Annexure II

BONAFIDE CERTIFICATE

Certified that this project report **"EMOTION MONITORING SYSTEM FOR THE ELDERLY"** is the bonafide work of "Ms. RESHMA SRI CHALLA AND Mr. ADITYA KUMAR MISHRA" who carried out the project work under my supervision.

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ABSTRACT

According to the recent surveys, increase in number of elderly patients is periodic; there is an urgent requirement for monitoring patients' mental health along with their physical health to support their physical medication and to avoid preventable deaths. Thus, understanding a patient's mental health has become an integral segment during the patient's treatment. Emotion monitoring established on physiological signals using electrocardiogram (ECG) signal procurement is a crucial focus in patients' healthcare monitoring system. Emotion monitoring is peculiarly important in the stated, which includes the types of gesture, physiological signal, face appearance, feelings, behavior, oration, cognitive reactions, bodily changes and thoughts. Nonetheless, physiological signals truly indicate emotions. Although a remarkable consignment of research is already done in behavioral modalities, little traversed attributes comprises the physiological signals. This project presents analyzing emotion using ECG data collected from ECG Kit and analyzed using SVM algorithm. This project consists (i) Data acquisition (ii) Pre-Processing (iii) Feature extraction (iv) Feature Reduction and (v) Data classification through SVM algorithm. The noise *like* electrode motion artifacts, baseline wander, electromyography (EMG) noise, power-line interference is removed from the tender ECG signal before processing using the Low-pass filters-Butterworth. Pan Tomkins algorithm is applied to discover the QRS complex of the signals to discover the heart rate. Feature extraction is done using the six different features from the ECG signals. Principle Component Analysis (PCA)- algorithm is applied for feature reduction to dimensionally reduce the signals. The Support Vector Machine (SVM), a supervised learning approach is adapted for classification. The ECG data analyzed is then forwarded to the healthcare professionals to provide them medication accordingly.

Keywords---Butterworth filter, Support Vector Machine, Electrocardiogram, Feature Extraction, Feature Reduction, Principle Component Analysis, and Pan Tomkins.

Annexure III

ACKNOWLEDGEMENTS

We take this opportunity to express our deep sense of gratitude and sincere thanks to all who helped us to complete the project successfully.

We are deeply indebted to our guide   Mr. V. Hari Baabu Asst. professor (O.G), Department of Software Engineering for his excellent guidance, positive criticism and valuable comments. We are greatly thankful to Dr. C. Lakshmi, Head of Software Engineering Department for her support and cooperation. Finally we thank our parents and friends near and dear ones who directly and indirectly contributed to the successful completion of our project.

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Place: Chennai
Date:

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ABBREVIATIONS

1. IoT	Internet of Things
2. ECG/EKG	Electrocardiography
3. EMG	Electromyography
4. CRAMM	CCTA Risk Analysis and Management Method
5. BAN	Body Area Network
6. PCA	Principal Component Analysis
7. SVM	Support Vector Machine
8. RBF	Radial Basis Function
9. LOC	Lines of Code
10. LLOC	Logical lines of code
11. UAT	User Acceptance Testing
12. IT	Integration Testing
13. ER	Entity–relationship model
14. UML	Unified Modeling Language
15. DFD	Data flow diagram
16. UI	User interface
17. COCOMO	Constructive Cost Model
18. KNN	K-Nearest Neighbor
19. DAQ	Data Acquisition

CHAPTER 1

1. INTRODUCTION

Picard aforesaid that “Emotions portray a vital task in rational learning, decision-making, perception, and a variation of activities”

With the comprehension of the patient's emotional condition, Psychologist can effortlessly identify the disease. Implementations can be elongated to assignments involving new born, very aged people, etc., who won’t be able to show their emotions absolutely. This paper is proposed for elderly to distinguish emotion using ECG signals. Using discrete modalities such oration, facial snapshots, actions, physiological signals etc, and several researches have already been done to distinguish emotions.

The electrocardiogram (ECG) signal resembles the overtime change of the cardiac electrical potential. ECG is a test that judges electrical exercise of the heart with the assistant of electrodes fixed on the exterior of the body. The ECG signal is composed of heartbeat reoccurrences which is quasi periodic. Each beat consists three different waves: P wave, QRS complex, and finally T wave.

The R wave slope is the typical feature to recognize the QRS complex, for which Pan Tomkins algorithm is used in this paper. In the initial stage the signal is trained for later detection, smoothing the signal, deducting noise, and amplifying the QRS slope and width, where the Butterworth filter is used. Later, in the decision stage, thresholds are enforced to the signal to delete noise peaks and consider only signal peaks.

To monitor emotions using ECG signals opting a convenient set of features is paramount. Many features extraction approaches had been stated. Since physiological signals are non-stationary and nonlinear, research indicates that features in the frequency and time domains are irrelevant to arrest civic features of physiological signals. A fruitful approach to examine these non-stationary and nonlinear data is by adopting the six features mentioned in the feature extraction section of methodology. These classical emotion monitoring approaches using facial snapshots, tempo, strength and pitch of homo specimen dialogues is deficient in monitoring accuracy, which is not global and depends on sex and age. Nonetheless, they had been noted broadly because of its feature extraction approaches which are previously correlated to other kind of modalities.

Succeeding the feature selection, the ideal feature subgroup was embraced for classification. In this paper, the techniques Support Vector Machine (SVM) and Principal Component Analysis (PCA) were integrated to monitor emotions in humans. With these, the computation degree and accuracy have been upgraded. This kind of study was supported to display the versatility of combining Support Vector Machine with Principal Component Analysis to identify emotions from physiological signals. Here, ECG signal had been adapted to identify happy and sad emotions.

CHAPTER 2

2. PROJECT OVERVIEW

2.1 LITERATURE SURVEY

ECG Pattern Analysis for Emotion Detection by Foteini Agrafioti ,.et.al [1] IEEE Transactions on Affective Computing, March-2012, which explained synthesis of acquired ECG data using BEMD and Local oscillation and instantaneous frequency features were used for the detection of emotional conditions which was very useful in understanding varying moods.

The Research on Emotion Recognition from ECG Signal by CAI Jing ,.et.al [2] International Journal on Information Technology, 2009, which classified emotions from ECG data into joy and sadness, segmentation of waves in P-QRS-T waves and classification of obtained results using KNN Algorithm.

Patient Health Monitoring System by Arijit Ghosh ,.et.al [3] International Conference on Intelligent Control Power and Instrumentation, 2016, which explains the implementation of methodologies to find out body temperature and saline status monitoring which is essential part for health monitoring by using Fast Fourier Transform and DAQ in Matlab.

Health Monitoring and Management Using Internet-of-Things (IoT) Sensing with Cloud-based Processing: Opportunities and Challenges by Moeen Hassanalieragh, .et.al [4] IEEE International Conference on Service Computing, 2015, which applied health monitoring using wearable sensors equipped with IOT intelligence which can be communicated to multiple devices. It shows improvement on healthcare services and reduction in cost.

Physiological Signals Based Human Emotion Recognition: A Review by Jerritta, .et.al [5] IEEE 7th International Colloquium on Signal Processing and its Applications,2011,which is a review of the recent advancements in emotion research using physiological signals; in specific to the emotion elicitation stimuli, feature extraction and classification methodologies.

2.2 PROBLEM DESCRIPTION

The ability to recognize emotion is one of the hallmarks of emotional intelligence. Recent research in the field of Human Computer Interaction aims at recognizing the user's emotional state in order to provide a smooth interface between humans and computers. This would make life easier and can be used in vast applications involving areas such as education, medicine etc. Human emotions can be recognized by several approaches such as gesture, facial images, physiological signals and neuro imaging methods. Most of the researchers have developed user dependent emotion recognition system and achieved maximum classification rate. Very few researchers have tried to develop a user independent system and obtained lower classification rate. Efficient emotion stimulus method, larger data samples and intelligent signal processing techniques are essential for improving the classification rate of the user independent system.

Because of the increase in number of elderly patients, there is an urgent need for monitoring patients' mental health along with their physical health to support their physical medication and to avoid preventable deaths. Thus, understanding a patient's mental health has become an integral segment during the patient's treatment.

This project presents analyzing emotion using ECG data collected from ECG Kit and analyzed using SVM algorithm. This process includes (a) Data acquisition (b) Pre-processing (c) Feature extraction (d)Feature Reduction and (e)Data classification through SVM algorithm. The ECG data analyzed is then sent to the healthcare professionals to provide them medication accordingly.

2.3 REQUIREMENTS GATHERING

Brainstorming:

Brainstorming is a group creativity technique by which efforts are made to find a conclusion for a specific problem by gathering a list of ideas spontaneously contributed by its members. The members are Reshma Sri Challa, Aditya Kumar Mishra and Mr.V.Haribaabu.

Idea Generation:

Health is one of the global challenges for humanity.

Because of the increase in number of elderly patients, there is an urgent need for monitoring patients' mental health along with their physical health to support their physical medication and to avoid preventable deaths. Thus, understanding a patient's mental health has become an integral segment during the patient's treatment.

Idea Selection (decision making):

Emotion recognition based on physiological signals using electrocardiogram (ECG) signal acquisition is a major focus in patient healthcare monitoring system.

Emotion recognition is particularly significant in foregoing kingdom, which mainly includes the ways of face expression, speech, gesture, physiological signal, feelings, bodily changes, cognitive reactions, behavior and thoughts.

However, physiological signal can truly reflect our emotions. Although a significant amount of research has been done on behavioral modalities, less explored characteristics include the physiological signals.

Implementation:

We provide an IoT based solution by combining communication technologies, Interconnected apps, devices and sensors, and people to function together as one smart system to monitor, track, and store patients' healthcare information for ongoing care.

This presents analyzing emotion using ECG data collected from ECG Kit and analyzed using support vector machine (SVM) algorithm. This process includes

(a) Data acquisition (b) Pre-processing (c) Feature extraction (d)Feature Reduction and (e)Data classification through SVM algorithm.

The ECG data analyzed is then sent to the healthcare professionals to provide them medication accordingly.

Requirements Workshop:

ECG Sensor:

An ECG sensing device commonly consists of a group of electrodes to detect electrical events of a heart.

ECG Kit:

The data which contains the ECG readings of an individual during different times.

Emotion Detection System:

It consists of a system that detects the emotions of the patient from the recorded ECG data by applying Pan-Tomkins algorithm

And SVM (Support Vector Machine) Algorithm.

2.4 REQUIREMENT ANALYSIS

2.4.1 FUNCTIONAL REQUIREMENTS

The main functional requirements can be given as:

1) **Flexibility:** The ease of making changes required by changes in the operating environment refers to flexibility of the system. The operating environment of Jupyter Notebook is manually configurable and provides flexibility for handling each of the nodes.

2) **Availability:** The effort required to locate and fix a fault in the system within its operating environment refers to maintainability of the system. The operating range for the devices can be manually handled using sever under the Windows OS.

3) **Testability:** The ease of testing the system, to ensure that it is error-free and meets its specification refers to testability. The environment provides compilation based testing for each lines of code the runs over the system to generate the desired interaction between the nodes.

4) **Efficiency:** The system conforms to execution efficiency and storage efficiency which generally means the use of resources. The application provides efficient usage of all the resources necessary for the operation.

2.4.2 NON- FUNCTIONAL REQUIREMENTS

Emotion detection system requirements are satisfied when they fulfill following requirements to make effective authentication scheme.

1) **Portability:** The effort required to transfer a program from one environment to another refers to portability. The simulator composites the portability between different environments that let the node interaction under different environment.

2) **Correctness:** The extent to which a program fulfils its specification refers to correctness of the system .Jupyter Notebook conforms to the performance analysis of the nodes in their ranges of operation.

3) **Forward security:** It is very compulsory to provide forward security to authentication scheme. As provided in various authentications scheme we can locate the past location of the tag. It can be very problematic for owner's privacy and security.

4) **Integrity:** The protection of the program from unauthorized access refers the system's integrity. Jupyter Notebook conforms to the system's integrity be providing suitable operating motes for the code.

5) **Attack resistance:** To provide guaranteed authentication this scheme should be secured against various attacks as man in the middle attack, reply attack, modification attack, server spoofing attack etc.

2.5 DATA SOURCE

The electrocardiogram

An electrocardiogram (ECG or EKG) is a register of the heart's electrical activity.

Electrical activity going through the heart can be measured by external (skin) electrodes. The electrocardiogram (ECG) registers these activities from electrodes which have been attached onto different places on the body. In total, twelve leads are calculated using ten electrodes.

Data Set:

A real time data set which has reading of a person throughout the day. It contains 60 files which contains five columns each, which are as follow:

1. The time at which the reading of electrodes was taken
2. The time interval
3. The left electrode reading,
4. The right electrode reading,
5. The reference electrode reading.

Each file denotes readings at one second. Each file has rows with readings of these electrodes for each 0.001 sec in that one second.

2.6 COST ESTIMATION

Constructive Cost Model (COCOMO) is a procedural software cost estimation model.

COCOMO applies to three classes of software projects:

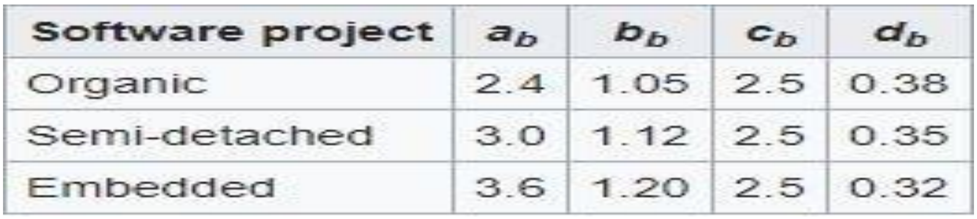
- Organic projects - "small" teams
- Semi-detached projects - "medium" teams
- Embedded projects -developed within a set of "tight" constraints

COCOMO equations take the form

- Effort Applied (E) = $a_b(KLOC)^{b_b}$ [man-months]
- Development Time (D) = $c_b(\text{Effort Applied})^{d_b}$ [months]
- People required (P) = Effort Applied / Development Time [count]

Where,

- KLOC is the estimated number of delivered lines (expressed in thousands) of code for project.
- The coefficients a_b, b_b, c_b and d_b are given in the following table.



Software project	a_b	b_b	c_b	d_b
Organic	2.4	1.05	2.5	0.38
Semi-detached	3.0	1.12	2.5	0.35
Embedded	3.6	1.20	2.5	0.32

Figure 1: Cost Estimation

2.7 PROJECT SCHEDULE

Table 1: Timeline for Review 1

Time Line		Activities of the Project	Name/Register Number of the Individual Contributor	Name/Register Number of the Joint Contributor
From Date	To Date			
Week 1 (December)		Domain Introduction and survey for 10-15 recent papers	RA1411020010171 Aditya Kumar Mishra (Recent 6 papers)	RA1411020010157 Reshma Sri Challa (Recent 6 papers)
Week 2		Problem Description Existing Methodology Proposed Methodology	RA1411020010171 Aditya Kumar Mishra (Problem Description Existing Methodology)	RA1411020010157 Reshma Sri Challa (Proposed Methodology)
Week 3		Abstract	RA1411020010157 Reshma Sri Challa (Abstract)	RA1411020010171 Aditya Kumar Mishra (Abstract)
Week 4		Requirement Gathering Cost Estimation Risk Analysis	RA1411020010157 Reshma Sri Challa (Requirement Analysis)	RA1411020010171 Aditya Kumar Mishra (Cost Estimation Risk Analysis)
Week 5 (January 1st week)		Data Flow Diagram Sequence Diagram Class Diagram	RA1411020010171 Aditya Kumar Mishra (Data Flow Diagram)	RA1411020010157 Reshma Sri Challa (Sequence Diagram Class Diagram)

Table 2: Timeline for Review 2

Time period		**Checkpoints of the project**	**Name/Register Number of the Individual Contributor**	**Names/Register Number of the Joint Contributor**
From Date	**To Date**			
Week1		Modules Description	RA1411020010171 Modules Description	RA1411020010157 RA1411020010171 Modules requirement
Week2		Proposed Algorithm	RA1411020010171 Proposed Algorithm	RA1411020010157 RA1411020010171 Proposed best Algorithm
Week3		ER – Diagram Relational Model	RA1411020010171 ER – Diagram RA1411020010171 Relational Model	RA1411020010157 RA1411020010171 ER – Diagram Relational Model
Week4		Technologies and Tools Used 80% of implementation Unit Testing	RA1411020010171 Technologies and Tools Used RA1411020010157 80% of implementation	RA1411020010157 RA1411020010171 Unit Testing
Week5 (February - Ist Week)		Report , Presentation & Documentation	-	RA1411020010171 RA1411020010157

Table 3: Timeline for Review 3

Time period		Checkpoints of the project	Name/Register Number of the Individual Contributor	Names/Register Number of the Joint Contributors
From Date	To Date			
Week1 (February)		Survey for 3-5 recent papers for implementation	RA1411020010157 (Survey for recent 3 papers) RA1411020010171 (Survey for recent 2 papers)	RA1411020010157 RA1411020010171 Survey for 5 recent papers
Week2		Implementation	RA1411020010171 (Graph analysis) RA1411020010157 (Code implementation)	RA1411020010157 RA1411020010171 (Code implementation)
Week3		Integration Testing User Testing	RA1411020010171 Integration Testing User Testing RA1411020010157 SVM Algorithm compilation	RA1411020010157 RA1411020010171 Integration Testing User Testing SVM Algorithm compilation
Week4		Defect Analysis Cost Analysis Mc Call's Quality Model	RA1411020010171 Mc Call's Quality Model RA1411020010157 Defect Analysis Cost Analysis	RA1411020010157 RA1411020010171 Defect Analysis Cost Analysis Mc Call's Quality Model
Week5 (March-Ist Week)		Report , Presentation & Documentation	-	RA1411020010157 RA1411020010171

2.8 RISK ANALYSIS

In recent years, the escalating advances in information and communication technologies created many new opportunities, but also an environment with more risks than ever before. As far as healthcare information systems are concerned, quality of health services and security of medical data play an important role in the wide acceptance of new technologies by patients and practitioners. Risk analysis involves the identification and assessment of the levels of risks calculated from the known values of assets and the levels of threats to, and vulnerabilities of, those assets. Furthermore, risk management involves the identification, selection, and adoption of countermeasures justified by the identified risks to assets and the reduction of those risks to acceptable levels. Several methods have been developed and applied to information systems. In the proposed risk analysis method, the main steps of the CRAMM methodology have been adopted. CRAMM is owned, administered, and maintained by the Security Service on behalf of the UK Government. In line with nearly all risk analysis methods, CRAMM asserts that risk is dependent on the asset values, the threats, and the vulnerabilities. Moreover, it enables the practitioner to build a system model encapsulating the asset interdependencies; it provides useful insights into system operational characteristics as well as a comprehensive identification of which assets are at greatest risk, due to what threats, and with what impacts should those threats succeed.

