Tremor Detect

By

Aymen Shahid

Ammara Asif

Noor-Ul-Huda Shahid

Amjad Ali

Supervisor

A/P Bilal Rauf

Submitted to the faculty of Computer Software Engineering,
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CERTIFICATE OF CORRECTIONS & APPROVAL

Certified that work contained in this thesis titled Tremor Detect, carried out by Ammara Asif, Aymen Shahid, Noor-Ul-Huda Shahid and Amjad Ali under the supervision of Asst. Prof Bilal Rauf for partial fulfillment of Degree of Bachelor of Computer Software Engineering, in Military College of Signals, National University of Sciences and Technology, Islamabad during the academic year 2020-2021 is correct and approved. The material used from other sources has been properly acknowledged / referred.

Approved by
Asst. Prof Bilal Rauf
Department of CSE, MCS

Date: 20/6/2021

DECLARATION

No portion of work presented in this thesis has been submitted in support of another qualification or award in either this institute or anywhere else.

Plagiarism Certificate (Turnitin Report)

This thesis has been checked for Plagiarism. A report endorsed by Supervisor is attached as Appendix B.

Signature of Student

Noor Ul Huda Shahid

Ammara Asif

Aymen Shahid

Amjad Ali

Signature of Supervisor

A/P Bilal Rauf

ACKNOWLEDGEMENTS

Without the will of ALLAH Almighty, there is no success. We are grateful to ALLAH, for giving us strength, guidance and for enabling us to accomplish this task. Whatever we have achieved, we owe it to Him, in totality. We are also grateful to our parents, family and well-wishers for their critical reviews and their constant support. We thank our supervisor, A/P Bilal Rauf for his continuous motivation and guidance throughout the course of our project. We would not have been able to accomplish anything without their help.

DEDICATION

In the name of Allah, the Most Beneficent, the Most Merciful. To our parents, without whose unflinching cooperation and support, work on such a large scale was impossible. Our supervisor A/P Bilal Rauf for his countless hours of support and encouragement.

ABSTRACT

Revolutionizing Healthcare Analytics through AI and Machine Learning

The era of information technology brings with it a plethora of solutions in all fields especially if we talk about medical. Artificial Intelligence has brought some revolutionary changes in the medical field leaving the world astonished with its results.

Parkinson's Disease (PD) is a progressive, chronic illness, with the cause unknown and no cure. Treatment is effective only if the disease is caught early enough and early tremors typically begin in the fingers and hands. Different tests have been designed to detect tremors in hand. Two of the most common tests are the Spiral Test and the Wave Test. The traditional approach requires patients to draw either a spiral or a wave pattern on a paper. The presence of tremors is indicated by the irregular and shaky patterns drawn by the patient. The problem with this approach is that it is qualitative in nature, non - shareable and subjective to the doctor's opinion.

The idea is to develop a responsive web application that uses machine learning and digital image processing techniques. The application will provide digitized versions of the Spiral Test and the Wave Test and will predict whether a user has Parkinson's Disease or not based on the digital input provided by the user. The digital inputs will be processed and quantified, and Parkinson's prediction will be done through trained and tested machine learning models. These digitized tests enable users to take test from home. This also eliminates the expenses associated with routine clinical visits. Furthermore, these tests take a quantitative and standard approach thus removing the subjective aspect of the paper tests.

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CHAPTER

1 INTRODUCTION

1.1 Overview

Parkinson's Disease is a chronic and progressive illness *[1].* The cause is unknown and there are no cures. Treatment is effective if the disease is caught early enough and early tremors typically begin in the fingers and hands. For effective treatment of the disease, it is necessary to detect it at the earliest stage. Because of the delay in early detection caused due to waiting for doctor's appointments and scarcity of neurologists, the symptoms can worsen considerably. The whole process of appointments and tests is costly, time consuming and dangerous during the ensuing COVID-19 pandemic.

To overcome this problem, Tremor Detect has an innovative solution that will allow the users to detect Parkinson's at an early stage through a digitized spiral/wave test that will allow progress tracking and detection. This solution reduces costs because of no travel and most importantly provides early detection, which is the most crucial factor in effective treatment.

Tremor Detect has digitized the two already designed paper tests for Parkinson's Disease detection i.e., Spiral Test and Wave Test. The technical problem with the paper tests is that the patterns drawn do not provide a quantitative approach. Moreover, the physical drawings are subjective to the doctor's opinion and people would have to leave their homes just to get tested as these tests are non-shareable. Also, it is technically difficult to track progress of Parkinson's Disease patients. Tremor Detect offers a technical solution in the form of a responsive web application that will provide digitized versions of the Wave Test and the Spiral Test. The web application will be easily accessible over all platforms.

1.2 Problem Statement

Parkinson's Disease is the second most common neurodegenerative disorder which has affected 10 million people worldwide. This disease has no cure and treatment is only effective if the disease is caught early. Most of the time Parkinson's is not detected early because symptoms mostly appear in advanced age where patients usually associate them with old age and only get themselves checked when it is too late. Scarcity of neurologists, travel expenses and the ongoing COVID-19 pandemic further cause a delay in early detection.

1.3 Approach

The approach is to digitize the two popular detection tests, i.e., the spiral and wave tests. Tremor Detect allows patients to get themselves checked at an early stage from the convenience of their homes. Main goal of Tremor Detect is to make patients aware of their condition which otherwise may have been overlooked because of travel expenses and scarcity of neurologists. This will serve as a motivation to get treated early and thus prevent the appearance of uncontrolled tremors.

1.4 Scope

This product intends to provide a convenient and an early diagnosis of Parkinson's disease by providing digitized versions of two PD detection tests: the spiral test and the wave test. Parkinson's disease can also be detected through characteristics of finger movement recorded while typing using keystroke timing information. However, this test is beyond the scope of our project.

Through a web-based application, the user will be asked to trace a spiral or wave *[2]*, which would be sent for testing. The image will run through the ML model and will notify the user with the result. The application prints out 2 results: "Healthy" vs. "Detection of Parkinson's" along with the quantitative result. Using this application, users will be able to detect PD from the comfort of their homes without an expensive visit to the hospital and possible exposure to COVID-19. The digitized spiral/wave test provides a snapshot of the patient's condition, which can be shown to the doctor. Through Tremor Detect, we intend to advance diagnostic and

progress measurement approaches for people with Parkinson's by reducing the need for routine clinic visits. It will also allow patients to track their progress to keep track of their condition.

1.5 Aims and Objectives

The aims and objectives of project include:

1. Using software engineering techniques for gathering requirements during the development process, designing the software, implementing and testing requirements gathered.
2. To provide accurate detection of tremors.
3. To learn web Development and create a responsive website with an elegant user interface.
4. To learn database and development and provide each user with a secure account.
5. To learn Machine Learning and create a suitable model that aligns with the available dataset.
6. To help PD patients track their tremors.
7. To make people aware about Parkinson's disease.

1.6 Deliverables

Deliverable Name	Deliverable Summary Description
Software Requirements Specification Document (SRS)	This document provides a complete description of what the system will do, who will use it, as well as detailed description of functional and non-functional requirements and the system features.
Software Design Specification (SDS) Document	Complete description of how the system will be implemented i.e., the detailed design.
Code	Complete code.
Complete System	Complete working system.

Table 1-1 Project Deliverables

1.7 Document Conventions

This thesis is divided into different parts and categories with the first part being the abstract describing the main details of Tremor Detect. Then comes the introduction section specifying the problem statement, approach, scope and objectives, followed by the literature review section stating the various resources read online before the commencement of the project. They include learning about Parkinson's Disease and the need for Tremor Detect. The design and development part illustrates the diagrams which outline the architecture and detailed design of the Tremor Detect, as well as its interfaces, components and data necessary for the implementation phase. The analysis and evaluation part give details of the unit testing, system integration testing, black box testing and actual results against expected results. The future work describes the prospective enhancements that can be applied to the project.

1.8 Intended Audience

The intended audiences for the Thesis of Tremor Detect includes the project supervisor, the BESE 23 FYP groups (developers), UG project evaluation team, and other personnel at MCS CSE Department.

1.8.1 Project Supervisor (A/P Bilal Rauf)

The project supervisor to check and guide the group about the understanding and implementation of the requirements properly and completely during the development lifecycle will use this document.

1.8.2 Developers (Tremor Detect Group)

For FYP group members, the document will ensure the development of the right project that fulfills the provided requirements.

1.8.3 Testers (Tremor Detect Group)

It will provide testers with an exact list of the features and functions that must be according to the requirements.

1.8.4 Users

To familiarize with the project and how to use/respond in failure situations as well as suggest other features for further improvement.

1.8.5 Documentation Writers (Tremor Detect Group)

To familiarize with the system's features and how to explain them for further clarification. Explaining technologies required, how the system will respond according to user's action, what possible system failures may happen and what are the solutions to all those failures etc.

1.8.6 UG Project Evaluation Team:

It will help the evaluation team to evaluate the progress of the FYP project. The document will provide the evaluators with the project's scope, requirements, and further details.

CHAPTER
2 LITERATURE REVIEW

The goal of this chapter is to establish the significance of the general field of study and identify a place where a new contribution could be made. This required a detailed study about Parkinson's disease. The disease is explained, and its statistics are given. After carefully studying about the disease and its treatment, it was found that the only possible method for effective treatment is early detection. A study for already present detection tests was done and the problems were identified. The two most popular tests for Parkinson's disease were researched and that led us to digitizing them. The last step was to analyze the findings and develop a system which improves patient compliance, increases motivation to get early treatment and provides an easy way of progress monitoring.

2.1 Parkinson's Disease

PD affects the nerve cells in the brain responsible for producing dopamine. It's symptoms include tremors, muscle rigidity and changes in gait and speech. Treatments can help relieve symptoms, but unfortunately this disease cannot be completely cured. Different tests like spiral and wave tests are designed to detect Parkinson's Disease through tremors in the traced patterns. There are different treatments for PD including physiotherapy which can help to maintain and improve levels of function and independence, improving a person's quality of life.

