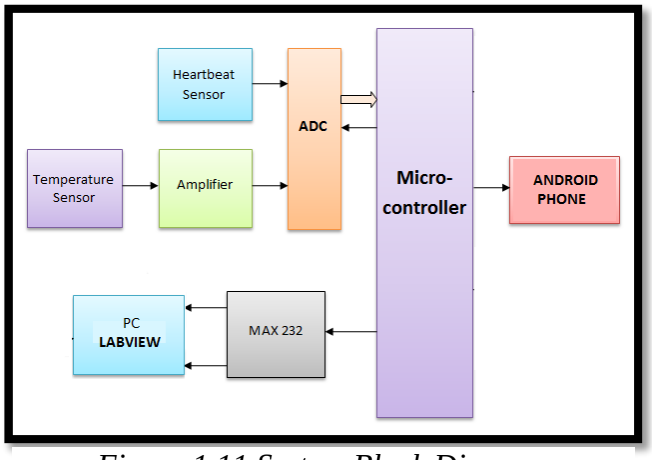


Figure 1.11 System Block Diagram

Source: [19]

There is a research done by Graduate school of Dongseo Univercity, Department of Ubiquitous IT and Division of Computer and Engineering. They design and implement a healthcare monitoring application for ubiquitous sensor network. The pulse sensor uses the arduino board to send the data to the web server via RN-XV wireless module base on 802.11 protocols. The data collected from the patient can be remotely viewed and analyzed by a physician or nurse [20].

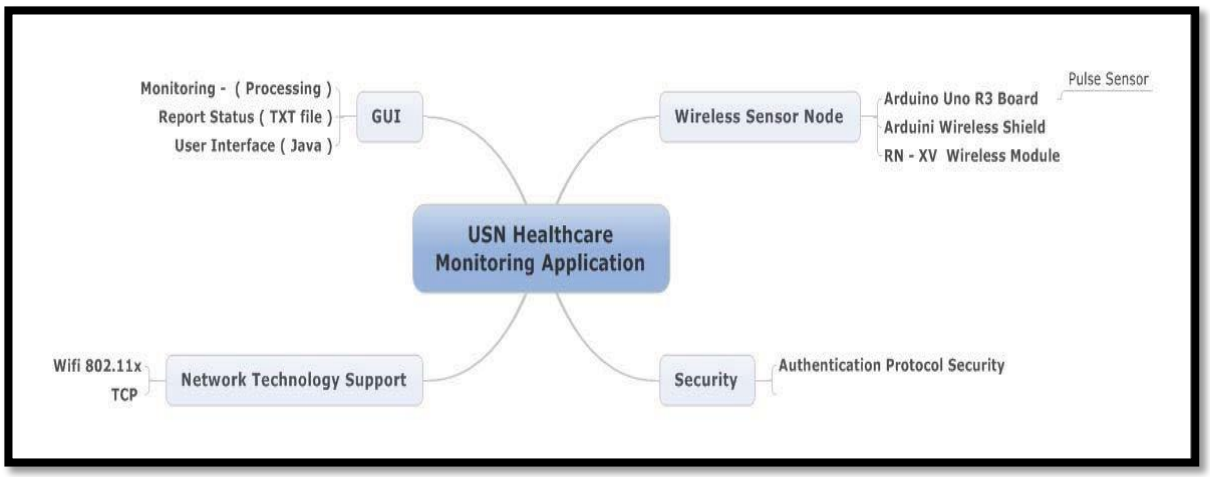


Figure 1.12 Overview of the USN Healthcare Monitoring Application

Source: [20]

N.Watthanawisthu and his crew design and developed "Wireless Wearable Pulse Oximeter for Health Monitoring using ZigBee Wireless Sensor Network". They developed a portable real-time wireless health monitoring system. This system developed for monitoring of patients' heart rate and oxygen saturation in blood. This system was designed and implemented using ZigBee wireless technologies and demonstration of pulse oximetry data (heart rate and SpO2) monitoring on three patients in the home. From their experimental results, the system was successfully install for testing in patient's home for health care monitoring [21].

In this system diagram shows the component and the technologies that they use for their system.

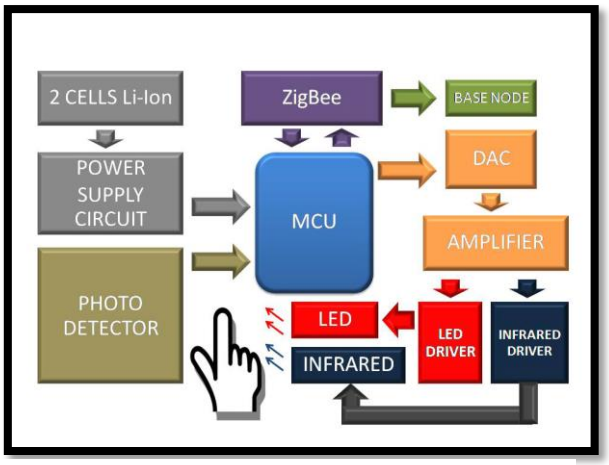


Figure 1.13 Block diagram showed system architecture

Source: [21]

Alan Sands, Phoenix, AZ (US) has proposed “mobile patient monitoring system with automatic data alert”. This system to increase compliance with patient monitoring protocols for patients with chronic disease. They used wireless telecommunication device as the hub of the system. The hub is configured to increase patient compliance with a monitoring protocol by being integrate with a mobile device. The hub receives physiological data about the patient from a medical sensor then collates the sensed data with certain data input by the patient. The reading is transmitted to a server that uses a software application to automatically examine and interpret the data. Alerts send to the care giver via the network when the reading is outside specified parameters [22].