CRAMM comprises three stages, each supported by objective questionnaires and guidelines. The first two stages identify and analyze the risks to the system. The third stage recommends how these risks should be managed.

The three stages of CRAMM are as follows:

Stage 1

The establishment of the objectives for security by:

- Defining the boundary for the study for Risk Assessment
- Identifying and valuing the physical assets that form part of the system;
- Determining the 'value' of the data and the impacts that could arise from unavailability, destruction, disclosure or modification;
- Identifying and valuing the software assets that form part of the system.

Stage 2

The assessment of the risks to the proposed system and the requirements for security by:

- Identifying and assessing the type and level of threats that may affect the system;
- Assessing the extent of the system's vulnerabilities to the identified threats;
- Combining threat and vulnerability assessments with asset values to calculate measures of risks.

Stage 3

Identification and selection of countermeasures that are commensurate with the measures of risks calculated in Stage 2.

CRAMM contains a very large countermeasure library consisting of over 3,000 detailed countermeasures organized into over seventy logical groupings.

Factor affecting the performance of the system are:-

- Sensor failure
- Invalid data entry
- Hacking of system
- Wearables do not have sufficient battery.

Data collection from smart objects of IoT: When we conduct our data collection from smart objects of IoT, the special needs of smart objects should be taken into account. For example, if we want to collect data from distributed sensor networks, energy-efficiency, scalability and fault-tolerance should be considered. A series of strategies, e.g., data aggregation, can be adopted. Thus, the amount of transmission data is reduced, and the utilization of energy of sensor nodes is promoted.

Hacking of System: System hacking is the way hackers get access to individual computers on a network. Ethical hackers learn system hacking to detect, prevent, and counter these types of attacks. This course explains the main methods of system hacking—password cracking; privilege escalation, spyware installation, and key logging—and the countermeasures IT security professionals can take to fight these attacks. Security expert Lisa Bock also covers steganography, spyware on a cell phone, and tactics for hiding files and tools.

2.9 Software Requirements Specification

for

EMOTION MONITORING SYSTEM FOR THE ELDERLY

Version 1.0 approved

Prepared by

RA1411020010157- Reshma Sri Challa

RA1411020010171- Aditya Kumar Mishra

SRM Institute of Science and Technology

12th April 2018

Table of Contents

2.9.1 Introduction

2.9.1.1 Purpose

The purpose of the document is to collect and analyze all assorted ideas that have come up to define the system, its requirements with respect elderly. Also, we shall predict and sort out how we hope this project will be used in order to gain a better understanding of the outline concepts that may be developed later, and document ideas that are being considered, but may be discarded as the project develops.

In short, the purpose of this SRS document is to provide a detailed overview of our project, its parameters and goals. This document describes the project's target audience and its user interface, hardware and software requirements. This project presents analyzing emotion of the elderly as happy or sad using ECG data collected from ECG Kit and analyzed using SVM algorithm. Nonetheless, it helps any designer and developer to assist in software delivery lifecycle (SDLC) processes. Document Conventions.

2.9.1.2 Document Conventions

This document follows MLA Format. Bold faced text has been used to emphasize section and sub-section headings. Highlighting is to point out words in the glossary and italicized text is used to label and recognize diagrams.

2.9.1.3 Intended Audience and Reading Suggestions

This document is to be read by the users and developers for better understanding of our project. The SRS has been organized approximately in order of increasing specificity.

2.9.1.4 Product Scope

Physiological signal can truly reflect our emotions. Although a significant amount of research has been done on behavioral modalities, less explored characteristics include the physiological signals. Because of the increase in number of elderly patients, there is an urgent need for monitoring patients’ mental health along with their physical health to support their physical medication and to avoid preventable deaths. Thus, understanding a patient’s mental health has become an integral segment during the patient’s treatment. This SRS is also aimed at specifying requirements of software to be developed to allow monitoring of emotion of elderly.

The standard can be used to create software requirements specifications directly or can be used as a model for defining an organization or project specific standard. It does not identify any specific method, nomenclature or tool for preparing an SRS.

2.9.2 Overall Description

2.9.2.1 Product Perspective

Emotion recognition based on physiological signals using electrocardiogram (ECG) signal acquisition is a major focus in patient healthcare monitoring system. Emotion recognition is particularly significant in foregoing kingdom, which mainly includes the ways of face expression, speech, gesture, physiological signal, feelings, bodily changes, cognitive reactions, behavior and thoughts. However, physiological signal can truly reflect our emotions. Although a significant amount of research has been done on behavioral modalities, less explored characteristics include the physiological signals. Because of the increase in number of elderly patients, there is an urgent need for monitoring patients’ mental health along with their physical health to support their physical medication and to avoid preventable deaths. Thus, understanding a patient’s mental health has become an integral segment during the patient’s treatment. This project presents analyzing emotion using ECG data collected from ECG Kit and analyzed using SVM algorithm. This process includes (a) Data acquisition (b) Pre-processing (c) Feature extraction (d)Feature Reduction and (e)Data classification through SVM algorithm. The ECG data analyzed is then sent to the healthcare professionals to provide them medication accordingly. The noise and artefacts are removed from the raw ECG signal before processing using the Low-pass filters-Butterworth. Pan

Tomkins algorithm is used to detect the QRS complex of the signals. Feature extraction is done using the six different features from the ECG signals. Principle Component Analysis (PCA)-algorithm is applied for feature reduction to dimensionally reduce the signals. The Support Vector Machine (SVM), a supervised learning technique is adapted for classification.

2.9.2.2 Product Functions

The existing system of emotion monitoring of elderly has features like Data acquisition, Pre-processing, Feature extraction, Feature Reduction and Data classification through SVM algorithm.

2.9.2.3 User Classes and Characteristics

The users of emotion monitoring of elderly are the patients and doctors .These users are identified based on their experience and technical expertise.

2.9.2.3.1 **Admin:** In this module admin has the permission to collect the data in data acquisition and to implement the steps like pre-processing, Feature Extraction, Feature Reduction and classification.

2.9.2.3.2 **Users:** The paints proving the data during data acquisition and doctors using this system to treat patients.

2.9.2.4 Operating Environment

This application is built in python and will be hosted by a jupyter notebook. This project can be viewed by any browser but in a system that has python and jupyter notebook installed, and has been tested for compliance with Mozilla, Internet Explorer.

2.9.2.5 Design and Implementation Constraints

The user interface (UI) must have specific fonts and font sizes. The system shall match the fonts and font sizes used for all the pages of the application. Hardware Limitations Intel core i5 at 2 GHz 2nd generation and Minimum-1 GB to Maximum-1 TB of RAM with a disk space of 124 MB. Accessibility: Initially, the software should be available as a web application for a small set of users to test. Others: The application should be built using python and jupyter notebook.

2.9.2.6 User Documentation

The user documentation components used in Data acquisition.

An electrocardiogram (ECG or EKG) is a register of the heart's electrical activity.
Electrical activity going through the heart can be measured by external (skin) electrodes. The electrocardiogram (ECG) registers these activities from electrodes which have been attached onto different places on the body. In total, twelve leads are calculated using ten electrodes.

Data Set:

A real time data set which has reading of a person throughout the day. It contains 60 files which contains five columns each, which are as follow:

1. The time at which the reading of electrodes was taken
2. The time interval
3. The left electrode reading,
4. The right electrode reading,
5. The reference electrode reading.

Each file denotes readings at one second. Each file has rows with readings of these electrodes for each 0.001 sec in that one second.

2.9.2.7 Assumptions and Dependencies

Users and the administrator are accustomed to the system with version of python and jupyter notebook and would require minimum knowledge to use python and jupyter notebook. We assume that system users adhere to the system’s minimum software and hardware requirements.

2.9.3 External Interface Requirements

2.9.3.1 User Interfaces

User interface (UI) is everything designed into an information device with which a person may interact. This can include display screens, keyboards, a mouse and the appearance of a desktop. It is also the way through which a user interacts with an application or a website.

In complex systems, the human–machine interface is typically computerized. The term human–computer interface refers to this kind of system. In the context of computing the term typically extends as well to the software dedicated to control the physical elements used for human-computer interaction. In this project it is the Body area Network used to record the data and jupyter notebook software used.

User interfaces are designed with a focus on usability and efficiency. Here Users are able to achieve their goals as efficiently as possible. In that sense, a well-designed user interface becomes effectively invisible to those using it. In other words, they interact directly with the 'reality' the design portrays without reckoning on the point that.

2.9.3.2 Hardware Interfaces

Client Side			
	Processor	**RAM**	**Disk Space**
Google Chrome	Intel core i5 at 2 GHz 2nd generation	Minimum-1 GB	729 MB
Server Side			
Jupyter Notebook	Intel core i5 at 2 GHz 2nd generation	Minimum-1 GB Maximum-1 TB	124

2.9.3.3 Software Interfaces

Software used	**Description**
Operating system	We have chosen Windows operating system for its best support and user-friendliness.
Database	To save the patients records, for patient records we have chosen MS Excel database.
Python	To implement the project we have chosen Python language for its more interactive support.
Web Server	Jupyter Notebook exists to develop open-source software, open-standards, and services for interactive computing across dozens of programming languages.
Web Browser	Microsoft Edge, Mozilla, Google Chrome

2.9.3.4 Communications Interfaces

The system shall use the HTTP protocol for communication over the internet and for the intranet communication will be through TCP/IP protocol suite.

2.9.4 System Features

2.9.4.1 System Feature 1

In this project, it consists of 4 modules. They are as follows:

2.9.4.1.1 Pre-Processing

A filter works by removing or reducing frequencies where noise occurs, while allowing the signal frequency through. Especially in ECG work, the signal levels are very small (around 1mV), so it is necessary to use filtering to remove a wide range of noise.

This noise may come from an unstable dc offset from electrode/body interface, muscle noise, mains hum (50/60Hz), electrical noise from equipment in the environment and from within the ECG equipment itself, such as from internal dc/dc converters.

In general different types of Low-pass filters such as Adaptive filters, Elliptic filters, Butterworth filters.

2.9.4.1.2 Feature Extraction

Once the signals are pre-processed, it is necessary to extract statistical information or features from the signal which can be used to detect the emotional content of the signal.

2.9.4.1.3 Feature Reduction

Feature Extraction transforms the data in the high-dimensional space to a space of fewer dimensions.

Principle Component Analysis (PCA)- is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components.

The goal of principal component analysis is to compute the most meaningful basis to re-express a noisy data set. This new basis will filter out the noise and retrieve hidden structure.

2.9.4.1.4 Classification

After selecting the features that are relevant to the emotional states, they must be used to train a classifier so that it can classify the various emotional states using the features presented. For This Support Vector Machine will be used.

2.9.4.1.5 Functional Requirements

The main functional requirements can be given as:

a. **Flexibility:** The ease of making changes required by changes in the operating environment refers to flexibility of the system. The operating environment of Jupyter Notebook is manually configurable and provides flexibility for handling each of the nodes.

b. **Availability:** The effort required to locate and fix a fault in the system within its operating environment refers to maintainability of the system. The operating range for the devices can be manually handled using sever under the Windows OS.

c. **Testability:** The ease of testing the system, to ensure that it is error-free and meets its specification refers to testability. The environment provides compilation based testing for each lines of code the runs over the system to generate the desired interaction between the nodes.

d. **Efficiency:** The system conforms to execution efficiency and storage efficiency which generally means the use of resources. The application provides efficient usage of all the resources necessary for the operation.

2.9.5 Other Nonfunctional Requirements

2.9.5.1 Performance Requirements

The system must be interactive and the delays involved must be less .So in every action-response of the system, there are no immediate delays. In case of opening windows forms, of popping error messages and saving the settings or sessions there is delay much below 2 seconds, In case of opening databases, sorting questions and evaluation there are no delays and the operation is performed in less than 2 seconds for opening ,sorting, computing, posting > 95% of the files. Also when connecting to the server the delay is based on the configuration of the system so there is high probability that there will be or not a successful connection in less than 20 seconds for sake of good communication.

2.9.5.2 Safety Requirements

a. **Data collection from smart objects of IoT**: When we conduct our data collection from smart objects of IoT, the special needs of smart objects should be taken into account. For example, if we want to collect data from distributed sensor networks, energy-efficiency, scalability and fault-tolerance should be considered. A series of strategies, e.g., data aggregation, can be adopted. Thus, the amount of transmission data is reduced, and the utilization of energy of sensor nodes is promoted.

b. **Hacking of System:** System hacking is the way hackers get access to individual computers on a network. Ethical hackers learn system hacking to detect, prevent, and counter these types of attacks. This course explains the main methods of system hacking—password cracking; privilege escalation, spyware installation, and key logging—and the countermeasures IT security professionals can take to fight these attacks. Security expert Lisa Bock also covers steganography, spyware on a cell phone, and tactics for hiding files and tools.

c. **Attack resistance:** To provide guaranteed authentication this scheme should be secured against various attacks as man in the middle attack, reply attack, modification attack, server spoofing attack etc.

d. **Forward security:** It is very compulsory to provide forward security to authentication scheme. As provided in various authentications scheme we can locate the past location of the tag. It can be very problematic for owner's privacy and security.

2.9.5.3 Security Requirements

System security is a vital aspect when it comes to developing a system. The system should ensure the facility of preventing unauthorized personnel from accessing the information and the data within the system. The system should provide total protection for each user's information so that the integrity of data is sustained and also prevent hackers from hacking the system.

The proposed system ensures the security and the integrity of data. This is done by providing a password login system for each authorized users. And for example the System Administrator has access to all kinds of information.

The business logic is hidden from the users and is much safer and thus avoids unauthorized or illegal access or database corruption. Security of the user's information is also safe as there is a login facility.

2.9.5.4 Software Quality Attributes

Availability The system shall be made available to the user/administrator year round.

Reliability The capability to maintain the specified level of performance is called reliability. This application is a web based application that runs on any device that has a browser.

Maintainability Maintenance is typically done after the software development has been completed. As the time evolves, so do the requirements and needs. It revolves around the understanding of the existing software and the effects of the changes.

Portability: The effort required to transfer a program from one environment to another refers to portability. The simulator composites the portability between different environments that let the node interaction under different environment. As the application is based on the python language, the application is portable.

Correctness: The extent to which a program fulfils its specification refers to correctness of the system .Jupyter Notebook conforms to the performance analysis of the nodes in their ranges of operation.

Integrity: The protection of the program from unauthorized access refers the system's integrity. Jupyter Notebook conforms to the system's integrity be providing suitable operating motes for the code.

2.9.5.5 Business Rules

A Business rule is anything that captures and implements business policies and practices. A rule can enforce business policy, make decision or infer new data from existing data. This includes the rules and regulations that the system users should abide by. This includes the cost of the project and the discount offers provided. The users should avoid illegal rules and protocols. Neither admin nor member should cross the rules and regulations.