2.1.1 Statistics

Statistics show that about 50,000 Americans are diagnosed with Parkinson's disease each year, with more than half a million Americans affected at any one time. In Pakistan PD is spreading at an alarming rate and it is feared that by 2030, the number of patients with neurological movement disorder, which is around 600,000 at the moment, would be doubled.

Parkinson's disease affects men more than women and all people are at equal risks irrespective of the geographical region. Scientists have not been successful to explain this apparent lower incidence in certain populations. It is reasonable to assume, however, that all people have a similar probability of developing the disease.

Age is one of the most common factors in Parkinson's Disease. It is a disease of late middle age, affecting people age of 50. The average age of onset is 60 years. However, recent studies have shown that in todays age, the disease is having an early onset and some have estimated that 5 to 10 percent of patients are under the age of 40.

2.2 Related Work

The dataset needed for this project was available on Kaggle *[3]* and considerable work had already been done in the collection of Spiral and wave hand drawn samples. There are research works available on the effectiveness of the spiral and the wave tests taken on paper. However, digitization of these tests has not been done and no work is available in this domain making Tremor Detect the only web application to take the initiative to digitize the said tests.

2.3 Proposed System: Tremor Detect

Tremor Detect is a web application that will take the user's digital input and detect tremors in their hands through Machine Learning techniques. These tremors will be a clear indication of Parkinson's Disease hence leading to its detection. Moreover, a progress tracking feature will be provided to keep track of the disease.

2.3.1 Web Application

Tremor Detect is a responsive web application that can be used on any device (Laptops, mobiles, tablets etc.). Users can give input through both mouse and touch interface. The Graphical User Interface (GUI) is user friendly, simple to use and has interactive graphs to make it more visually appealing.

The web application will be managed by an admin, who will be able to update the users.

2.3.2 Digitized Tests

Tremor Detect provides two digitized tests in the form of digital Spiral and Wave Test *[2]*. The tests will require the user to trace the provided sample. The traced pattern can also be reset through the reset button and submitted for tremor detection. The digital input will be run through digital image processing and machine learning models to detect the chance of Parkinson.

Moreover, empty patterns will not be accepted by the system. For successful completion of tests, it is necessary for the user to trace the provided sample.

2.3.3 Progress Tracking

The progress tracking feature plots a graph of all the tests taken by the user. It will represent the user's condition quantitatively. Two graphs will be plotted, one for the Wave Test and one for the Spiral Test to show the users progress of each test.

CHAPTER

3 SOFTWARE REQUIREMENT SPECIFICATION

This part of the document contains the software requirements specification for the product Tremor Detect.

3.1 Introduction

This chapter provides an overview of the entire SRS with purpose, scope, definitions, acronyms, abbreviations and references. The aim is to present a detailed description of the project Tremor Detect that uses Machine Learning to improve the diagnosis of Parkinson's Disease (PD) by providing a digitized version of the 'Spiral Test' – a commonly used method for detecting tremors by asking a person to draw a spiral. Tremor Detect also introduces a second test for tremor detection called 'Wave test'. This document includes the detailed requirements of the project Tremor Detect.

3.1.1 Purpose

This document includes software requirements for Tremor Detect, release number 1.0. The purpose of the document is to collect and analyze all assorted ideas that have come up to define the system and its requirements with respect to consumers. Moreover, we shall predict and control how we hope this product will be used in order to gain a better understanding of the project. We will see the concepts that can be developed later and document ideas that are being considered, but may be discarded as the product develops. In a nutshell, the purpose of this SRS document is to provide a detailed overview of our software product, its parameters, and goals. This document describes the project's target audience and its user interface, hardware, and software requirements. It defines how our clients and team see the product and its functionality.

The aim of this work is to develop a web-based application that will allow users to detect Parkinson's disease at an early stage without needing to go to a hospital.

3.1.2 Document Conventions

All requirements are inherited to have the same priority. First an overall view about Tremor Detect is presented, followed by all functional and non-functional requirements analyzed in detail. Hence, this SRS is divided accordingly into sections detailing an overall description, the external interface requirements, system features, and other nonfunctional requirements. Moreover, italic text has been used to highlight critical points.

3.1.2.1 Headings

Multilevel headings are used.

All headings are bold with font style Times New Roman. Level 1 headings are of font size 18, level 2 of font size 14 and level 3 of font size 12.

3.1.2.2 Links to web pages

All links have been provided with underlined font, the title of the web page is written at the top of the link and the title may be searched on Google to pinpoint to the exact address.

3.1.2.3 Basic Text

All other basic text appears in regular size 12 Times New Roman with margins of at least 2 cm and line spacing of 1.5 lines. Every paragraph explains one type of idea.

3.1.3 Intended Audience and Reading Suggestions

The intended audiences for Tremor Detect includes the project supervisor, the BESE 23 FYP groups (developers), UG project evaluation team, and other personnel at MCS CSE Department.

3.1.3.1 Project Supervisor (A/P Bilal Rauf)

The project supervisor to check and guide the group about the understanding and implementation of the requirements properly and completely during the development lifecycle will use this document.

3.1.3.2 Developers (Tremor Detect Group)

For FYP group members, the document will ensure the development of the right project that fulfills the provided requirements.

3.1.3.3 Testers (Tremor Detect Group)

It will provide testers with an exact list of the features and functions that must be according to the requirements.

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To familiarize with the system's features and how to explain them for further clarification. Explaining technologies required, how the system will respond according to user's action, what possible system failures may happen and what are the solutions to all those failures etc.

3.1.3.6 UG Project Evaluation Team:

It will help the evaluation team to evaluate the progress of the FYP project. The document will provide the evaluators with the scope, requirements, and details of the project to be built.

3.1.3.7 Reading suggestions

The SRS begins with the title and table of contents. All level 1 and level 2 headings are given in the table of contents, but the lower subheadings are not included. Each main heading is succeeded by several subheadings, which are all in bold format. The product overview is given at the start, succeeded by the complete detailed features. The entire interface is also described.

3.1.4 Product Scope

This product intends to provide a convenient and an early diagnosis of Parkinson's disease by providing digitized versions of two PD detection tests: the spiral test and the wave test. Parkinson's disease can also be detected through characteristics of finger movement recorded

while typing using keystroke timing information. However, this test is beyond the scope of our project.

Through a web-based application, the user will be asked to trace a spiral or wave, which would be sent for testing. The image will run through the ML model and will notify the user with the result. The application prints out 2 results: "Healthy" vs. "Detection of Parkinson's" along with the quantitative result. Using this application, users will be able to detect PD from the comfort of their homes without an expensive visit to the hospital and possible exposure to COVID-19.

The digitized spiral/wave test provides a snapshot of the patient's condition, which can be shown to the doctor. Through Tremor Detect, we intend to advance diagnostic and progress measurement approaches for people with Parkinson's by reducing the need for routine clinic visits.

3.1.5 References

Following are the references and helping material we used for our understanding to make this document:

● Template referenced from IEEE **(INSPEC Accession Number:** 2476965) **Persistent Link:** http://ieeexplore.ieee.org/servlet/opac?punumber=2228

3.2 Overall Description

3.2.1 Product Perspective

This Product is a replacement of an existing solution to the following problem:

Parkinson's is a progressive, chronic illness. The cause is unknown and there are no cures. Treatment is effective if the disease is caught early enough and early tremors typically begin in the fingers and hands. For effective treatment of the disease, it is necessary to detect it at the earliest stage. Because of the delay in early detection caused due to waiting for doctor's appointments and scarcity of neurologists, the symptoms can worsen considerably. The whole process of appointments and tests is costly, time consuming and dangerous during the ensuing COVID-19 pandemic.

To overcome this problem, the tremor detect team has an innovative solution that will allow the users to detect Parkinson's at an early stage through a digitized spiral/wave test that will allow

progress tracking and detection. This solution reduces costs because of no travel and most importantly provides early detection, which is the most crucial factor in effective treatment.

3.2.2 Product Functions

The basic features of the system 'Tremor Detect' are listed below:

- User account creation.
- Login mechanism.
- Provide an intuitive, simple interface on the screen for performing each test.
- Performance of Digital Spiral Test.
- Performance of Digital Wave Test.
- Detection of tremors through digital image processing and Machine Learning.
- To Display the result of Digital Spiral Test.
- To Display the result of Digital Wave Test.
- Mechanism to calculate, record and display progress of the patient.
- Downloading Results/Progress report.
- To allow the user to log out.
- To allow the user to delete their account.

3.2.3 User Classes and Characteristics

Following are the User Classes and their level of usage, which can interact with the system (Tremor Detect) in any aspect with respect to the use/development/testing:

3.2.3.1 Tester (occasional user)

Testers will check the project for bugs and ensure that it is in accordance with the Software Requirements Specification document.

Testers include the following people:

- Developers
- Evaluation Panel

3.2.3.2 Project Supervisor (occasional user)

Project supervisor will evaluate the project and determine whether the product development is going in a smooth manner or not and whether the development team is meeting the deadlines or not.

3.2.3.3 Users / Patients (Regular user)

People who fear they have Parkinson's symptoms can use the product to undergo a spiral/wave test for possible Parkinson's detection without needing a Doctor's appointment. Patients can also track their progress through the progress-tracking feature. This will allow them to determine whether their tremors are improving or not.

3.2.4 Operating Environment

3.2.4.1 Software Requirements

- OpenCV.
- Python and its related libraries for example NumPy etc.
- Client-Side: JavaScript, HTML5, CSS, Bootstrap.
- Database: Microsoft Azure SQL database.
- Web browser for running the product requiring minimum HTML5.

3.2.4.2 Hardware Requirements

Client-Side Requirements:

- Touch Interface (Can be of a Mobile device/ Tablet/ Laptop)

Server-Side Requirements:

- Minimum 8GB RAM required
- Core i7 and above required
- Minimum 500 HDD storage or above is required.