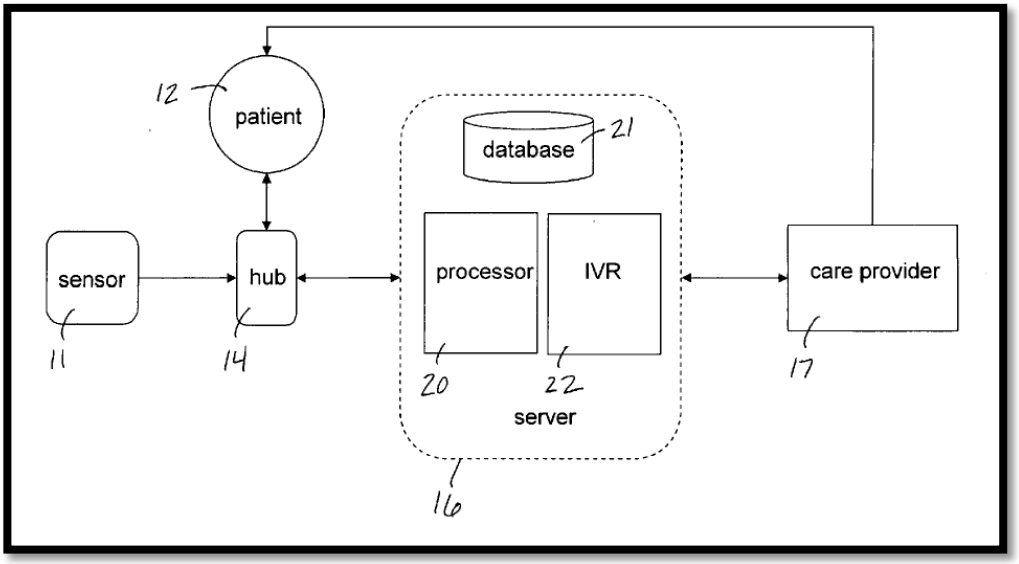


Figure 1.14 System architecture diagram

Source: [22]

P. A. Pawar has proposed “Heart Rate Monitoring System using IRbase Sensor & Arduino Uno”. This system is used to monitor physical parameter like heart beat and send the measured data directly to a doctor through SMS. They used an IR base heart beat sensor, Arduino Uno & GSM module in this system. This device will be able to measure heart beat from an infant to elder person. In their system the heart beat sensor will provide digital signal to Arduino Uno. This internally does the calculation as per programming & display heart rate on LCD along with the information. Further Arduino will communicate with GSM module & will send SMS to doctor cell phone, which is predefined in the program [23].

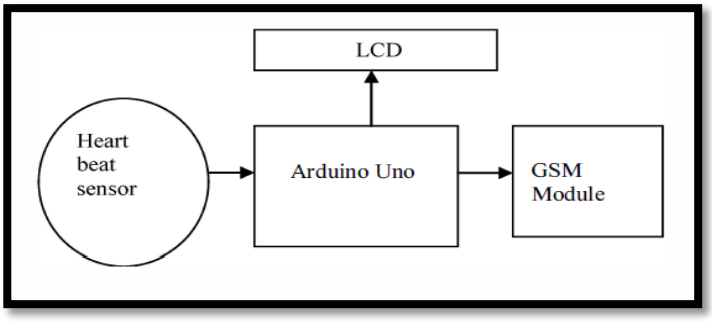


Figure 1.15 Architecture diagram of the system

Source: [23]

Proposed System mainly focus on bedridden patients in this research. All those mentioned above researches are focused on normal patients and those mainly focused on heart rate or some other features using sensors. Here the proposed system will be focused on drag and analysis arrhythmia of heart rate (HR) and deviation of peripheral capillary oxygen saturation (SpO2).

There was a research done by Fadzilah Siraj and others from the faculty Information Technology, University of Utara Malaysia to classify emotion using neural network. Nowadays emotion is a major network for the communication between human and machines. By detecting the emotion of the human machines can make decisions, learning and do various cognitive tasks [24]. In this study they classified six major human emotions using neural network as shown in the following figure.

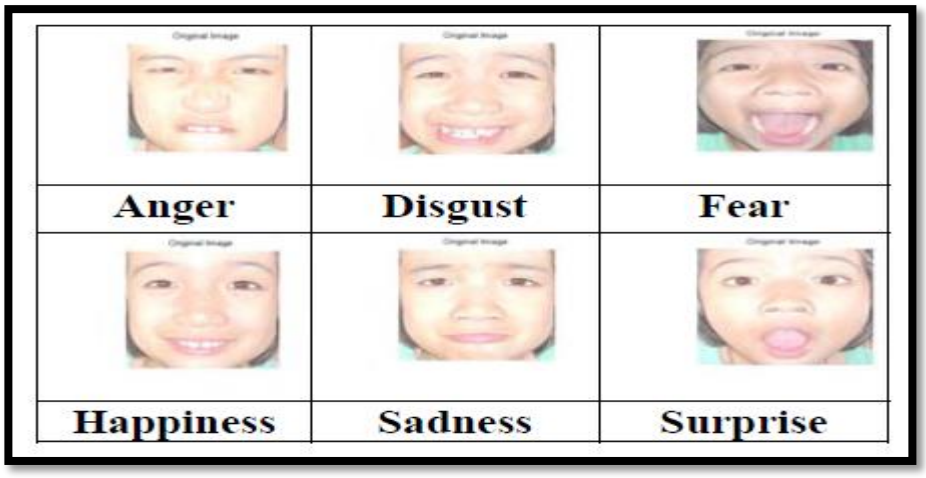


Figure 1.16 Six universal emotions

Source: [24]

In here the particular image is processed in a flow as mentioned below.

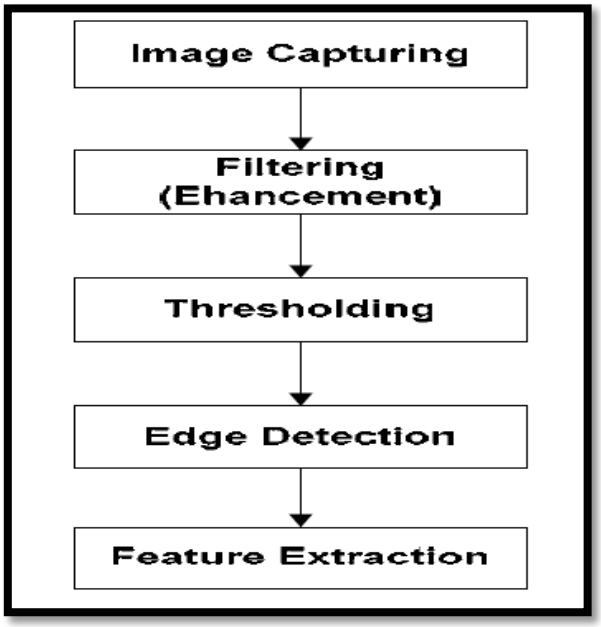


Figure 1.17 The Flow of Process of Image Processing

Source: [24]

They had used a Sony Cybershot DSC U50 digital camera for the capturing purposes of the image. And use image filtering for the training and the testing. They have used Otsu's

method for thresholding and Sobel technique for edge detection. The magnitude of the gradient is then calculated from following equation.

$$|G| = \sqrt{Gx^2 + Gy^2}$$

Group of researchers Patrick Lucy (Member, IEEE), Jrffrey F.Cohn(Associate member, IEEE) and some other researches described a research about Automatically Detecting Pain in video through facial Action Units. Here they use videos of patients with shoulder injuries. They proposed an Active Appearance Model (AAM) which can automatically detect the patients' pain in a video at a frame-by-frame level based on Action units. In here, they used UNBC-McMaster Shoulder Pain Archive (which contains data on patients moving both their injured and uninjured shoulders) database which can detect the spontaneous emotions with respect to reaction of the patient's pain. By using this system they were able to find whether a patient is currently suffering from a pain or not [25].

