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A Project Report on

TOUCHLESS HEARTBEAT DETECTION USING IMAGE PROCESSING

By

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C E R T I F I C A T E

This is to certify that *Ms. GARGEE SHAH Exam No B150574314*, *Ms. DIKSHITA JUNGADE Exam No B150574258*, *Ms. RAKHEE MAHAJAN Exam No B15057273*, *Ms. SHARVARI GADAM Exam No B150574234* have successfully completed the Project Stage-II entitled *Touchless Heartbeat Detection using Image Processing* under my supervision, in the partial fulfillment of Bachelor of Computer Engineering of Savitribai Phule Pune University.

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Abstract

Heart rate is the number of heartbeats per minute. In the current pandemic situation estimating or monitoring heart rate of a subject with the help of instruments can be risky as it involves physical contact and also one has to visit the clinic which might not be possible all the time. Research focused on non-contact based systems has increased over the past years. Existing systems include those which require contact, some having restrictions on skin tone, and others often involve high costs and complex application of sensors. This paper focuses on real time monitoring of Heart rate of multiple people simultaneously. It is obtained through a real time video using a webcam of laptop/computer. As blood circulation causes facial skin variation, therefore facial video is considered. Signal processing methods such as Fast Fourier Transform have been applied on the region extracted after applying colour magnification channels in video recordings. Application also sends a notification via a text message to the specified contact number if the Heart rate is below or above a given range. This algorithm is easy to implement, low cost and simple for real time application. Testing included trials to calculate heart rate of multiple people simultaneously. Once such a trial involved detection of faces of four people and their Heart rate calculation at the same time. Measured value of Heart rate in comparison with the ideal method was within justifiable range. Further, work can be done on environmental conditions which can be very useful in many real time applications.

Keywords: Heart Rate, Fast Fourier Transform, Colour magnification, Image processing, Guassian pyramid.

List of Abbreviations

FFT	**Fast Fourier Transform**
BVP	**Blood Volume Pulse**
HRM	**Heart Rate Monitoring**
ROI	**Region Of Interest**
ICA	**Independent Component Analysis**
BPM	**Beat Per Minutes**

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Chapter 1

INTRODUCTION

Measuring the HR of people has multiple applications in telemedicine, Internet-of-Things(IoT), sports, security, etc. However, sometimes it is difficult to use a classic method for measuring HR or the classical method does not scale. This project presents a solution that works on live video streams and can measure the HR of multiple people at the same time. This chapter discusses the overview, motivation, problem definition and objectives of the project, project scope and its limitations and methods used behind this project.

The heart rate of a person represents the number of heart beats per minute. It is an essential physiological parameter, a source of information related to the entire cardiovascular system. People who are less physically active are expected to have a higher heart rate, as their heart muscle has to work harder to maintain a constant cardiac rhythm. Also, there are situations in which continuous heart rate monitoring is required but skin contact is problematic, and the patient feels uncomfortable to be continuously connected to a pulse measuring apparatus. So there is a need to design a system which will continuously monitor the condition of patients heart rate. It is useful for patients/doctors safety and also reduces the spread of covid-19.

This system is composed of:

- **Monitoring Devices like web cam/Camera required at the monitoring environment.**
- **Web server/ Cloud platforms provide a multiple of services that can be integrated with web apps to rapidly develop features. These can be hosted on a cloud service and accessed virtual.**

1.1 Overview

As of late, human beings are struggling from coronary heart associated diseases. According to the World Health Organization over 17.9 million people die from Cardiovascular diseases. Of these deaths, 80 percent are due to coronary heart diseases, for example coronary heart attack. So, our system describes how to develop and design heart monitoring systems. Heart continuously pumps blood around the physique and for each heart beat, blood circulation takes place which results in a colour version in facial pores and skin that is no longer seen with the aid of the bare eye. Therefore, it is viable to extract heart from colour change of skin through live video. To plan such a system, Image processing which is an application of Artificial Intelligence that gives gadgets the capability to routinely exam-

ine and enhance from experience without being explicitly programmed is being used. This website will act as a medium for the subject which can be monitored virtually through an android app.

1.2 Motivation

The motivation behind selecting this project is as follows. In situations like Covid-19 ,it is very necessary to maintain social distancing and it has become very difficult with the old traditional methods to maintain distancing for doctors also to treat their patients. So we have decided to ease the process by using a touch less technique to detect heart rate of patients. Moreover, in this current scenario physical contact should be avoided in all possible ways.

1.3 Problem Defintion and Objectives

A problem definition and objectives can be termed as the building blocks of any project. This particular section will mention the project definition and the objectives required for this project.

1.3.1 Problem Definition

The problem definition of this project is as follows:

" To monitor and detect the Heart Rate using Image processing, and wireless networks in order to provide a real time system in the medical field ".

1.3.2 Objectives

The list of objectives to be completed for this project are as follows:

- To measure the rate of heartbeat of a person ,without any physical contact.
- To observe multiple persons heart rate at the same time.
- To provide alert message while emergency.
- To develop a flask based web application for GUI.

Activities per Objective

1. To measure the rate of heartbeat of a person ,without any physical contact.
   - The subject needs to be relaxed, steady and to be seated in front of the web cam.
   - The distance between the camera and the patient can vary between 1 and 3 meters.
   - The region of interest to be selected is forehead.
2. To observe multiple persons heart rate at the same time.
   - Collecting the data of patients from different rooms to the single destination.
   - Examine multiple patients from one location.
3. To provide alert message while emergency.
   - Trigger message when the heart rate are abnormal.
   - Set the threshold value or range to limit the abnormality.

- **Emergency action is to be taken quickly.**

4. **To develop a Flask based web application for GUI.**
   - **Flask is built in development server and debugger, integrated unit testing support, RESTful request dispatching, support for secure cookies (client side sessions),uses Jinja2 templating.**
   - **OpenCV is used as an image processing library in many computer vision real-time applications. There are thousands of functions available in OpenCV. These simple techniques are used to shape our images in our required format.**

1.4 Project Scope and Limitations

No matter what project methodology you choose, it will require you first and foremost to define the scope of the project. The scope states what the objectives of the project are and what goals must be met to achieve success.

Scope:

1. **Easy to operate like any other website and android app.**
2. **The purpose of web-platform or website being developed for live monitoring of patient.**
3. **Android app is developed for doctor/admin to observe patients.**
4. **It saves doctor time in going to the each patient and check them.**
5. **It provide user a single concise about the heart rate.**
6. **Doctor can monitor and observe individual patient easily by using android app without having to go through each patient .**
7. **Above all, the web-platform and Android app will provide a comfortable user experience.**
8. **It also provides Emergency Alert for patients such as abnormal change in heart rate**

There are some limitations to this project which can be worked upon in the future. Some of them are as follows:

- **The subject or patient must be seated in front of the camera.**
- **Local network is required i.e all the devices must be connected to a same network.**
- **Poor network connection may lead to inefficiency of the website.**

1.5 Methodologies of Problem solving

1. **Face Detection**

   The preliminary stage of the system is to detect the subject which needs to be steady in front of the web camera. The live video streaming must continuously progress so that face can be detected or it can also detect the absence of subject. The most important part is to detect the single subject through the camera so that we will be using a haar cascade classifier which is an effective object detection way and helps to locate the subject in the live video. Face detection is refined further by extracting the forehead area specially for better accuracy.

2. **Defining Parameter**

   The different parameters need to be set to increase the accuracy of the system. The required parameter are discussed below:

   - **Web Camera parameter: Different parameters are defined based on requirements like number of VideoframeRate, Video channel count and some video capturing parameter. This parameter changes according to the user.**

   - **Color Magnification Parameters: There are a number of frames captured which need to store for accurate magnification of exact colours. So for that buffer size and buffer index are needed to set it initially some threshold values like minimum and maximum frequency for defining the range for frequency rate.**

   - **Heart Rate Calculation Parameters: We need to set some limit for beats per sec to use a specific count of frame frequency to achieve the accuracy.**

3. **Image Pyramid**

   This stage is to extract the feature from the face color variant. These images can be studied deeper using the image pyramid. There are two types of image pyramid. They are (A) Gaussian Pyramids (B) Laplacian Pyramids. Here we used a gaussian pyramid which consists of multi scale copies of image and used as a low pass filter for image blurring. In the gaussian pyramid, the image resolution reduces level by level to discover the smallest magnifying image. It comprises down sampling of image, scale search and extract the major characteristics. The gaussian pyramid rectifies the color changes happening in images and enlarges it level by level. After extracting features the level again reconstructs into its original size and displays the continuous streaming.

4. **Heart Rate Estimation**

   The gaussian pyramid gives refined image in the smallest pixel and on that image the color magnification algorithm is utilized to locate the variant in color alternate in veins for precise body inside video for getting the change in parameter, the bandpass filter is used and grab that pulses the amplify it. For finding the frequency, Fourier transform is used and calculate the mean average of frequency and for best result we take 15 as a video frame rate. The resultant value of frequency we get is in hertz. As per the requirement to calculate heart beat per second we need some mathematical equation to convert hertz into beats per sec. After getting the frequencies we need to reconstruct the frames. The result based on the frame rate to be chosen for calculating the frequency. When the first 15 image frames are read, the actual time Heart rate extraction begins and after that each value is introduced to the firebase and the approach presents a new Heart Rate.

Till the point the overview of proposed system followed by motivation and problem definition along with objectives has been known. The studies carried out by various authors related to proposed system will be figured out in further chapter.

Chapter 2

LITERATURE SURVEY

The first chapter described the overall project. It gave the introduction of the domain that is machine learning and the issue that we are going to solve by developing this system. The problem statement described the project idea and objectives specified the step wise execution i.e. different modules of the project.

This chapter gives the literature survey of different research papers that we have referred. These papers describe the objectives and each paper presents a methodology to satisfy objectives. Also, it describes the advantages of that methodology. The literature review helps in understanding the problem statement and its objectives.

2.1 Literature Survey

Minal Patil et.al. [1] in 2019 proposed system will be connected to the wi-fi module which will send the information of rate of heartbeat continuously on the cloud server. So when a person is required to see his pulse rate history then it can be retrieved from the cloud serve along with his temperature. Along with heart rate monitoring it also notify the temperature of a person.

Face detection (FD) has been implemented using Haar cascades.It is based on machine learning and is trained on a set made of both positive images (photos of faces) and negative images (pictures which don't contain any face). This method was proposed by Carmen Nadrag et.al. [2] in 2018. Apart from Heart rate, several other physiological parameters related to health status can also be measured. But errors of 3 percent were detected, but it is hard to calculate the real error rate, as the monitors exhibit intrinsic errors.

Jifeng Huang et.al. [3] in 2018 proposed a system that uses LiPPG algorithm, which extracts the PPG signal with the heat rate robustly, uses color pattern to represent the PPG signal, enabling the extraction of the PPG signal under low illuminance and a multiscale variable-weight Savitzky-Golay combination (MVSGC) model, to extract the signal from noise or trend.

Joel Hernandez et.al. [4] in 2018 concluded a HR monitoring system that uses the angular rate data from a single axis of a MEMS gyroscope to detect heartbeats. With a mean absolute error (MAE) and standard deviation of the absolute error (SDAE) ,when our tests are compared with a reference ECG signal, we show that our system is accurate enough to

track HR changes. It is not considered as a reliable way due to its less accuracy in heart rate detection.

Johan Bathile et.al. [5] in 2018, proposed a method that was evaluated on a novel approach that extracts the PPG using face video from a self-collected dataset of 45 subjects. Dataset is divided into 9 parts(5 subjects per part) such that each part is used as the test data once when the remaining 8 parts are used as the training data. Apart from Heart rate, Blood pressure can also be estimated. This approach can be used for stress management and hypertension monitoring at home, office, school, college, meditation and medical centers in future.

Monika Jain et.al. [6] in 2017 proposed a light-based sensor can be used to detect variations in heart rate; this is done by using Photoplethysmography (PPG) sensor. The sensor consists of a LED with a photo detector and is able to detect the variations in blood volume or blood flow in the body and directly correlates to heart rate. The approach to build sensor proposed here is of very low cost and also detects heart arrhythmia.

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M. A. Hassan et.al. [8] in 2017 proposed a methodology which is Ballistocardiography used for video based heart rate detection. It measures heart beat rate by estimating the motion generated by pumping of blood, from the heart at each cardiac cycle.This methodology overcomes challenges of the realistic environment. However , distance of the subject from the camera(i.e 0.8m) appeared to be an issue. Therefore, the ability of the motion tracking algorithm to track the microscopic reduces because ROI size is reduced to certain pixels and due to which the accuracy of the heartbeat rate estimation was decreased.

Rahul Kumar Singh et.al. [9] in 2016 proposed a simple and reliable real time heart rate monitoring system for automatic drivers. The developed system employs the principle of non contact is easy on the Steering Wheel. This used a simple analog conditioning unit to give a real time HR monitoring .However, it was specifically designed for drivers and also the subject needs to hold the steering wheel through an insulator.

A brief explanation of the concepts that can be used for the implementation of the proposed system is given by Hamidur Rahman et. al. [10]. They have used MATLAB for designing a GUI to monitor Heart rate in real time. Also explained calculating Heart rate from a recorded video by extracting image frames. Different signal processing methods like Fast Fourier Transform (FFT), Independent Component Analysis (ICA) and Principal Component Analysis (PCA) have been applied in video recordings and the blood volume pulse (BVP) is extracted from the facial regions.

2.2 Summary

Table. 5.2 shows the summary of the Literature Review conducted with the help of various research papers.

Table 2.1: Literature Review

Ref. No.	HIGHLIGHTS	OBSERVATIONS
1	• Connects to the wi-fi module which will send the rate of heart-beat continuously on the cloud server. Pulse rate history can be retrieved along with his temperature. • It also informs the temperature of a person.	• Approach is based on physical contact with help of hardware devices.
2	• Face detection (FD) has been implemented using Haar cascades for heart rate monitoring. • Several other physiological parameters related to health status can also be measured.	• Errors of 3 percent were detected, hard to calculate the real error rate.
3	• Works well under the low or vary illuminate condition.	• Unable to give accurate results under dark environments.
4	• Implemented as an embedded system using low-cost micro controllers. • The use of a single axis of the gyroscope reduces the power consumption and increases battery life.	• Not considered as a reliable way due to its less accuracy in heart rate detection.

Ref. No.	HIGHLIGHTS	OBSERVATIONS
5	• Uses Photoplethysmography (PPG) sensor, which is able to detect the variations in blood volume or blood flow in the body and directly correlates to heart rate. • Sensors proposed here are of very low cost and also detects heart arrhythmia.	• Uses low cost hardware and MI band, which is worn at the wrist so it is based on physical contact.
6	• Extracts the PPG using face video from self-collected dataset of 45 subjects. • Heart Rate, Blood pressure can also be estimated. Used for stress management and hypertension.	• Challenging to extract PPG from the face video with a darker skin-tone. Approach is tested over a very small database that mostly had young and healthy volunteers.
7	• Fitness exercise video with optical flow algorithm and motion information frequency can be improved. • Used in applications for smart health and sports medicine.	• The face images were roughly aligned using the face tracker.
8	• Measures heartbeat rate by estimating the motion generated by pumping of blood, from the heart at each cardiac cycle. • Overcomes challenges of the realistic environment.	• Distance of the subject from the camera (i.e. 0.8 m) appeared to be an issue. Therefore, the ability of motion tracking algorithms reduces. Accuracy of the heartbeat rate estimation was decreased .

Ref. No.	HIGHLIGHTS	OBSERVATIONS
9	• Designed for drivers where decrease in heart rate can be easily used to detect driver fatigue and also alert the driver. • The system can also be designed to send the data to a central server.	• Specifically designed for drivers and also the subject needs to hold the steering wheel through an insulator.
10	• Extraction of Heart rate using three signal processing methods ICA, PCA, FFT methods and display continuous Stress assessment.	• Subjects need to be in ambient light for better visibility of video. First approx. for 5 min video is recorded through a webcam and then in an offline mode heart rate is estimated. Values extracted are stored in the excel file.

This section discusses about the literature review and the next section will be discussed on Software Requirements Specifications. From the surveys, it is clear that the project is quite feasible and quite a lot of work has been done in the field related to this project. Also, there are some attributes such as accuracy, scalability, performance, etc. which can be further improved with the use of current technologies. More about the current technologies and the implementation of the project will be discussed in the further chapter.