3.2.5 Design and Implementation Constraints

This system has some constraints in the implementations and in designing. Some of the limitations and constraints the system has are discussed below:

- The digital spiral/wave test requires input via touch interface to be able to capture the tremors in the hands effectively.
- Dataset must be pre-available.
- Training deficiency of the model, as the dataset is limited hence the machine- learning model cannot be trained with100% accuracy.
- Web application hosting and database issues.

3.2.6 User Documentation

Tremor Detect is very easy and simple to use however, for the convenience of the user we are providing a complete guide on how to use the product. For this purpose, we intend to provide:

- User Manual that contains textual and pictorial help for users in guiding them to use the software correctly and troubleshooting it.
- A webpage in the website interface for the software that answers frequently asked questions and has a guide on using the software.

3.2.7 Assumptions and Dependencies

3.2.7.1 Assumptions:

- The user is comfortable and familiar with using touch interface.
- The user has a web browser in their device.
- The user will trace complete spiral/wave.

3.2.7.2 Dependencies:

- Dataset consisting of Parkinson patients and healthy people should be available to train models and effectively predict the results.
- Database is required for storing user information, test results and progress detection.
- An Internet connection is the major constraint for this application because it fetches data from the database over the Internet and stores data in the database. Hence it is critical that there is an Internet connection at all times while using the application.

3.3 External Interface Requirements

3.3.1 User Interfaces

UI plays a vital role when a user is interacting with the system. Tremor Detect has the following screens that the user can possibly interact with:

- Sign Up/Sign In screen
- Main Screen
- Test execution Screen
- Progress Tracking Screen

All these screens are explained below:

3.3.1.1 Sign Up/Sign In Screen

On this screen the new user will be asked to register/create an account and a returning user will be asked to sign in. This enables the relevant information to be stored in the database and the progress of each user to be tracked.

- **Sign In Interface:**

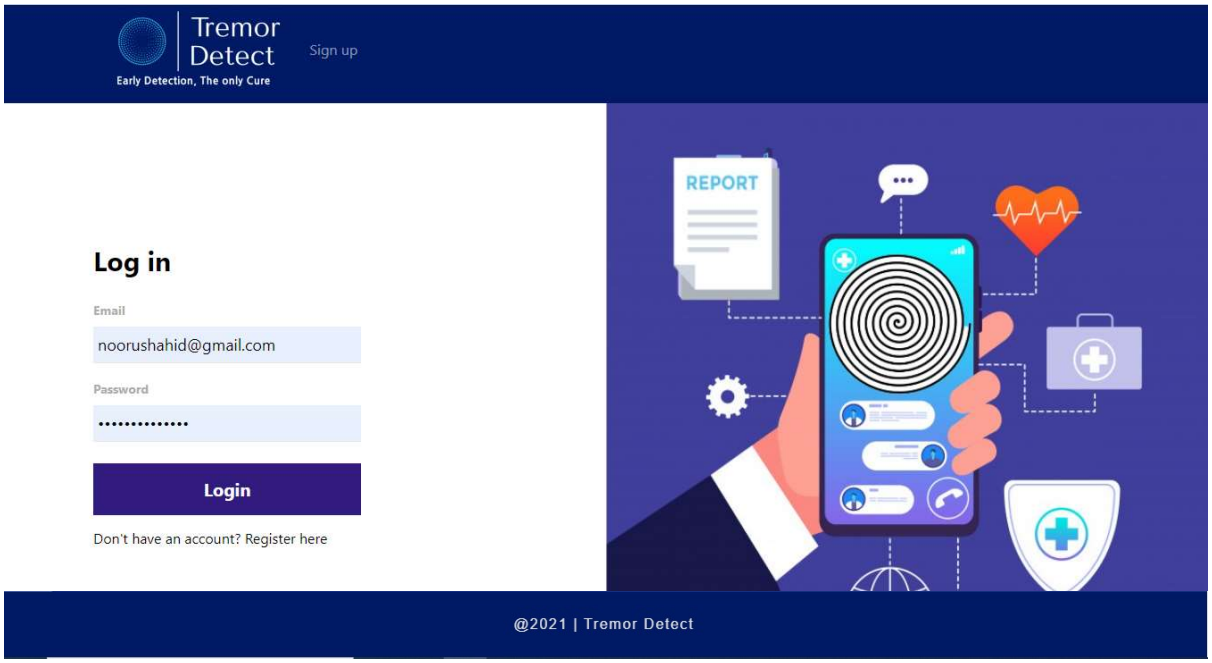


Figure 3.1 Sign In – Tremor Detect

- **Sign Up Interface:**

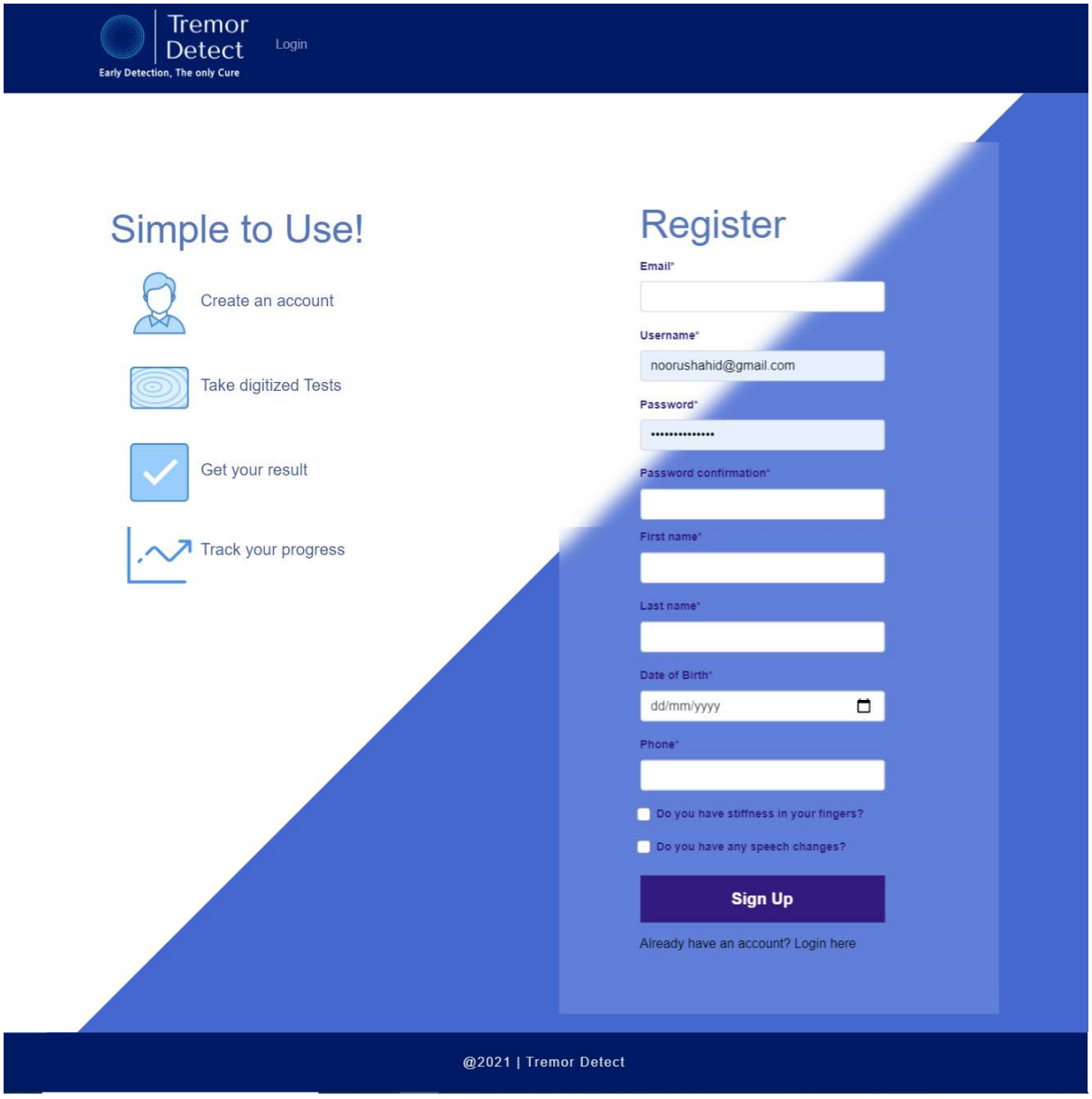


Figure 3.2 Sign Up Interface – Tremor Detect

3.3.1.2 Main Screen

This screen allows the user to choose between taking a detection test or viewing their progress based on the previous tests taken.

Tremor detect offers two tests for PD detection.

1. Spiral Test
2. Wave Test

There will be two buttons for tests and the user will be asked to choose one. The third button will ask the user to view their progress report.