CHAPTER 3

3. ARCHITECTURE & DESIGN

3.1 SYSTEM ARCHITECTURE

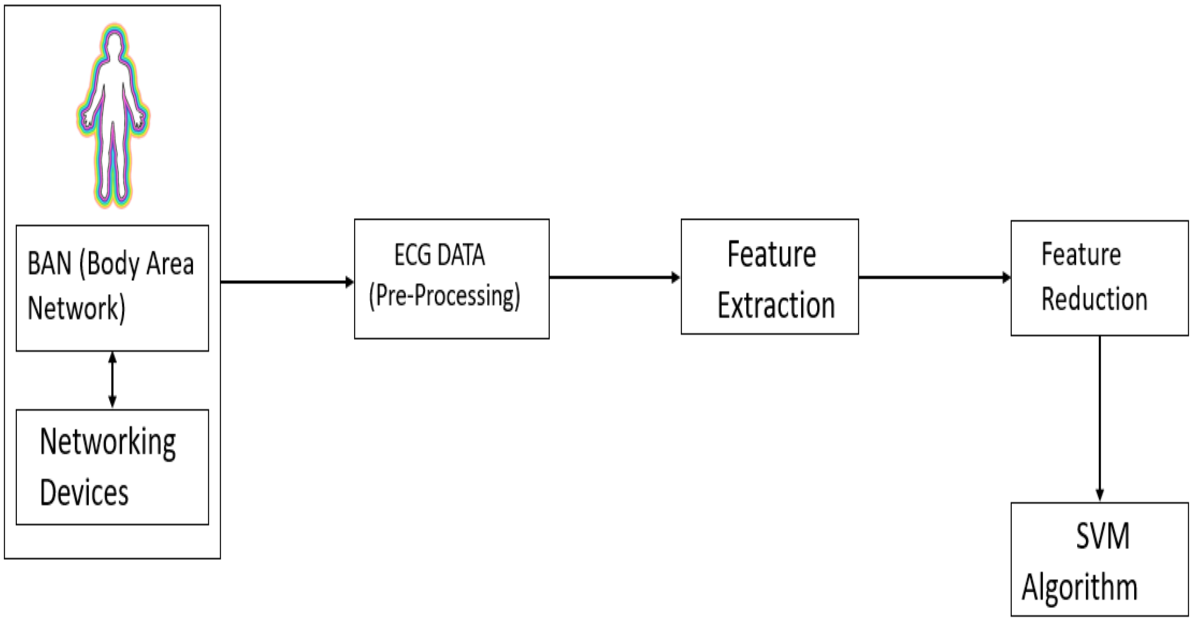


Figure 2: System Architecture

This section describes the architecture of health care and elderly monitoring system to predict emotion. Figure 1 shows the block diagram of the proposed system. The system has following components basically, Body Area Network (BAN), Patient’s database and emotion detection system.

Components of system

1. **Body Area Network (BAN):** also referred to as a *wireless body area network* (WBAN) or a *body sensor network* (BSN), is a wireless network of wearable computing devices. BAN devices may be embedded inside the body, implants, may be surface-mounted on the body in a fixed position Wearable technology or may be accompanied devices which humans can carry in different positions, in clothes pockets, by hand or in various bags.
2. **Pre-Processing:** The raw ECG signals are always contaminated with noises and other external interferences. This noise and artefacts are removed from the raw ECG signal before processing.
3. **Feature Extraction:** Once the signals are pre-processed, it is necessary to extract statistical information or features from the signal which can be used to detect the emotional content of the signal .The automatic location of P-QRS-T wave was performed, which was crucial for ECG feature extraction by the computer.
4. **Feature Reduction:** It transforms the data in the high-dimensional space to a space of fewer dimensions.
5. **Support Vector Machine:** It constructs a hyperplane or set of hyperplanes in a high- or infinite-dimensional space, which can be used for classification. Intuitively, a good separation is achieved by the hyperplane that has the largest distance to the nearest training-data point of any class (so-called functional margin).

3.2. INTERFACE PROTOTYPING (UI)

User interface (UI) is everything designed into an information device with which a person may interact. This can include display screens, keyboards, a mouse and the appearance of a desktop. It is also the way through which a user interacts with an application or a website.

In complex systems, the human–machine interface is typically computerized. The term human–computer interface refers to this kind of system. In the context of computing the term typically extends as well to the software dedicated to control the physical elements used for human-computer interaction. In this project it is the Body area Network used to record the data and jupyter notebook software used.

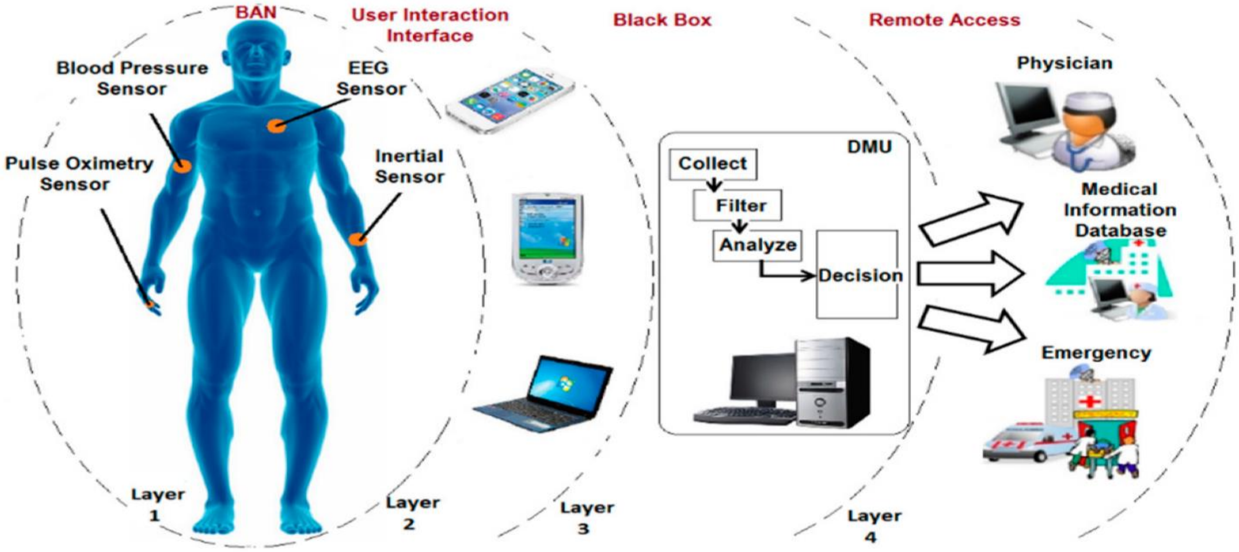


Figure 3: Interface Prototype

User interfaces are designed with a focus on usability and efficiency. Here Users are able to achieve their goals as efficiently as possible. In that sense, a well-designed user interface becomes effectively invisible to those using it. In other words, they interact directly with the ‘reality’ the design portrays without reckoning on the point that.

3.3. DATA FLOW DESIGN

A data flow diagram (DFD) is a graphical representation of the “flow” of data through an information system, modeling its process aspects. ADFD is often used as a preliminary step to create an overview of the system without going into great detail, which can later be elaborated

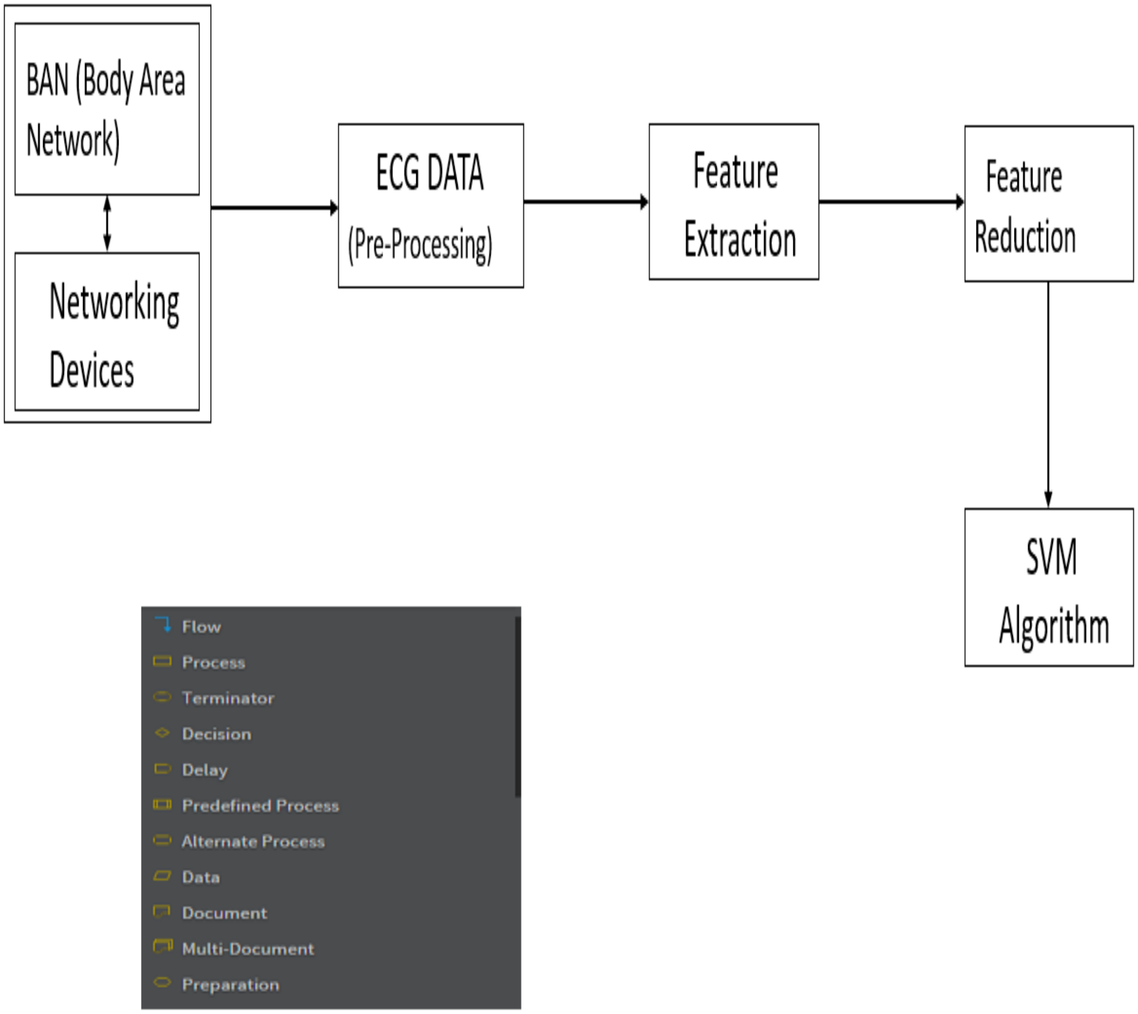


Figure 4: Data Flow Diagram

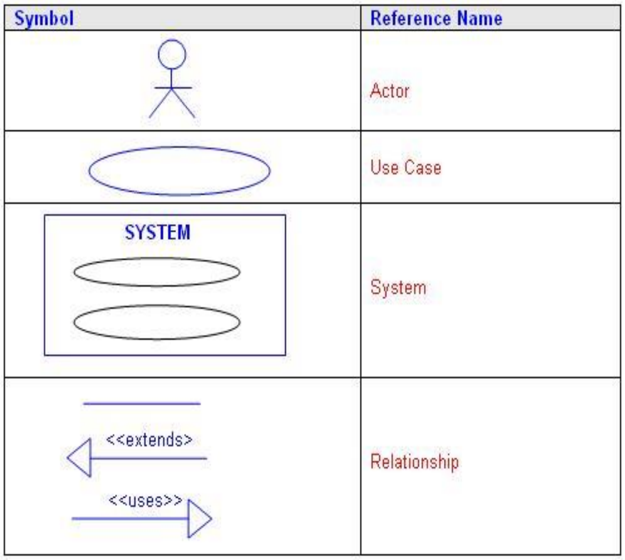
3.4. USE CASE DIAGRAM

A **use case diagram** at its simplest is a representation of a user's interaction with the system that shows the relationship between the user and the different use cases in which the user is involved. A use case diagram can identify the different types of users of a system and the different use cases and will often be accompanied by other types of diagrams as well.

Primary Actors: The **Actor(s)** using the system to achieve a goal. The Use Case documents the interactions between the system and the actors to achieve the goal of the primary actor.

Secondary Actors: Actors that the system needs assistance from to achieve the primary actor's goal.

- UML use case includes relationship shows that behavior of the included use case is inserted into the behavior of the including use case.
- UML Use Case Extend. Extend is a directed relationship that specifies how and when the behavior defined in usually supplementary (optional) extending use case can be inserted into the behavior defined in the extended use case.



Symbol	Reference Name
	Actor
	Use Case
SYSTEM	System
<<extends> <<uses>>	Relationship

Figure 5: Symbols in Use Case Diagram

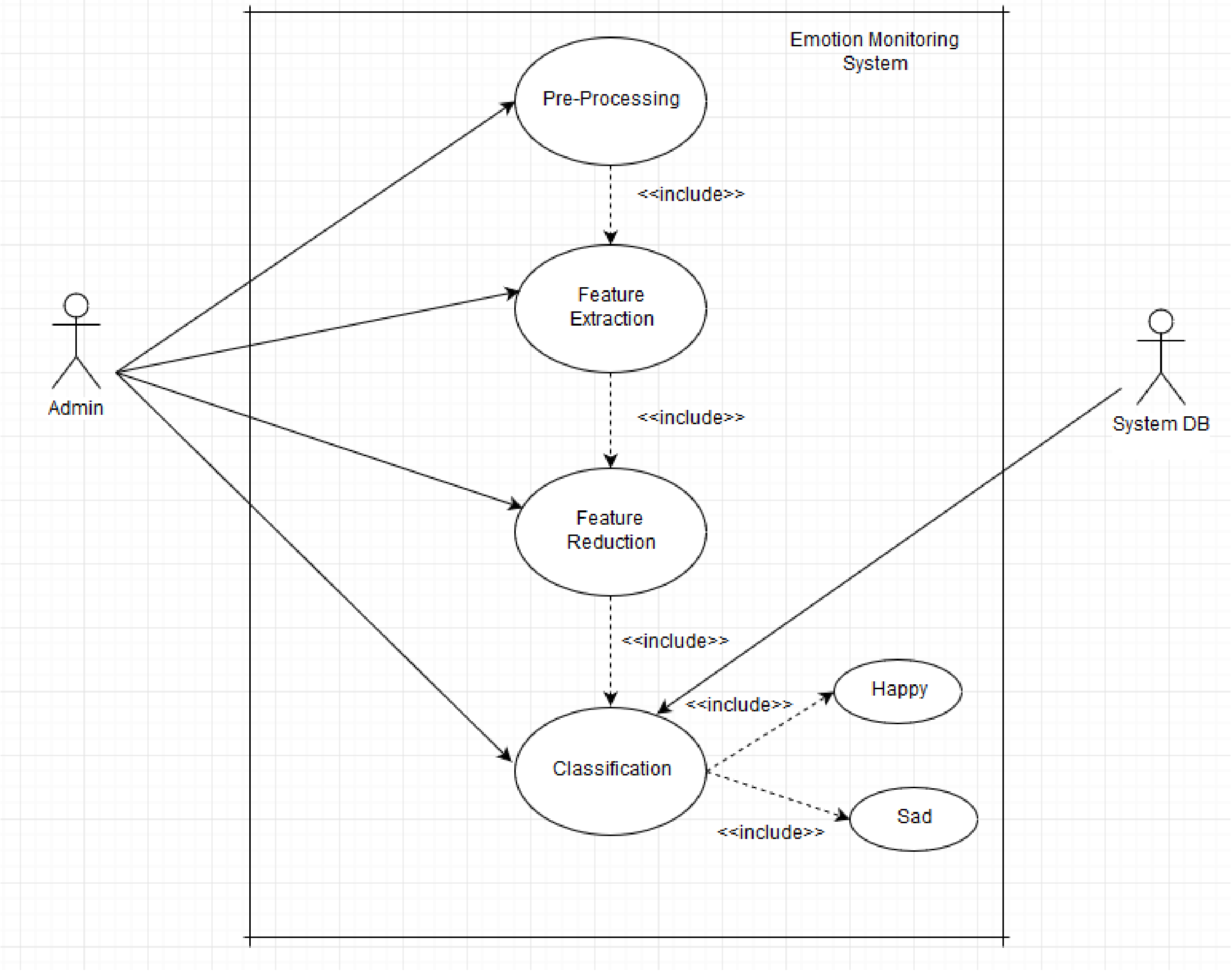


Figure 6: Use Case

3.5. SEQUENCE DIAGRAM

A **sequence diagram** shows object interactions arranged in time **sequence**. It depicts the objects and classes involved in the scenario and the **sequence** of messages exchanged between the objects needed to carry out the functionality of the scenario.