Chapter 3

SOFTWARE REQUIREMENTS SPECIFICATION

The second chapter gave literature review of all the reference papers referred for the project. Section 2.1 described the literature survey of all the 10 papers referred. Section 2.2 contained the summary table for all the referred papers highlighting it's advantages and issues if any. The literature review helped in understanding the problem statement and its objectives.

This chapter details about the software requirements. It details about all the functional, non-functional requirements, external interface requirement, system requirements, agile analysis model and system implementation plan.

3.1 Assumptions and Dependencies

Assumptions are the presumptions made regarding the project while implementing it. Dependencies are the necessary elements needed for the project to work. This section will mention the Assumptions and Dependencies required for this project.

The assumptions in this project are as follows.
Assumptions -

- **User has basic knowledge of Heart Rate, about its usage and can use the application.**
- **Internet is working properly.**
- **User follows proper posture required for face detection.**
- **Updates regarding heart rate of a user will be provided to administrator or doctor.**

The dependencies in this project are as follows.
Dependencies –

- **A stable internet connection.**
- **A web browser.**
- **High camera resolution.**

3.2 Functional Requirements

This section describes all the functionalities of the system.

3.2.1 System Feature 1: Login for web app

Admin logins to the system by entering valid user id and password.

3.2.2 System Feature 2: User input screen

After login in, rectangle box will be shown on the screen for face detection.

3.2.3 System Feature 3: Shows Heartrate

Heartrate of respective person is displayed when they seat in front of webcam.

3.2.4 System Feature 4: Login for Android

Admin/User logins to the android app by entering valid user id and password.

3.2.5 System Feature 5: Tracking Each patient

After login to android app, each person's heartrate will be shown and if needed live monitoring can also be done.

3.2.6 System Feature 6: Monitoring individual

Through web app each user can be monitored locally.

3.2.7 System Feature 7: Emergency alert

When there is abnormality in the reading of heartrate i.e. below 60 or beyond 110, then text message will be delivered to the given number.

3.3 External Interface Requirements

This section gives the external interfaces such as user interfaces, hardware and software interfaces and communication interfaces.

3.3.1 User Interfaces

Flask based graphical user interface.

3.3.2 Hardware Interfaces

PC/Laptop/Smartphone.

3.3.3 Software Interfaces

Any OS with supported browsers.

3.3.4 Communication Interfaces

This project supports all types of web browsers.

3.4 Nonfunctional Requirements

It specifies all the non-functional requirements such as performance, safety, security requirements and software quality attributes.

3.4.1 Performance Requirements

These requirements give the performance aspects required from the project. This is part of the general capacity planning process. The performance requirements are as follows.

- **The website will be user friendly.**
- **It will be available 24/7.**
- **Image Quality in real time environment is clear (Noise free).**
- **Unstable or flickering while capturing the image must be avoided.**

3.4.2 Safety Requirements

Safety requirements specify the needs that can help a system to keep intact after any problem takes place. The requirements are as follows.

- **A backup of the database will be available on Firebase.**
- **Database access is restricted to Admin only through an API.**

3.4.3 Security Requirements

Security requirements are needed to prevent any malicious attack that can take place on the project. These requirements are as follows.

- **The information will be secured from ethical hackers.**
- **Only admin panel will used the verified credentials for login .**

3.4.4 Software Quality Attributes

- **Correctness: Website should display correct results i.e. heartrate.**
- **Availability: Website should be available 24x7. If the internet service gets disrupted while sending information to the server, the information can be sent again for veri cation.**
- **Reliable: Website should get updated dynamically.**
- **Usability: System is easy to handle and navigates in the most expected way with minimum delay. In that case the system program reacts accordingly and transverses quickly between its states.**

3.5 System Requirements

It includes all the system requirements such as database, software and hardware requirements.

3.5.1 Database Requirements

- **Firebase (Cloud storage)**

3.5.2 Software Requirements

- **Web Browser - A web browser is the most essential when we need to access a website.**
- **Operating System - The primary need for any project is the compatible operating system which we use in our project is Ubuntu or Windows 10.**
- **Languages - Python 3.6.0, HTML.**
- **Firebase - The benefit of Firebase Hosting allows you to set-up a single-page, a mobile landing page, web page or progressive web page with ease. It also helps to deliver the content rapidly anywhere. The developers can deploy the web apps as well as static content at CDN (Content Delivery Network).**
- **Twilio - Twilio allows software developers to programmatically make and receive phone calls, send and receive text messages, and perform other communication functions using its web service APIs.**
- **Framework - Flask is a small and lightweight Python web framework that provides useful tools.**
- **Visual studio - IDE to write code.**
- **Excel - to store the data from firebase for analysis.**
- **Open CV - Open CV used for image processing.**

3.5.3 Hardware Requirements

- **CPU - Intel core i3/i5/i7**
- **RAM - 8GB (2GB minimum)**
- **720p HD webcam**

3.6 Analysis Models: SDLC Model to be applied

Agile SDLC model is a combination of iterative and incremental process models with focus on process adaptability and customer satisfaction by rapid delivery of working software product. Agile method break the product into small incremental builds. These builds are provided in iterations. Each iteration is reviewed and assessed by the development team and client. Every iteration involves cross functional teams working simultaneously on various areas as shown in 3.1
This model emphasizes on interaction, as the customers, developers and testers work together throughout the project. By breaking the product into cycles, the agile model quickly delivers a working product and is considered a very realistic development approach. The agile method anticipates change and allows for much more flexibility than traditional methods. Clients can make small objective changes without huge amendments to the budget or schedule. The model produces ongoing releases, each with small, incremental changes from the previous release.

Considering all these benefits, agile software development model is being followed in the implementation of this system.

- **Phase 1: Requirements gathering**
  During this phase, all the relevant information is collected to develop a system as expected. All the ambiguities related to expected features are resolved in this phase only.
- **Phase 2: Planning and design**
  In this phase, the requirements gathered in the SRS document is used as an input and software architecture that is to be used is finalized.
- **Phase 3: Development**
  The planned software design is translated into source code. All the components of the software are implemented.
- **Phase 4: Testing**
  Testing starts once the coding is complete and the modules are released for testing. In this phase the developed software is tested thoroughly and any defects found are assigned to developers to fix them.
- **Phase 5: Evaluation**
  All the modules generated are deployed and evaluated by the end user.

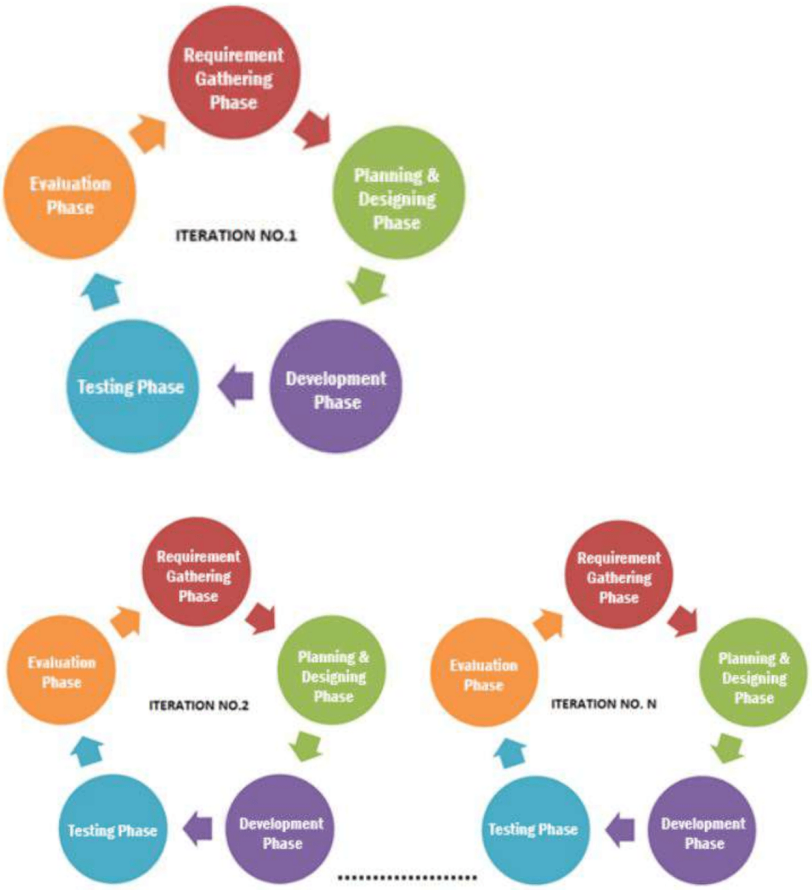

Figure 3.1: Agile Model

The above mentioned parameters sum up the SRS document and are elaborated in an appropriate manner. A brief explanation about the SDLC is also mentioned. The above mentioned parameters sum up the SRS document and are elaborated in an appropriate manner. A brief explanation about the SDLC is also mentioned.

Chapter 4

SYSTEM DESIGN

The third chapter detailed about the Software Requirements Specification (SRS) document. It detailed about all the functional, non-functional requirements, external interface requirement, system requirements of the system and also the agile development model.

This chapter gives all the system designs such as system architecture and all the UML diagrams e.g. use-case diagram, class diagram, activity diagram, sequence diagram, etc.

4.1 System Architecture

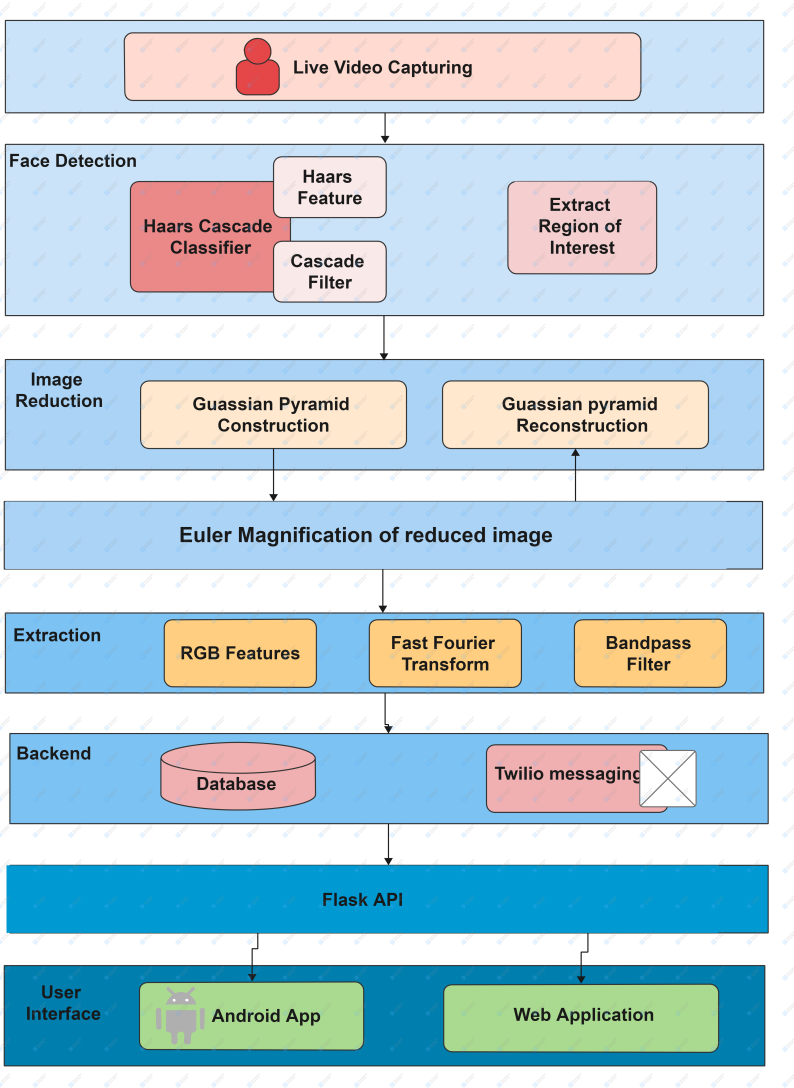

Figure 4.1: System Architecture

A system architecture or systems architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system.

The architecture of the system is divided into 4 layers Face detection, Image reduction, Extraction, Backend as shown in 4.1. The face detection layer describes the Haar Cascade classifier used to detect any object here its is face. Haar Cascade classifier consists of Haar feature and Cascade filter. After detecting face it will extract the region of interest i.e. forehead by using this classifier only. The Image Reduction layer uses Gaussian pyramid for different resolution of image frames. Gaussian pyramid is a two step process -

1. **Downward pyramid: Also known as Gaussian pyramid construction which takes input as frames(i.e. images of face) and breaks down level by level as we want to check**

heartrate or colour variation on different levels. As colour variation is not feasible at normal scaling thus we need to consider different levels.

2. **Upward pyramid: Also known as Gaussian pyramid reconstruction which is reverse of downward pyramid. To maintain the originality of image it is necessary to reconstruct the image level by level.**

Next is to extract RGB features from the ROI, and by applying Euler colour magnification algorithm on it heart rate is calculated. Bandpass filter will pass the particular frequency only i.e. heart rate whose frequency range is 1Hz - 2Hz and Fast Fourier Transform is used to transform an image between the frequency domain. Database connectivity will be provided for storing each patient's hear rate. The backend data will be stored in multiple NoSQL databases. and when heart beat is beyond or above the threshold value text message will be send to admin's side through Twilio messaging tool.

4.2 UML Diagrams

UML defines various kinds of diagrams to cover most of the aspects of a system. Various UML diagrams related to the project are as follows:

1. **Use-Case Diagram**
2. **Class Diagram**
3. **Activity Diagram**
4. **Sequence Diagram**

4.2.1 Use Case Diagram

A use case diagram is simple 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.

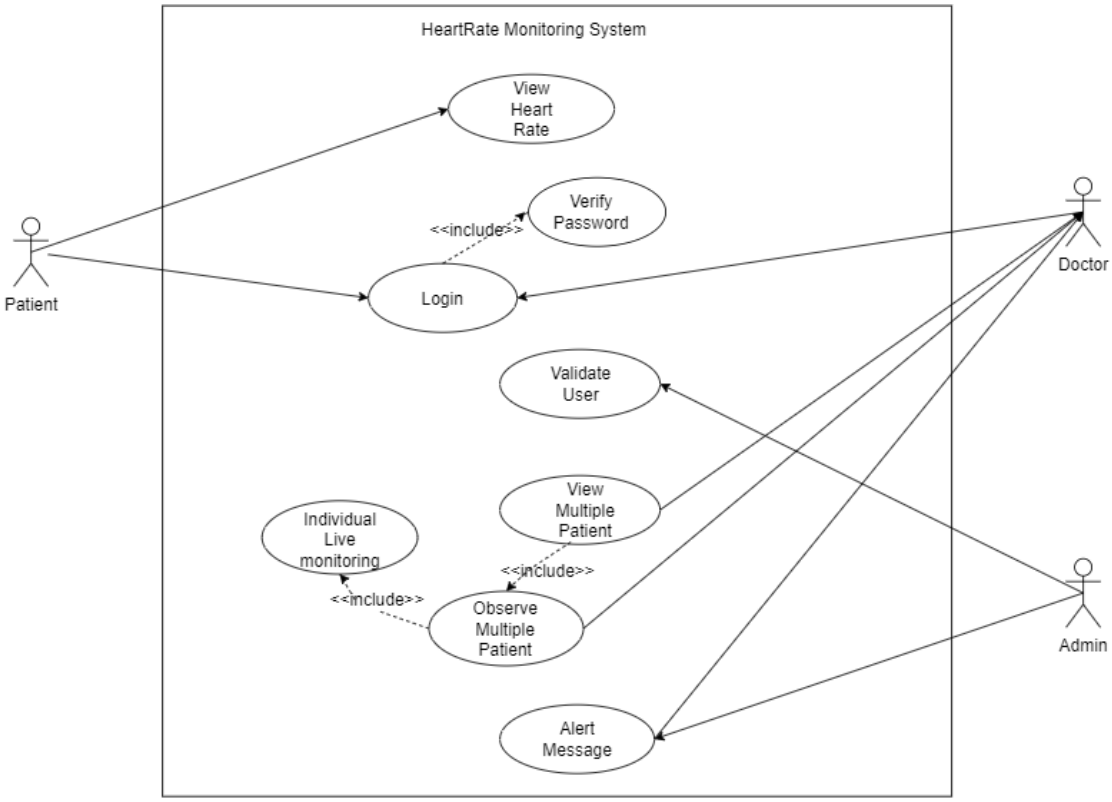

Figure 4.2: Use Case Diagram

Figure 4.2 depicts the use case diagram which is a way to summarize details of a system and the users within that system. A methodology used in system analysis to identify, clarify, and organize system requirements, usually referred to as behavior diagrams used to describe a set of actions (use cases) that some system or systems should or can perform in collaboration with one or more external users of the system (actors). Here, the actors are Admin, Data users. The user can perform functions like turn on or launch the camera, etc. Admin can log in to page, observe the data of users. The use case diagram of web application is as shown in Figure 4.2. There will be two primary actors i.e. Patient/User and Doctor and one secondary actor i.e. Admin using the website. The use case like login

will be shared to doctor only. Additionally, the user will be able to place their face in front of camera and determine heart rate. The doctor in addition, will be able to monitor the patient. The admin on the other hand will use the login details of the doctor to verify them.