- **Main Screen Interface:**

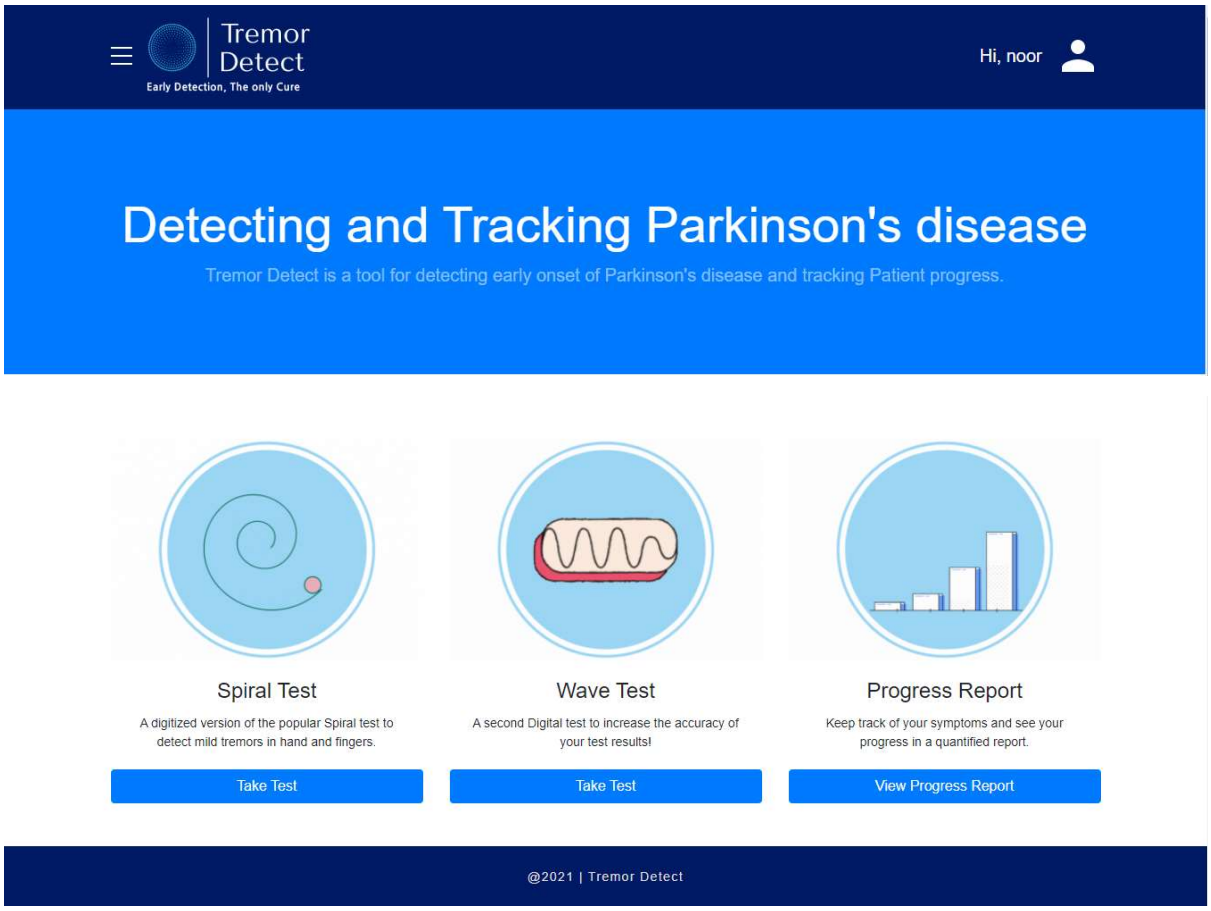


Figure 3.3 Main Screen – Tremor Detect

3.3.1.3 Test Execution Screen

On this screen, the user will be asked to trace a spiral or a wave depending upon the test chosen on the previous screen. This screen also shows the result of the detection test that the user had undergone. The user will also be able to download the result to their local machine.

- **Test Execution Screen Interface: (Screen 1)**

Figure 3.4 Test Execution Screen 1 – Tremor Detect

- **Test Execution Screen Interface: (Screen 2)**

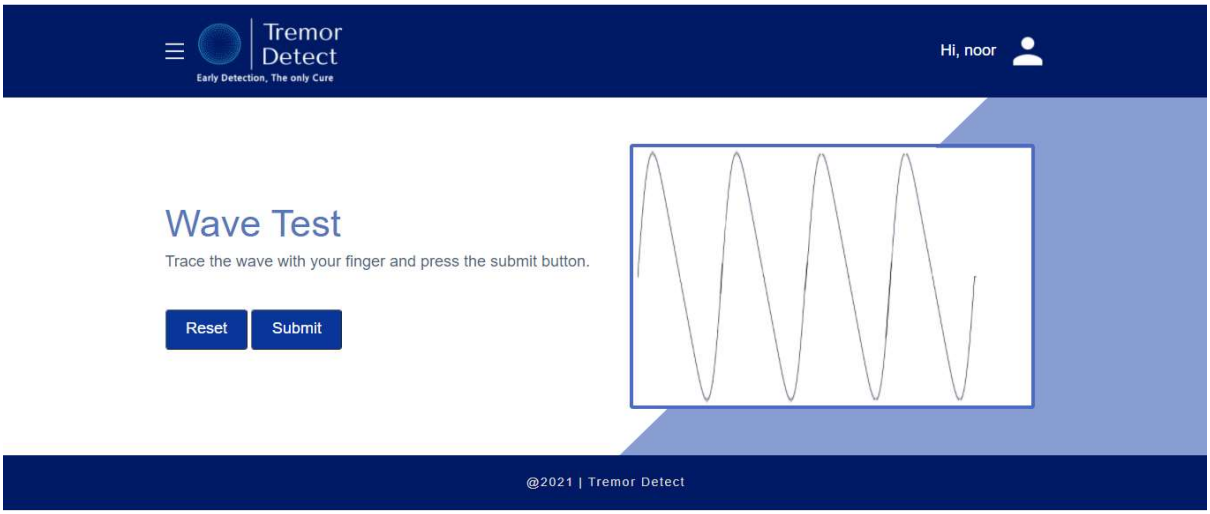


Figure 3.5 Test Execution Screen 2 – Tremor Detect

3.3.1.4 Test Result Screen

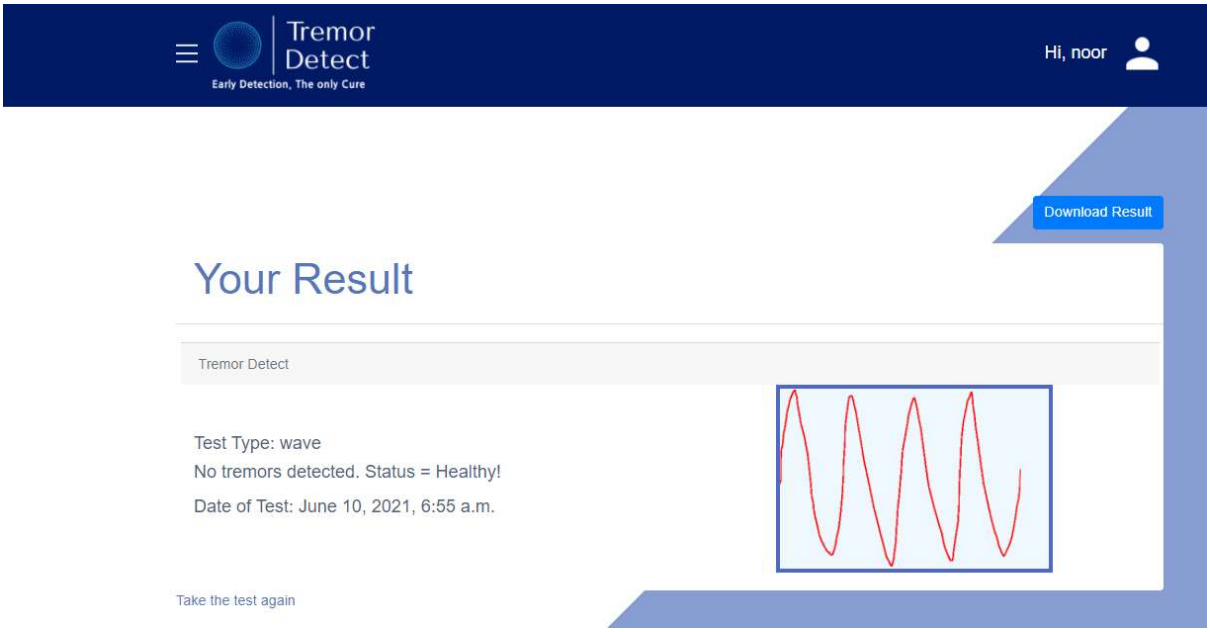


Figure 3.6 Test Result Screen – Tremor Detect

3.3.1.5 Download Test Result

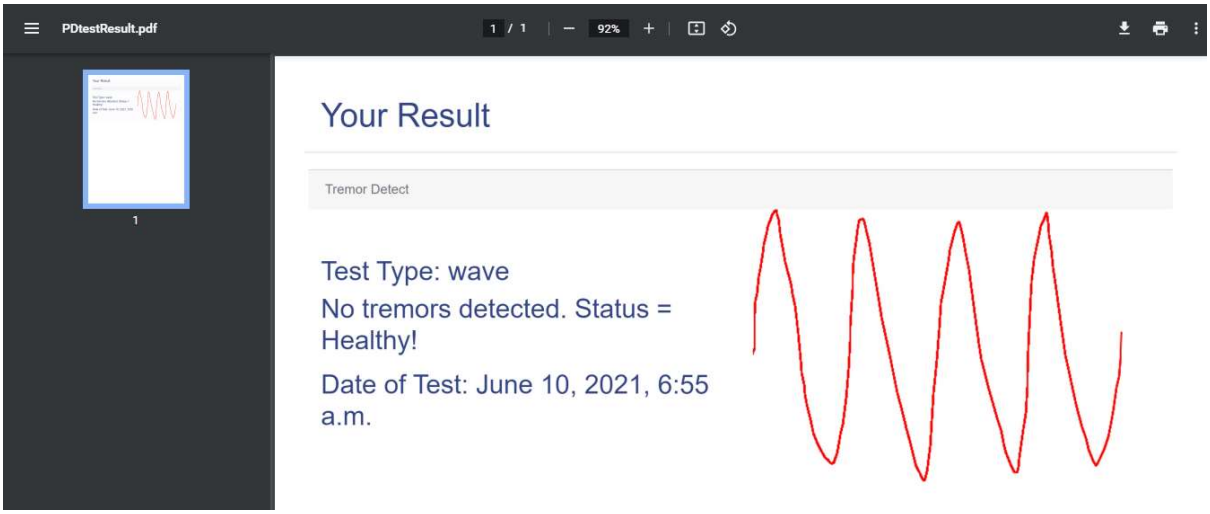


Figure 3.7 Test Result – Tremor Detect

3.3.1.6 Progress Tracking Screen

This screen shows the progress of the user's condition. This allows the user to check whether their symptoms have worsened or improved. The user will also be able to download their progress result to their local machine.