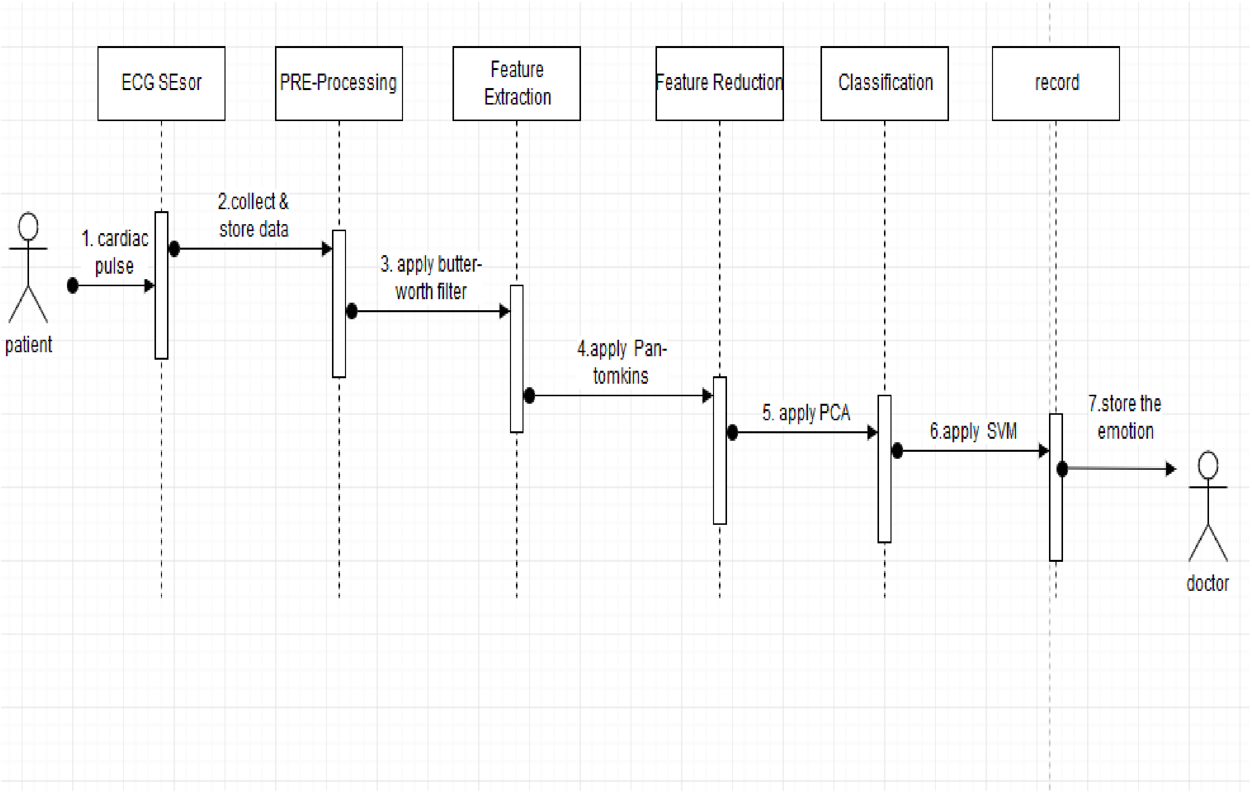


Figure 7: Sequence Diagram

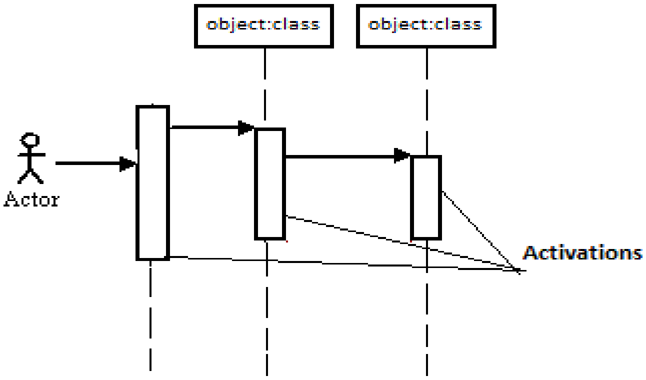


Figure 8: Symbols in Sequence Diagram

3.6. CLASS DIAGRAM

A **class diagram** in the Unified Modelling Language (UML) is a type of static structure **diagram** that describes the structure of a system by showing the system's **classes**, their attributes, operations (or methods), and the relationships among objects.

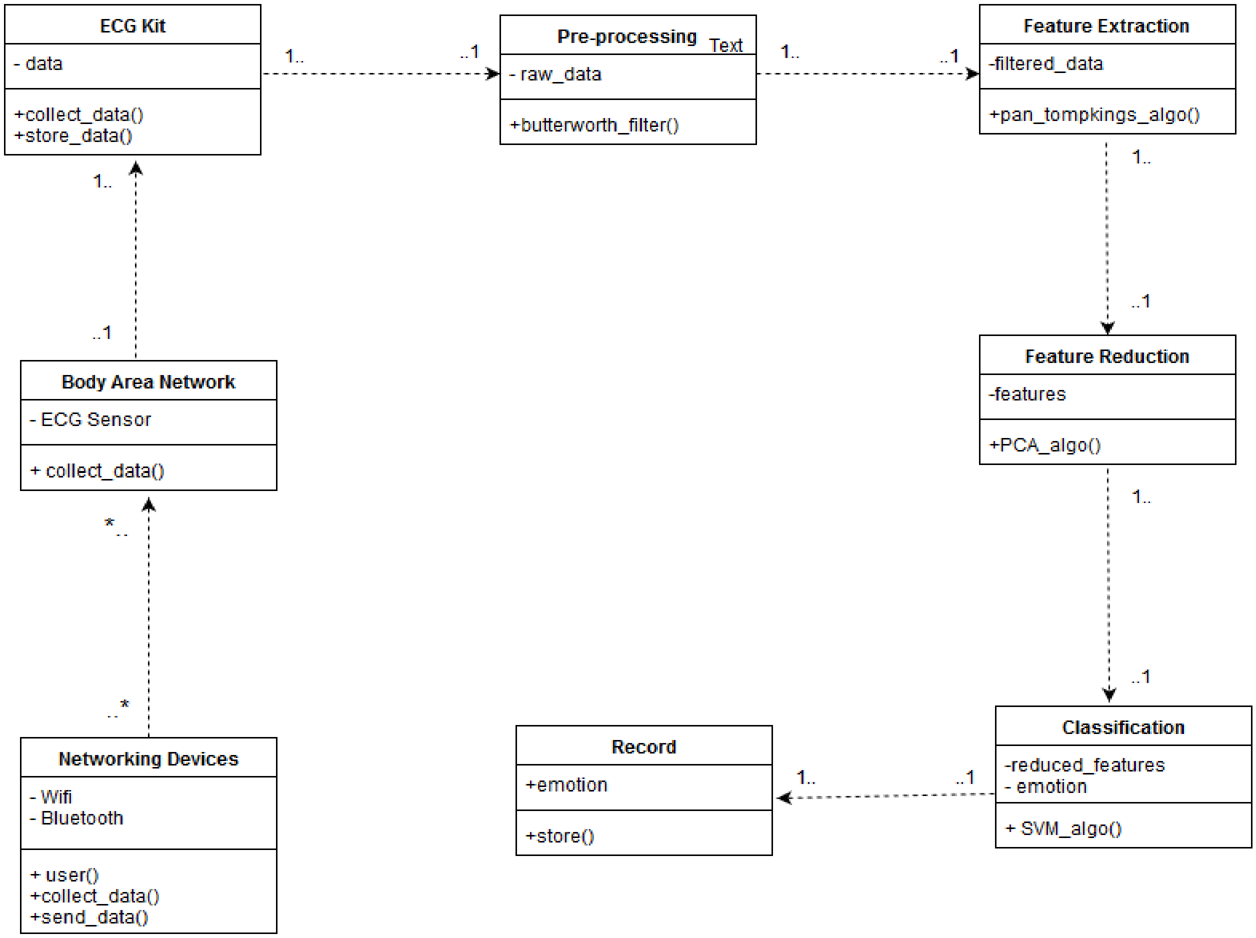


Figure 9: Class Diagram

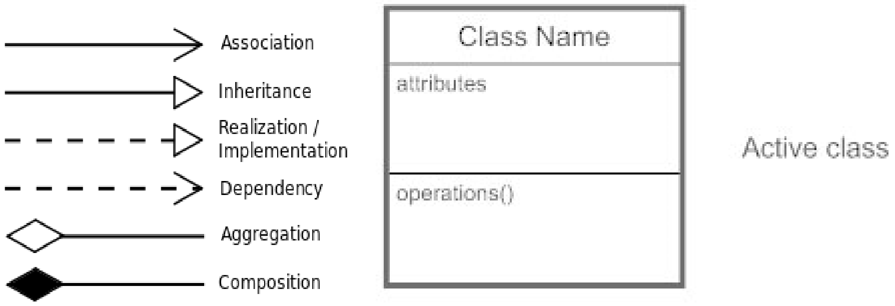


Figure 10: Symbols in Class Diagram

3.7 . INTERACTION DIAGRAM

Communication diagram (called **collaboration diagram** in UML 1.x) is a kind of UML interaction **diagram** which shows interactions between objects and/or parts (represented as lifelines) using sequenced messages in a free-form arrangement.

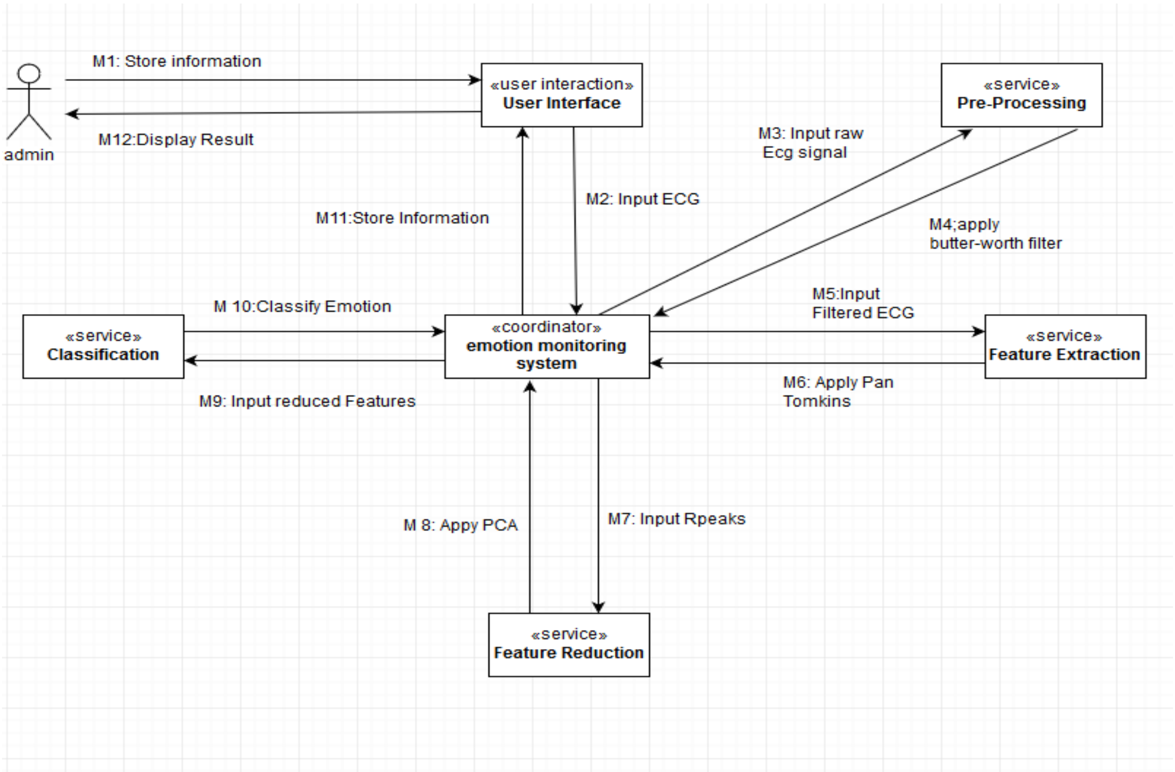


Figure 11: Interaction Diagram

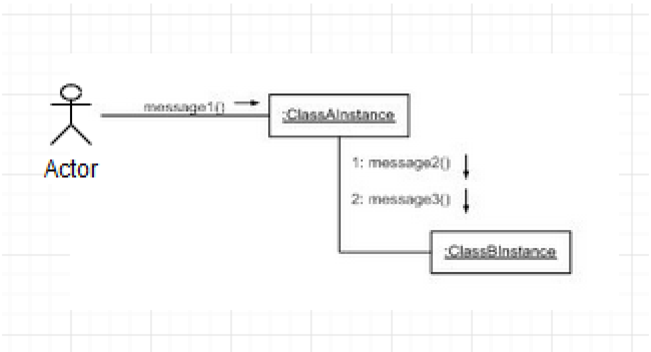


Figure 12: Symbols in Interaction Diagram

3.8 ACTIVITY DIAGRAM

Activity diagram is another important **diagram** in UML to describe the dynamic aspects of the system. **Activity diagram** is basically a flowchart to represent the flow from one **activity** to another **activity**. The **activity** can be described as an operation of the system. The control flow is drawn from one operation to another.

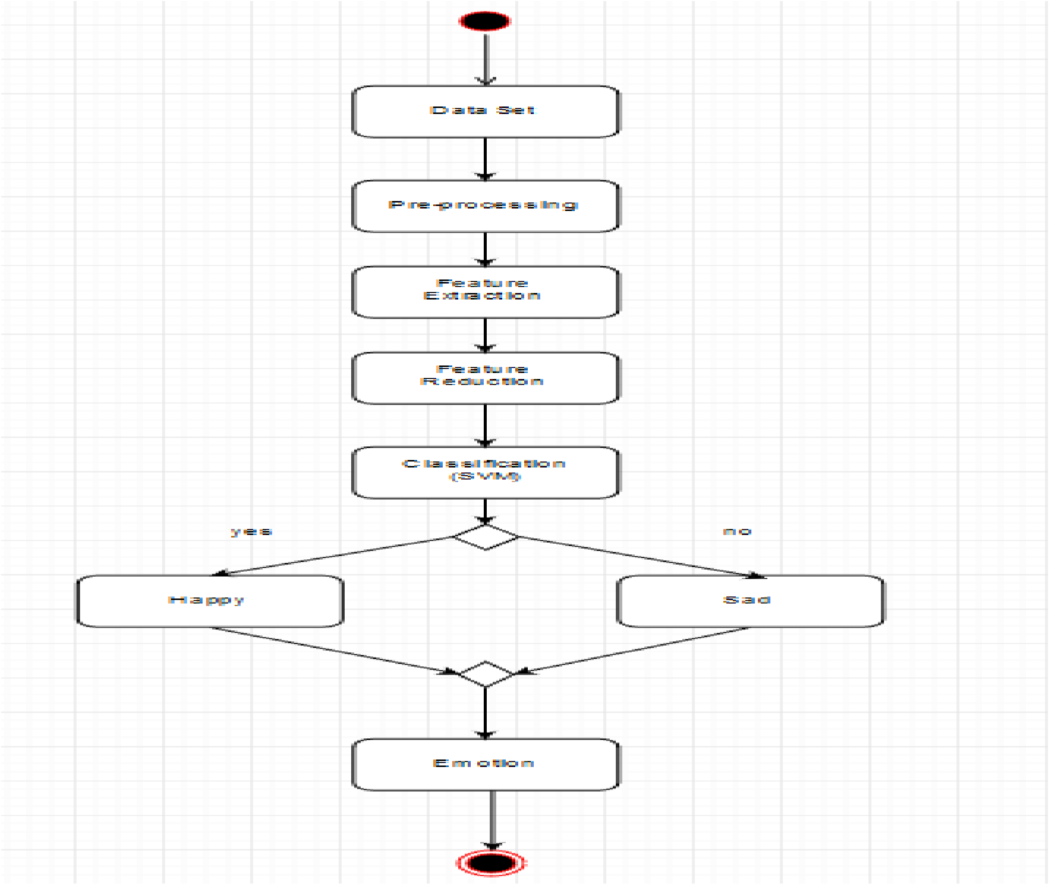


Figure 13: Activity Diagram

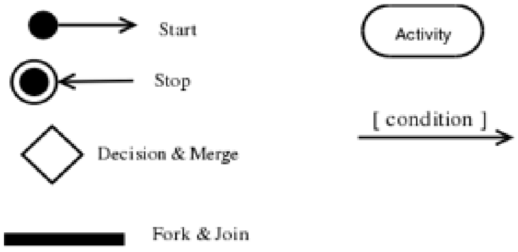


Figure 14: Symbols in Activity Diagram

3.9 COMPONENT & DEPLOYMENT DIAGRAM

In Unified Modeling Language (UML), a component diagram depicts how components are wired together to form larger components or software systems. They are used to illustrate the structure of arbitrarily complex systems.