4.2.2 Class Diagram

A class diagram in the Unified Modeling Language is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations, and the relationships among objects.

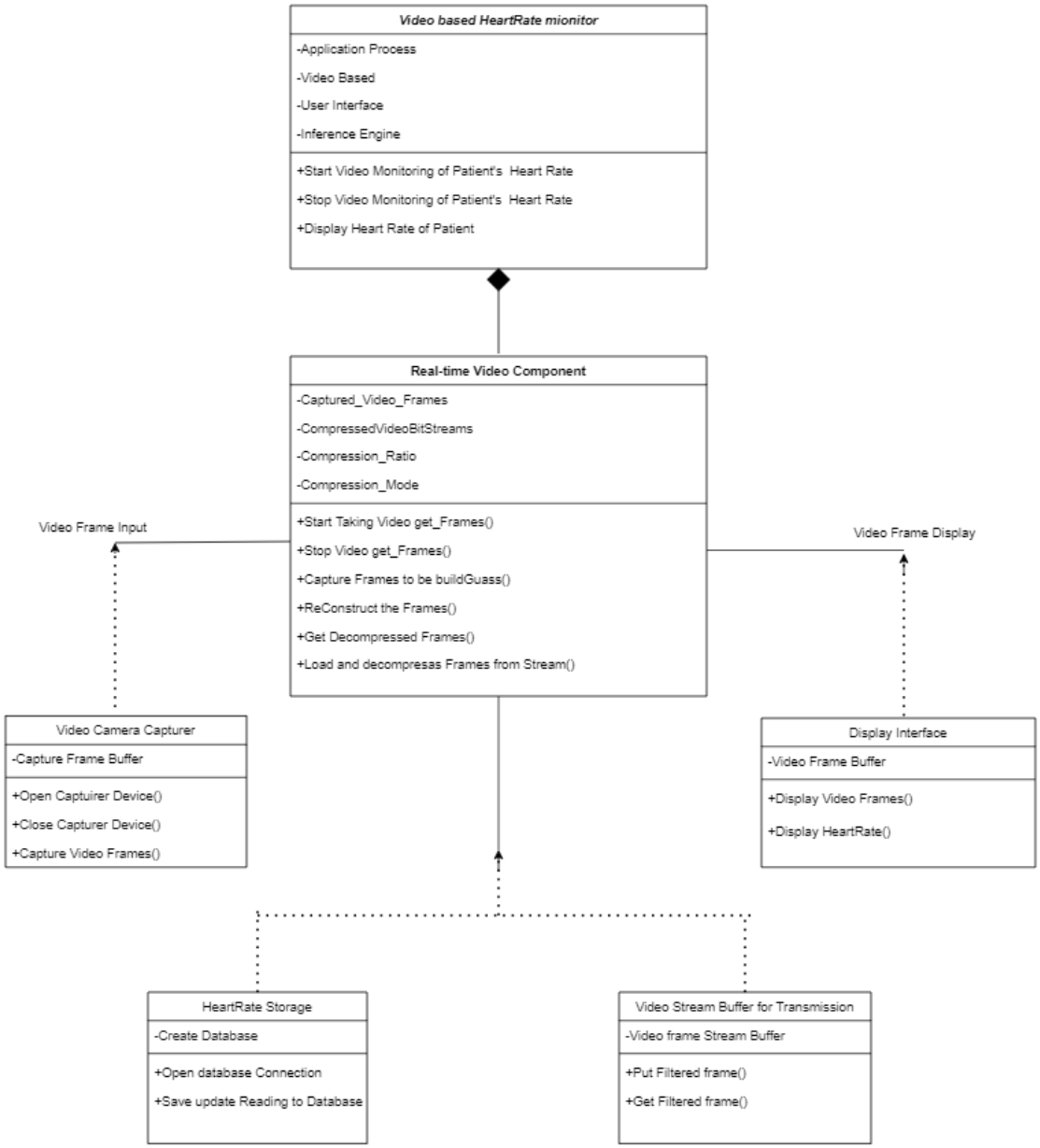

Figure 4.3: Class Diagram

The different classes are used to represent the different component of the system as shown in Fig. 4.3 contain different classes like Real time Video component, Video Camera Capture,Display inter fence,HeartRate storage and Video Stream Buffer for Transmission. This classes are generalize with Video based Heart Rate Monitor. Generalization is a directed relationship between a general and a special class. That means Video based Heart Rate Monitor has all the properties of general classes. These are implicit properties because they are not expressly declared,the video based heart rate class is inherit by all the general classes Each class consist of attributes and each attribute are class properties.

4.2.3 Activity Diagram

An Activity diagram describes the dynamic aspects of the system. Activity diagram is basically a flowchart to represent the ow 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.

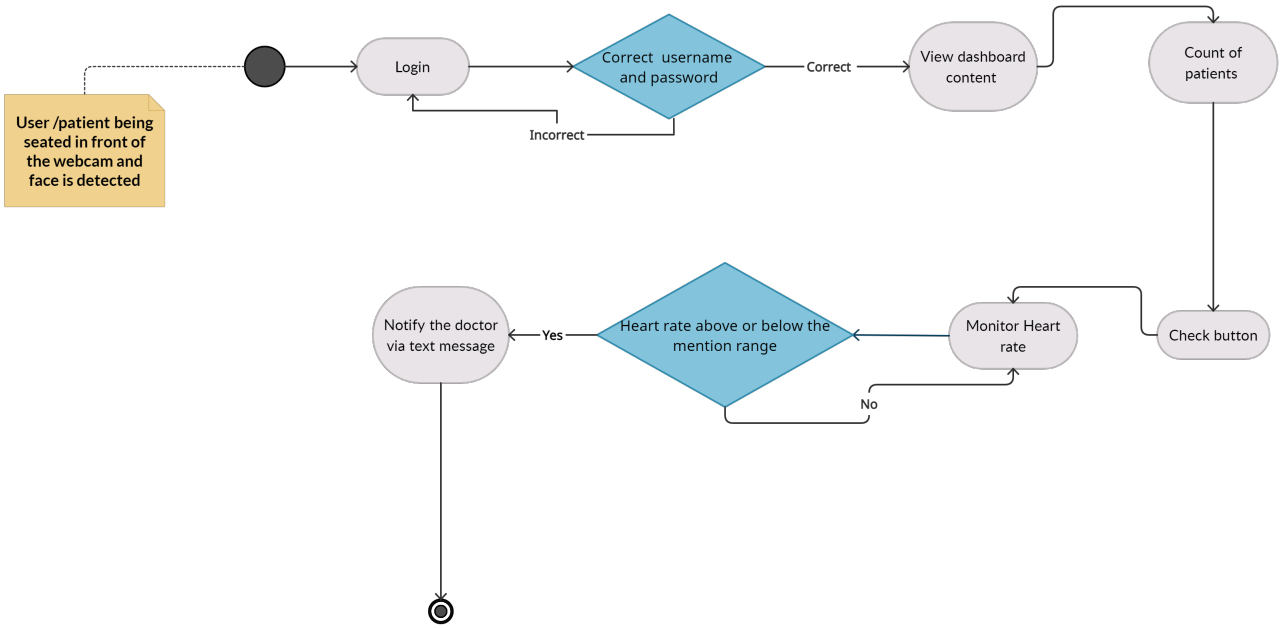

Figure 4.4: Activity Diagram

An activity diagram is a behavioral diagram i.e. it depicts the behavior of a system. An activity diagram portrays the control flow from a start point to a finish point showing the various decision paths that exist while the activity is being executed. As shown in Figure 4.4 user/patient have to seat in front of webcam for the face detection through which heart rate i.e. beats per minute is calculated will be the first activity after which doctor/admin will login. They will now able to monitor hear rate of a particular user/patient, details displayed on the dashboard. If BPM goes below or above specified range, the system will then send the alert message to the mentioned number.

4.2.4 Sequence Diagram

A sequence diagram simply depicts interaction between objects in a sequential order i.e. the order in which these interactions take place. We can also use the terms event diagrams or event scenarios to refer to a sequence diagram. Sequence diagrams describe how and in what order the objects in a system function.

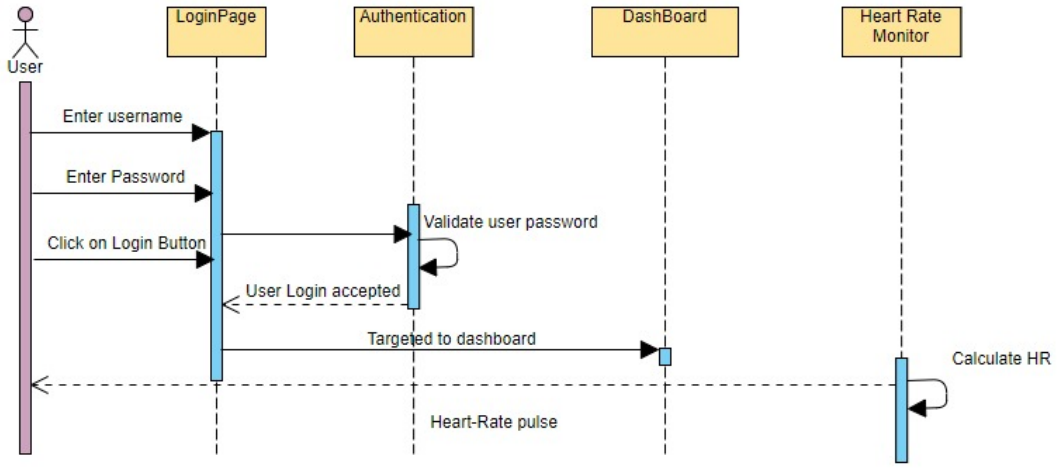

Figure 4.5: Sequence Diagram

The sequence diagram shown in 4.5, shows object interactions arranged in time sequence. It depicts the objects involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. As the user login then credentials are authenticated and after that the doctor can access the dashboard and monitor the heart rate.

This concludes the visual representation on the system. Various UML diagrams were used to describe the structure of the project. It is now almost fully possible to go for implementation of the system. In further chapter, the plan of implementing the proposed system along with its cost estimation will be reviewed.

Chapter 5

PROJECT PLAN

The fourth chapter described about the system designs using which the proposed system will be implemented. The designs like system architecture and various UML diagrams were illustrated.

Here in this chapter, the overall project plan along with its cost estimation, risk management, schedule, team structure is discussed. A project plan is a formal document designed to guide the control and execution of a project. It is the key to a successful project and is the most important document that needs to be created when starting any business project.

5.1 Project Estimate

Within project management, an estimate is simply an approximate calculation of the effort and cost it might take to complete a project.

5.1.1 Reconciled Estimates

COCOMO (Constructive Cost Model) is used for calculating the project estimates. It is a procedural cost estimate model for software projects and often used as a process of reliably predicting the various parameters associated with making a project such as size, effort, cost, time and quality.

Different models of COCOMO have been proposed to predict the cost estimation at different levels, based on the amount of accuracy and correctness required.

1. **Organic - A software project is said to be an organic type if the team size required is adequately small, the problem is well understood and has been solved in the past and also the team members have a nominal experience regarding the problem.**
2. **Semi-detached - A software project is said to be a Semi-detached type if the vital characteristics such as team-size, experience, knowledge of the various programming environment lie in between that of organic and Embedded.**
3. **Embedded - A software project with requiring the highest level of complexity, creativity, and experience requirement fall under this category.**

Table 5.1: Cost Estimation

Software Project	**A(b)**	**B(b)**	**C(b)**	**D(b)**
Organic	2.4	1.05	2.5	0.38
Semi-detached	3.0	1.22	2.5	0.35
Embedded	3.6	1.20	2.5	0.32

The effort is measured in Person-Months and as evident from the formula is dependent on Kilo-Lines of code. These formulas are used as such in the Basic Model calculations, as not much consideration of different factors such as reliability, expertise is taken into account, henceforth the estimate is rough.

$$Effort(E) = A(b)KLOC^{B(b)} \tag{5.1}$$

As our project comes under Semi Detached system therefore, a= 3.0 and b= 1.12 and KLOC = 12.8 (12800 lines of code approx)

$$Effort = 3.0 * (12.8)^{1.12} = 44.20PM \tag{5.2}$$

$$DevelopmentTime(D) = C(b)E^{d(b)} \tag{5.3}$$

As our project comes under Semi Detached therefore, c=2.5 and d=0.35

$$DevelopmentTime = 2.5 * (44.20)^{0.35} = 9.4months \tag{5.4}$$

Average Team Size = Effort/Development Time = 44.20/9.4 = 4 persons
Productivity = KLOC/Efforts = 12.8/44.20 = 0.28 KLOC/PM

5.1.2 Project Resources

The project resources are the people, capital, and/or materials, goods required for successful execution and completion of project. The project was implemented by a team of 4 members using the database, hardware and the software resources stated in section 3.5.

5.2 Risk Management

Risk is inevitable in a business organization when undertaking projects. However, the project manager needs to ensure that risks are kept to a minimal. Managers face many difficulties when it comes to identifying and naming the risks that occur when undertaking projects. These risks could be resolved through structured or unstructured brainstorming or strategies. It's important to understand that risks pertaining to the project can only be handled by the project manager and other stakeholders of the project. Risk management is the identification, evaluation, and prioritization of risks followed by coordinated and economical application of resources to minimize, monitor, and control the probability or impact of unfortunate events or to maximize the realization of opportunities.

5.2.1 Risk Identification

Risks, such as operational or business risks will be handled by the relevant teams. The risks that often impact a project are supplier risk, resource risk and budget risk. Supplier risk would refer to risks that can occur in case the supplier is not meeting the timeline to supply the resources required. Resource risk occurs when the human resource used in the project is not enough or not skilled enough. Budget risk would refer to risks that can occur if the costs are more than what was budgeted.

Risk Identification is an ongoing and continues activity that takes place during the Risk Management Process and throughout the life-cycle of a project. Each step in the Risk Management Process should include some level of risk identification. The risk sources are elaborated in table 5.2.

Table 5.2: Risk Identification

Risk Source	**Risk description**
Database inconsistency	The application stores each patient heartrate in a database which is then used by the android app, so any inconsistency in the database or incorrect reading of heart rate can lead to user disinterest and also system failure.
Internet Connectivity	To store entries in database and also the system is a web based application, an active internet connection is required. Failure in connectivity causes system failure.
Distance between camera and person	The position and distance between the camera and person should be maintained. Failure will affect the video streaming.
Handling multiple users at a time	The web application may get a crash or failure due to increased load of more no. of users using the system simultaneously.
Camera Quality	The quality of the camera should be good so that while capturing video, the face can be detected well.

5.2.2 Risk Analysis

Risk analysis involves examining how project outcomes and objectives might change due to the impact of the risk event. Once the risks are identified, they are analyzed to identify the qualitative and quantitative impact of the risk on the project so that appropriate steps can be taken to mitigate them. The following guidelines are used to analyze risks:
Risk Impact
High - Catastrophic
Medium - Critical
Low - Marginal
The analysis of risks identified in section 5.2.1 is explained in table 5.3.

Table 5.3: Risk Analysis

Risk Source	**Impact Level**	**Analysis**
Database inconsistency	High	In the event where the database entries are invalid with respect to the database schema, there can be inconsistencies in databases which can lead to major issues such as wrong heartrate which can lead to mislead of the situation.
Internet connectivity	High	If there is a loss in internet connectivity while communicating with the back end servers, the web app cannot function or display real time data. Every module in the application requires active communication with the database hosted on the cloud servers, and failure may result in application crashes.
Handling multiple users at a time	High	If there is increased load on the system due to lot of users using the system simultaneously which results in making multiple concurrent requests to the backend servers, the web application may get a crash or behave abnormally.
Camera Quality	High	There will be errors if the quality of the camera does not fulfill the requirement of the system which may result in wrong calculations of heart rate.
Distance between camera and person	Medium	If the distance between person and camera is greater then video quality will decrease and heart rate can't detect properly.