- **Progress Tracking Interface:**

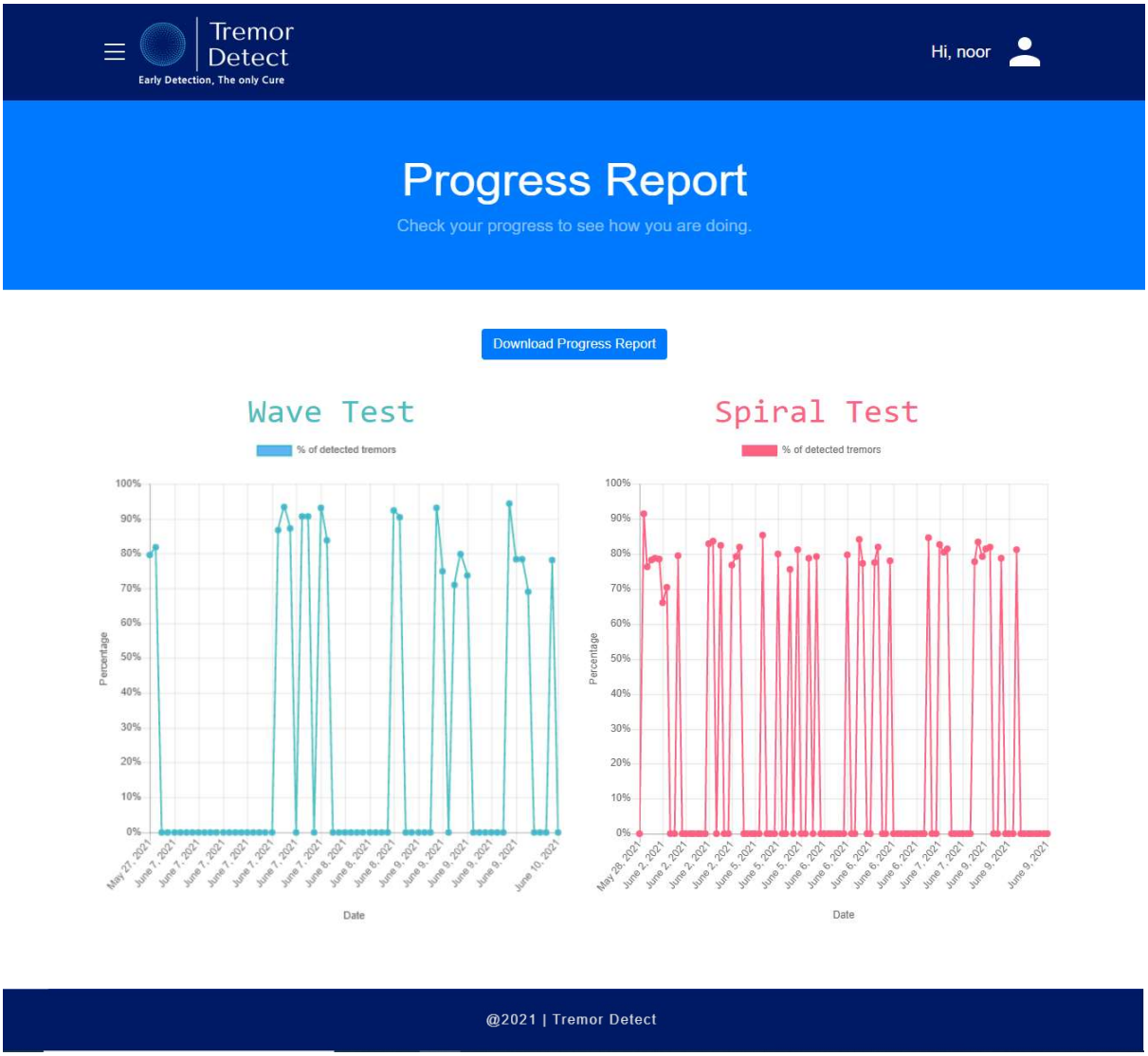


Figure 3.8 Progress Tracking – Tremor Detect

3.3.1.6.1 Download Progress Report Interface:

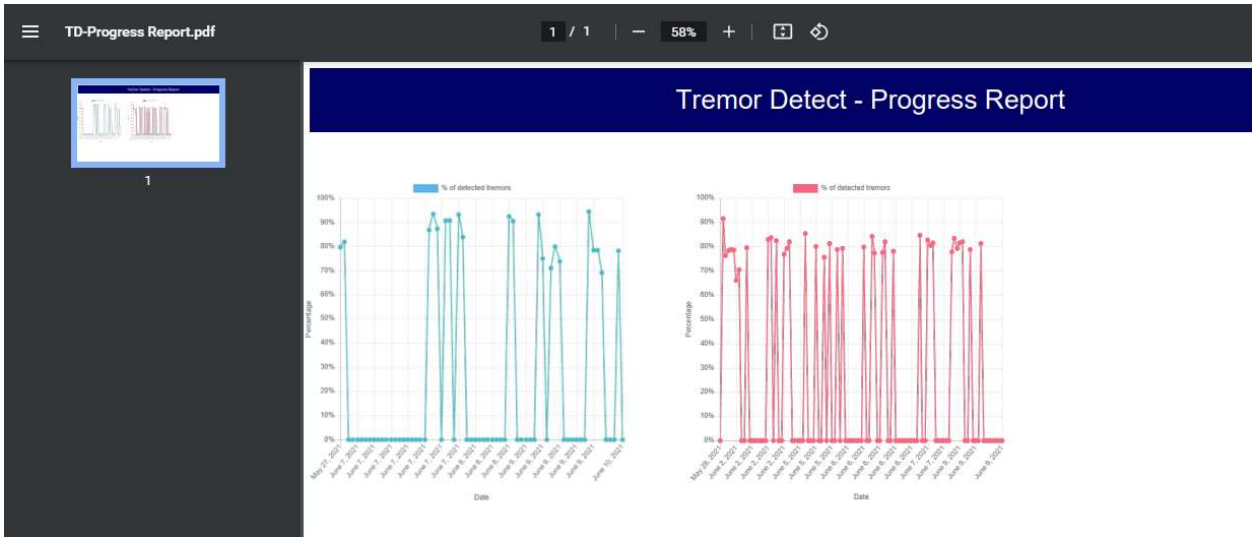


Figure 3.9 Progress Interface – Tremor Detect

3.3.2 Hardware Interfaces

Tremor Detect is a purely software-based product, which makes it very cost efficient and convenient to use. The only requirement of the hardware is that the device should be equipped with a touchscreen because the spiral and wave tests require a touch input for efficient tremor detection.

3.3.3 Software Interfaces

- Web browser with HTML5 (Chrome, Firefox etc.)
- Server-Side: Microsoft Azure
- Databases: Azure SQL Database
- NumPy will be used in mathematical computations and key point extraction
- OpenCV and SciPy will be used to process images

3.3.4 Communications Interfaces

Tremor detect is a web-based product and requires a web browser with HTML5. The network requirement is IP network using standard HTTP protocol.

3.4 System Features

System features are represented by functional hierarchy and use cases so that the main functions of the system will be understandable.

3.4.1 Create Account

3.4.1.1 Description

This feature allows account creation, which is required when the user first uses the system. On the sign-up screen, there will be mandatory fields required for users to fill their information in order to create their account.

3.4.1.2 Stimulus/Response Sequences

Stimulus: User opens web application

Response: The web application displays the welcome page with a create account button.

Stimulus: User clicks the create account button.

Response: Sign up screen is displayed

Stimulus: User enters the mandatory fields and presses the submit button

Response: User account is created, and information is stored in the database. The application displays the main screen.

3.4.1.3 Functional Requirements

REQ-1: The user will be able to successfully connect to the web application's server.
REQ-2: The user will be able to view and click the create account button.
REQ-3: The user will be able to enter mandatory fields and submit information.
REQ-4: The database shall be able to save the entered information.

3.4.2 Sign In

3.4.2.1 Description

Provides the user with a page to login to Tremor Detect.

3.4.2.2 Stimulus/Response Sequences

Stimulus: User opens web application.

Response: The web application displays the welcome page with a login button.

Stimulus: User clicks the Login button.

Response: Login Page is displayed.

Stimulus: User Enters Username and Password.

Response: Username and Password are validated from Database.

Stimulus: User Clicks on Login Button.

Response: Main Screen is displayed if Username and Password is correct else, Error Message is displayed.

3.4.2.3 Functional Requirements

REQ-1: The user will be able to view and click the Login button.
REQ-2: The user will be able to enter the username and password
REQ-3: The database will be able to validate username and password.

3.4.3 Delete Account

3.4.3.1 Description

This feature allows users to delete their account. The option to delete the account will be available on the home page. This function is of low priority because it will be rarely used, and no function depends on this function.

3.4.3.2 Stimulus/Response Sequences

Stimulus: User will click on view profile and the information screen shall be displayed.

Response: User will click on the Delete Account option available on the View profile screen.

Stimulus: A dialog will appear to confirm deletion of the account.

Response: A dialog will appear to confirm deletion of the account.

Stimulus: The user will click ‘Ok’.

Response: Account will be deleted from the database.

3.4.3.3 Functional Requirements

REQ-1: The system will allow user to delete their account.
REQ-2: The system will delete all the information of the user from the database.

3.4.4 Logout

3.4.4.1 Description

This feature allows users to logout of the web portal.

3.4.4.2 Stimulus/Response Sequences

Stimulus: User will select the logout option.

Response: The applications will successfully logout.

3.4.4.3 Functional Requirements

REQ-1: The system will allow user to log out from the application.
REQ-2: The system shall display the main log in page after user logs out

3.4.5 Spiral Test

3.4.5.1 Description

Provides the user with a spiral test performance page where the user will be able to trace a pre-drawn spiral.

3.4.5.2 Stimulus/Response Sequences

Stimulus: User successfully logs into the application

Response: Main page is displayed.

Stimulus: User selects a spiral test.

Response: Spiral test page is displayed with a pre-drawn spiral on screen.