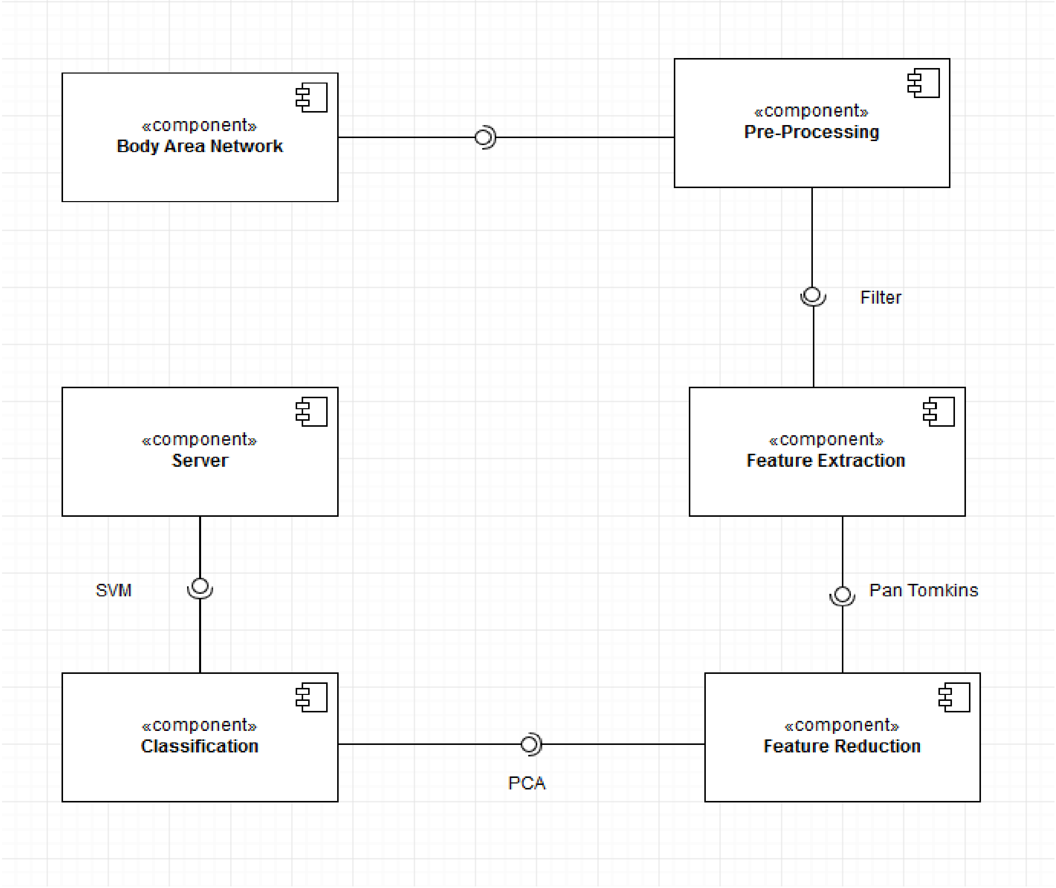


Figure 15: Component Diagram

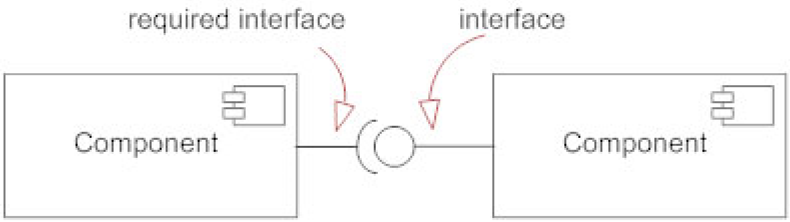


Figure 16: Symbols in Component Diagram

Deployment diagram is a structure diagram which shows architecture of the system as deployment (distribution) of software artifacts to deployment targets. Artifacts represent concrete elements in the physical world that are the result of a development process.

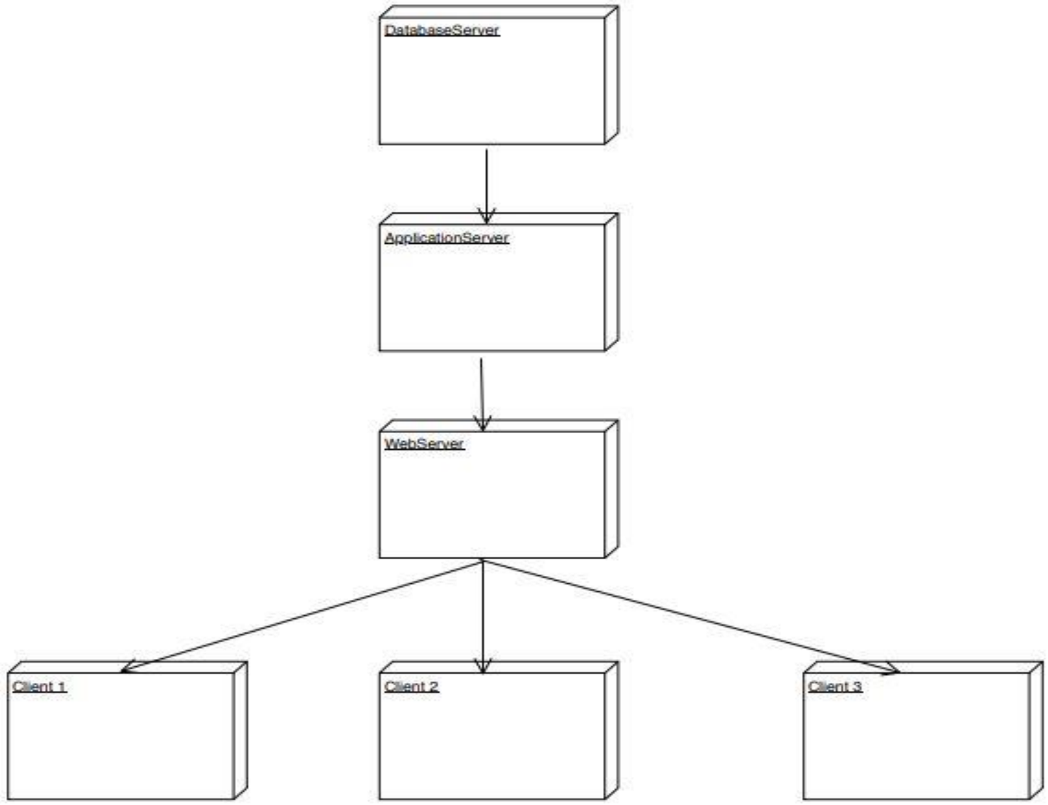
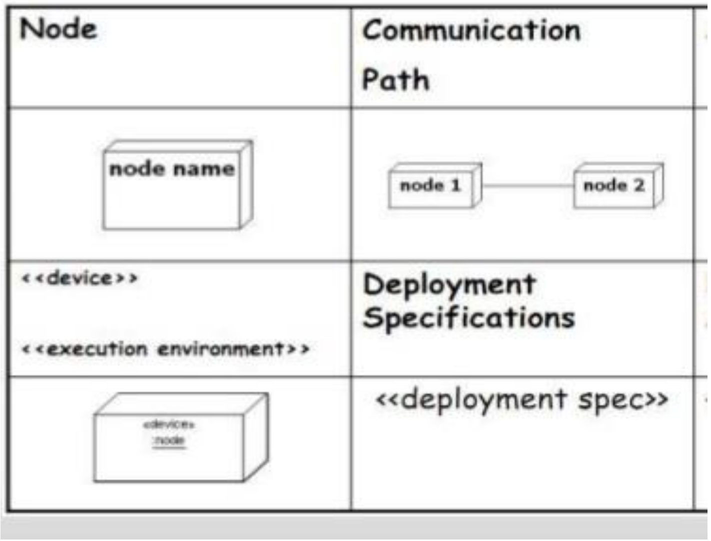


Figure 17: Deployment Diagram



Node	Communication Path
node name	node 1 node 2
<<device>> <<execution environment>>	Deployment Specifications
«device» :node	<<deployment spec>>

Figure 18: Symbols in Deployment Diagram

CHAPTER 4

4. IMPLEMENTATION

1) Data Set

A record of the heart's electrical activity is electrocardiogram (ECG or EKG). Electrical functions going between the heart can be judged by external electrodes. The electrocardiogram (ECG) records these functions from electrodes which are linked to various places on the human body. Using ten electrodes, twelve leads are computed. These electrodes are used to document the dataset. A real time data set which has reading of a person throughout the day. It contains 60 files which contains five columns each, which are as follow:

1. The time at which the reading of electrodes was taken
2. The time interval
3. The left electrode reading,
4. The right electrode reading,
5. The reference electrode reading.

Each file denotes readings at one second. Each file has rows with readings of these electrodes for each 0.001 sec in that one second.

2) Pre-processing

ECG signals are obtained by placing electrodes on the body surface of a human being. The raw signals are always adulterated with noises. Electrode motion artifacts, baseline wander, electromyography (EMG) noise, power-line interference are the noises contaminated in the raw signals. ECG signal pre-processing's objective is to give a filtered conclusion with maximal accuracy.

Elliptic filters, Adaptive filters, and Butterworth filter are the different varieties of Low-pass filters used widely. In this project we have applied Butterworth filter, a sort of signal processing filter constructed to have a frequency feedback as flat as achievable. This filtering permits adoption of little thresholds, thereby rising detection sensitivity.

Butterworth filter frequency response:

[B, M] =butter (n, wn)

Where,

- n = order of the filter
- wn = the cut-off frequency (must range from 0 to 1)
- B (numerator) and M (denominator) are the filter coefficients having length n+1.

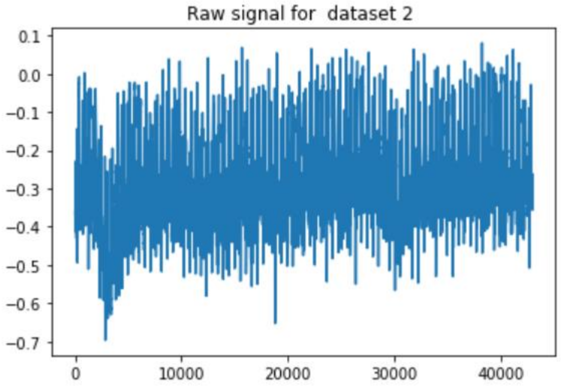


Figure 19: Raw ECG signals

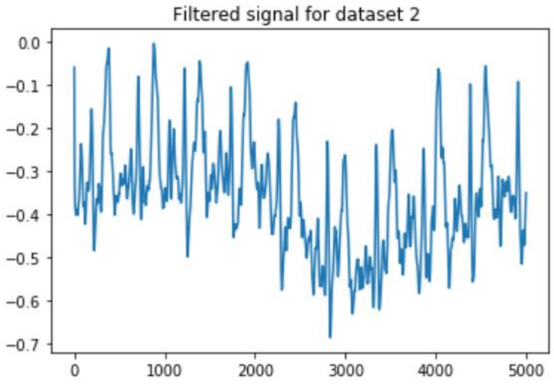


Figure 20: Filtered ECG signals

3) Feature extraction

Succeeding the pre-processing, it is essential to drive out the features in the signal so that they can be applied to figure out the emotion of the signal. For which we have use Pan Tomkins Algorithm and the features cited beneath.

a. Pan Tomkins

The QRS complexes situated upon digital analyses of slope, amplitude and width are accurately discovered by Pan Tomkins. Thresholds and parameters are automatically arranged periodically by the algorithm, to adapt to such physiological variations such as heart rate and QRS Morphology.

b. In this project, for each file in the dataset, we calculate the following six parameters proposed by Picard.

Feature 1- calculating the raw signals mean:

$$\mu_y = \frac{1}{T}\sum_{t=1}^{T} Y(T) = \bar{Y}(t) \tag{1}$$

Feature 2- calculating raw signals standard deviation:

$$\sigma_y = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y(t) - \mu_y)^2} \tag{2}$$

Feature 3- calculating the mean of the absolute values of the first differences of raw signals:

$$\delta_y = \frac{1}{T-1}\sum_{t=1}^{T-1}|Y(t+1) - Y(t)| \tag{3}$$

Feature 4- calculating the mean of the absolute values of the first differences of normalized signals:

$$\bar{\delta_y} = \frac{1}{T-1}\sum_{t=1}^{T-1}|\bar{Y}(t+1) - \bar{Y}(t)| = \frac{\delta_y}{\sigma_y} \tag{4}$$

Feature 5- calculating the mean of absolute values of the second differences of raw signals:

$$\gamma_y = \frac{1}{T-2}\sum_{t=1}^{T-2}|Y(t+2) - Y(t)| \tag{5}$$

Feature 6- calculating the mean of absolute values of the second differences of normalized signals:

$$\bar{\gamma}_y = \frac{1}{T-2}\sum_{t=1}^{T-2}|\bar{Y}(t+2) - \bar{Y}(t)| = \frac{\gamma_y}{\sigma_y} \tag{6}$$

Where in,

T is called sampling count

t is called the total count of samples.

4) Feature reduction

From high-dimensional space, Feature Extraction reconstructs the information into a space of little dimensions. The features that have been drawn out from different bio-signals might or might not correlate with emotion. Therefore, makes it essential to eliminate the features that may not have any association among the various emotional classes, which weaken the efficiency of the classifiers. Abundant nonlinear dimensionality reduction approaches also exist but we have applied Principal Component Analysis as the data transformation in linear.

a. Principal Component Analysis

We can explain that the aim of PCA is to decide that Y- the unit basis vector on the x-axis - is the most crucial dimension. Determining this reality permits an experimenter to anticipate which dynamics is necessary, which are just excessive and that is just noise.

In the data set operated for this project, at a point in instant, there are 17 columns. One trial can then be expressed as a 17-dimensional column vector.

$$Y = \begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ . \\ . \\ . \\ x_{17} \end{bmatrix} \tag{7}$$

Let us assume Y is the data set, where each column is a single trail (or instant of time) of our data set. Let X be another A× B matrix associated by a linear transformation R. Y is the documented dataset and X is a re-depiction of this data set.

$$\mathbf{RY = X} \tag{8}$$

Also let us characterize the following quantities.

- r_i are the rows of R
- x_i are the columns of X.
- y_i are the columns of Y.

The above Equation 8 represents a variation of basis and thus has many explications.

1. R is a matrix that reconstructs Y into X.

2. According to Geometry, R is a rotation and an outline which again reconstructs Y into X.

3. The rows of R {$r_1 . . . r_m$}, are a group of fresh basis vectors for indicating the columns of Y.

The form of each column of X can be noted as shown below.

$$x_i = \begin{bmatrix} r_1 \cdot y_i \\ . \\ . \\ . \\ \mathrm{r_m \cdot y_i} \end{bmatrix} \tag{9}$$

It can be observed that each coefficient of x_i is a dot product of y_i with the corresponding row of R. In other aspect, the j^{th} coefficient of x_i is a projection on to the j^{th} row of P. Where x_i is a projection on to the basis of $\{r_1. . . r_m\}$, is in fact the very form of an equation. Therefore, the rows of P are undoubtedly a new group of basis vectors for depicting the columns of Y. Feature projection on the dataset with the help of principal component analysis is shown.

5) Classification

Once the features are chosen, they must be trained using a classifier to classify them into emotional classes like happy and sad using the features conferred. This paper suggested an approach called Support Vector Machine (SVM) for classification, which is a classifier officially characterized by a distinguishing hyperplane. Otherwise, we can infer from the given named training data, the algorithm produces an optimal hyperplane which distinguishes new samples. This hyperplane is a line separating a plane into two regions where in every class lays in either side, either class 0 or class 1, in two-dimensional space. Using kernel trick, SVM can smoothly perform classification.

The kernel functions are:

- the linear kernel
- the polynomial kernel
- the RBF (Gaussian) kernel
- the string kernel

Here, we will concentrate on two-dimensional space. In two-dimensional case, we can assume this as a line that completely divides all our input points.

$$A0 + (A1 * Z1) + (A2 * Z2) = 0 \tag{10}$$

Where,
A1 and A2 are the coefficients that establish the slope of above the line,
A0 is the intercept that is discovered by the learning algorithm,
Z1 and Z2 are input variables.