5.2.3 Overview of Risk Mitigation, Monitoring, Management

Risk management is the identification, evaluation, and prioritization of risks followed by coordinated and economical application of resources to minimize, monitor, and control the probability or impact of unfortunate events or to maximize the realization of opportunities. The mitigation strategies are explained in the table 5.4.

Table 5.4: Risk Mitigation

Risk Source	**Mitigation strategy**
Database inconsistency	Mandatory regular updation of database entries as and when required.
Internet connectivity	Secured constant connectivity should be there for seamless performance of the web application.
Handling multiple users at a time	Using APIs to handle the user requests and having a small delay between them in case of large number of concurrent requests to the backend servers.
Camera Quality	Proper quality of camera should be there for good video performance.Camera quality quality should be between 1mb-2mb.
Distance between camera and person	The suggested distance between the person and camera is 1m to 3m , so the video will be proper and continually streamed in order to detect heart rate.

5.3 Project Schedule

In project management, a schedule is a listing of a project's milestones, activities, and deliverables, usually with intended start and finish dates. Those items are often estimated by other information included in the project schedule of resource allocation, budget, task duration, and linkages of dependencies and scheduled events. A schedule is commonly used in the project planning and project portfolio management parts of project management.

5.3.1 Project Task Set

Table 5.5: Project Task Set

Task no.	Task Name	Task Description	Deadline
1	Overall System Design	Brainstorming the features of the system, their environment, development process and platforms, and identifying and mitigating inconsistencies	Week 2
2	Implementation of Face Detection and Magnification	Processing of face Detection with Haar Cascade and Color Magnification to get grey/white images.	Week 4
3	Filter Image and Algorithm	Filtering image with gaussian pyramids and reconstruction of Images to get fine resolution of images.	Week 7
4	Frontend Development UI	Development of Front end part of Web Application	Week 10
5	Search and Filter Development	Filtering of frequencies and storing frequency which is in mentioned range	Week 11
6	Android App Development	Implementation of Buttons and UI elements for the Mobile Application.	Week 15
7	Connectivity with Firebase and Alert messaging	Storing data in firebase i.e. establishing database connectivity and sending a text message in case of any abnormality in reading of heart rate	Week 13
8	System Integration	Integrating all the components of the systems	Week 17
9	System Testing	Testing integrated system components	Week 19

5.3.2 Task Network

A Task Network is a diagram of project activities that shows the sequential relationships of activities using arrows and nodes. The below figure 5.1 illustrates the task network.

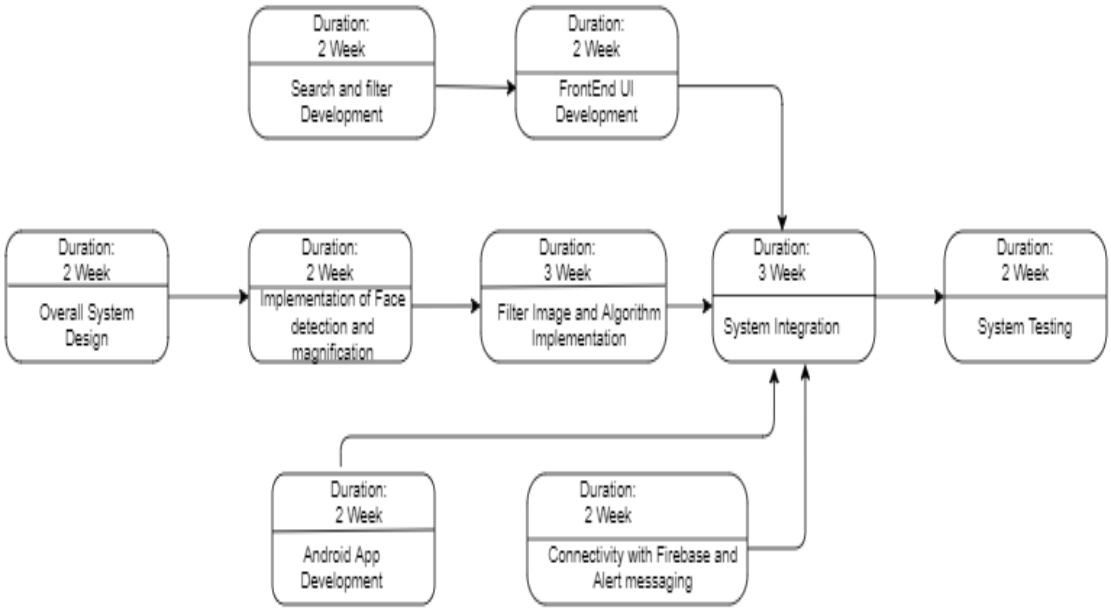

Figure 5.1: Task network

5.3.3 Timeline Chart

The timeline chart illustrates the implementation plan of the proposed system. The Fig. 5.2 illustrates the timeline chart.

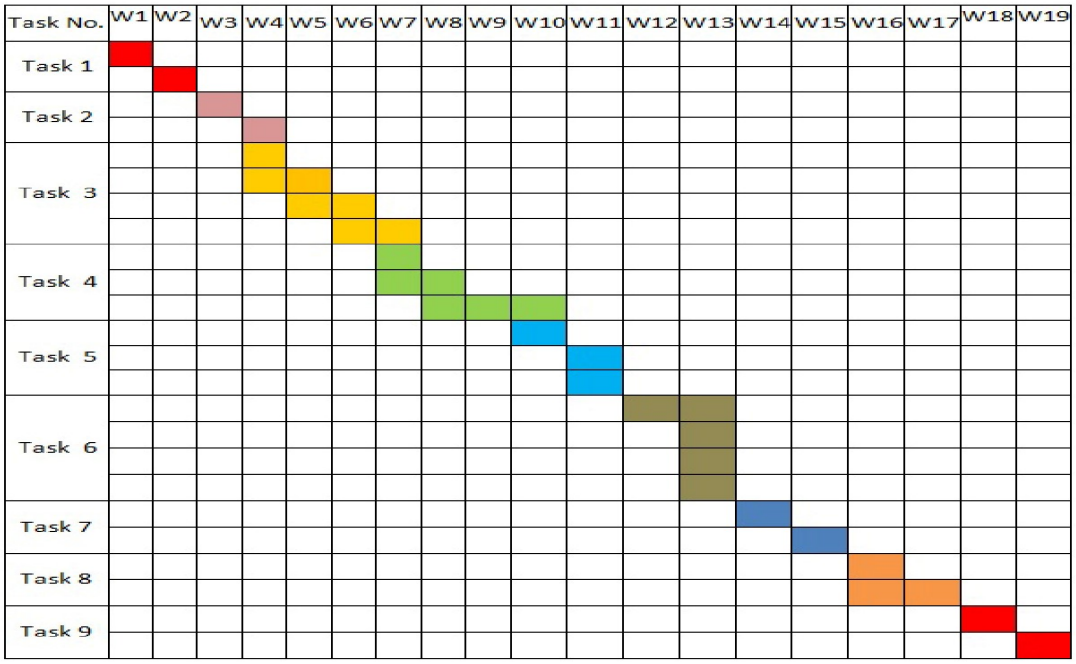

Figure 5.2: Timeline Chart

5.4 Team Organization

A Project Team is an organized group of individuals engaged in carrying out the project's shared activities and goals to accomplish the project and produce its outcomes. The project team consists of final year computer engineering students. The team is passionate about using technology to solve problems and innovate new systems.

5.4.1 Team Structure

The project is accomplished by a group of four members viz. Gargee Shah, Dikshita Jungade, Sharvari Gadam and Rakhee Mahajan under the guidance of internal guide, Prof. B. D. Shendkar. Each working member is aware of the entire working of the project. It has been decided that the entire team will be highly flexible throughout the project. The project was divided into various modules and the modules were equally divided and completed by the group members. It would be impossible to achieve all the results without teamwork. It was easy to complete all the modules and documentation with the help of each member contributing to it equally and abiding by the comments and suggestions given by the internal guide.

5.4.2 Management, Reporting and Communication

All the group members have to report and submit the assigned tasks to the project guide and project coordinator. A project diary is maintained where all the date wise implemen-

tation details are mentioned and is regularly checked by our internal guide.

To conclude, the project plan explains all the phases involved in the development of the project. It explains the team structure and the distribution of roles among the team members. It also involves identification and prioritizing the risks.

Chapter 6

PROJECT IMPLEMENTATION

The fifth chapter described about the overall project plan along with its cost estimation, risk management, schedule, team structure, etc. It included identification and prioritizing the risks. The project plan explained all the phases involved in the development of the project.

Here in this chapter, the project implementation details such as various project modules, different technologies and tools used to implement system functionalities are discussed. Also the algorithms of various system modules are stated.

6.1 Overview of Project Modules

The proposed system presents the heart rate monitoring system without any physical contact. The system detects the face of the subject via the digicam and performs image processing based totally on frames and calculates the coronary heart rate. The aim behind this system is to avoid physical contact and grant an emergency remedy to the situation to limit the hazard and additionally alert will set off via textual content message to admin. The proposed system consists of different modules : (A) Face Detection, (B) Defining Parameter, (C) Image pyramid, and (D) Heart Rate Estimation.

6.2 Tools and Technologies Used

The following table 6.1 shows all the tools and technologies used to develop different modules of the 'Touchless Heartrate detection using Image Processing' along with their purpose.

Table 6.1: Tools and technology

Tool/Technology used	**Purpose**
Visual Studio Code	Source code editor used to write and edit the code for UI.
PyCharm IDE	Python IDE used to perform all the python implementations.
FireBase	Data Storage
Twilio	To pro grammatically send and receive text messages,and perform other communication functions using its web service APIs.
Flask framework	Building web APIs to manage database interactions.
Excel	To store the data from rebase for analysis.
OpenCV	OpenCV used for image processing.
Camera/Web Camera(720p HD min)	To Detect the face

6.3 Algorithm Details

The algorithms used in the project are mentioned in this section.

6.3.1 Algorithm 1

Algorithm Face Detection

1. **Start**
2. **Selecting Haar-like features which is Horizontal,vertical,Diagonal**
3. **Creating an integral image to the sum of pixel values in an image or rectangular part of an image.**
4. **Running AdaBoost training**
5. **Creating classifier cascades**
6. **Classifies the face and shows the Green box.**
7. **End.**

6.3.2 Algorithm 2

Algorithm Gaussian Pyramid

1. **Start.**
2. **Start with the original image.**
3. **Iteratively compute the image at each level of the pyramid, first by smoothing the image (with the Gaussian filter) and then down-sampling it.**
4. **Stop at a level where the image size becomes sufficiently small (for example, 1 X 1).**
5. **The function to implement the previous algorithm is left as an exercise for the reader**
6. **Stop.**

6.3.3 Algorithm 3

Algorithm Colour Magnification

1. **Start.**
2. **Take a standard frame as input and apply spatial decomposition.**
3. **Apply temporal Filtering to the frames.**
4. **The resulting signal is then amplified.**
5. **Reveal hidden colour changes in veins by visualizing the flow of blood.**
6. **Temporal Frequencies are selected to calculate heart rate.**
7. **End.**

6.3.4 Algorithm 4

Algorithm Heartrate Estimation

1. **Start.**
2. **Result provided by colour magnification is passed to the Mathematical Module.**
3. **Fast Fourier Transform gives the frequency of heartRate.**
4. **Then the frequency is convert into beats per sec**
5. **Estimate the Heart rate and go on updating.**
6. **End.**

This chapter covers the various implementation tools and technologies used for the proposed system in brief. It also describes various modules created for the system and the algorithms developed to implement the same respectively.

Chapter 7

SOFTWARE TESTING

The sixth chapter described about the project implementation details such as various project modules, different technologies and tools used to implement system functionalities. Also the algorithms of various system modules are stated.

Here this chapter illustrates software testing performed on the system. It includes all the test cases carried out on different modules of the system. Software Testing is define as an activity to check whether the actual results match the expected results and to ensure that the software system is Defect free. It involves execution of a software component or system component to evaluate one or more properties of interest. Software testing also helps to identify errors, gaps or missing requirements in contrary to the actual requirements. It can be either done manually or using automated tools.

7.1 Type of Testing

There are various types of testing available for testing different software. In this section, the type of testing performed is unveiled.
The types of testing performed are:

1. **Unit testing**
    - **Unit testing is one of the software testing types which includes the initial testing phase where the smallest components or the modules of a software are tested individually. With this method of testing, both testers and developers can isolate each module, identify and fix the system defects at a very early stage of the software development lifecycle (SDLC). Primarily, a unit test verifies different behavioral aspects of the system under test and can be broadly classified into state-based and interaction-based unit testing.**
2. **Integration Testing**
    - **System Integration Testing is defined as a type of software testing carried out in an integrated hardware and software environment to verify the behavior of the complete system. It is testing conducted on a complete, integrated system to evaluate the system's compliance with its specified requirement.**
    - **System Integration Testing (SIT) is performed to verify the interactions between the modules of a software system. It deals with the verification of the high and low-level software requirements specified in the Software Requirements Specification/Data and the Software Design Document.**

- It also verifies a software system's coexistence with others and tests the interface between modules of the software application. In this type of testing, modules are first tested individually and then combined to make a system.

3. Cross System Testing

   - Cross Browser Testing is a technique of testing web applications across multiple browsers. In this testing, websites, web applications, HTML file or client-side scripting are tested in order to support all the web browsers. Through cross-browser testing, it is ensured that all the websites or web applications run successfully on different browsers. This process of checking comprises testing on both the client-side vis-à-vis server-side applications.

4. GUI testing

   - Modern applications are beyond the desktop they are either mobile based or cloud-based applications. They need to be more user-friendly as per customer demand. The application interface and user experience play a significant role in application success as it is released to the market. A GUI testing team always pays close attention to each detail in visual dynamics to ensure end-user satisfaction and ease.
   - It tests the various aspects of the user interface, such as:

     Visual Design Functionality Security Compliance Usability Performance Benefits of using GUI testing are: It releases an error-free application software It increases the efficiency of software Improves software quality What we check in GUI Testing? It extensively checks the user-interface of the application under test.
   - Testing the size, position, height, width of the visual elements Verifying and testing the error messages are displayed or not Testing different sections of the display screen Verifying the usability of carousel arrows Checking the navigation elements at the top of the page Checking the message displayed, frequency and content Verifying the functionality of proper filters and ability to retrieve results. Checking alignment of radio buttons, drop downs Verifying the title of each section and their correctness Cross-checking the colors and its synchronization with the theme

7.2 Test cases and Test Results

A Test Case is a set of conditions or variables under which a tester will determine whether a system under test satisfies requirements or works correctly. The process of developing test cases can also help and problems in the requirements or design of an application.

7.2.1 Test Case ID 1

The table 7.1 describes the user login test case for both android and web app.

Table 7.1: Test case ID 1

Test Case Summary	To verify username and password for sign-up.
Prerequisites	Users/admin must Know username and password.
Test Procedure	1. Go to Homepage of the website. 2. Enter valid User name. 3. Enter valid password.
Expected Result	Username and password must follow the constraints.
Actual Result	Username and passwords are correct. Sign-Up is successful.
Status	Pass

7.2.2 Test Case ID 2

The table 7.2 describes the camera availability.

Table 7.2: Test case ID 2

Test Case Summary	To verify whether a camera is available i.e in working state.
Prerequisites	Camera should capture high resolution images.
Test Procedure	1. Go to Homepage of the website. 2. Enter valid User name. 3. Enter valid password. 4. Allow camera access.
Expected Results	Camera should work properly.
Actual Results	Camera is working properly.
Status	Pass

7.2.3 Test Case ID 3

The table 7.3 describes the distance between camera and user test case.

Table 7.3: Test case ID 3

Test Case Summary	To verify whether a distance between camera and user is sufficient enough to give accurate result.
Prerequisites	The distance should be 1m - 3m.
Test Procedure	1. Go to Homepage of the website. 2. Enter valid User name/admin name. 3. Enter valid password . 4. Allow access to camera. 5. There should be distance between user and camera
Expected Results	The distance should be between 1m - 3m.
Actual Results	The distance is within a range.
Status	Pass

7.2.4 Test Case ID 4

The table 7.4 describes the face detection test case.