A research, "Automated coding software outperforms people in recognizing neutral from neutral faces as neutral from standardized datasets" was done by Peter Lewinski in the Amsterdam School of Communication Research, Department of communication Science, University of Amsterdam, Amsterdam, Netherland. Automated Facial Coding Software (AFC software) is a software which can detect human's neutral faces via a computer. Here he had used two data sets Karolinska Directed Emotional Faces and Warsaw set of emotional express pictures to analyze neutral faces using his AFC software. Following figure shows how the face reader of the AFC is analyzing a neutral face [26].

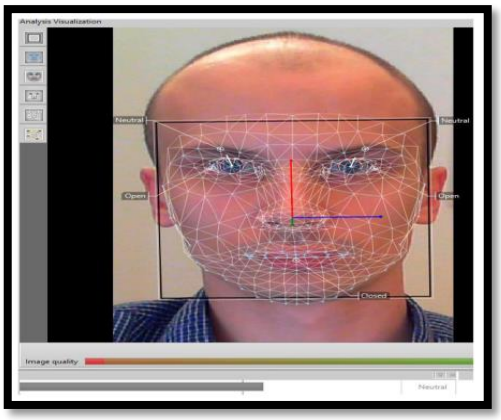


Figure 1.18 Face Reader analysis of a neutral face

Source: [26]

Here, the face reader in AFC works in three steps.

1. It detects a face in the image.
2. Identifies 500 key landmarks in the face through Active Appearance Model, visualized as a 3D superimposed virtual mesh.
3. The image is classified according to how likely the emotion is present in a person's face.

This AFC software was tests with 100 human participants images and the face reader has analyze all of them without any failure.

There was a research "Real-Time System for Facial Emotion Detection Using GPSO Algorithm" done by Bashir Mohommed Ghandhi, R.Nagarajan and Harry Desa in the School Mechatronics Engineering, University of Malaysia Perlis, Malaysia. Here they proposed an algorithm called Guided Particle Swarm Optimization (GPSO) which is a modification of Particle Swarm Optimization (PSO) algorithm. PSO algorithm is designed for facial emotion detection while GPSO algorithm designed for keep track of relevant points, called Action Units which are specified on the face of a subject. They have used

Lucas-Kandade (LK) Algorithm to keep track of the action units in each iteration of GPSO algorithm. LK algorithm was derived on three assumptions [27].

1. Brightness Constancy
2. Temporal Persistence
3. Spatial coherence

The combination of above algorithms helps them to detect six basic emotions in a real-time and they say this is easy to deploy in a robot or any computer system for real time applications.

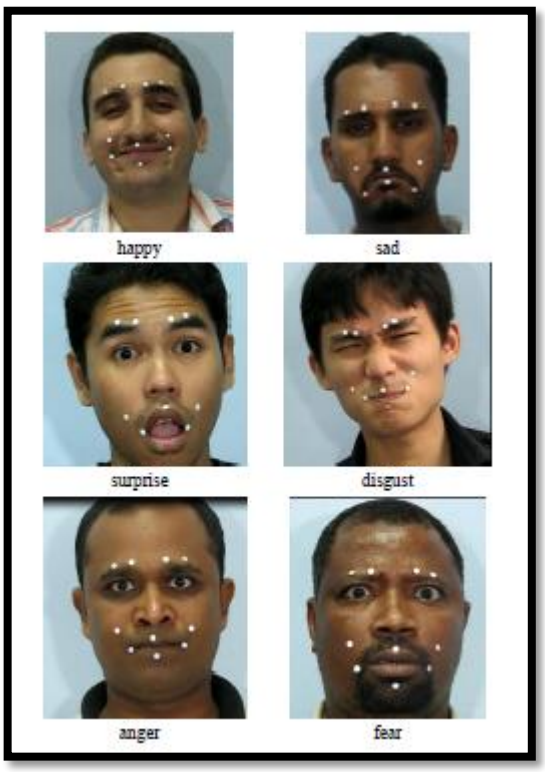
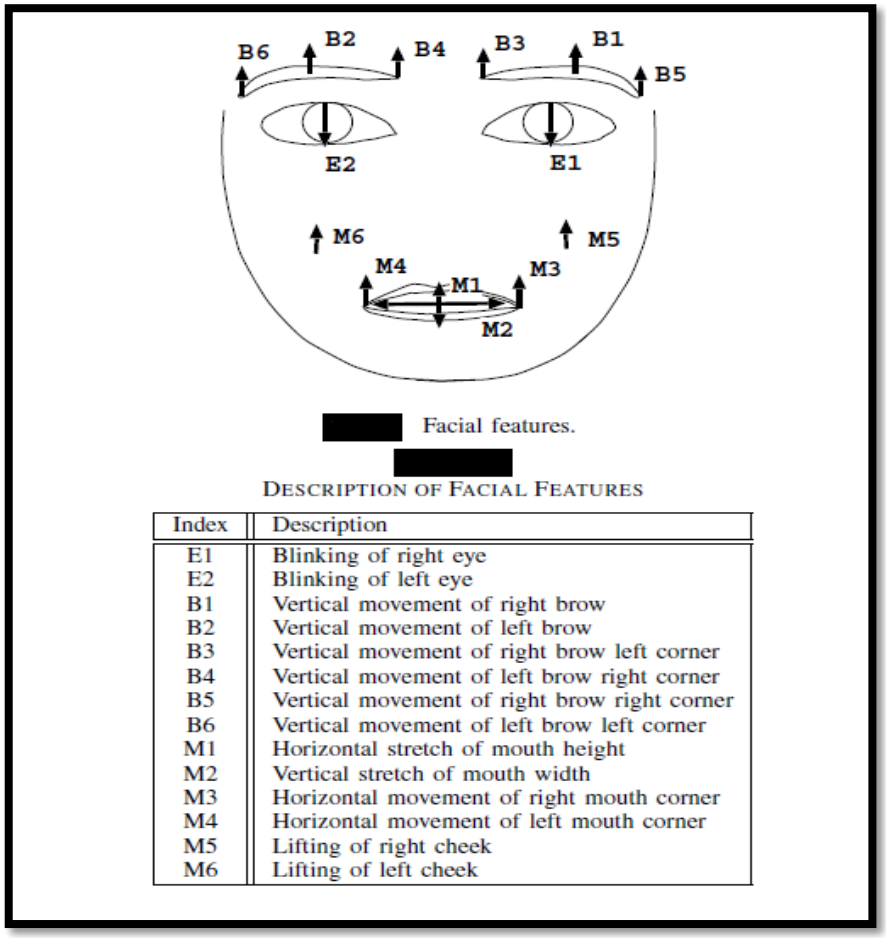