Stimulus: User traces the spiral and clicks submit test button or else the user clicks reset button to perform the test again.

Response: Either the test is submitted, or the page is reset displaying the spiral again depending on the user input.

3.4.5.3 Functional Requirements

REQ-1: User will be able to view and select spiral test.

REQ-2: User will be able to view the spiral test page.

REQ-3: Spiral test page will display a clear and complete spiral of reasonable size.

REQ-4: Page will not refresh while the user is tracing the spiral.

REQ-5: The user will be able to reset and draw the spiral again.

REQ-6: User will be able to submit the test.

REQ-7: The database will be able to store the traced spiral.

REQ-8: On submission, the application will check if the spiral is traced completely.

3.4.6 Wave Test

3.4.6.1 Description

Provides the user with a test performance page where the user will be able to trace a pre-drawn wave.

3.4.6.2 Stimulus/Response Sequences

Stimulus: User successfully logs into the application

Response: Main page is displayed.

Stimulus: User selects wave test.

Response: Wave test page is displayed with a pre-drawn wave on screen.

Stimulus: User traces the wave and clicks submit test button or else the user clicks reset button to perform the test again.

Response: Either the test is submitted, or the page is reset displaying the wave again depending on the user input.

3.4.6.3 Functional Requirements

REQ-1: User will be able to view and select a wave test.

REQ-2: User will be able to view the wave test page.

REQ-3: Wave test page will display a clear and complete wave of reasonable size.

REQ-4: Page will not refresh while the user is tracing the wave.

REQ-5: The user will be able to reset and draw the wave again.

REQ-6: User will be able to submit the wave test.

REQ-7: The database will be able to store the traced wave.

REQ-8: On submission, the application will check if the wave is traced completely.

3.4.7 Detecting tremors through ML

3.4.7.1 Description

The traced pattern from the test screen will be used to detect tremors through Machine learning models trained with the help of the available dataset **Invalid source specified.Invalid source specified.**.

3.4.7.2 Stimulus/Response Sequences

Stimulus: the user successfully submits the test.

Response: The image is sent for processing

3.4.7.3 Functional Requirements

REQ-1: ML models should be trained and tested correctly

REQ-2: System should be able to process image and extract accurate key points.

REQ-3: System should be able to produce accurate result using the key points based on the trained ML model.

3.4.8 Progress Tracking

3.4.8.1 Description

This system feature allows the user to track their progress and determine whether the tremors have reduced or worsened.

3.4.8.2 Stimulus/Response Sequences

Stimulus: User clicks the Progress Tracking button from the menu screen.

Response: The application will compare all the previous test results and perform a statistical analysis. The user's progress will be displayed on the Progress Tracking screen.

3.4.8.3 Functional Requirements

REQ-1: User will be able to view and click the Progress Tracking button.

REQ-2: The application shall be able to access the database and fetch previous test results.

REQ-3: Accurate Quantitative analysis of the user's condition will be calculated based on previous tremor detection tests.

REQ-4: Simple and easily understandable figure will be displayed showing the user's progress.

3.4.9 Result Generation

3.4.9.1 Description

This system feature allows the user to view the result of the spiral or wave test after they have submitted their traced pattern for testing.

3.4.9.2 Stimulus/Response Sequences

Stimulus: User has successfully submitted the wave/spiral test.

Response: Test result will be displayed stating user's condition.

3.4.9.3 Functional Requirements

REQ-1: User will be able to view the test result.

REQ-2: The system shall be able to accurately determine the result.

REQ-3: System shall display result in easily understandable quantitative term.

3.4.10 Download

3.4.10.1 Description

This feature allows the user to download the test result and progress tracking report to their local machine.

3.4.10.2 Stimulus/Response Sequences

Stimulus: User clicks the download result button on the test detection screen.

Response: The traced spiral/wave and the result are downloaded to the user's local machine.

Stimulus: User clicks the download button on the progress-tracking screen.

Response: The user's progress report is downloaded to the user's local machine

3.4.10.3 Functional Requirements

REQ-1: System will download the specified document to the user's local machine.

REQ-2: The downloaded document will be understandable by the user.

3.4.11 Admin

3.4.11.1 Description

This feature allows the user to download the test result and progress tracking report to their local machine.

3.4.11.2 Stimulus/Response Sequences

Stimulus: Admin clicks the view users' button on the web application.

Response: The list of all users will be displayed.

Stimulus: Admin clicks the view tests' button on the web application.

Response: The list of all tests will be displayed.

Stimulus: Admin clicks the add user button on the web application.

Response: A new user will be added to the system.

Stimulus: Admin clicks the delete user button on the web application.

Response: The selected user will be deleted from the system.

Stimulus: Admin clicks the add test button on the web application.

Response: A new test will be added to the system.

Stimulus: Admin clicks the delete test button on the web application.

Response: The selected test will be deleted from the system.

3.5 Other Nonfunctional Requirements

3.5.1 Performance Requirements

3.5.1.1 Response Time
The web pages should load in less than 5 seconds.

3.5.1.2 Efficiency
Tremor Detect should be able to process the test result in minimum time.

3.5.1.3 Accessibility
Tremor Detect will be accessible across all devices equipped with a web browser and touch interface.

3.5.2 Safety Requirements
Tremor Detect is a web application and has no safety concerns. The use of the software product has no harms whatsoever; nor does it have any possibility of loss or damage that might be inflicted. If the app crashes, there will be no change in its original processing algorithms.

3.5.3 Security Requirements
- Every user will have access to only his/her own information/data.
- Any other user will breach no sensitive information of a user.
- A user will only be able to download their own progress report/result.
- The system will keep the user's information confidential so that their privacy is not breached.
- Every user needs to sign into the program; hence, each session is password protected

3.5.4 Software Quality Attributes

3.5.4.1 Reliability
In the event that the application crashes or becomes unresponsive, data loss will not occur. In case the server is down, it will automatically reboot.

3.5.4.2 Availability
The system will be available 24/7 as long as the user has an internet connection.

3.5.4.3 Correctness
The system will run the ML algorithms correctly and will display the correct result/Progress report.

3.5.4.4 Adaptability
The web application will be responsive and will adapt to a range of devices.

3.5.4.5 Portability
Tremor Detect is platform independent as long as the device has a touch interface and web browser.

3.5.4.6 Usability
Tremor Detect is simple, straightforward and user friendly. The detection test involves no hardware components making the application convenient to use.

3.5.4.7 Flexibility
The architecture and design of the application will be made flexible enough for catering any new requirements, if any emerge at some later stage for the application enhancement or for fixing bugs.

3.5.5 Business Rules
Tremor Detect does not specify any specific circumstances or any functions to be performed by specific individuals

CHAPTER 4 SOFTWARE DESIGN SPECIFICATION

This part of the document contains the software design specification for the product Tremor Detect.

4.1 Introduction

This document provides an overview of the entire SDS with purpose, scope, definitions, acronyms, abbreviations, references and overview of the SDS. The detailed descriptions and visualizations of the Tremor Detect are provided in this document.

4.1.1 Purpose

The aim of this document is to present a detailed description of the project Tremor Detect that uses machine learning and image processing techniques to detect early symptoms of Parkinson's Disease.

This document covers the software design specifications for Tremor Detect. The document is intended to inform stakeholders of the details of the design and its process. The document is meant to detail the design of features and requirements of Tremor Detect, to serve as a guide to the developers on one hand and a software validation document for the prospective client on the other. Document includes classes and their inter-relationships, use cases with detailed descriptions, sequence diagrams and architectural models.

4.1.2 Scope

This product intends to provide a convenient and an early diagnosis of Parkinson's disease.

- It provides digitized versions of two Parkinson's Disease detection tests: the spiral test and the wave test.
- Parkinson's Disease can also be detected using multiple characteristics of finger movement while typing using keystroke timing information. However, this test is beyond the scope of our project.
- Through a web-based application, the user will be asked to trace a spiral or a wave, which would be sent for testing. The image will be run through the ML model and will notify the user with the result. The application prints out two results: "Healthy" vs. " Parkinson's" along with the quantitative result.

Using this application, users will be able to:

- Detect PD from the comfort of their homes without an expensive visit to the hospital and possible exposure to COVID-19 [4].
- The digitized spiral/wave test provides a snapshot of the patient's condition, which can be shown to the doctor.
- Through Tremor Detect, we intend to advance diagnostic and progress measurement approaches for people with Parkinson's by reducing the need for routine clinic visits.

4.1.3 Overview

4.1.3.1 Heading
Multilevel headings are used. All headings are bold with font style Times New Roman. Level headings are of font size 18, level 2 of font size 14 and level 3 of font size 12.

4.1.3.2 Figures
All figures in this document have captions and are numbered. All diagrams are based on UML standards.

4.1.3.3 References
All references in this document are provided where necessary, however where not present, the meaning is self-explanatory. Glossary clarifies all the ambiguous terms.

4.1.3.4 Links to Web pages
All links have been provided with underlined font.

4.1.3.5 Basic Text

All other basic text appears in regular, size 12 Times New Roman with margins of at least 2 cm and line spacing of 1.5 lines.

4.1.4 Reference Material

- Approved SRS Document Version 1.0 For Tremor Detect.
- Use Case Modeling Guidelines, which documents the guidelines used to develop the use case model specifying the functional requirements in this specification.
- http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=787548
- MVC architecture from HCI book Building Interactive Systems- Principles of HCI- Dan Olsen
- http://en.wikipedia.org/wiki/Sequence_diagram

4.1.5 Definitions And Acronyms

SDD	Software Design Document
SRS	Software Requirement Specification
URD	User Requirement Document
PD	Parkinson's Disease
TD	Tremor Detect
DIP	Digital Imagining Processing
UML	Unified Modeling Language
MVC	Model View Controller

Table 4-1 Definitions and Acronyms

4.2 System Overview

4.2.1 Product Perspective

Tremor Detect aims to predict Parkinson's Disease by detecting tremors in the hand. Parkinson's Disease is a progressive, chronic illness with unknown cause and no cure. Treatment is effective if the disease is caught early enough and early tremors typically begin in the fingers and hands. For effective treatment of the disease, it is necessary to detect it at the earliest stage. Because of the delay in early detection caused due to waiting for doctor's appointments and scarcity of neurologists, the symptoms can worsen considerably. The whole process of appointments and tests is costly, time consuming and dangerous during the ensuing COVID-19 pandemic [4]. To overcome this problem, the tremor detect team has an innovative solution that will allow the users to detect Parkinson's at an early stage through a digitized spiral/wave test that will allow progress tracking and detection. This solution reduces costs because of no travel and most importantly provides early detection, which is the most crucial factor in effective treatment.