Table 7.4: Test case ID 4

Test Case Summary	To verify whether a face is detected within a given window .
Prerequisites	Users must be stable in front of the camera.
Test Procedure	1. Go to Homepage of the website. 2. Click on login. 3. Allow access to camera. 4. Shows green rectangle window to detect face.
Expected Results	The face to be detected in the green window.
Actual Results	The face is successfully detected in the green window.
Status	Pass

7.2.5 Test Case ID 5

The table 7.5 describes the face not detected test case.

Table 7.5: Test case ID 5

Test Case Summary	To verify whether a face is not detected within a given window.
Prerequisites	No one is in front of the camera and successfully login to the web page.
Test Procedure	1. Go to Homepage of the website. 2. Click on login. 3. Allow access to camera. 4. Shows message that Face is not detected.
Expected Results	Display message -Face Not Detected.
Actual Results	The face is successfully not detected in the green window.
Status	Pass

7.2.6 Test Case ID 6

The table 7.6 describes the heart rate display test case.

Table 7.6: Test case ID 6

Test Case Summary	To check if the estimated heart rate is displayed.
Prerequisites	Face should be recognized and detected.
Test Procedure	1. Go to Homepage of the website. 2. Click on login. 3. Allow access to camera. 4. Shows green rectangle window to detect face. 5. Display the estimated heart rate.
Expected Results	The heart rate to be estimated should be displayed within the frame.
Actual Results	Estimated heart rate is displayed in the frame.
Status	Pass

7.2.7 Test Case ID 7

The table 7.7 describes the heart rate display test case.

Table 7.7: Test case ID 7

Test Case Summary	To verify whether the estimated heart rate is updating on firebase.
Prerequisites	Face should be recognized and display the heart rate on screen.
Test Procedure	1. Go to Homepage of the website. 2. Click on login. 3. Allow access to camera. 4. Shows a green rectangle window to detect face. 5. Every heart rate updated on firebase
Expected Results	Continuous updation of heart rate on firebase.
Actual Results	Updating on firebase successfully.
Status	Pass

7.2.8 Test Case ID 8

The table 7.8 describes the updation of data in excel sheet.

Table 7.8: Test case ID 8

Test Case Summary	To check if the estimated heart rate is getting stored and updating frequently in the excel sheet.
Prerequisites	Heart rate of the user should be estimated.
Test Procedure	1. Go to Homepage of the website. 2. Click on login. 3. Allow access to camera. 4. Display the estimated heart rate. 5. Open Excel sheet of respective user.
Expected Results	The heart rate should be stored and updated in the excel sheet.
Actual Results	Excel Sheet updating successfully.
Status	Pass

7.2.9 Test Case ID 9

The table 7.9 describes the tracking of data in the android test case.

Table 7.9: Test case ID 9

Test Case Summary	To Check data is updating in android app.
Prerequisites	Successful login in android and web App. Also bpm should be calculated.
Test Procedure	1. Go to Android App. 2. Click on login. 3. Enter Username and password. 4. check Data is visible or not.
Expected Results	Values should be displayed and updated frequently.
Actual Results	HeartBeat display and update successfully.
Status	Pass

7.2.10 Test Case ID 10

The table 7.10 describes the working of check button in the android test case.

Table 7.10: Test case ID 10

Test Case Summary	To check the working of check button.
Prerequisites	Successful login in android and web App. Also bpm should be calculated.
Test Procedure	1. Go to Android App. 2. Click on login. 3. Enter Username and password. 4. Data is visible. 5. click on the check button.
Expected Results	Check button should be clickable and redirect to local host where the user is visible.
Actual Results	Check button clickable and redirect to local host successfully.
Status	Pass

This chapter explored software testing along with the different types of testing. The chapter also covered test cases used for testing the modules of the project along with their expected and actual outputs.

Chapter 8

RESULTS

The seventh chapter explored the topic software testing. Test cases used for testing the modules of the project along with their expected and actual outputs are also mentioned.

This chapter describes the final output of the proposed systems. It also is the proof that all the functional models are efficiently implemented.

8.1 Outcomes

According to the plan, the final outcome was supposed to be web-application/website that a user can access. The web-application is successfully build as planned in the earlier stages. The proposed system gave following outcomes as a result:

- **An interactive, user-friendly interface.**
- **The user will get to know Heart-rate.**
- **The user need not go through physical contact of any apparatus to check heart rate.**
- **The use of heart rate monitor and detector web platform will increase the safety and reduce considerable amount of time delay in emergency situation.**
- **The tracking facility to admin through an android app will help the admin/doctor to monitor and analyze the multiple patients/users depending on the situation and health status of them.**
- **The admin/Doctor is not accessing the android app then also he/she will get an emergency alert on mobile phone through a message about the patient's emergency.**

8.2 Screen Shots

WEB APPLICATION

Figure 8.1 describes the process, designed in such a way to run on a local host server that is a deployment server which is used for debugging and tracking multiple hosts connected to the server.

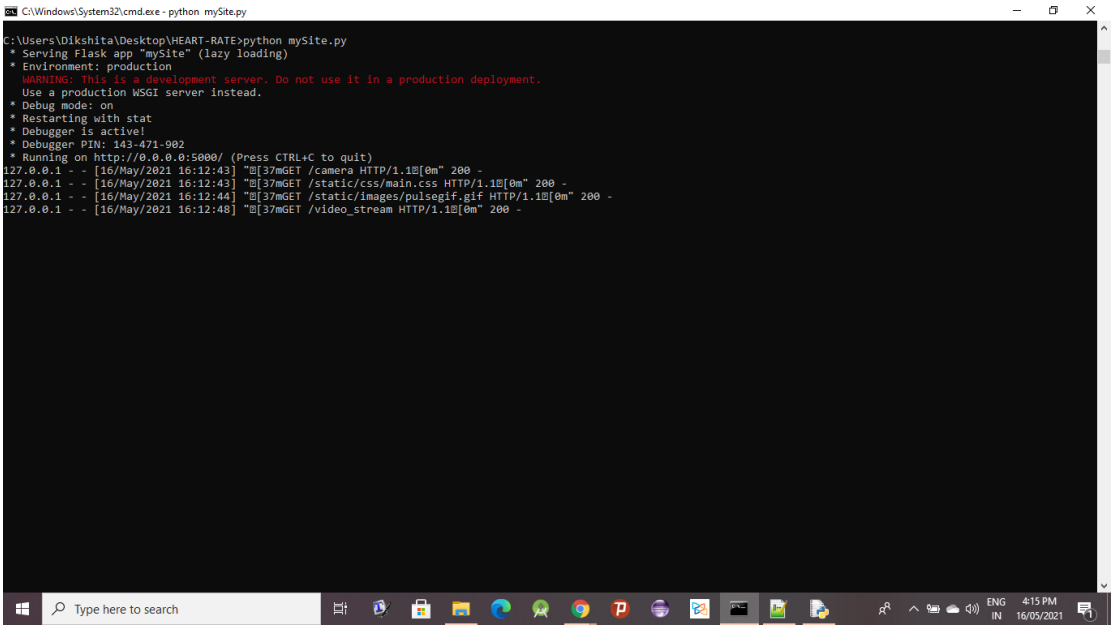

Figure 8.1: Backend process

The figure 8.2 is a screen shot of the login page which asks the user's email and password for authentication.

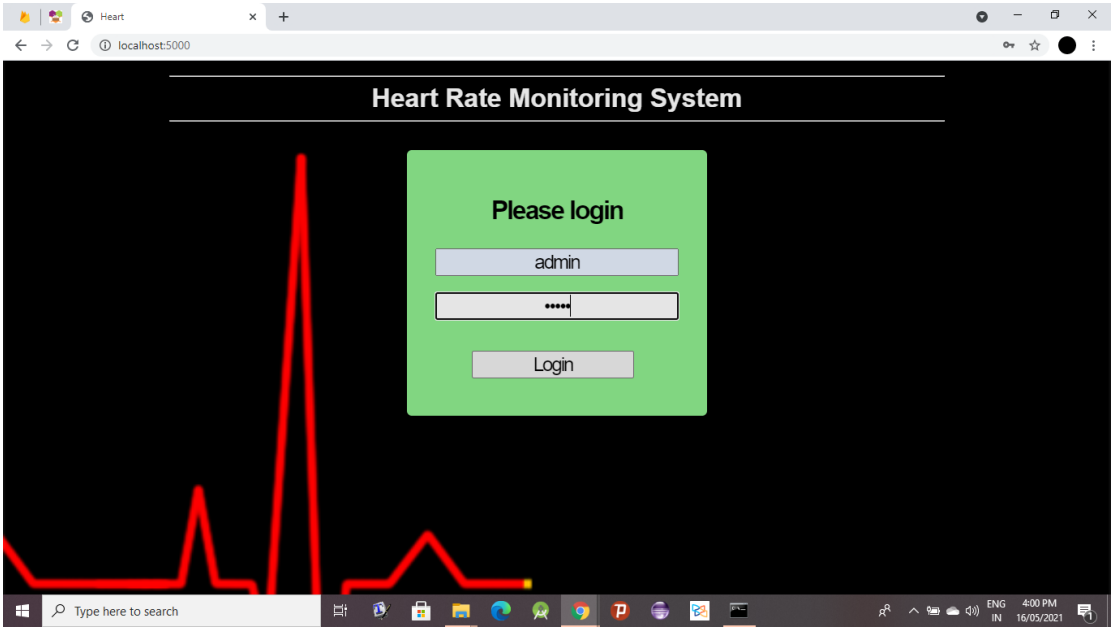

Figure 8.2: Login Screen

After successful login, the main interface appears which shows the camera frame and green frame at the center for the user where face detection is done so heart rate is calculated as shown in figure 8.3.

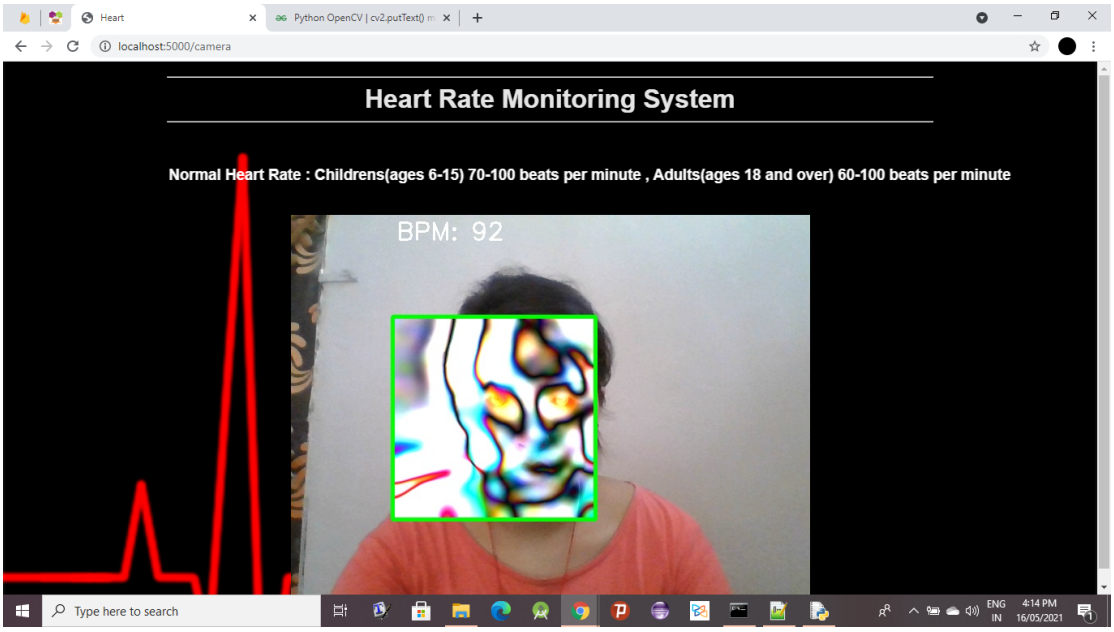

Figure 8.3: Face detected

The figure 8.4 shows where the face is detected or not in the frame and shows the message-face Not Detected.

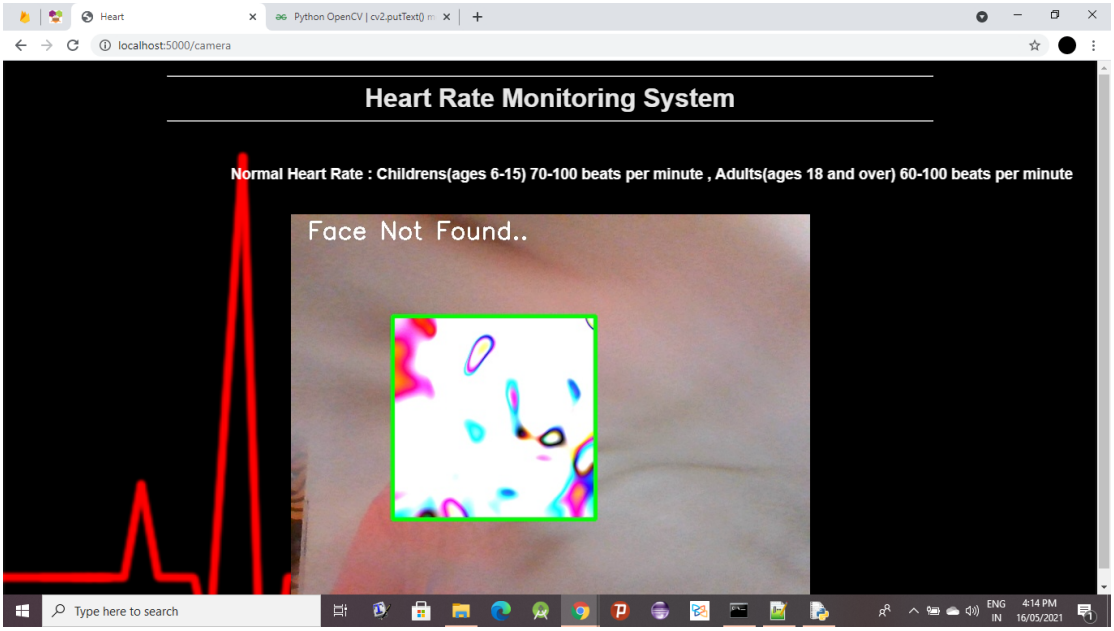

Figure 8.4: Face not detected

Estimating heart rate and storing, updating in the database as shown in figure 8.5 is done simultaneously. For each user data is stored in excel sheet.

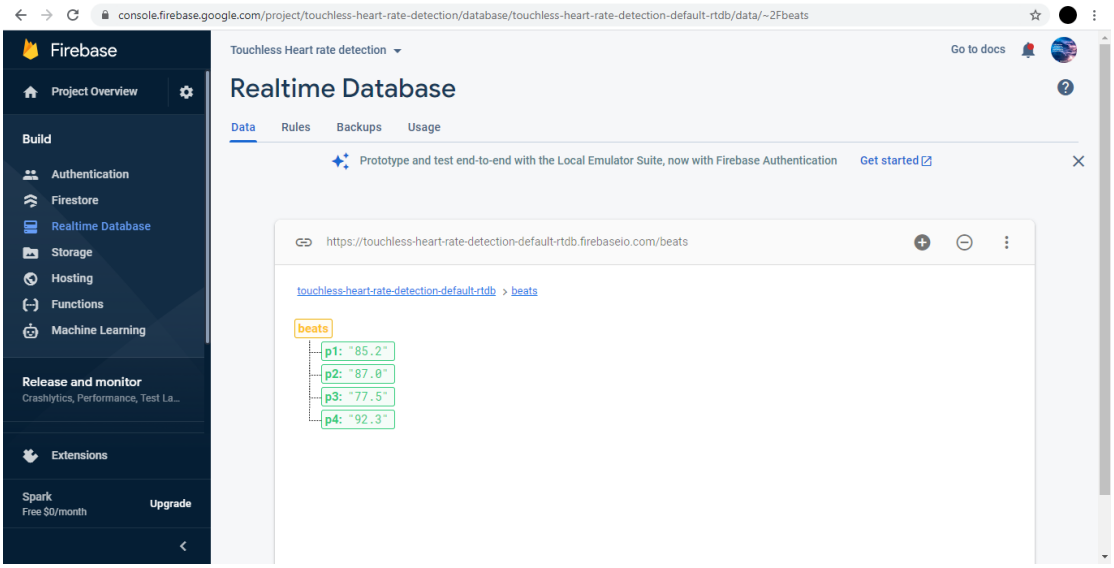

Figure 8.5: Data stored

ANDROID APP

Figure 8.6 shows a splash page in android app. A splash page is a page that precedes any page on your website. A splash screen can appear while a game or program is launching. It is an introduction page on a website.