Figure 1.19 Samples of the six basic universal emotions

Source: [27]

A group of researches in department of Computer Science And Engineering, Nagoya Institute of Technology, Japan done a research to detect facial emotion by considering

partial Occlusion of face using Bayesian Network. In real world it is possible that the face can be partially covered by some ornamentation materials such as caps, scarfs glasses and many more materials. In this type of a situation detecting facial emotions is difficult. Here in this research they proposed an emotion detection system taking into consideration partial occlusion of face using casual relations between facial features. They used Bayesian network to detect emotions without filling in the gaps of occluded features. Because this Bayesian network classifiers figure out from the dependencies among the target attribute and explanatory variables. The figure following shows how Bayesian network detect human facial features and their descriptions [28].



DESCRIPTION OF FACIAL FEATURES

Index	Description
E1	Blinking of right eye
E2	Blinking of left eye
B1	Vertical movement of right brow
B2	Vertical movement of left brow
B3	Vertical movement of right brow left corner
B4	Vertical movement of left brow right corner
B5	Vertical movement of right brow right corner
B6	Vertical movement of left brow left corner
M1	Horizontal stretch of mouth height
M2	Vertical stretch of mouth width
M3	Horizontal movement of right mouth corner
M4	Horizontal movement of left mouth corner
M5	Lifting of right cheek
M6	Lifting of left cheek

Figure 1.20 Facial features with their Descriptions

Source: [28]

In the above literature reviews which was under emotion detection, all those researches were under normal patients, but here, the proposed system will manage a special patient profile (bedridden patients). The proposed system will mainly focus on the abnormality detection on bedridden patients having breathing difficulties. It is very important to have a proposed system like this, because if any patient is having any breathing difficulty, it will be shown in his/her facial emotions. Here the changing of those type of emotions will be detected I this proposed system. And if any abnormality is detected it will be informed to the care giver immediately.

1.2 Research Gap

There are several computerized monitoring systems available to date, but which are lack of many mandatory features worth to their extreme cost. None of the solutions provided up to today, do not cover a large area compared to our proposed system. We identify the several issues and try to come up with proper solutions for those. Most of the current solutions mainly consider on monitoring health parameters such as heart rate, spO2 and respiratory rate of the patient. But our proposed system will monitor the heart rate to in order to check the irregularity or arrhythmia. Because only displaying the heart rate of a given time will not provide any benefits for the patient or the caregiver. Derivation of the SpO2 with respective to time is way better than showing only the SpO2 level .Continuous monitoring of the emotions and the behaviors of the patients as important as monitoring the major health parameters. But the proposed solution are lacking the features of the detecting anomalies in emotions and detecting anomalies of the behaviors. Proposed system will monitor the emotions and the behaviors of the patient in every single second to capture any abnormality or an unknown observation. Additionally a component to analyze the respiratory sounds of the patient is

effective in many ways. Even the majority of the systems related to respiratory issues are only focusing on getting the respiratory rate of the patient. But the analysis of the respiratory sounds has been experimented as a separate component and few experiments are having much higher success rate comparative to other experiments. Facility of alerting the caregiver about the drug taking of the patient is one unique feature comparing with the existing systems. None of the solutions have not even mentioned the importance of drug taking for an elderly patient. Overall components of the proposed system will produce an optimized product which can be effectively used by patients with respiratory problems.

1.3 Research Problem

Majority of the elderly bedridden patients are getting treatments under their own roof and require special caring with continuous human monitoring. Problem with the human monitoring is that it requires well trained caregiver with sound knowledge and skills to keep eye on the patient all the time. Finding well qualified caregivers/private nurses is not an easy task while they are limited and already assigned for particular jobs. It requires high concentration level even for well trained and qualified caregivers to monitor the patient in every single second. Therefore an inexpensive system which can monitor multiple necessary facts about the patient's health would be ideal. Luxury of an automated patient monitoring system is that even a family member can become a caregiver to look after the patient since all the monitoring tasks is done through the system. With the industrialization and the globalization, most of the people are affected by respiratory problems and the majority of them are elderly people. Since deploying a system for all kinds of bedridden patient is not practical, system which is going to propose will be aimed for bedridden patients with respiratory problems.

2. Objectives

2.1 Main Objectives

- 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

2.2 Specific Objectives

- Provide continuous monitoring of the primary health parameters to minimize the adverse events which can occur.

- Provide solutions for the mental issues of the patient such as stress, anxiety by monitoring emotions where caregiver can pay more attention with much more special care.

- Reduce cost and time that requires to attend at hospital and clinics in order to monitor the health conditions.

- Help the caregiver to identify the abnormal respiratory sounds prior to meet the doctor where doctor can take necessary steps regarding the disease.

- Provide a mechanism to alert the caregiver in case of an abnormality of the patient detected.

- Provide a mechanism to alert the caregiver about the drug taking of the patient prior to exact time.

3. Methodology

This section will describe the methodologies and techniques that we have planned to follow in order to accomplish our objectives. It's a systematic approach to the research, project development and implementation of successful solution within time, budget, and using current technologies. Basically we designed our solution according to agile software development methodology, scrum.