4.2.2 Context Diagram

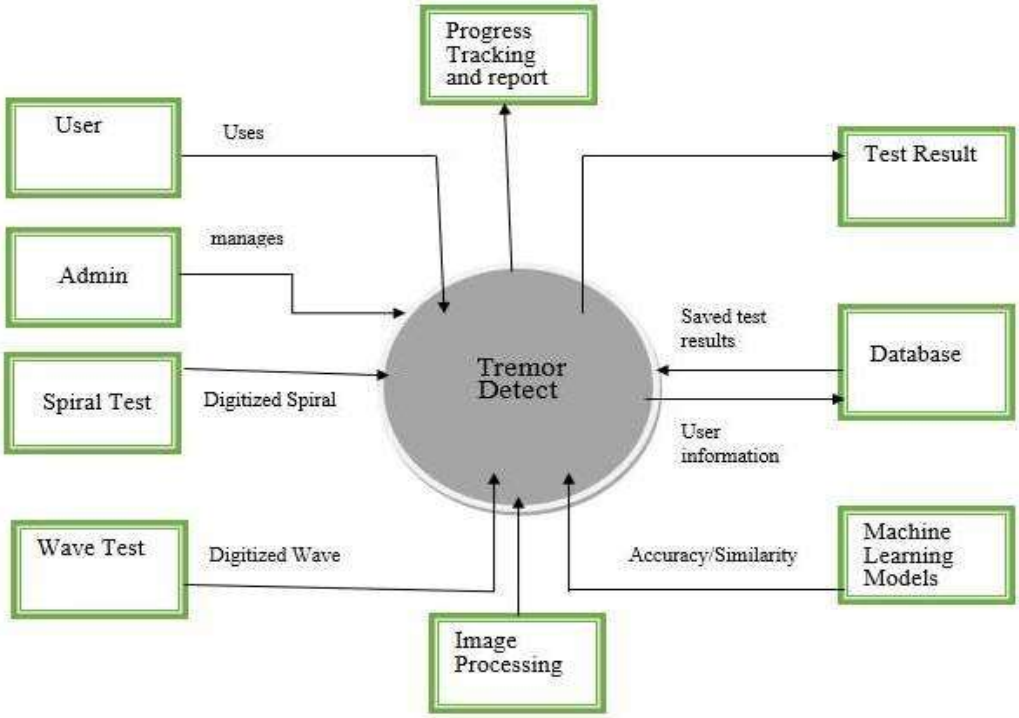


Figure 4.1 Context Diagram

4.2.3 Product Functions

The basic functions of the system ‘Tremor Detect’ are categorized as client and server-side functions:

4.2.3.1 Client Side

- User account creation
- An admin account to manage users (view, add and remove users)
- Log in function
- Provision of an intuitive, simple interface on the screen for performing each test.
- Performance of Digital Spiral Test.
- Performance of Digital Wave Test.
- Display the result of Digital Spiral Test.
- Display the result of Digital Wave Test.
- Downloading Results/Progress report.
- Log out function
- Account deletion

4.2.3.2 Server Side

- Stores user account information in the database.
- Processing input pattern from user through Digital Image Processing.
- Predicting Parkinson’s Disease through Machine Learning algorithms.
- Mechanism to calculate and store test results and progress of the patient.

4.3 System Architecture

4.3.1 ARCHITECTURAL DESIGN

Tremor Detect has a hybrid architectural design consisting of **MVC-Model View Controller** [5] and **Client Server Architecture** [6]. The MVC and Client Server divides the system into the following modules to achieve the complete functionality.

The **Client side** of the system architecture consists of view.

View:

The view shows the user and admin interface. It allows the user to sign in and sign up. The user is given the option to perform two types of tests; the spiral and wave test through tracing a pattern using a touch interface. Moreover, the view also allows the user to view and download the test result and progress report. Various functionalities will be provided to the admin to manage users.

The **Server side** of the architecture consists of Model and Controller

Model:

The Model is linked with the database that contains the user and admin account information and the results of the tests that have been taken by the user.

Controller:

The controller processes the user requests from the view and forwards them to the respective modules to generate the appropriate response. For example, if the user wants to track their progress, the view forwards the HTTP request to the controller. The controller in turn will interact with the model to fetch all the required data to plot the progress report. The controller sends the data back to the view which displays the progress report to the user. If the user wants to determine whether he/she has PD, then they will undertake a spiral/wave test. The view sends the traced image to the controller which sends it to Digital Image Processing module from where the extracted useful information is passed through Trained ML models.

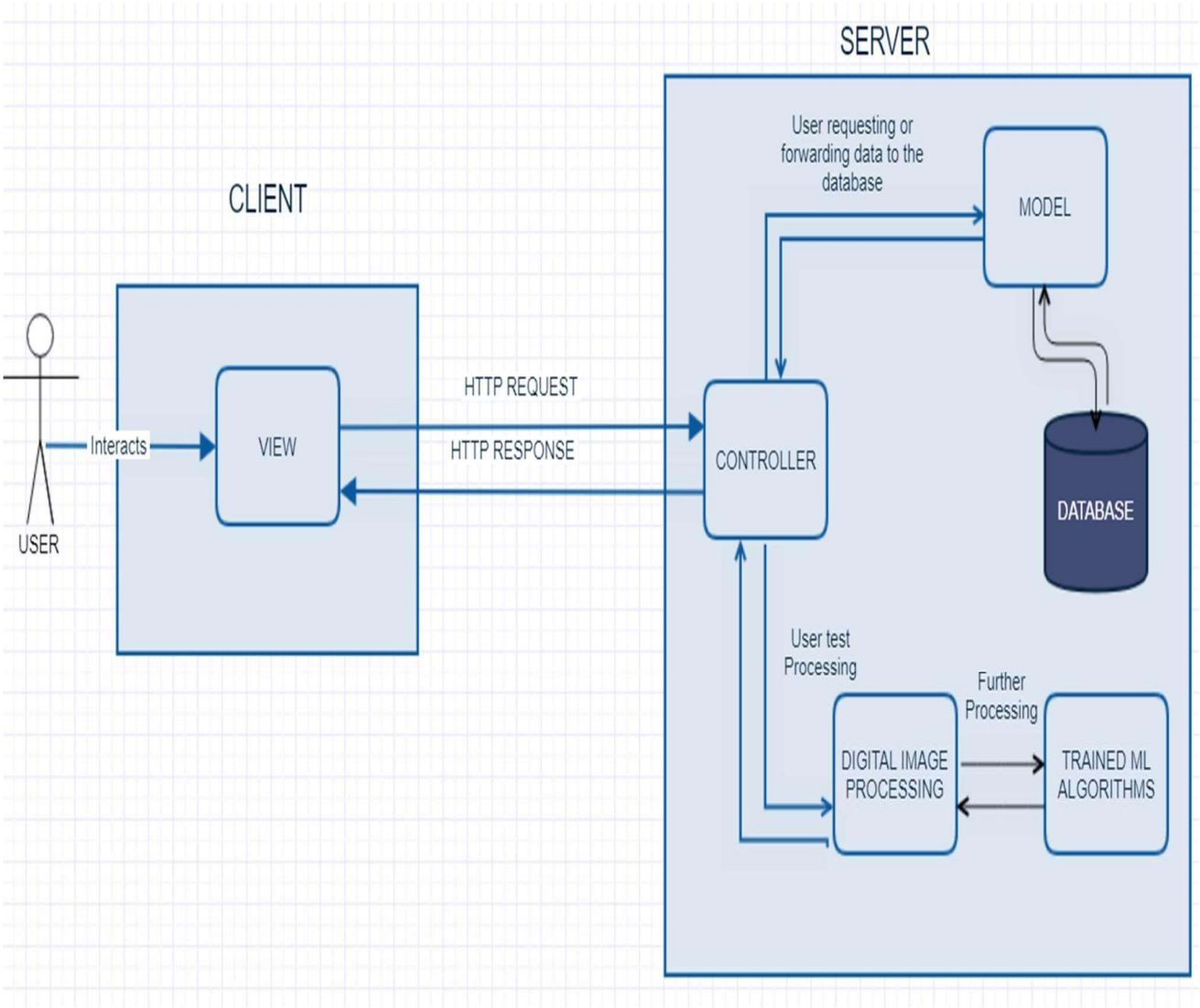


Figure 4.2 MVC Architecture Design of Tremor Detect

4.3.2 DECOMPOSITION DESCRIPTION

The decomposition of the subsystems shown in the architectural design is explained in the following ways.