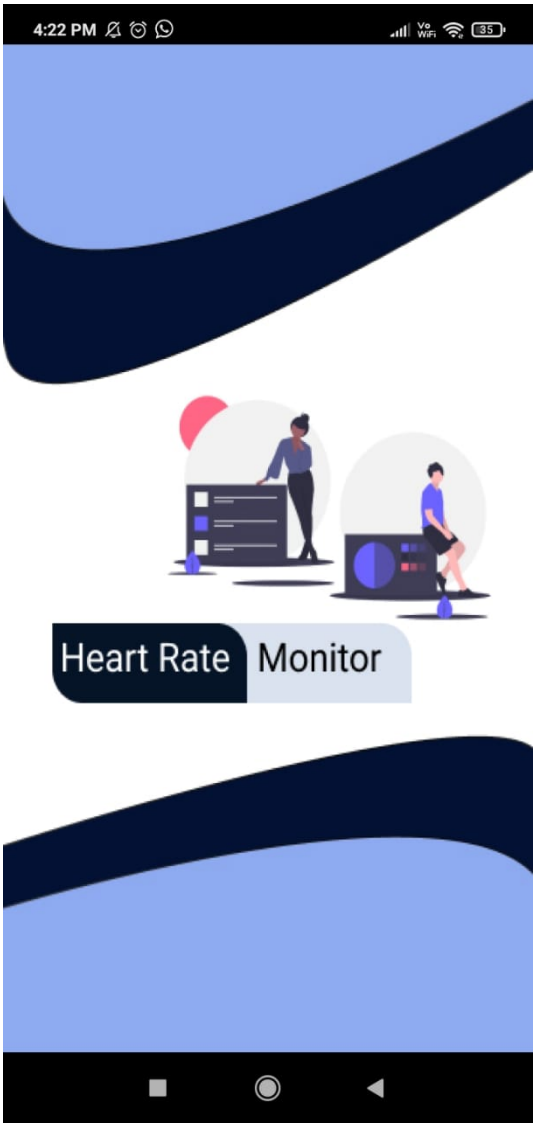

Figure 8.6: Splash screen of android app

The figure 8.7 is a screen shot of the login page which asks the user's email and password for authentication in android app.

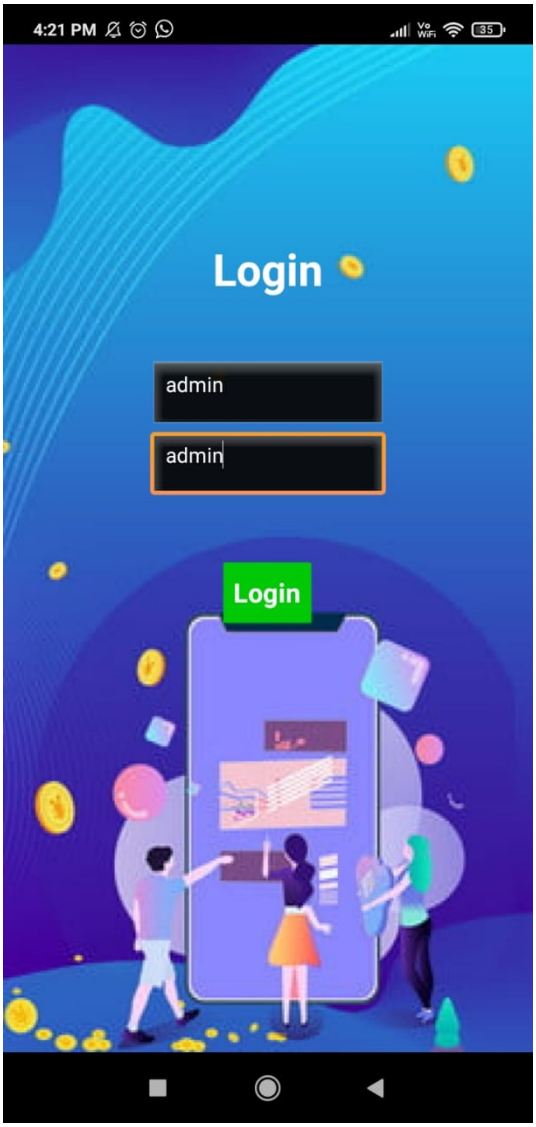

Figure 8.7: Login screen of android app

The image 8.8 shows the dashboard displaying the heart rate of multiple patients, which is accessible to admin,can continuously keep track of heart rate of each patient and also heart rate keeps on updating frequently.

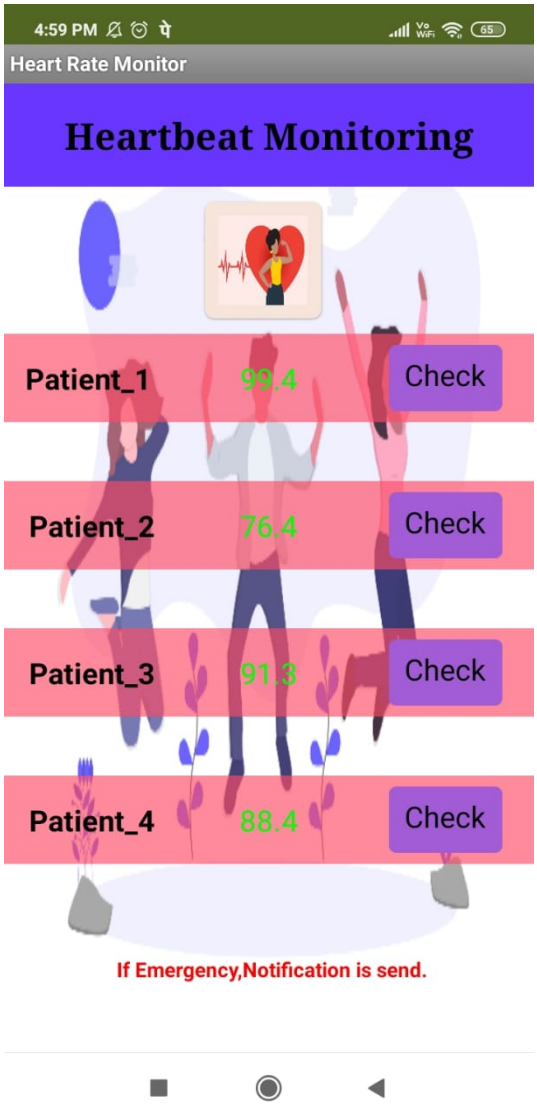

Figure 8.8: Home screen

The image 8.9 shows the virtual monitoring of user/patient through clicking the check button of respective person in android app.

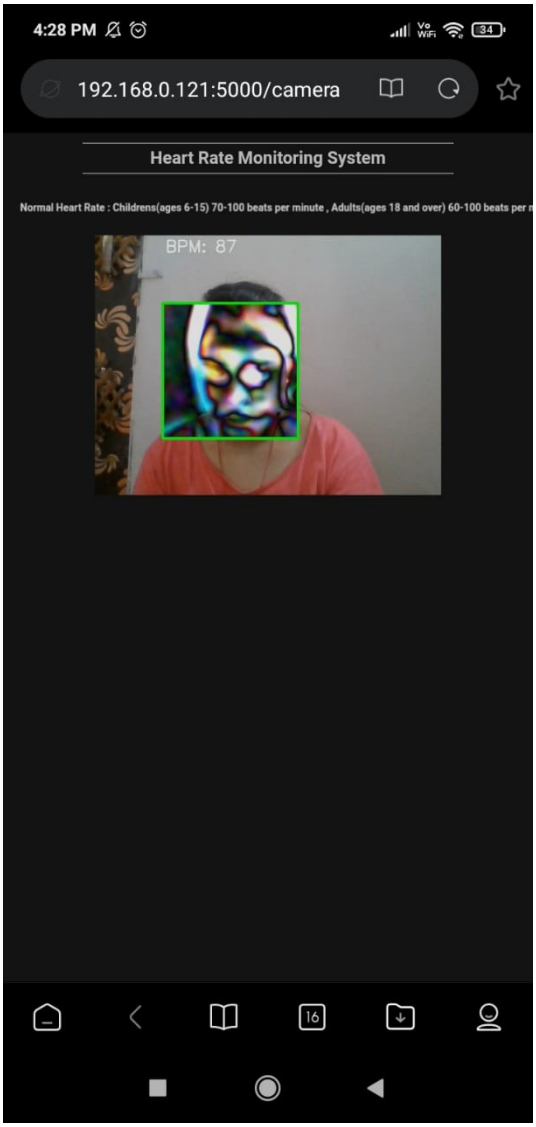

Figure 8.9: Virtual monitoring through android app

The figure 8.10 shows where the face is detected or not in the frame of an android app and shows the message-face Not Detected

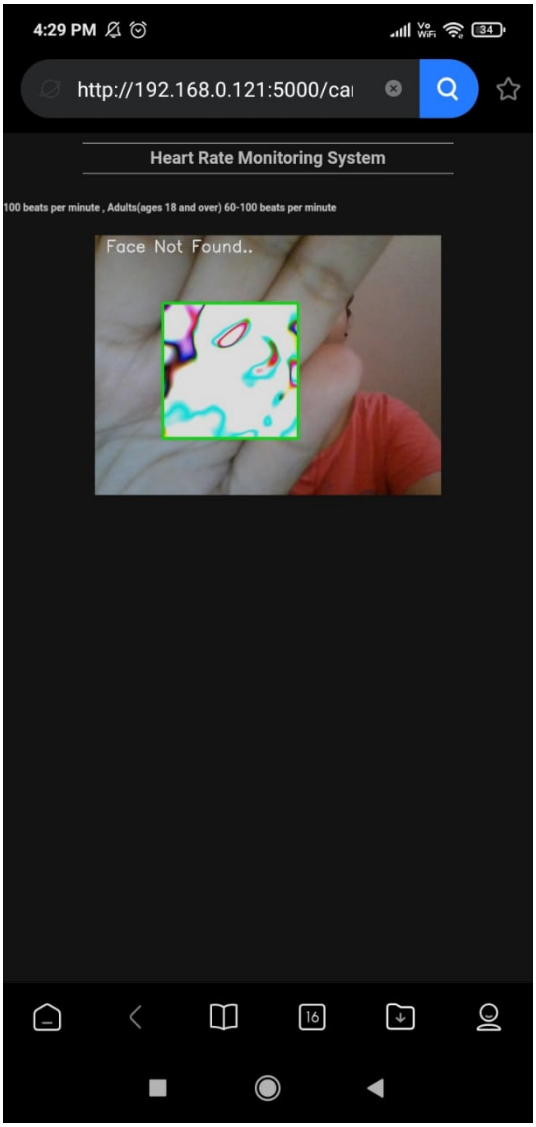

Figure 8.10: Face not detected (android app)

Text message as shown in figure 8.11 is sent to the given number in case of any abnormality in heart rate i.e. it goes beyond or below the threshold value.

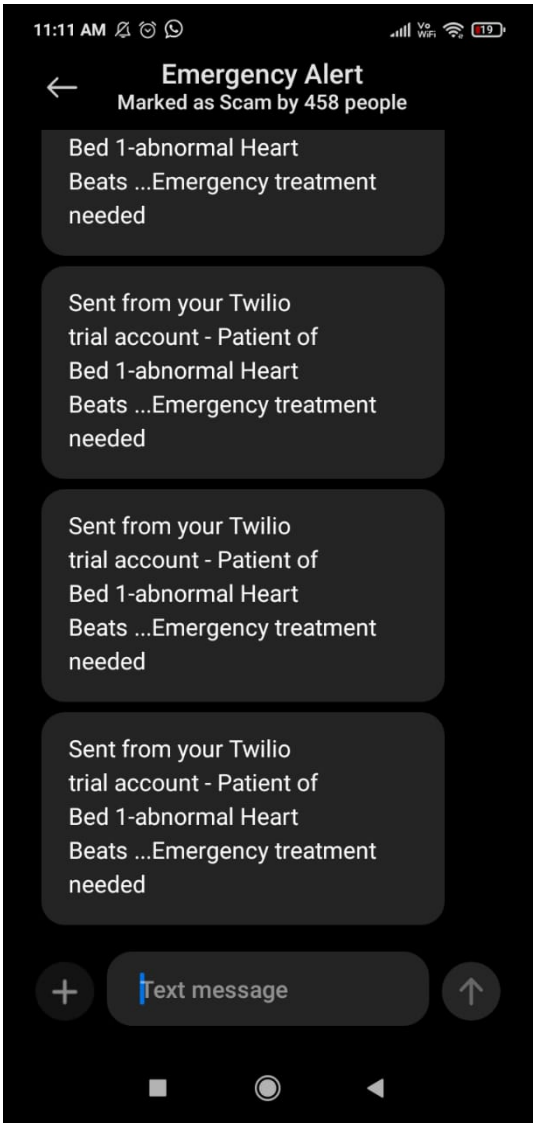

Figure 8.11: Alert text message

8.2.1 Analysis

In order to measure accuracy of our system, we have calculated heart rate on the system and compared it with already existing technologies/apparatus like Oximeter, Smartwatch, Heart rate monitoring(android app), etc. Total for each tool we have mentioned 20 readings i.e. total = 60.

To determine accuracy and error rate we need to know formula and corresponding variables:
Let x = Average heart beat from oximeter/app/watch.
y = Heart beat from our system.
Error rate:

$$Errorrate = absolute(x - y)/x * 100 \tag{8.1}$$

By putting values of x and y i.e. in first case x will be heart rate from oximeter and like wise. y in all cases will be heart rate from the system, we will get the percentage of error.

Note - Take absolute value of (x - y).
Accuracy:

$$Accuracy = 100 - error \tag{8.2}$$

Subtracting error percentage or error rate from 100 will give us accuracy of our system with respect to the corresponding technology.

Sr. No.	**Oximeter comparison**		**Android app comparison**		**Smartwatch comparison**	
Readings	**Our System**	**Oximeter**	**Our system**	**App**	**Our system**	**Watch**
1	88	83	84	96	88	82
2	83	83	74	94	83	80
3	76	79	87	91	76	78
4	85	85	89	95	85	80
5	88	87	92	90	88	81
6	89	83	93	95	89	83
7	85	84	93	97	85	84
8	82	82	96	100	82	80
9	81	85	104	95	81	81
10	82	84	90	103	82	86
11	81	81	94	96	81	81
12	90	90	91	96	90	92
13	122	123	94	97	122	97
14	83	85	90	97	83	76
15	114	116	96	96	114	87
16	86	86	97	105	86	71
17	86	84	95	102	86	81
18	81	82	84	99	81	81
19	79	85	81	101	79	79
20	82	80	94	99	82	80
Average:	87.15	87.35	90.9	97.2	87.15	82

Table 8.1: Readings of heartrate from different apparatus

As shown in table 8.1 total 20 readings are displayed for each standard method which is taken at a 2 min interval rate and we got the respective average heart rate value from 20 readings of each tool.
Substituting x and y in both the above equation, we successfully determine the accuracy. From table 8.2 highest accuracy of the proposed system is achieved in respect with oxim eter. Also accuracy of our system is directly proportional to intensity of light, so it is highly recommended to execute this in proper brightness and according to the study made on wrist-monitor accuracy [12], [13], it is found that smart watches are accurate about 91-94% with respect to standard measuring heart rate tools. Also, they are less accurate after doing any activity. Where as oximeters are considered reliable, accurate and portable.

	Oximeter	**App**	**Smartwatch**
Error rate	(87.35 - 87.15) /87.35 * 100 = 0.23	(97.2-90.9) /97.2 * 100 = 6.48	(82 - 87.15) /82 * 100 = 6.3
Accuracy	100 - 0.23 = 99.77	100- 6.48 = 93.52	100 - 6.3 = 93.71

Table 8.2: Error rate and Accuracy

Thus, this chapter clearly describes the outcomes and accuracy of the system. It also include all screenshots taken during the project implementation as well as at the time of

testing.