3.1 System Overview

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
2. Sensor configuration and anomaly detection via sensor inputs
3. Abnormality detection of behaviors
4. Abnormality detection in emotions

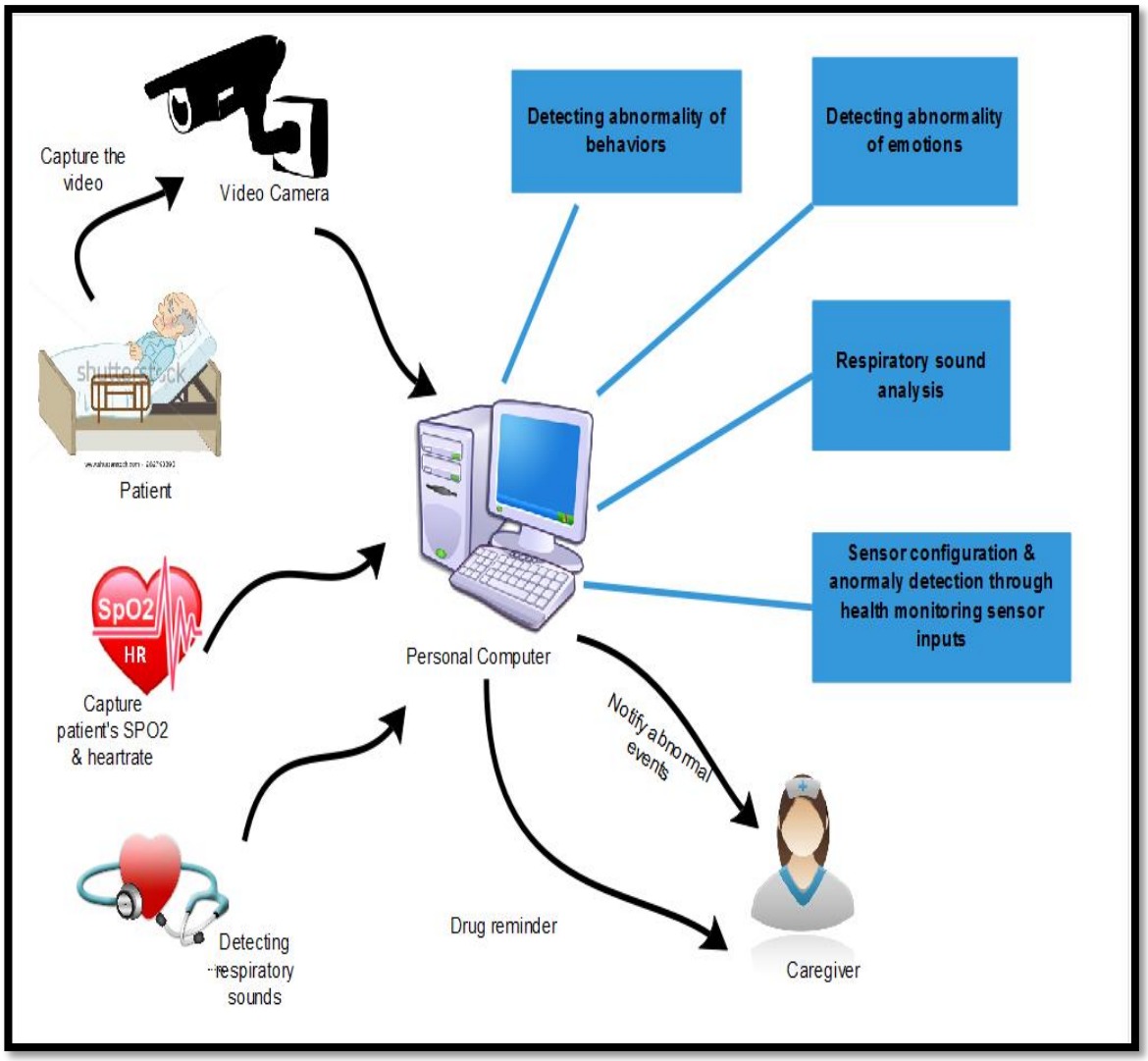