Classifications can be made applying this. By adding in input values in above the equation 10, if a new point is over or beneath the line can be calculated.

i. Above the line and point the resides in the first class, the equation returns a value greater than 0 (class 0).
ii. Below the line and the point resides in the second class, the equation returns a value less than 0 (class 1).
iii. A value closer to the above line restores a value closer to zero and the point might be tough for classification.
iv. If the weight of the value is huge, the model might get more self-assurance on the prediction.

A very effective intuition is that instead of the observations themselves, the linear SVM can be reconstructed using the inner product of any two provided observations.

The inner product of two vectors is equal to the addition of the multiplication of every duo of input values.

For instance, let us consider the inner product of the vectors mentioned below
[1, 4] and [2, 5]
which is 1*2 + 4*5 or 22.

The equation for calculating a prediction for a new input through the dot product of the input (y) and every support vector (yi) is computed as shown beneath:

$$f(y) = A0 + sum\left(ci * (y, yi)\right) \tag{11}$$

The above Equation 11 includes computing the inner products of a new input vector (y) along with all support vectors in the trained information provided. From the training data using the learning algorithm, the coefficients A0 and ci (for every input) should be computed.

a) Linear Kernel SVM

The kernel is the dot-product of vectors which can be revised as:

$$M(y, yi) = sum(y * yi) \tag{12}$$

The kernel decides the correspondence between the support vectors and new data. The dot product is the correspondence measure applied for linear kernel as the distance is a linear merger of inputs.

4.1 DATABASE DESIGN

4.1.1 ER DIAGRAM

An entity relationship diagram (ERD), also known as an entity relationship model, is a graphical representation of an information system that depicts the relationships among people, objects, places, concepts or events within that system.

Components of ERD:

An **Entity** can be any object, place, person or class.

An **Attribute** describes a property or characteristic of an entity.

A Relationship describes relation between **entities**.

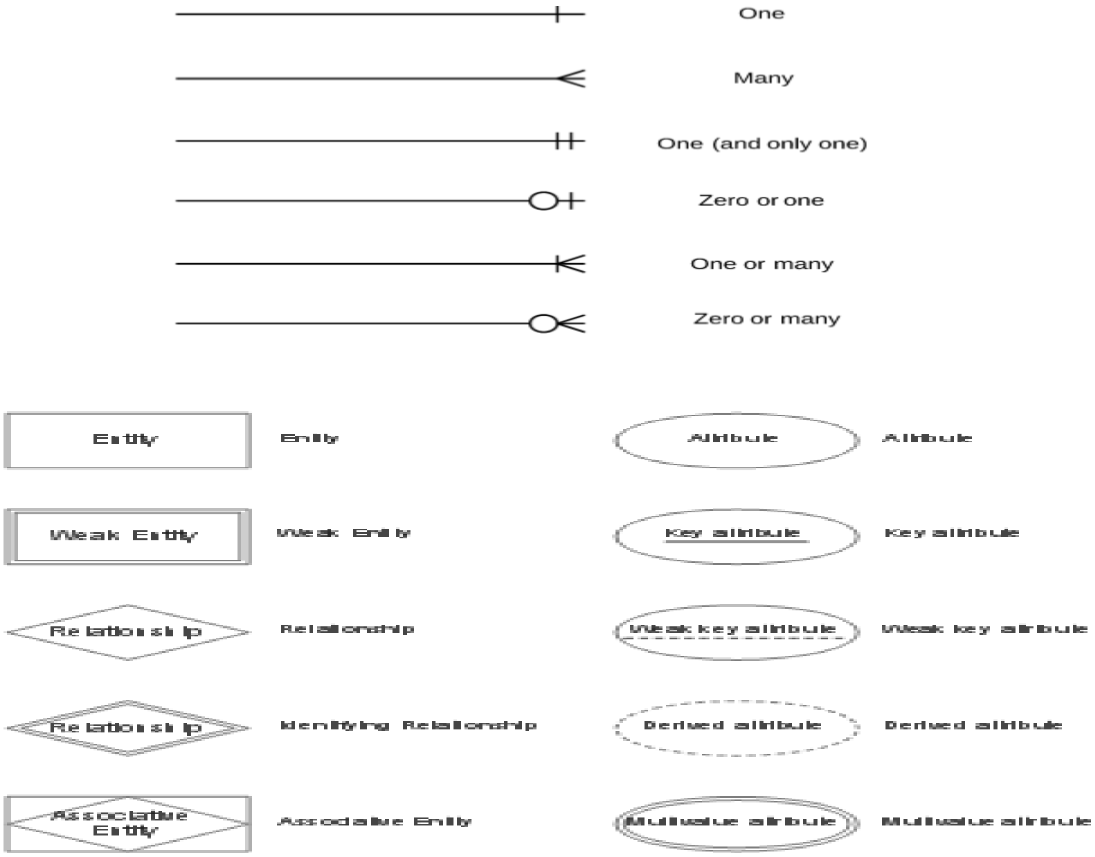


Figure 21: Symbols of ER Diagram.

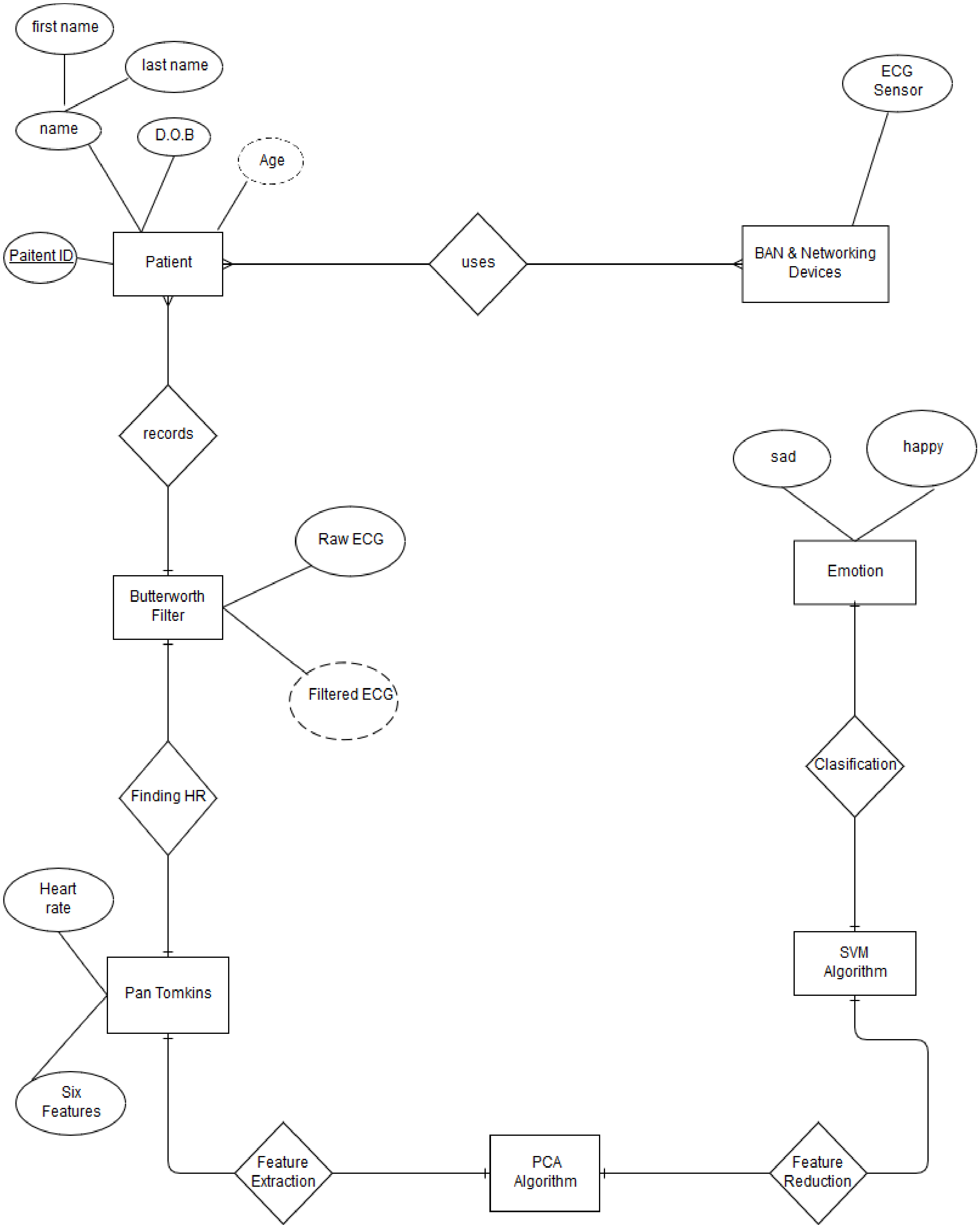


Figure 22: Entity Relationship Diagram

4.1.2 RELATIONAL MODEL

Relational data model is the primary data model, which is used widely around the world for data storage and processing. This model is simple and it has all the properties and capabilities required to process data with storage efficiency.

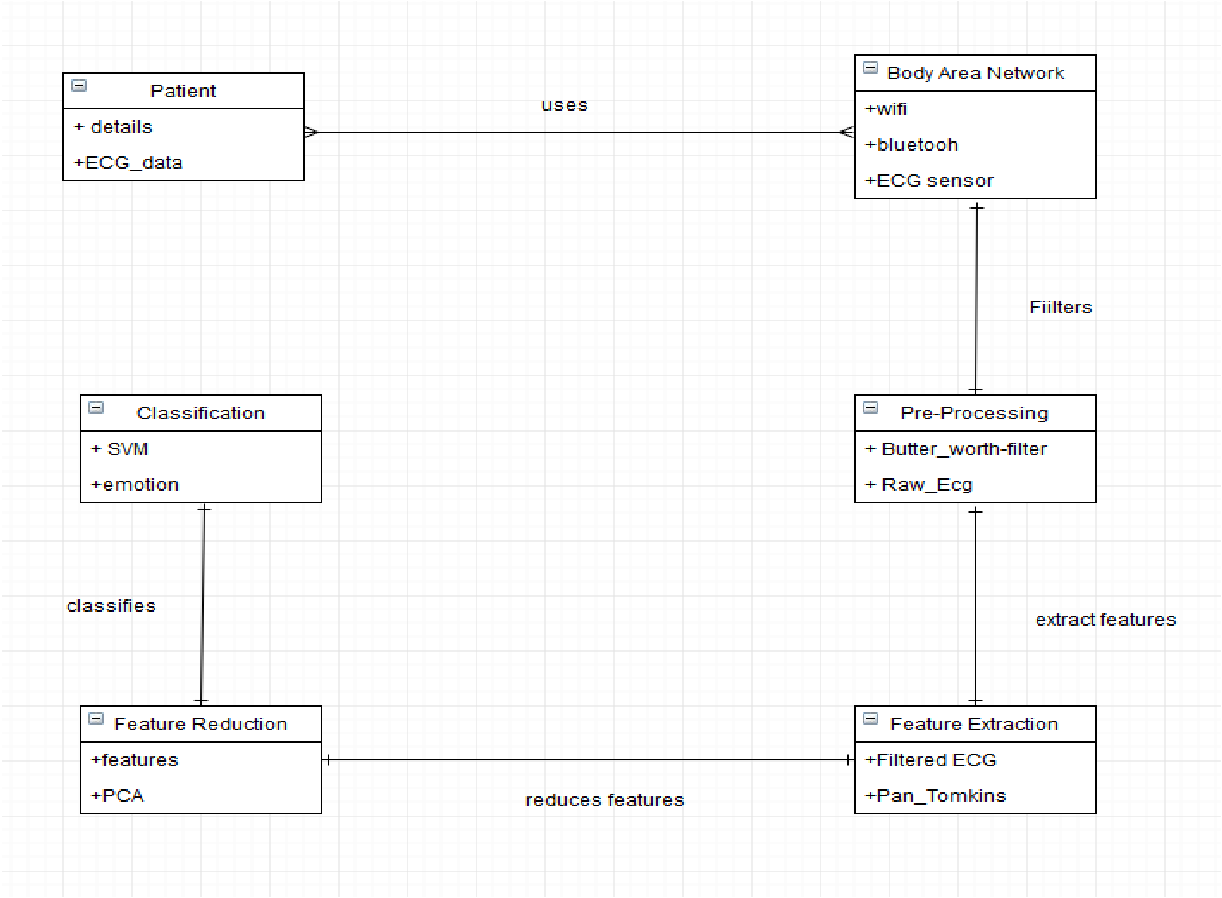


Figure 23: Relational Diagram

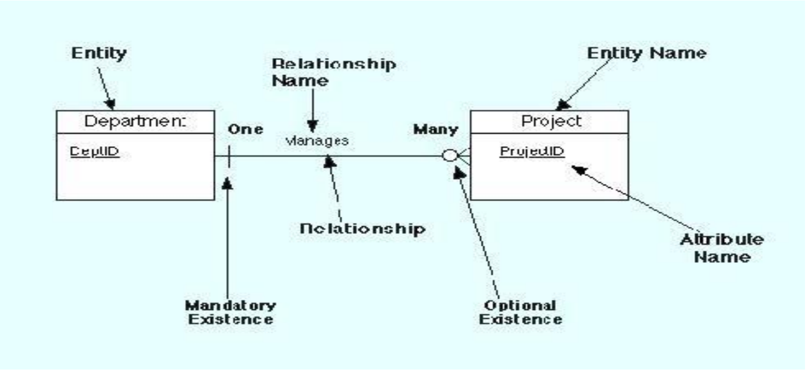


Figure 24: Symbols of Relational Diagram

4.2USER INTERFACE

The user interface (UI) is everything designed into an information device with which a person may interact. This can include display screens, keyboards, a mouse and the appearance of a desktop. It is also the way through which a user interacts with an application or a website.

In complex systems, the human–machine interface is typically computerized. The term *human–computer interface* refers to this kind of system. In the context of computing the term typically extends as well to the software dedicated to control the physical elements used for human-computer interaction. In this project it is the Body area Network used to record the data and jupyter notebook software used.

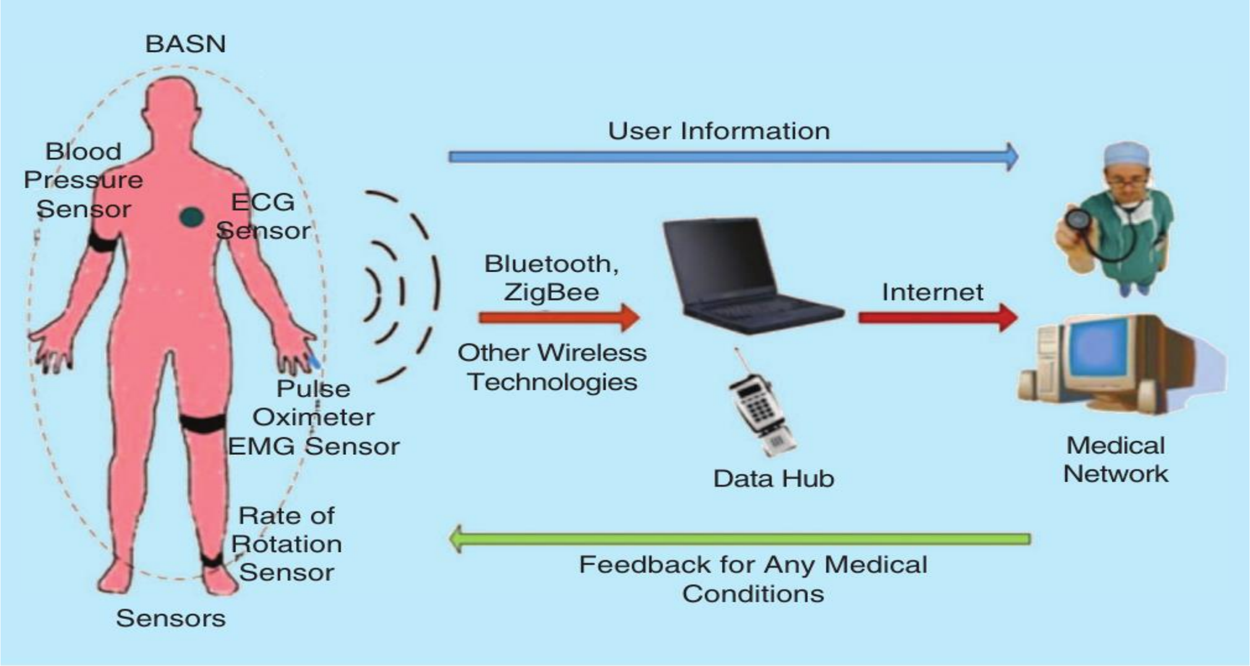


Figure 25: User Interface

User interfaces are designed with a focus on *usability* and *efficiency*. Here Users are being able to achieve their goals as efficiently as possible. In that sense, a well-designed user interface becomes effectively *invisible* to those using it. In other words, they interact directly with the 'reality' the design portrays without reckoning on the point that.