Chapter 9

CONCLUSION

9.1 Conclusion

The purpose of the Heart rate detection system is to help the user to monitor the heart rate and also monitor multiple people heart rate through an android app .The main aim behind the proposed system is to provide contactless monitoring and heart rate checkup that will be displayed at one place which will increase the safety of doctors .among all the pulse monitoring methods, the non-contact ones are considered to be the safest nowadays. The approach presented in the proposed system is to solve many problems of heart rate monitoring like emergency treatment and provide an android app for multi-user heart rate monitoring to maintain the social distance. An analysis will be performed on the facial video and frequency beat of heart that directly affect the performance and accuracy of the application. According to the objectives defined in chapter 1, all of the were implemented in the order below.

1. **Measure the rate of heartbeat of a person ,without any physical contact.**
2. **Observe multiple persons heart rate at the same time.**
3. **Monitor and analyze the rate of heart beat in real time condition.**
4. **Develop a flask based web application for GUI.**
5. **Develop Android App for multi user Monitoring.**
6. **Emergency Alert for critical Situation.**
7. **Maximizing accuracy by reducing error rate.**

9.2 Future Work

This system can further be extended and can be integrated with more featured treatment entities like emotions,Blood pressure ,Gesture,Mask detection and any other medical aspects that are suitable. Also,automation in the medical field is possible by using this proposed system with extra added features .

9.3 Application

- **The web application can be applied for single as well as multiple people such as in Hospitals, clinics.**

- **Virtual monitoring can be also possible and used by the Doctors to inspect patients heart rate and get alert about emergencies .**

Appendix A

Appendix: Assignment

Problem statement feasibility assessment using, satisfiability analysis and NP Hard, NPComplete or P type using modern algebra and relevant mathematical models.

Problem: he main problem is to perform Image processing on the video frame to generate a concise frame for filtering i.e magnify the frame.

Solution: In the Feasibility Study stage, the assigned project is analyzed, then information about the project participants is collected, and the requirements for the system are gathered and analyzed. During the Feasibility Study stage, the project's goals, parameters and restraints are agreed and a conceptual problem solution is prepared.

The project is in the domain of Artificial Intellegence. We are going to use Image Processing for Face recognization and generating concise review. It is an instance of Image Matching, which is NP-Complete (hence NP-Hard). Deep convolution neural networks are often used to "solve" that, meaning they can find reasonable solutions most of the time. Moreover, the field of image processing has been the subject of intensive research and development activities for several decades. This broad area encompasses topics such as image/video processing, image/video analysis, image/video communications, image/video sensing, modeling and representation, computational imaging, electronic imaging, information forensics and security, 3D imaging, medical imaging, and machine learning applied to these respective topics. Hereafter, we will consider both image and video content (i.e. sequence of images), and more generally all forms of visual information. Behind a camera, there may be several ways to process raw data, depending on the purpose. The alternatives usually break down into methods of either viewing or analyzing the image to understand the environment outside the module or system containing the camera. Each of these purposes, however, requires a different type of hardware. AI has completely disrupted hardware in vision systems and has had an impact on entire segments.

MATHEMATICAL MODEL:

THDUIP = {s, I, O, F, e, ϕ}
Where,
s = Start of program
I = {I1, I2, I3}

I1 = Stable Face
I2 = Proper light exposure
I3 = Login crendentials
O = {O1, O2, O3}
O1 = Heart rate status
O2 = Multiple patient heart rate available on android
O3 = Trigger alert
F = {F1, F2, F3, F4, F5}
F1 = Face Detection using haars cascade
F2 = Image pyramid based filtering
F3 = Bandpass System to render heart rate
F4 = Android based multi patient monitoring
F5 = Alert message when cross threshold value
e = End of program
ϕ **= Success and Failure conditions**

Success if:

1. **Face detection working properly.**
2. **Heart Rate calculating and visible on screen.**
3. **Android multi-patient monitoring working properly.**
4. **Alert message trigger when emergency.**

Failure if:

1. **Inconsistency in results.**
2. **Hardware or Software failure.**
3. **Camera and Internet doesn't work.**
4. **Face is not detecting due to high light exposure.**

Appendix B

Appendix: Publications

Details of paper publication: name of the conference/journal, comments of reviewers, certificate, paper.

[1] **Gargee Shah, Dikshita Jungade, Sharvari Gadam, Rakhee Mahajan, Bhagyashree Shendkar, "Touchless Heart Rate Detection using Image Processing: Real Time Application",** ***International Journal of Advances in Engineering Research*****, ISSN: 2454-1796, Vol. No. 21, Issue No. III, March 2021.**

TOUCHLESS HEART RATE DETECTION USING IMAGE PROCESSING: REAL TIME APPLICATION

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ABSTRACT

Heart rate is the number of heartbeats per minute which is the number of contractions of the ventricles (the lower chambers of the heart). For some human beings it might also be too excessive (tachycardia) or too low (bradycardia) which can cause clinical problems. In the current pandemic situation estimating or monitoring heart rate of a subject with the help of instruments can be risky as it involves physical contact and also one has to visit the clinic which might not be possible all the time. Research focused on non-contact based systems has increased over the past years. Existing systems include those which require contact, some having restrictions on skin tone, and others often involve high costs and complex application of sensors. This paper focuses on real time monitoring of Heart rate of multiple people simultaneously. It is obtained through a real time video using a webcam of laptop/computer. As blood circulation causes facial skin variation, therefore facial video is considered. Signal processing methods such as Fast Fourier Transform have been applied on the region extracted after applying colour magnification channels in video recordings. Application also sends a notification via a text message to the specified contact number if the Heart rate is below or above a given range. This algorithm is easy to implement, low cost and simple for real time application. Testing included trials to calculate heart rate of multiple people simultaneously. Once such a trial involved detection of faces of four people and their Heart rate calculation at the same time. Measured value of Heart rate in comparison with the ideal method was within justifiable range. Further, work can be done on environmental conditions which can be very useful in many real time applications.

Keywords *— Heart Rate, Fast Fourier Transform, Colour magnification, Image processing, Guassian pyramid.*

INTRODUCTION:

As of late, human beings are struggling from coronary heart associated diseases. According to the World Health Organization over 17.9 million people die from Cardiovascular diseases. Of these deaths, 80% are due to coronary heart diseases, for examplecoronary heart attack. So, our system describes how to develop and design heart monitoring systems. Heart continuously pumps blood around the physique and for each heart beat, blood circulation takes place which results in a colour version in facial pores and skin that is no longer seen with the aid of the bare eye. Therefore, it is viable to extract heart from colour change of skin through live video. To plan such a system, Image processing which is an application of Artificial Intelligence that gives gadgets the capability to routinely examine and enhance from experience without being explicitly programmed is being used. This website will act as a medium for the subject which can be monitored virtually through an android app.

MOTIVATION

In a situation like COVID-19, it is very necessary to maintain social distance and it has become very difficult with the old traditional method of measuring heart rate. So to reduce the physical contact, we proposed a touchless system which eases the process of heart rate monitoring. To reduce the complication and risk related to heart, this system provides a platform for doctors to examine the subject continuously from any location whenever needed and the emergency treatment will be provided within that time.So we have decided to ease the method through the use of a non contact method to observe coronary heart rate.

RELATED WORK

Minal Patil et. al. [1] in 2019 the proposed device will be connected to the wi-fi module which will send the statistics of rate of heartbeat continuously on the cloud server. So when a person is required to see his pulse rate history or records then it can be retrieved from the cloud serve along with his temperature. Along with heart rate monitoring it also notify the temperature of a person.

Face detection (FD) has been carried out with the use of Haar cascades. It is based on machine learning and is educated on a set made of both positive images (photos of faces) and negative images (pictures that don't include any face). This method was proposed by Carmen Nadrag et. al. [2] in 2018. Apart from Heart rate, various different physiological parameters related to health status can also be measured. But it's a complicated task to find the real error rate in heartbeat pulse as video display windows show intrinsic errors, so here 3 percent of the error rate was detected.

Jifeng Huang et. al. [3] in 2018 proposed a device that makes use of LiPPG the algorithm, which extracts the PPG signal with the heat rate robustly, uses color pattern to symbolize the PPG signal, enabling the extraction of the PPG signal under low illuminance and a multiscale variable weight Savitzky-Golay combination (MVSGC) model, to extract the signal from noise or trend.

Joel Hernandez et. al. [4] in 2018 concluded a heart rate monitoring system that uses the angular rate data from a single axis of a MEMS gyroscope to detect heartbeats. With a mean absolute error (MAE) and standard deviation of the absolute error (SDAE), when our tests are compared with a reference ECG signal, we exhibit that our machine is accurate enough to track HR changes. It is not regarded as a reliable way due to its much less accuracy in coronary heart rate detection.

J Johan Bathile et. al. [5] in 2018, proposed an approach that was once evaluated on a novel method that extracts the PPG using face video from a self-collected dataset of 45 subjects. Dataset is divided into 9 parts (5 subjects per part) such that every section is used as the test data once when the last remaining 8 components are used as the training data. Apart from Heart rate, Blood pressure additionally is estimated. This strategy can have multiple additions like stress management and hypertension monitoring at home, office, school, college, meditation, and clinical facilities in the future.

Monika Jain et. al. [6] in 2017 proposed a light-based sensor can be used to detect variations in coronary heart rate; this is accomplished via the usage of a Photoplethysmography (PPG) sensor. The sensor consists of a LED with a photodetector and isin a position to notice the variations in blood quantity of blood flow in the physique and directly correlates to heart rate. The strategy to construct the sensor proposed right here is of very low price and additionally detects heart arrhythmia means an irregular heartbeat.

Using Haar cascades Face detection (FD) has been implemented. It is primarily based on machine learning and is trained on a set made of both positive images (photos of faces) and negative images (pictures that don't contain any face). Apart from Heart rate, many different other physiological parameters associated with health status can also be measured. This method was proposed by Quing Zhu et. al. [7].

M. A. Hassan et. al. [8] in 2017 proposed a methodology that is Ballistocardiography used for video-based heart rate detection. It measures coronary heartbeat rate by estimating the movement generated through the pumping of blood, from the heart at every cardiac cycle. This methodology overcomes the challenges of the realistic environment. However, the distance of the subject from the camera(i.e. 0.8m) appeared to be an issue. Therefore, the potential of the motion tracking algorithm to trackthe microscopic reduces because ROI measurement is decreased to certain pixels and due to which the accuracy of the heartbeatrate estimation was decreased.

Rahul Kumar Singh et. al. [9] in 2016 proposed a simple and reliable actual-time heart rate monitoring system for automaticdrivers. The developed machine employs the principle of non-contact convenience on the Steering Wheel. This used a simple analog conditioning unit to give real-time HR monitoring. However, it used to be specially designed for drivers, and additionally, the subject needs to hold the steering wheel through an insulator.

A brief explanation of the concepts that can be used for the implementation of the proposed system is given by Hamidur Rahman et. al. [10]. They have used MATLAB for designing a GUI to monitor Heart rate in real time. Also explained calculating Heart rate from a recorded video by extracting image frames. Different signal processing methods like Fast Fourier Transform (FFT), Independent Component Analysis (ICA) and Principal Component Analysis (PCA) have been applied in video recordings and the blood volume pulse (BVP) is extracted from the facial regions.

Table 3.1 summarizes highlights and observations of the related work discussed above.

TABLE 3.1
LITERATURE REVIEW

Ref. No.	Highlights	Observations
[1]	Connects to the wi-fi module which will send therate of heartbeat continuously on the cloud server.Pulse rate history can be retrieved along with his temperature. It also informs the temperature of a person.	Approach is based on physical contact with help of hardware devices.
[2]	Face detection(FD) has been implemented usingHaar cascades for heart rate monitoring. Several other physiological parameters related to health status can also be measured.	Errors of 3 percent were detected, hard to calculate the real error rate.
[3]	Works well under low or very illuminate conditions.	Unable to give accurate results under dark environments.
[4]	Implemented as an embedded system using low-costmicrocontrollers. The use of a single axis of the gyroscope reduces the power consumption and increases battery life.	Not considered as a reliable way due to its lessaccuracy in heart rate detection.
[5]	Uses Photoplethysmography (PPG) sensor, which is able to detect the variations in blood volume or bloodflow in the body and directly correlates to heart rate. Sensors proposed here are of very low cost and also detects heart arrhythmia.	Uses low cost hardware and MI band, which isworn at the wrist so it is based on physical contact.
[6]	Extracts the PPG using face video from a self-collected dataset of 45 subjects. Heart Rate, Blood pressure can also be estimated. Used for stress management and hypertension.	Challenging to extract PPG from the face video with a darker skin tone. Approach is testedover a very small database that mostly had young and healthy volunteers.
[7]	Fitness exercise video with optical flow algorithm and motion information frequency can be improved. Used in applications for smart health and sports medicine.	The face images were roughly aligned using theface tracker.
[8]	Measures heartbeat rate by estimating the motiongenerated by pumping of blood, from the heart ateach cardiac cycle. Overcomes challenges of the realistic environment.	Distance of the subject from the camera (i.e. 0.8m) appeared to be an issue. Therefore, the ability of motion tracking algorithms reduces.Accuracy of the heartbeat rate estimation wasdecreased .
[9]	Designed for drivers where decrease in heart rate canbe easily used to detect driver fatigue and also alert the driver.	Specifically designed for drivers and also the subject needs to hold the steering wheel throughan insulator.

	The system can also be designed to send the data to a central server.	
[10]	Extraction of Heart rate using three signal processingmethods ICA, PCA, FFT methods and display continuous Stress assessment. Statistical parameters for 10 test persons are being presented. Statistical analysis has been done for theevaluation using 2 statistical parameters RSQ (R-squared) and CORREL (Correlation Coefficient).	Subjects need to be in ambient light for better visibility of video. First approx. for 5 min video is recorded through a webcam and then in an offline mode heart rate is estimated. Values extracted are stored in the excel file.

Based on the observations mentioned in TABLE, the proposed system is discussed in the next section. From all related researches it is observed that to monitor physiological parameters, many non-contact machines are designed and monitoring isbeing done in offline mode and most of them are good for the lab environment. This paper presents a non-contact method of monitoring heart rate in real time for an unlimited amount of time using a webcam which covers some of the flaws of previous work.

The rest of the paper is organised as follows: chapter 4 describes methods of real time heart rate monitoring. Finally, chapter 5 talks about the applications of this system and chapter 6 summarizes the work.

PROPOSED SYSTEM

The proposed system presents the heart rate monitoring system without any physical contact. The system detects the face of the subject via the digicam and performs image processing based totally on frames and calculates the coronary heart rate . Theaim behind this system is to avoid physical contact and grant an emergency remedy to the situation to limit the hazard and additionally alert will set off via textual conten**t** message to admin.

The proposed system consists of different steps : (A) Face Detection , (B) Defining Parameter , (C) Image pyramid , and (D) Heart Rate Estimation.

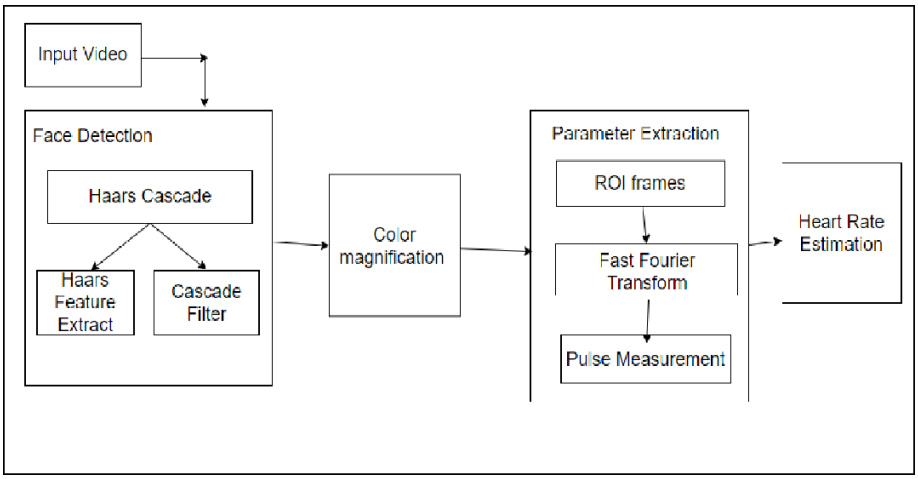

Fig 1: System Architecture

1.1 Face Detection

The preliminary stage of the system is to detect the subject which needs to be steady in front of the web camera .The live video streaming must continuously progress so that face can be detected or it can also detect the absence of subject . The most important part is to detect the single subject through the camera so that we will be using a haar cascade [2] classifier which is aneffective object detection way and helps to locate the subject in the live video. Face detection is refined further by extracting theforehead area [2] specially for better accuracy. Instead of making use of all the 7000 elements on a window, crew the points intodistinct ranges of classifiers and observe one-by-one. (Normally the first few tiers will comprise very much less variety of features). If a window is not applicable at the first stage, remove it. If it passes, observe the next stage of facets and proceed the process. The window which passes all degrees is a face region.