Figure 3.1 High level Architecture of the system

Gantt Chart

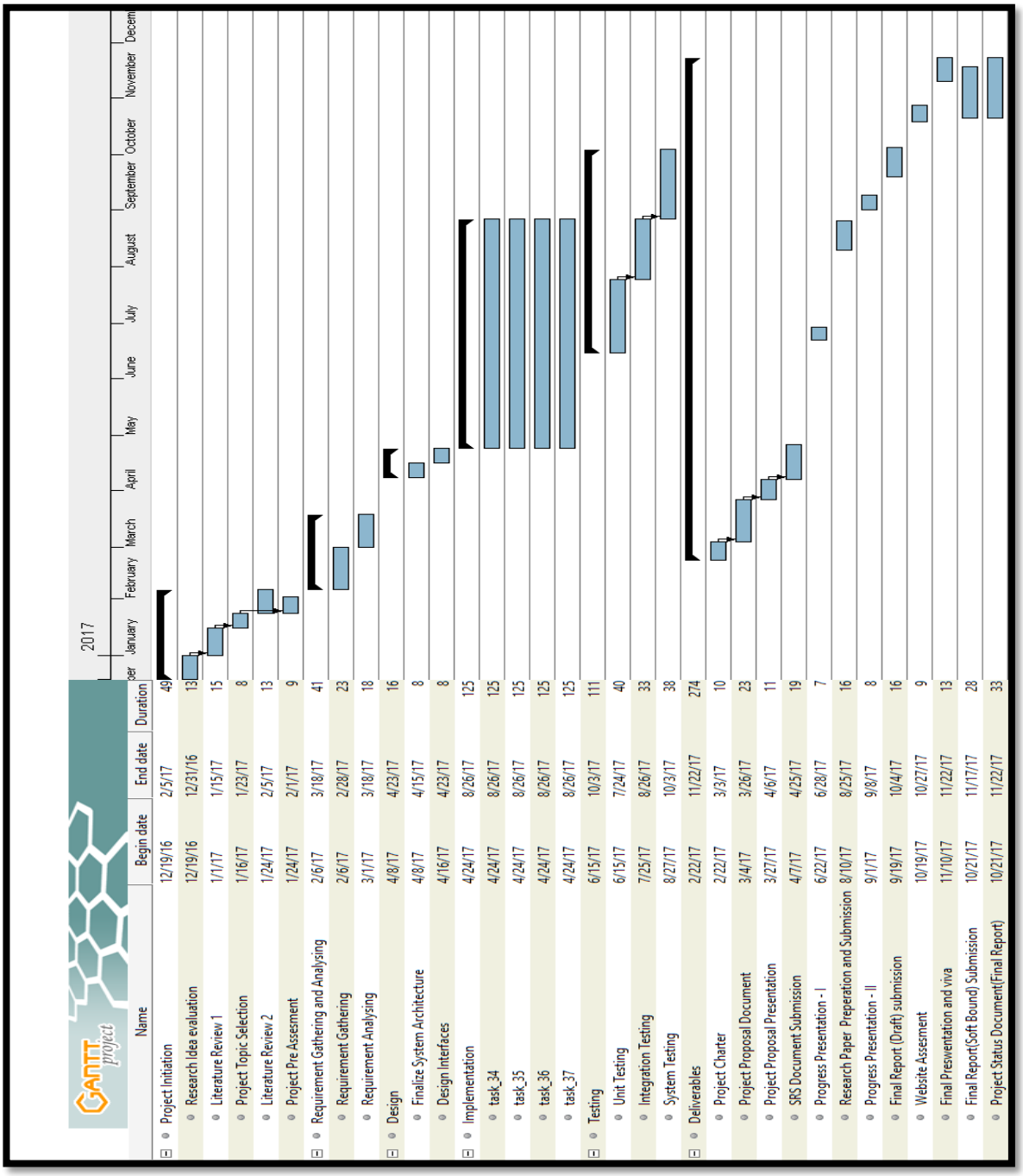


Figure 3.2 Gantt chart

Work Break down Structure

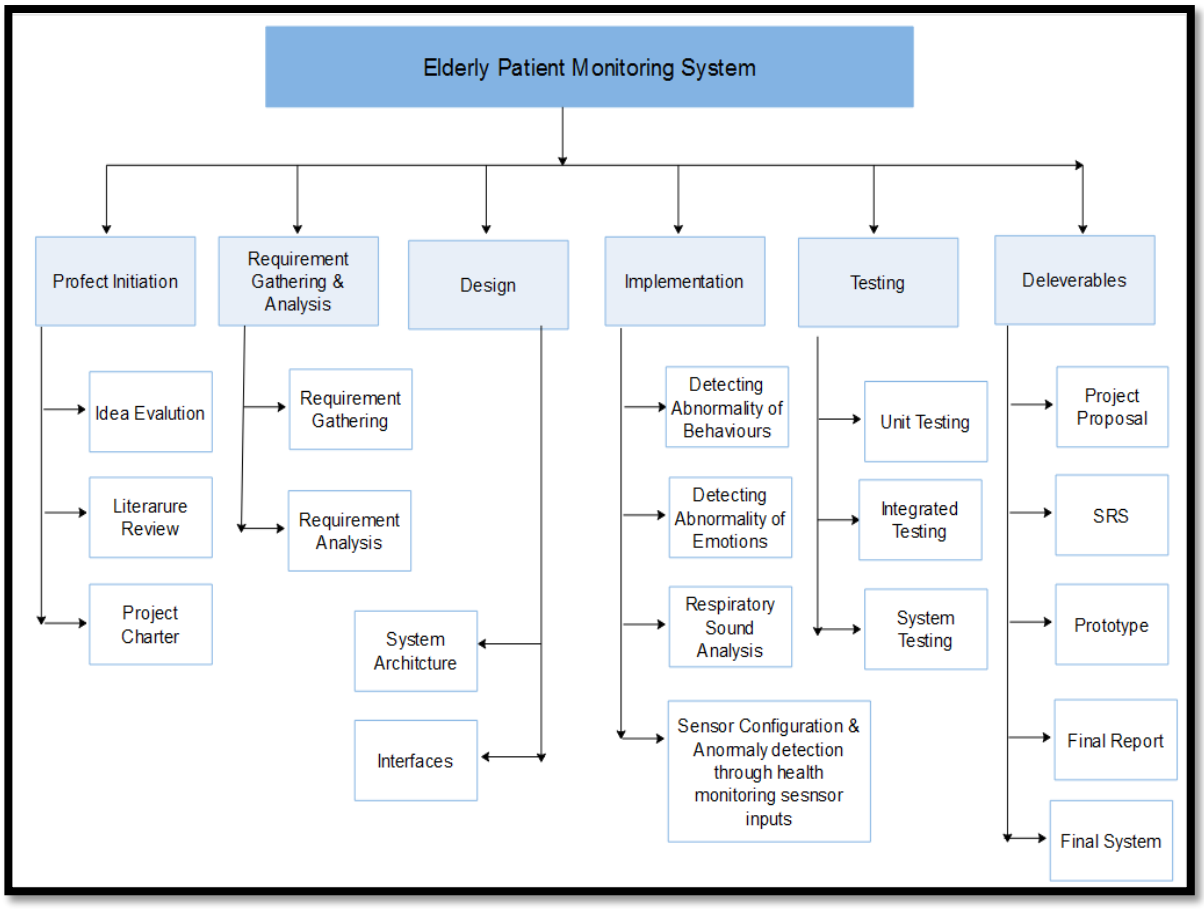


Figure 3.3 Work Breakdown Structure

3.2 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.