4.2MIDDLEWARE

Notebook:

A notebook integrates code and its output into a single document that combines visualizations, narrative text, mathematical equations, and other rich media. The intuitive workflow promotes iterative and rapid development, making notebooks an increasingly popular choice at the heart of contemporary data science, analysis, and increasingly science at large.These documents are produced by the Jupyter Notebook App.

Jupyter Notebook App:

As a server-client application, the Jupyter Notebook App allows you to edit and run your notebooks via a web browser. The application can be executed on a PC without Internet access or it can be installed on a remote server, where you can access it through the Internet.

Its two main components are the kernels and a dashboard.

A kernel is a program that runs and introspects the user’s code. The Jupyter Notebook App has a kernel for Python code, but there are also kernels available for other programming languages.

The dashboard of the application not only shows you the notebook documents that you have made and can reopen but can also be used to manage the kernels: you can which ones are running and shut them down if necessary.

ipynb File:

Each .ipynb file is a text file that describes the contents of your notebook in a format called JSON. Each cell and its contents, including image attachments that have been converted into strings of text, is listed therein along with some metadata.

Notebook Interface:

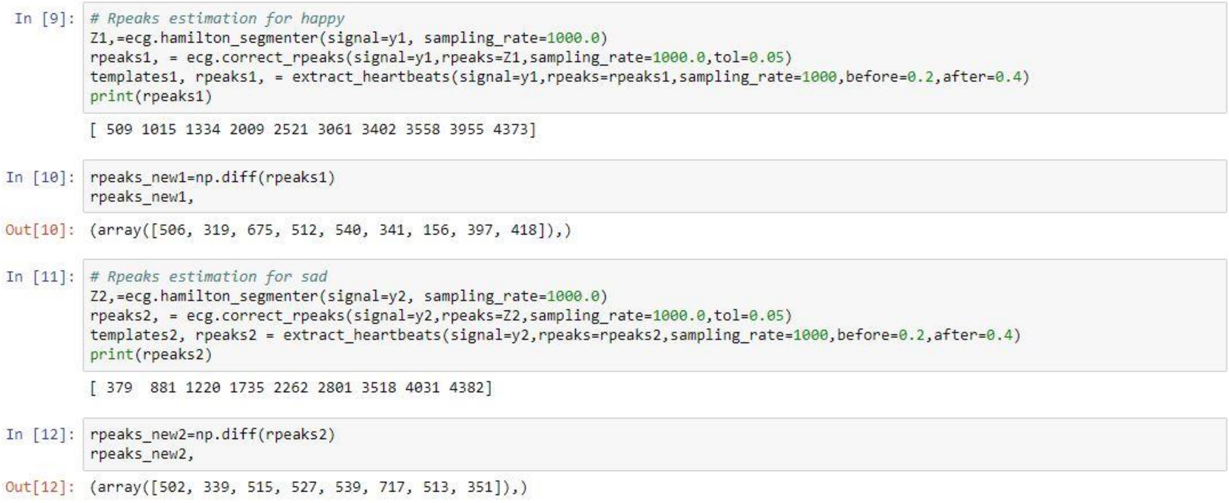
1) A kernel is a "computational engine" that executes the code contained in a notebook document.

Behind every notebook runs a kernel. When you run a code cell, that code is executed within the kernel and any output is returned back to the cell to be displayed. The kernel's state persists over time and between cells — it pertains to the document as a whole and not individual cells.

2) A cell is a container for text to be displayed in the notebook or code to be executed by the notebook's kernel.

There are two main cell types that we will cover:

- A **code cell** contains code to be executed in the kernel and displays its output below.
- A **Markdown cell** contains text formatted using Markdown and displays its output in-place when it is run.



```
In [9]:  # Rpeaks estimation for happy
          Z1,=ecg.hamilton_segmenter(signal=y1, sampling_rate=1000.0)
          rpeaks1, = ecg.correct_rpeaks(signal=y1,rpeaks=Z1,sampling_rate=1000.0,tol=0.05)
          templates1, rpeaks1, = extract_heartbeats(signal=y1,rpeaks=rpeaks1,sampling_rate=1000,before=0.2,after=0.4)
          print(rpeaks1)

          [ 509 1015 1334 2009 2521 3061 3402 3558 3955 4373]

In [10]:  rpeaks_new1=np.diff(rpeaks1)
          rpeaks_new1,

Out[10]:  (array([506, 319, 675, 512, 540, 341, 156, 397, 418]),)

In [11]:  # Rpeaks estimation for sad
          Z2,=ecg.hamilton_segmenter(signal=y2, sampling_rate=1000.0)
          rpeaks2, = ecg.correct_rpeaks(signal=y2,rpeaks=Z2,sampling_rate=1000.0,tol=0.05)
          templates2, rpeaks2 = extract_heartbeats(signal=y2,rpeaks=rpeaks2,sampling_rate=1000,before=0.2,after=0.4)
          print(rpeaks2)

          [ 379  881 1220 1735 2262 2801 3518 4031 4382]

In [12]:  rpeaks_new2=np.diff(rpeaks2)
          rpeaks_new2,

Out[12]:  (array([502, 339, 515, 527, 539, 717, 513, 351]),)
```

Figure 26: Middleware of System

CHAPTER 5

5. VERIFICATION & VALIDATION

The terms Verification and Validation are commonly used in software engineering to mean two different types of analysis. The usual definitions are:

- Validation: Are we building the right system?
- Verification: Are we building the system right?

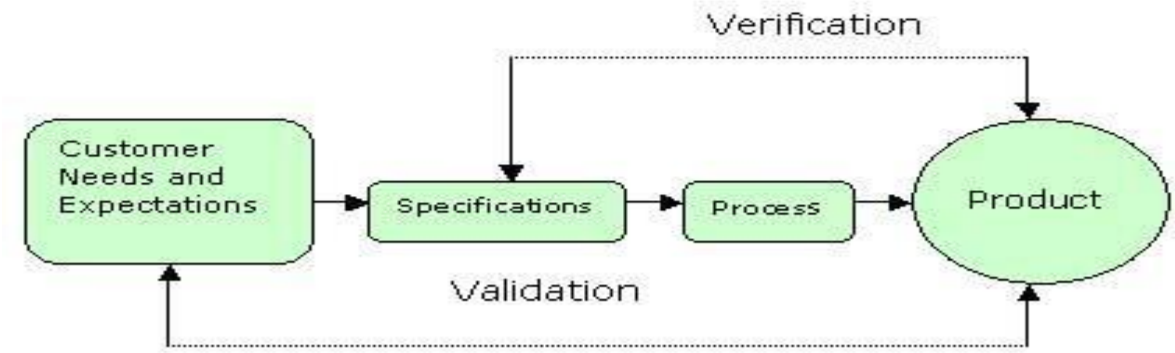


Figure 27: Verification/Validation

In other words, validation is concerned with checking that the system will meet the customer’s actual needs, while verification is concerned with whether the system is well-engineered, error-free, and so on. Verification will help to determine whether the software is of high quality, but it will not ensure that the system is useful.

The distinction between the two terms is largely to do with the role of specifications. Validation is the process of checking whether the specification captures the customer’s needs, while verification is the process of checking that the software meets the specification.

Verification includes all the activities associated with the producing high quality software: testing, inspection, design analysis, specification analysis, and so on. It is a relatively objective process, in that if the various products and documents are expressed precisely enough, no subjective judgments should be needed in order to verify software.

In contrast, validation is an extremely subjective process. It involves making subjective assessments of how well the (proposed) system addresses a real-world need. Validation includes activities such as requirements modeling, prototyping and user evaluation.

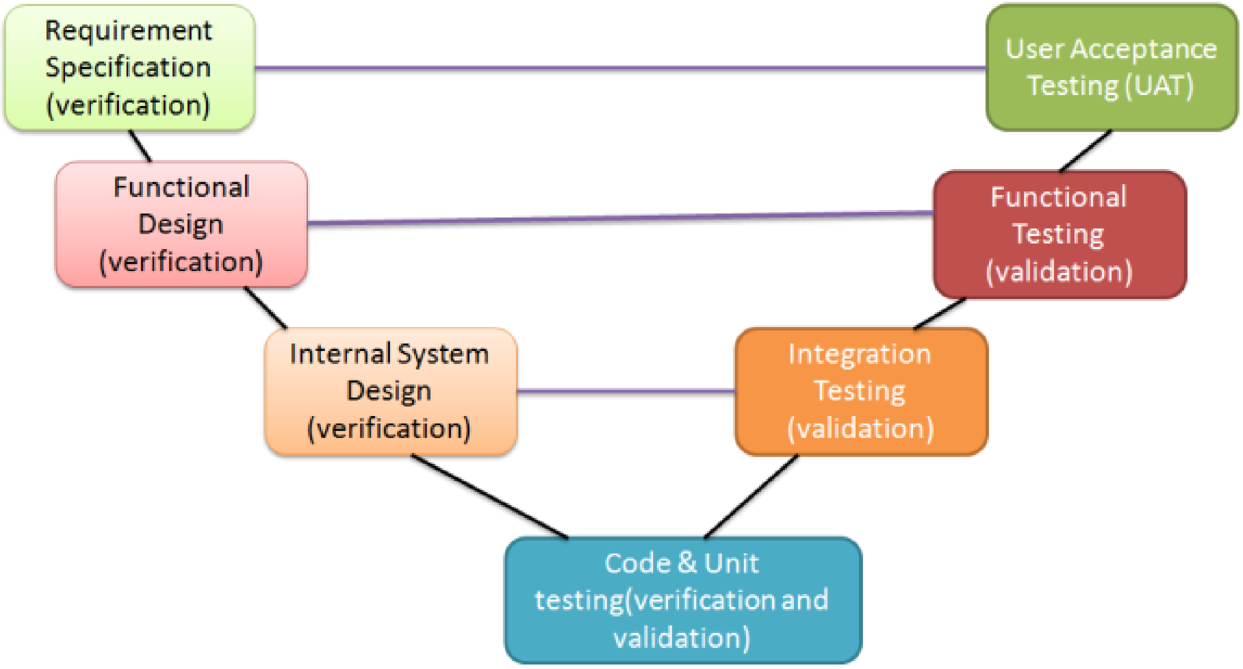

Requirement Specification (verification)
User Acceptance Testing (UAT)
Functional Design (verification)
Functional Testing (validation)
Internal System Design (verification)
Integration Testing (validation)
Code & Unit testing(verification and validation)

Figure 28: Verification/Validation in a project

5.1 UNIT TESTING

Unit testing is a software testing method by which individual units of source code, sets of one or more computer program modules together with associated control data, usage procedures, and operating procedures, are tested to determine whether they are fit for use.

Unit testing is a level of software testing where individual units/ components of software are tested. The purpose is to validate that each unit of the software performs as designed. A unit is the smallest testable part of any software. It usually has one or a few inputs and usually a single output. In procedural programming, a unit may be an individual program, function, procedure, etc. In object-oriented programming, the smallest unit is a method, which may belong to a base/ super class, abstract class or derived/ child class. (Some treat a module of an application as a unit. This is to be discouraged as there will probably be many individual units within that module.) Unit testing frameworks, drivers, stubs, and mock/ fake objects are used to assist in unit testing.

5.2 INTEGRATION TESTING

INTEGRATION TESTING is a level of software testing where individual units are combined and tested as a group. The purpose of this level of testing is to expose faults in the interaction between integrated units. Test drivers and test stubs are used to assist in Integration Testing.

APPROACHES:-

- *Big Bang* is an approach to Integration Testing where all or most of the units are combined together and tested at one go. This approach is taken when the testing team receives the entire software in a bundle. So what is the difference between Big Bang Integration Testing and System Testing? Well, the former tests only the interactions between the units while the latter tests the entire system.

- *Top Down* is an approach to Integration Testing where top-level units are tested first and lower level units are tested step by step after that. This approach is taken when top-down development approach is followed. Test Stubs are needed to simulate lower level units which may not be available during the initial phases.
- *Bottom Up* is an approach to Integration Testing where bottom level units are tested first and upper-level units step by step after that. This approach is taken when bottom-up development approach is followed. Test Drivers are needed to simulate higher level units which may not be available during the initial phases.
- *Sandwich/Hybrid* is an approach to Integration Testing which is a combination of Top Down and Bottom Up approaches.

5.3 USER TESTING

In software development, user acceptance testing (UAT) - also called beta testing, application testing, and end user testing - is a phase of software development in which the software is tested in the "real world" by the intended audience. UAT can be done by in-house testing in which volunteers or paid test subjects use the software or, more typically for widely-distributed software, by making the test version available for downloading and free trial over the Web. The experiences of the early users are forwarded back to the developers who make final changes before releasing the software commercially.

5.4 SIZE – LOC

Lines of code (LOC), is a software metric used to measure the size of a computer program by counting the number of lines in the text of the program's source code. SLOC is typically used to predict the amount of effort that will be required to develop a program, as well as to estimate programming productivity or maintainability once the software is produced.

There are two major types of LOC measures:

1. Physical LOC (LOC) and
2. Logical LOC (LLOC).

Specific definitions of these two measures vary, but the most common definition of physical LOC is a count of lines in the text of the program's source code excluding comment lines.

Physical Line of Code (LOC)	49
Logical Lines of Code (LLOC)	106
Comment Lines	37

Table 4: Lines of code

5.5 COST ANALYSIS

Table 5: Cost Analysis

System Cost	**136750**
Cost Of Body Area Network:	80000
Cost Of Heart Prediction System :	21750
Cost Of Setting Data Base & Server	35000
Requirement	**7000**
Cost Of Requirement Gathering	3500
Cost Of Requirement Analysis	3500
Planning	**10000**
Cost Of Scheduling	4000
Cost Of Architecture	6000
Design	**8000**
Cost Of UI Design	4500
Cost Of UML Designs	3500
Coding	**12000**
Cost Of Coding	8000
Cost Of Implementation	4000
Testing	**10000**
Cost Of Unit Testing	1500
Cost Of Integration Testing	6500
Cost Of User Testing	2000
Total cost	**184250**

5.6 DEFECT ANALYSIS

Defect analysis is part of the continuous quality improvement planning in which defects are classified into different categories and are also used to identify the possible causes in order to prevent the problems from occurring. It helps systems to identify how issues can be prevented and in reducing or eliminating significant numbers of defects from being injected into the system.

It is an important activity in any software project. In most software organizations, the project team focuses on defect detection and rework. Thus, defect prevention, often becomes a neglected component. It is therefore advisable to make measures that prevent the defect from being introduced in the product right from early stages of the project. While the cost of such measures are the minimal, the benefits derived due to overall cost saving are significantly higher compared to cost of fixing the defect at later stage. Thus analysis of the defects at early stages reduces the time, cost and the resources required. The knowledge of defect injecting methods and processes enable the defect prevention. Once this knowledge is practiced the quality is improved. It also enhances the total productivity.

There are various metrics for analysis of defects.

- **Defect Pareto Chart:** This chart reflects the frequency of occurrence of various categories of problems. The defect that has a higher frequency of occurrence is observed and priority is assigned.
    - The above bar chart shows the various problems/defects encountered in the system. Like the 'vital few' shows that downloading problem is high among the rest. File not found and open as read-only file has subsequently higher defect occurrence. Accordingly, priority is assigned to address those defects.

- **Root Cause Analysis:** This is the method of finding the reason that contributes to the defect. It is an essential part in the elimination of causes that leads to the defects. The key points that underlies the root cause analysis of a defect are-

  - Reducing defects to improve quality: The analysis should lead to implementing changes in processes that help prevent defects in the formation stage itself and ensure their early detection in case it is re-occurring.

  - Using expertise to catch the defects shall help in an efficient way: The people who really understand what went wrong should be present to analyze processes prevalent in that organization along with third party experts. A healthy debate ensures all possibilities are reviewed, analyzed and the best possible actions are arrived by consensus.

A collection of such causes will help in doing the root cause analysis. One of the tools used to facilitate root cause analysis is a simple graphical technique called cause-and-effect diagram/ fishbone diagram which is drawn for sorting and relating factors that contribute to a given situation.

5.7 MC CALL’S QUALITY FACTORS

McCall identified three main perspectives for characterizing the quality attributes of a software product these perspectives are:-

Product revision (ability to change)

- **Maintainability:** The effort required to locate and fix a fault in the system within its operating environment refers to maintainability of the system. The operating range for the devices can be manually handled using sever under the Windows OS.

- **Flexibility:** The ease of making changes required by changes in the operating environment refers to flexibility of the system. The operating environment of Jupyter Notebook is manually configurable and provides flexibility for handling each of the nodes.