1.2 Defining Parameter

The different parameters need to be set to increase the accuracy of the system. The required parameter are discussed below:

A. Web Camera parameter :

Different parameters are defined based on requirements like number of VideoframeRate, Video channel count and some video capturing parameter. This parameter changes according to the user.

.

B. Color Magnification Parameters:

There are a number of frames captured which need to store for accurate magnification of exact colours. So for that buffer size and buffer index are needed to set it initially some threshold values like minimum and maximum frequency for defining the range for frequency rate .

C. Heart Rate Calculation Parameters:

We need to set some limit for beats per sec to use a specific count of frame frequency to achieve the accuracy.

1.3 Image Pyramid

This stage is to extract the feature from the face color variant. These images can be studied deeper using the image pyramid. There are two types of image pyramid. They are (A) Gaussian Pyramids (B) Laplacian Pyramids. Here we used a gaussian pyramid which consists of multi scale copies of image and used as a low pass filter for image blurring. In the gaussian pyramid, the image resolution reduces level by level to discover the smallest magnifying image. It comprises down sampling of image, scale search and extract the major characteristics. The gaussian pyramid rectifies the color changes happening in images and enlarges it level by level. After extracting features the level again reconstructs into its original size and displays the continuous streaming.

1.4 Heart Rate Estimation

The gaussian pyramid gives refined image in the smallest pixel and on that image the color magnification algorithm is utilized to locate the variant in color alternate in veins for precise body inside video for getting the change in parameter, the bandpass filter is used and grab that pulses the amplify it. For finding the frequency, Fourier transform [10] is used and calculate the mean average of frequency and for best result we take 15 as a video frame rate. The resultant value of frequency we get is in hertz. As per the requirement to calculate heart beat per second we need some mathematical equation to convert hertz into beats per sec.

After getting the frequencies we need to reconstruct the frames. The heart rate can be calculated as HeartRate = 60*f_h bpm where the frequency is calculated using number of peaks per time. The result based on the frame rate to be chosen for calculating the

frequency. When the first 15 image frames are read, the actual time Heart rate extraction begins and after that each value is introduced to the firebase and the approach presents a new Heart Rate.

CONCLUSION

The proposed system is based on real time, touchless heart rate monitoring which utilizes the camera to detect subjects' face.The main aspect to come up with such a system which reduces the time delay in treatment and also increases the flexibility of the monitoring the subject from far distance. The purpose of the live monitoring system is to help the admin to observe the subjects heart rate from anywhere through an android app. The key threshold range of value was given to the model so that if the heart rate varies beyond the range the notification will send to the registered number so that required action needed is to be taken immediately. In this way, the system proposed is user friendly, robust and effective to measure heart rate without any physical contact.

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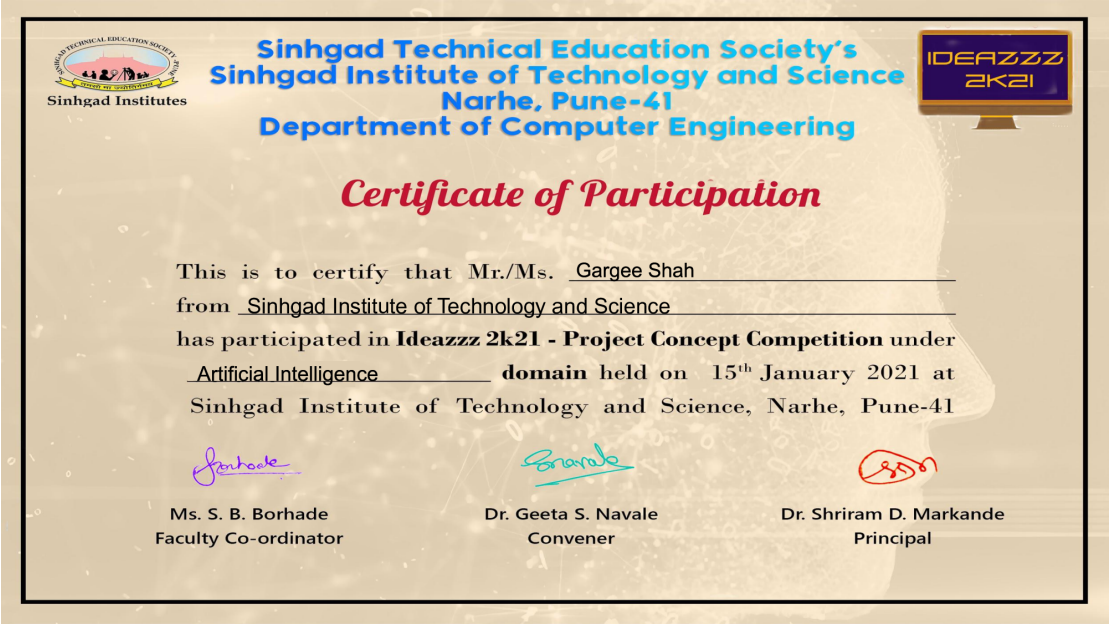
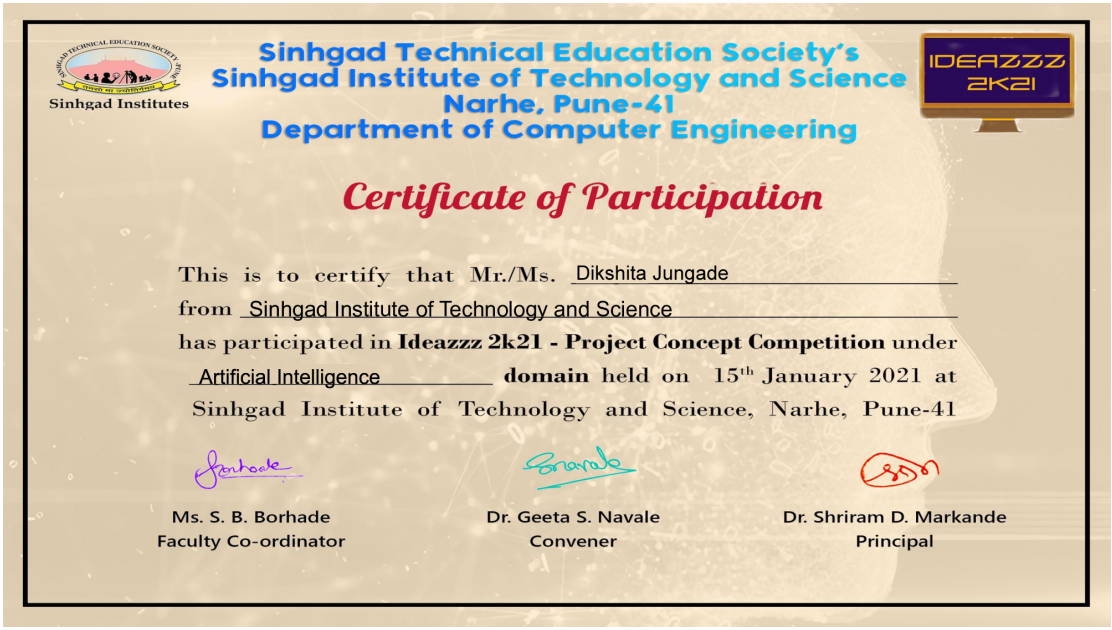
Appendix C

Appendix: Certificates

Project Competition Certificates





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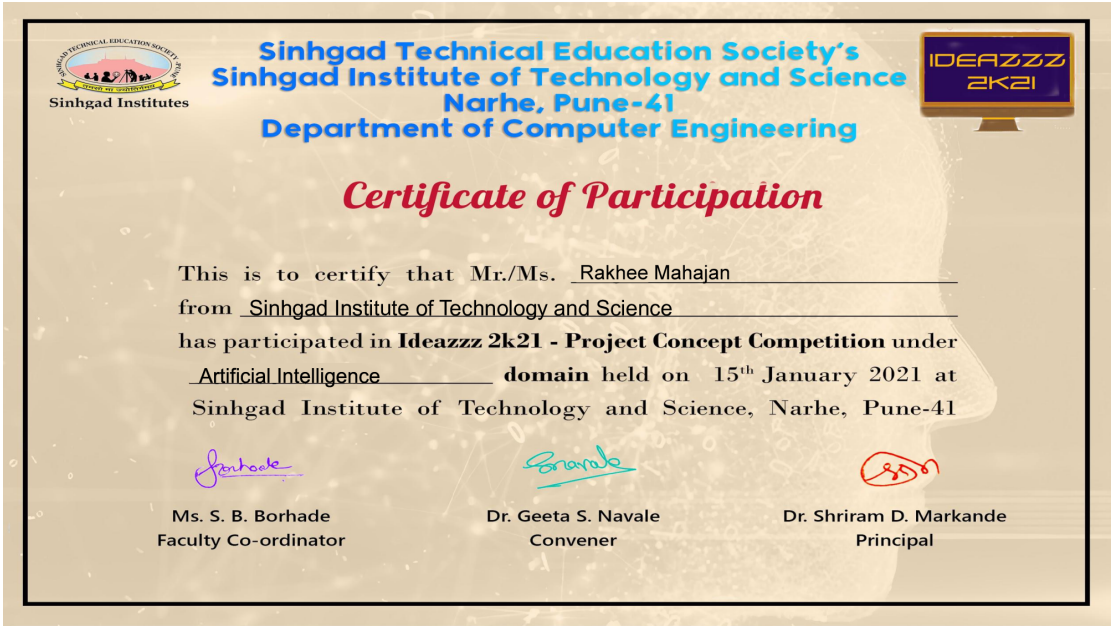
Faculty Co-ordinator

Dr. Geeta S. Navale
Convener

Dr. Shriram D. Markande
Principal



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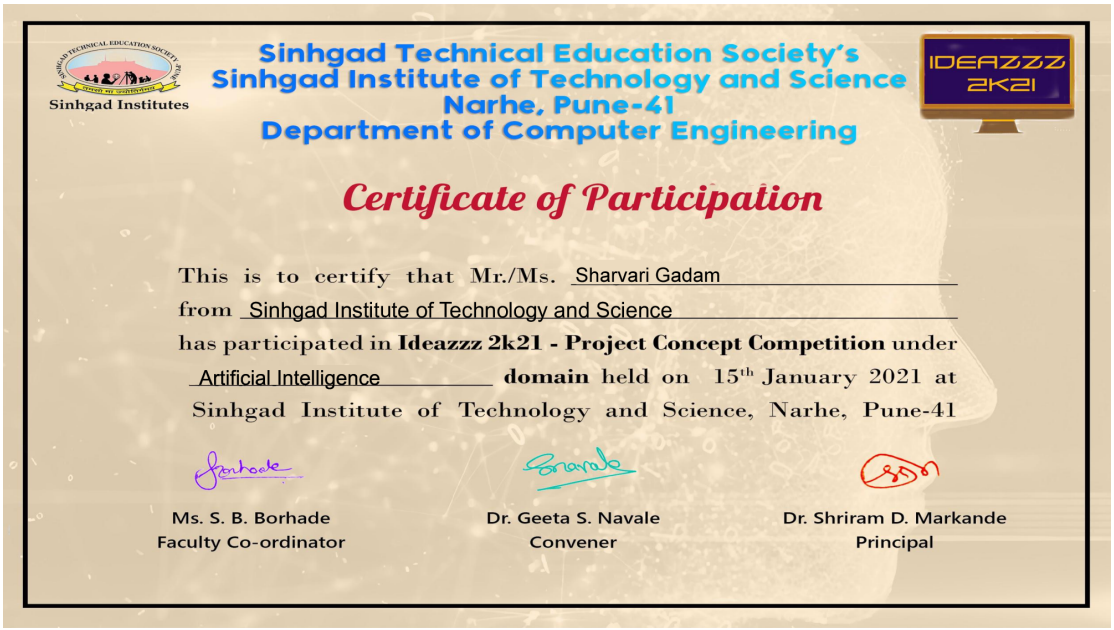

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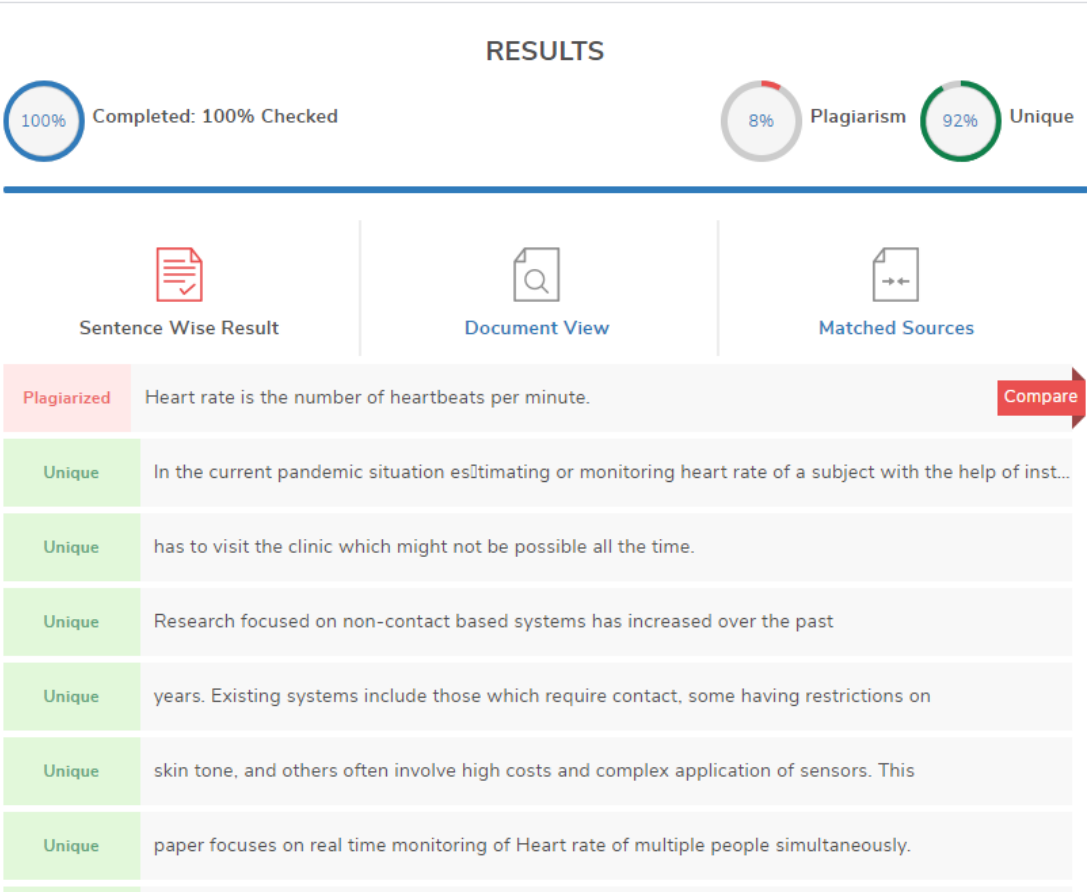
Appendix D

Appendix: Plagiarism Report

Plagiarism Report of project report



Unique	So, our system describes how to develop and design heart monitoring
Unique	systems. Heart continuously pumps blood around the physique and for each heart beat,
Unique	blood circulation takes place which results in a colour version in facial pores and skin that
Unique	is no longer seen with the aid of the bare eye.
Unique	To plan such a system, Image processing which is
Unique	an application of Artificial Intelligence that gives gadgets the capability to routinely exam
Unique	ine and enhance from experience without being explicitly programmed is being used. This
Unique	website will act as a medium for the subject which can be monitored virtually through an
Unique	android app.The motivation behind selecting this project is as follows.
Unique	is very necessary to maintain social distancing and it has become very difficult with the
Unique	old traditional methods to maintain distancing for doctors also to treat their patients. So
Unique	we have decided to ease the process by using a touch less technique to detect heart rate

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