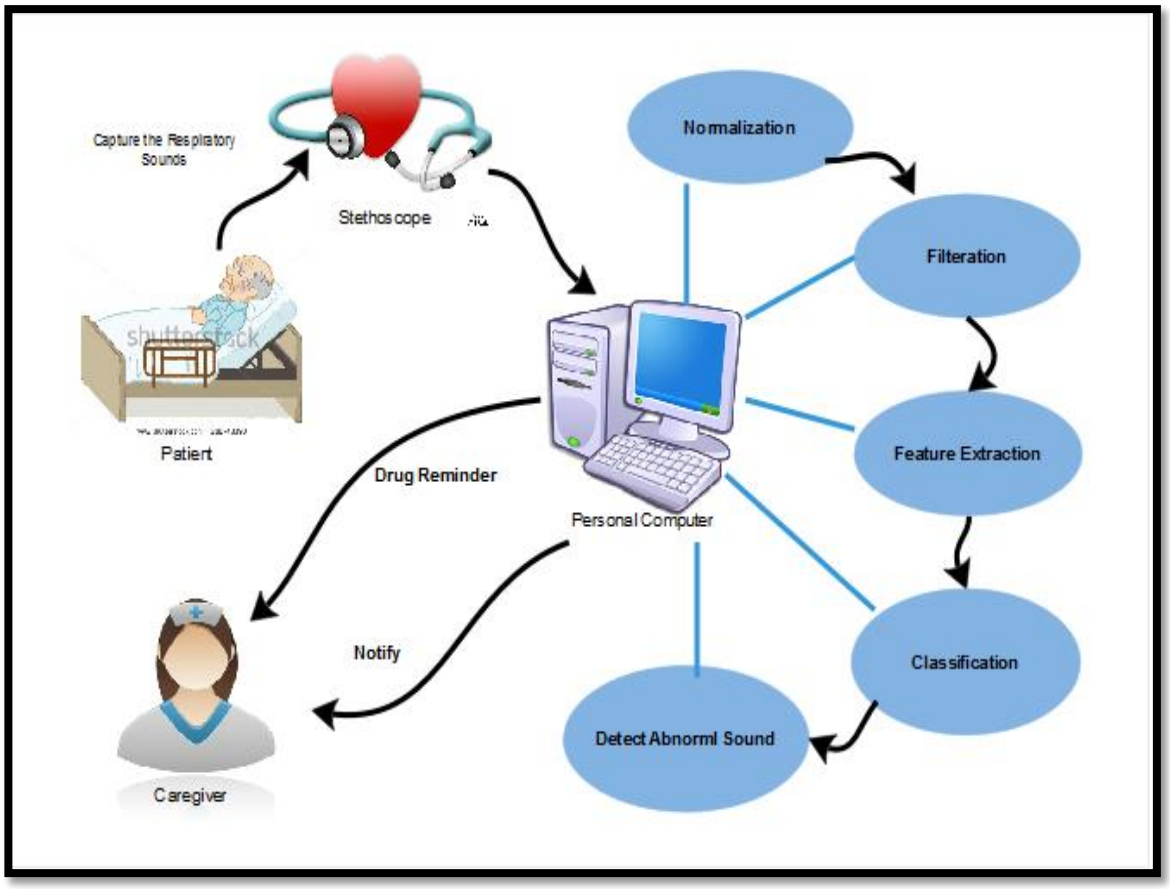


Figure 3.4 Architecture of Respiratory Sound Analysis

3.3 Sensor Configuration & 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.

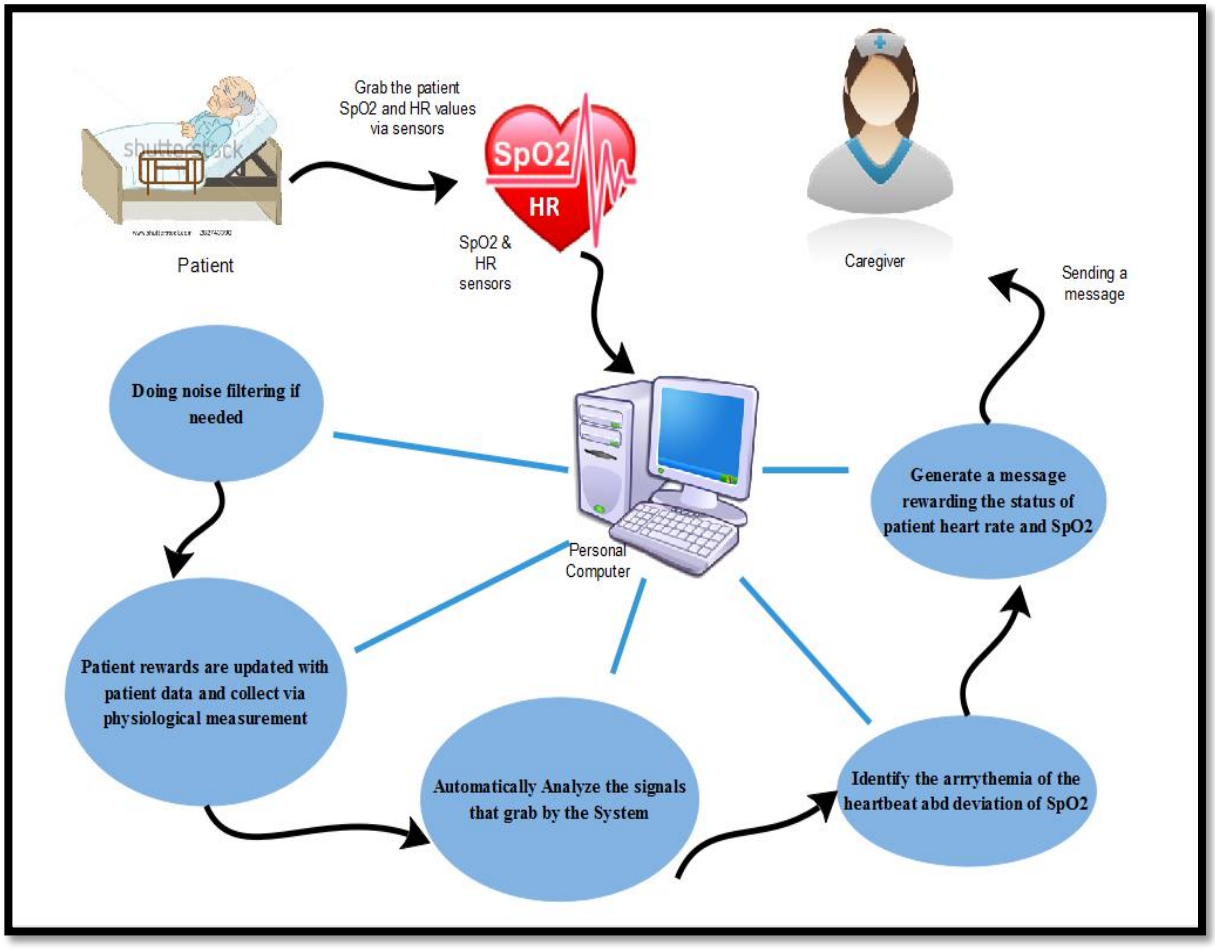


Figure 3.5 Architecture of Sensor Configuration & Anomaly Detection via Sensor Inputs

3.4 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.

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.