- **Testability:** The ease of testing the system, to ensure that it is error-free and meets its specification refers to testability. The environment provides compilation based testing for each lines of code the runs over the system to generate the desired interaction between the nodes.

Product transition (adaptability to new environments)

- **Portability:** The effort required to transfer a program from one environment to another refers to portability. The simulator composites the portability between different environments that let the node interaction under different environment.

- **Reusability:** The ease of reusing software in a different context refers to reusability. The node information can be reused in different context in the application for the purpose of enhancing the system's range of operation.

- **Interoperability:** The effort required to couple the system to another system refers to interoperability. The simulator enables the interpretability between different motes in the functionality of the system so that it conforms to different environment.

Product operations (basic operational characteristics)

- **Correctness:** The extent to which a program fulfils its specification refers to correctness of the system .Jupyter Notebook conforms to the performance analysis of the nodes in their ranges of operation.

- **Reliability:** The system's ability not to fail refers to the reliability factor of the system. The application environment is reliable in its performance. Each node performs under its operating ranges.

- **Efficiency:** The system conforms to execution efficiency and storage efficiency which generally means the use of resources. The application provides efficient usage of all the resources necessary for the operation.

- **Integrity:** The protection of the program from unauthorized access refers the system's integrity. Jupyter Notebook conforms to the system's integrity be providing suitable operating motes for the code.

- **Usability:** The ease of the system's accessibility refers to its usability. Jupyter Notebook lets the system to utilize the operating ranges of the nodes by providing the required working environment.

CHAPTER 6

6. EXPERIMENT RESULTS & ANALYSIS

6.1 RESULTS & ANALYSIS

We bestowed a procedure to emotion monitoring constructed on processing of ECG signals. Physiological data was accomplished in two stages (happy and sad) using one machine learning algorithm SVM. Accuracy of SVM classifier for the testing set is 75%. The results of this combination of pan Tomkins Algorithm, PCA and SVM classifier are comparatively better than many other existing combinations.

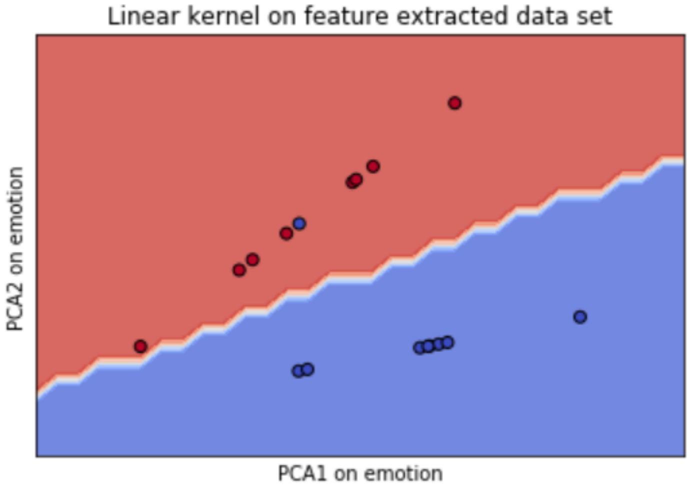


Figure 3: Hyperplane dividing emotions

Our dataset had around 43 thousand data points which on filtering changed to 5 thousand. After feature reduction we 17 significant features on which SVM was applied. Here, from the figure on the top, we can notice that the hyperplane of SVM linear kernel has divided the emotions into two which are happy and sad as blue and red color respectively.

6.2 CONCLUSION & FUTURE WORK

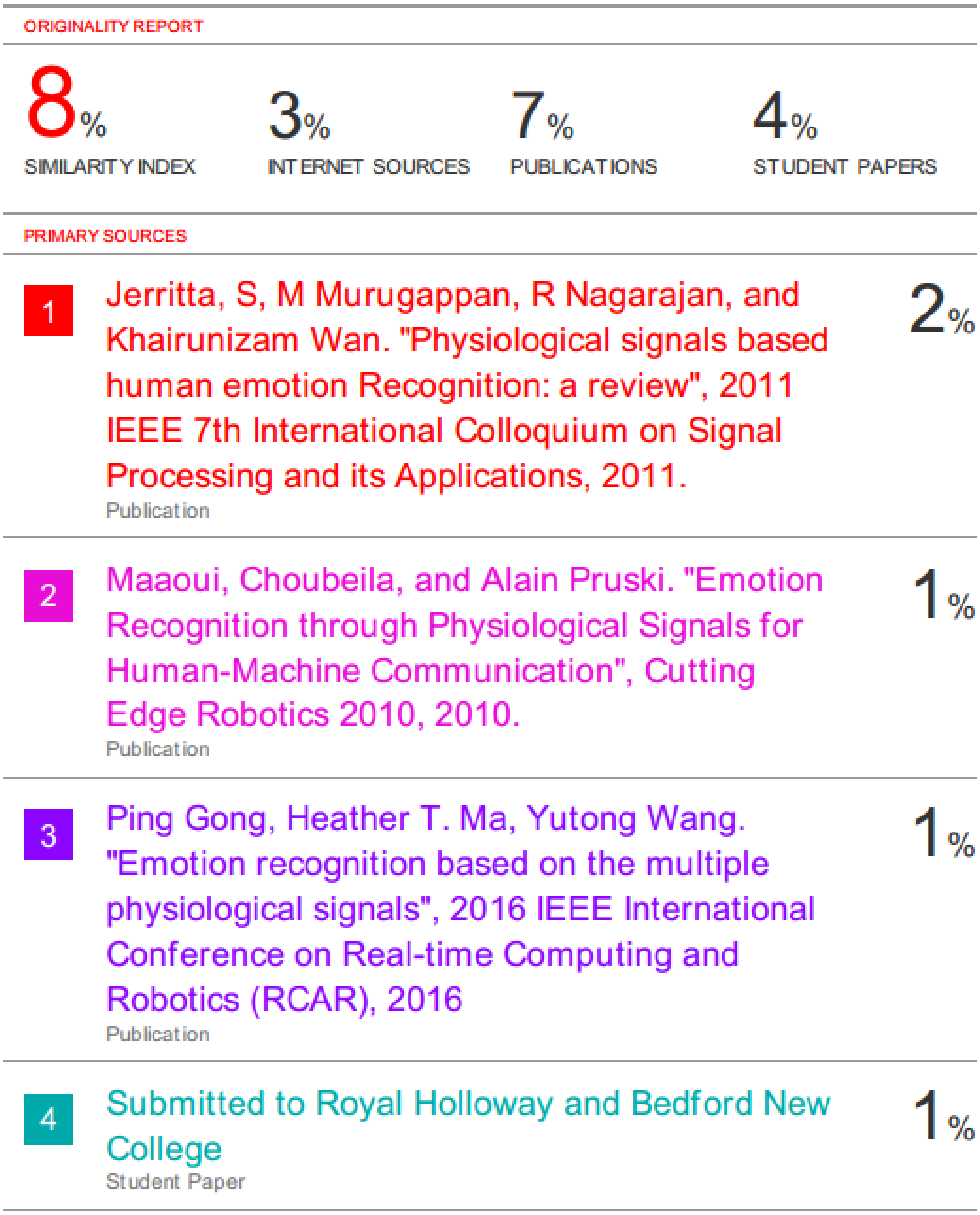
In this paper, we have inspected and bestowed two classes of human emotion (happy and sad) monitoring through ECG signals. We can observe that the actual-time emotion monitoring through ECG signals is stock-still in initial levels of advancement. The challenge is to establish a common technique for classifying the basic emotions, as emotions are extremely instinctive. The skill to monitor emotion is one of the trademarks of emotional intellect.

Emotion is a composite conception that cannot be described exactly .It is very tough to construct a structure that can impel the same emotion into every subject. Varying moods and characters and the inefficiency to meticulously account an emotional experience may highly influence the result of a study. In this analysis, the dataset used for emotion identification is acquired from many subjects while they were undergoing the unique behaviors. In future, we have to test more subjects under even more various emotions.

The conclusion of classification was absolutely motivating and depicted the practicability of a user-independent emotion monitoring established on electrocardiogram (ECG) signals.

CHAPTER 7

7. PLAGARISM REPORT



ORIGINALITY REPORT

8%	3%	7%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

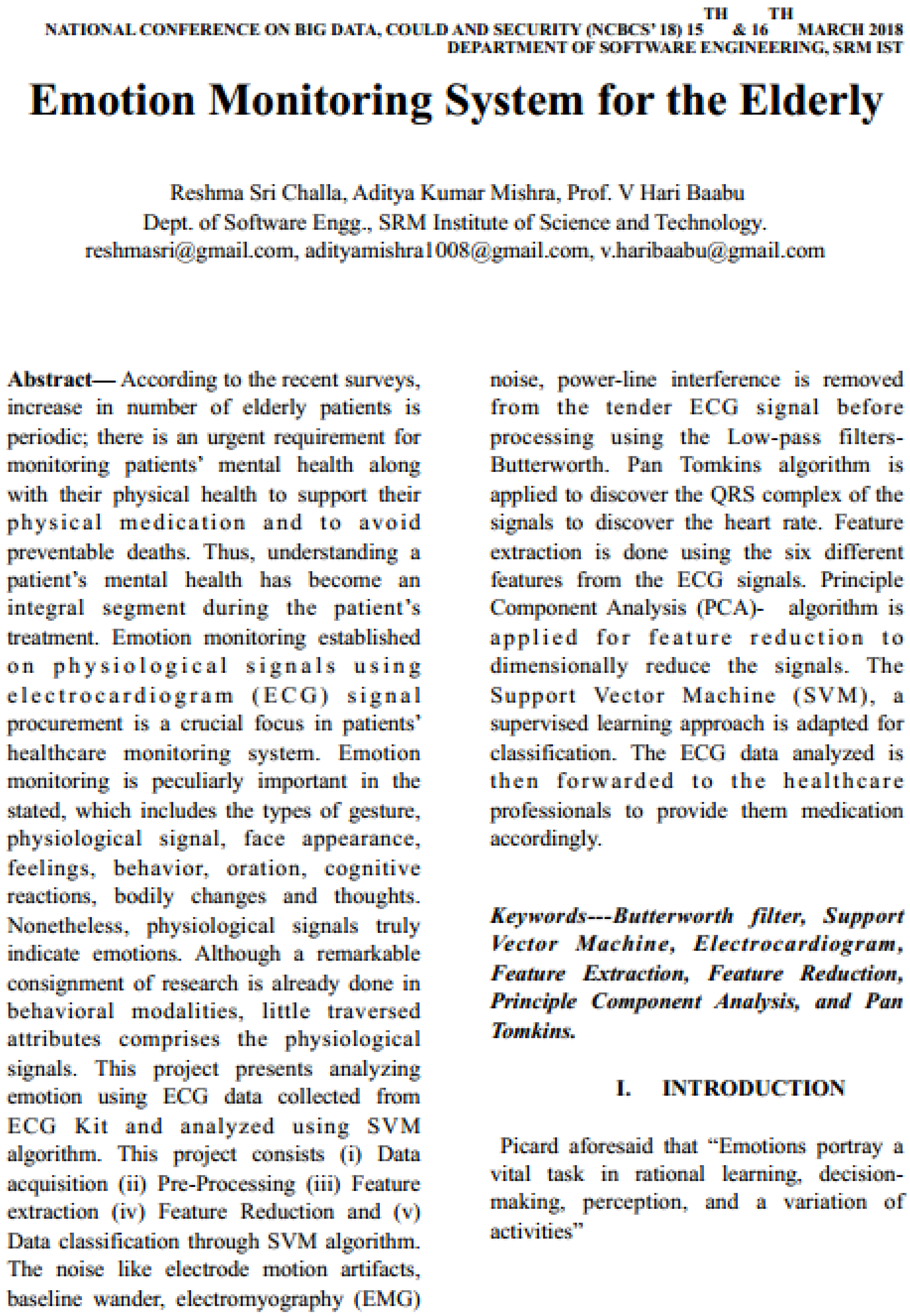
PRIMARY SOURCES

1	Jerritta, S, M Murugappan, R Nagarajan, and Khairunizam Wan. "Physiological signals based human emotion Recognition: a review", 2011 IEEE 7th International Colloquium on Signal Processing and its Applications, 2011. Publication	2%
2	Maaoui, Choubeila, and Alain Pruski. "Emotion Recognition through Physiological Signals for Human-Machine Communication", Cutting Edge Robotics 2010, 2010. Publication	1%
3	Ping Gong, Heather T. Ma, Yutong Wang. "Emotion recognition based on the multiple physiological signals", 2016 IEEE International Conference on Real-time Computing and Robotics (RCAR), 2016 Publication	1%
4	Submitted to Royal Holloway and Bedford New College Student Paper	1%

Figure 30: Plagiarism Report

CHAPTER 8

8.CONFERENCE CERTIFICATE /JOURNAL PAPER



NATIONAL CONFERENCE ON BIG DATA, COULD AND SECURITY (NCBCS' 18) 15TH & 16TH MARCH 2018
DEPARTMENT OF SOFTWARE ENGINEERING, SRM IST

Emotion Monitoring System for the Elderly

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Abstract— According to the recent surveys, increase in number of elderly patients is periodic; there is an urgent requirement for monitoring patients' mental health along with their physical health to support their physical medication and to avoid preventable deaths. Thus, understanding a patient's mental health has become an integral segment during the patient's treatment. Emotion monitoring established on physiological signals using electrocardiogram (ECG) signal procurement is a crucial focus in patients' healthcare monitoring system. Emotion monitoring is peculiarly important in the stated, which includes the types of gesture, physiological signal, face appearance, feelings, behavior, oration, cognitive reactions, bodily changes and thoughts. Nonetheless, physiological signals truly indicate emotions. Although a remarkable consignment of research is already done in behavioral modalities, little traversed attributes comprises the physiological signals. This project presents analyzing emotion using ECG data collected from ECG Kit and analyzed using SVM algorithm. This project consists (i) Data acquisition (ii) Pre-Processing (iii) Feature extraction (iv) Feature Reduction and (v) Data classification through SVM algorithm. The noise like electrode motion artifacts, baseline wander, electromyography (EMG) noise, power-line interference is removed from the tender ECG signal before processing using the Low-pass filters-Butterworth. Pan Tomkins algorithm is applied to discover the QRS complex of the signals to discover the heart rate. Feature extraction is done using the six different features from the ECG signals. Principle Component Analysis (PCA)- algorithm is applied for feature reduction to dimensionally reduce the signals. The Support Vector Machine (SVM), a supervised learning approach is adapted for classification. The ECG data analyzed is then forwarded to the healthcare professionals to provide them medication accordingly.

Keywords---Butterworth filter, Support Vector Machine, Electrocardiogram, Feature Extraction, Feature Reduction, Principle Component Analysis, and Pan Tomkins.

I. INTRODUCTION

Picard aforesaid that "Emotions portray a vital task in rational learning, decision-making, perception, and a variation of activities"

CHAPTER 9

9.REFERENCES

[1]. *“ECG Pattern Analysis for Emotion Detection “ by Foteini Agrafioti, Dimitrios Hatzinakos and Adam K. Anderson, Transactions on Affective Computing, March-2012.*

[2]. *“The Research on Emotion Recognition from ECG Signal” by , LIU Guangyuan'HAO CAI Jing Southwest University Chongqing, China, International Journal on Information Technology, 2009.*

[3]. “*Patient Health Monitoring System” by Arijit Ghosh, .et.al International Conference on Intelligent Control Power and Instrumentation, 2016*.

[4]. “*Health Monitoring and Management Using Internet-of-Things (IoT) Sensing with Cloud-based Processing: Opportunities and Challenges” by Moeen Hassanalieragh, .et.al IEEE International Conference on Service Computing, 2015.*

[5]. *“Emotion Recognition Using Physiological Signals from Multiple Subjects” by Lan Li1, Chen,JiangSu University, ZhenJiang, 212013, P. R. China.*

[6]. *“Physiological Signals Based Human Emotion Recognition:”Review by Khairunizam Wan, Jerritta, ,RNagarajan, M.Murugappan,, Universiti Malaysia Perlis Campus Ulu Pauh, 02600, Arau, Perlis, Malaysia.*

[7]. *“Emotion Recognition based on the multiple physiological signals”by Ping Gong, Heather T. Ma* and Yutong Wang.*

[8]. *W. R. Picard, "Affective computing: challenges," International Journal of Human-Computer Studies - vol. 59, pp. 55-64, 2003.*

[9]. *D. Lamb, A. Van Hecke , S. Porges ,E. Bal, E. Harden,J. Denver, and, "Emotion Recognition in Children with Autism Spectrum Disorders: Relations to Eye Gaze and Autonomic State," vol. 40, pp. 358-370,2009.*

[10]. *J. Kim and E. Andre ´, “Emotion Recognition Based on Physiological Changes in Music Listening,” vol. 30, no. 12, pp. 2067-2083, Dec. 2008*