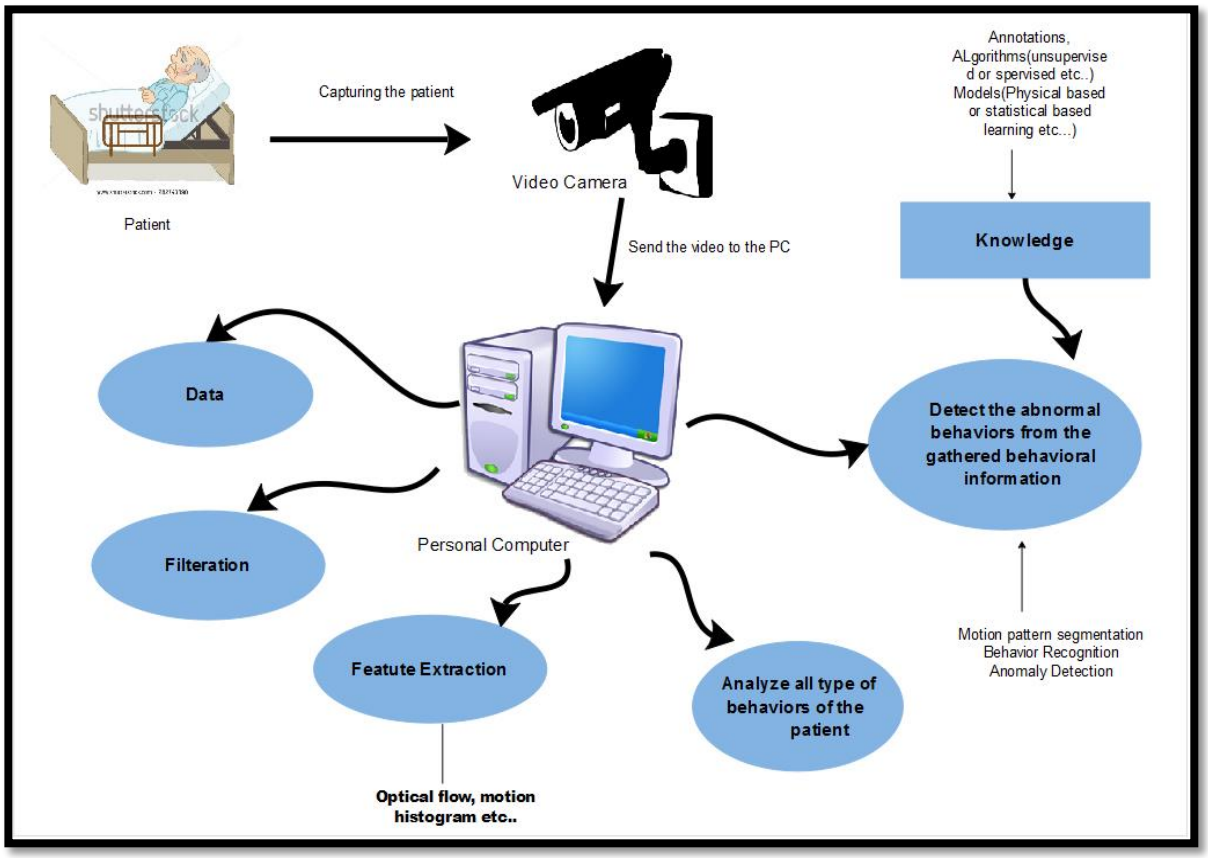


Figure 3.6 Architecture of Abnormality detection of Behaviors

3.5 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 a 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 detect 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.

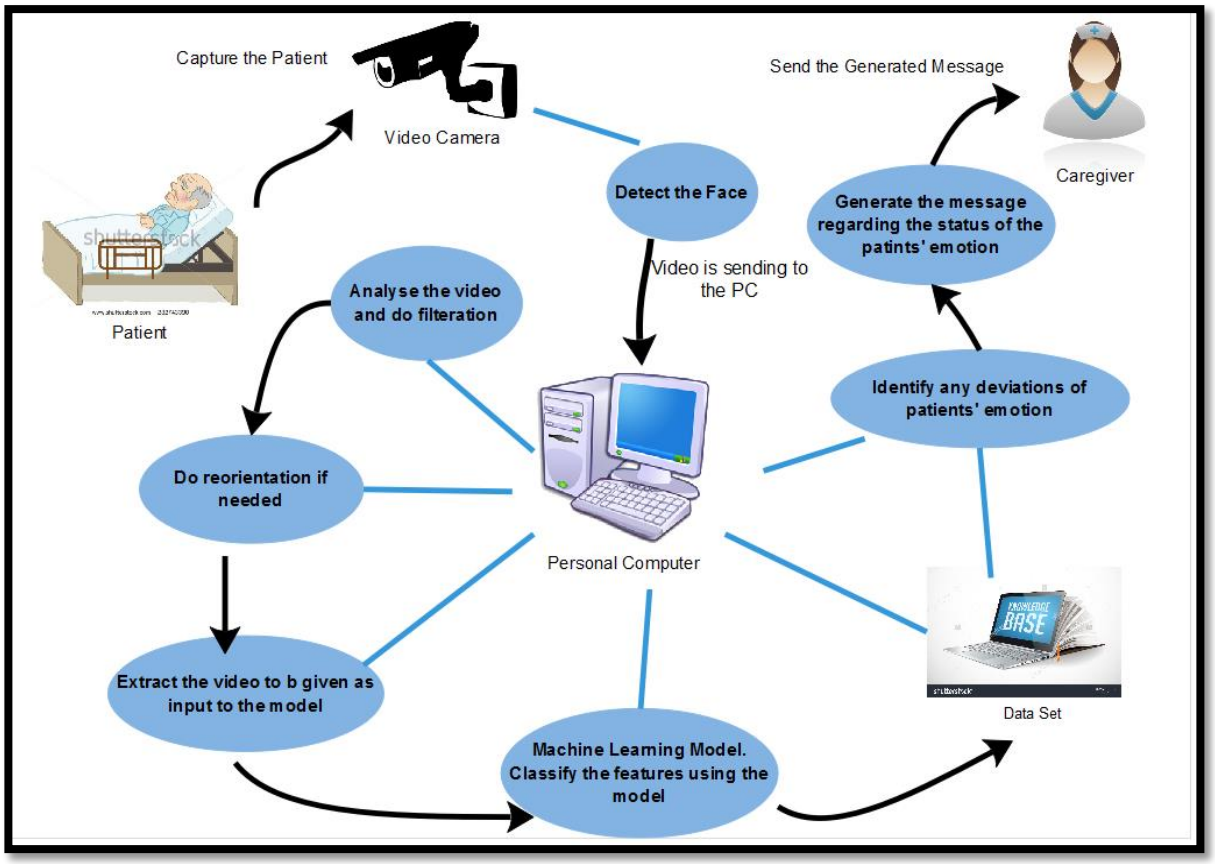


Figure 3.7Architecture of Abnormality Detection in Emotions

4. Description of Personal and Facilities

Table 4.1 Description of personal and facilities

Member	Component	Task
Abeyrathne H.V.L.K.	Respiratory Sound Analysis	Features will be extracted for classification in order to identify normal respiratory sounds and abnormal respiratory sounds. Train the module by providing data related to drugs of the patient and notify the responsible person regarding drug taking.
Sudhasinghe S.P.L.P.	Sensor configuration and anomaly detection via sensor inputs	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. Finally anomalies in the heart rate and the SpO2 should be detected

		according to the analysis using a signal processing technique.
Chathurangi W.A.S.	Abnormality detection of behaviors	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.
Ranathunga R.M.K.V.	Abnormality detection in emotions	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.

5. Budget and Budget Justification

Description	Amount
IP camera	3000.00
Microphone	300.00
Stethoscope	750.00
Arduino uno board	1500.00
SpO2 sensor module	500.00
Pulse sensor module	1500.00
Full Amount	**7550.00**

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