4.3.2.1 Module Decomposition

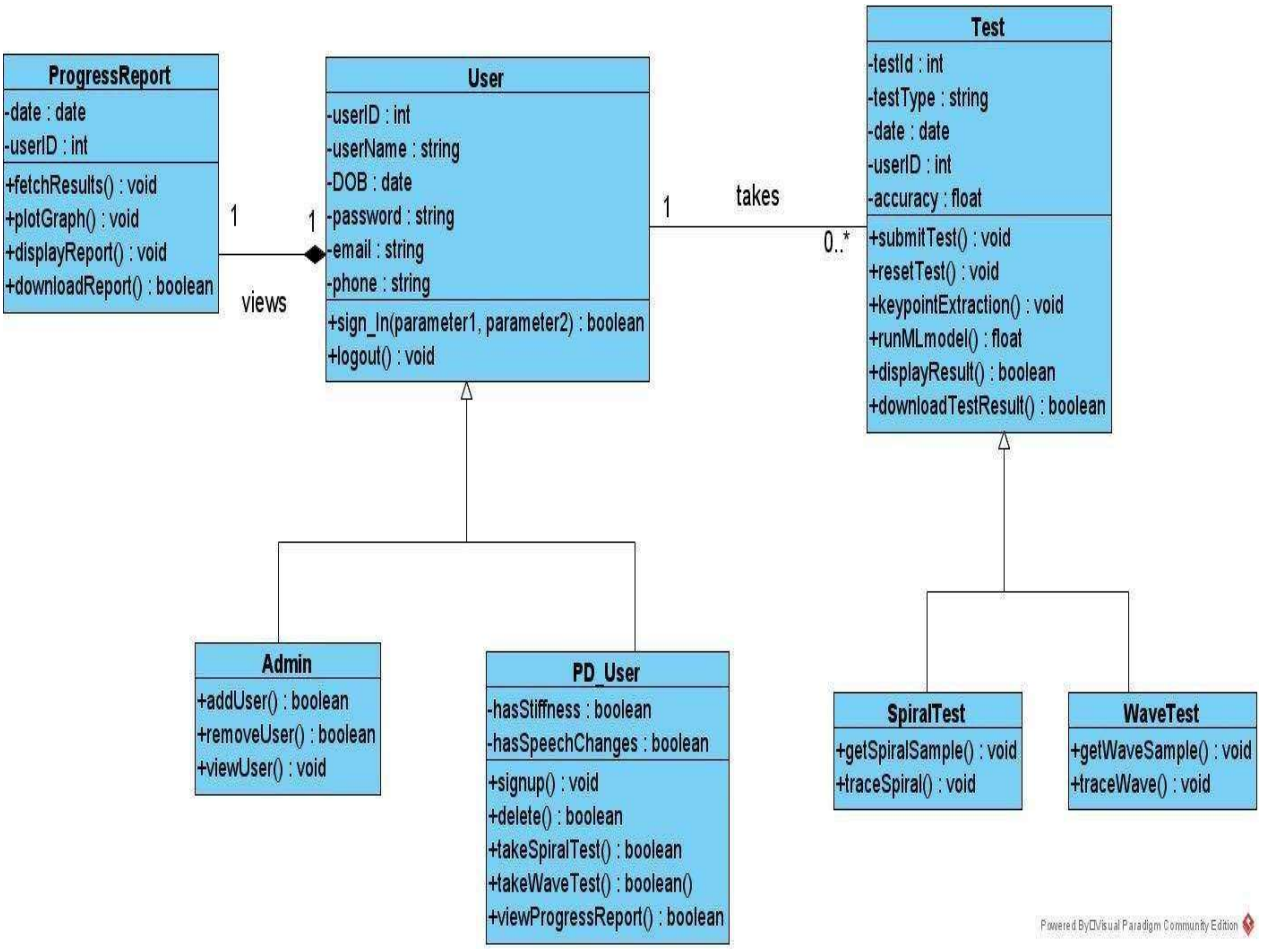


Figure 4.3 Class Diagram of Tremor Detect

The **class Diagram** of Tremor Detect consists of the following 7 classes.

1. User

The user class allows the user to use the functionalities provided by Tremor Detect. There are two kinds of users depending upon the functionalities: **Admin Class** and **PD_User Class**. Admin class allows the admin to manage the users. It stores admin information and provides functionalities like view, add and remove user.

PD_User class allows other users to sign up, take tests and view progress report.

2. Test

The test class contains the functionalities required to implement the tests and generate the test result. It is generalized into two more classes: **SpiralTest** and **WaveTest.** This class deals with Image Processing and Machine learning aspect of tremor Detect.

3. Progress Report

This class deals with downloading and displaying the progress report for the user. It generates the report by fetching the user test results from the database and plotting a graph through quantitative analysis.

4.3.2.2 Process Decomposition

The process decomposition is explained through use case and sequence diagrams which decompose the system into well-defined and cohesive processes. The use cases and the subsequent use case narratives explain the set of actions that a user undertakes while dealing with Tremor Detect.

4.3.2.2.1 Use Case Diagram:

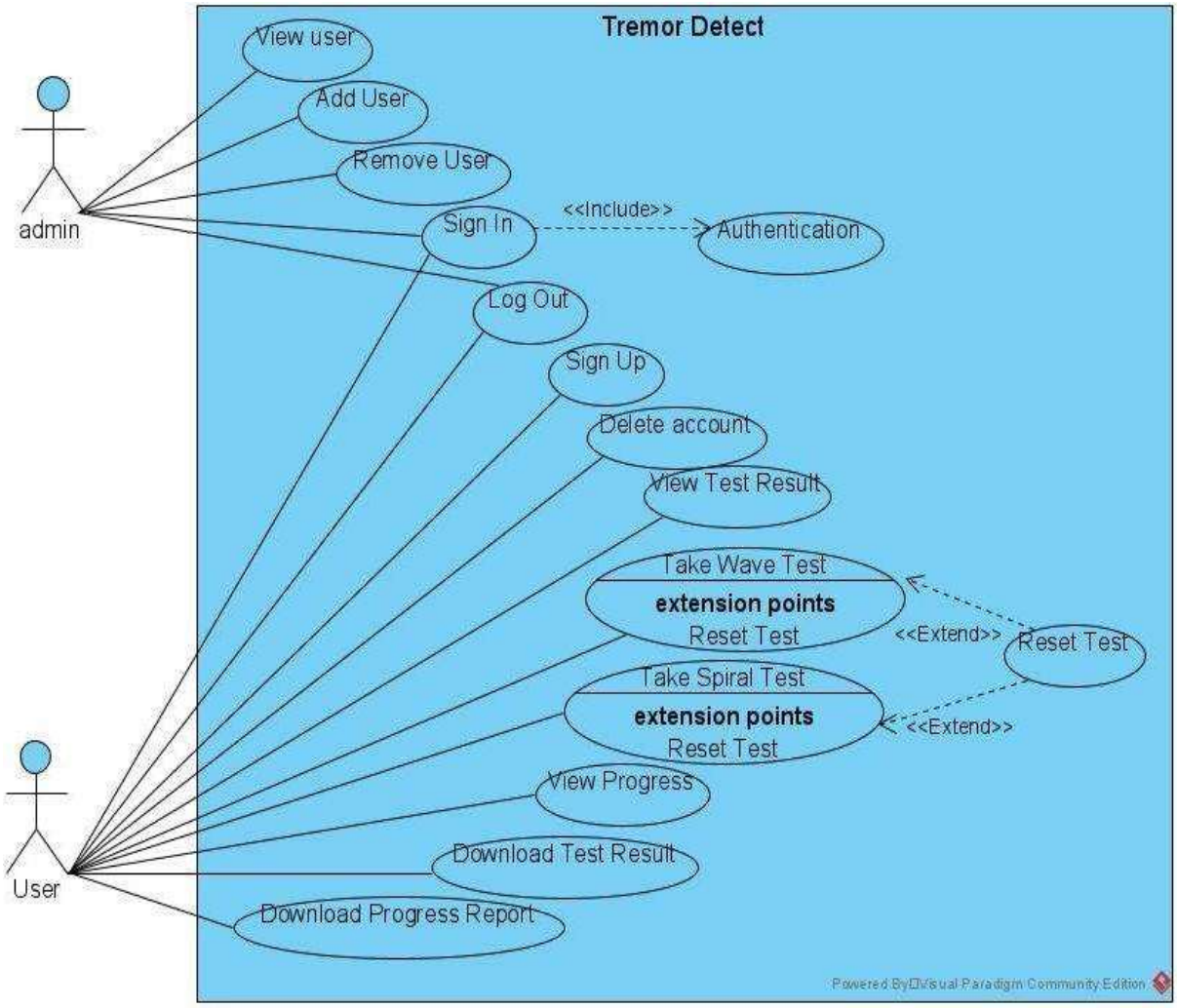
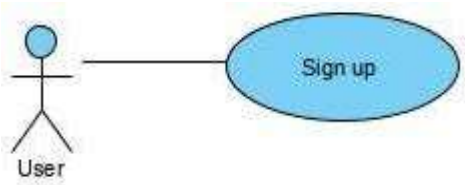


Figure 4.4 Use Case of Tremor Detect

4.3.2.3 Use Case Narratives

4.3.2.3.1 Sign up



4.5 Sign Up UC 1

Use Case ID:	UC-01		
Use Case Name:	Sign Up		
Actors:	User		
Created By:	Noor,Ammara, Aymen, Amjad	**Last Updated By:**	Noor, Ammara, Aymen, Amjad
Date Created:	27/12/2020	**Date Last Updated:**	27/12/2020
Description:	Customer creates his new account by providing his details and choosing a password.		
Preconditions:	The user must be at the sign-up page of the Tremor Detect website.		
Post conditions:	The user will have successfully created the account.		
Normal Flow (primary scenario):	After the user visits the sign-up page, the system will ask the user for personal details and a password to be chosen. If all the credentials entered by the user are correct, the account will be created successfully.		
Alternative Flows:	• If the user enters details in the wrong format, he will be asked to re-enter those details and then signup. • If the user chooses a weak password, he will be asked to choose a new password and then signup.		
Exception flows:	If the system crashes or the server is down, the account would not be made and the customer will have to sign up again.		

Table 4-2 Use Case Narrative UC 1

4.3.2.3.2 Sign In

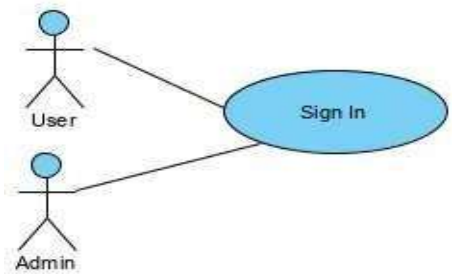
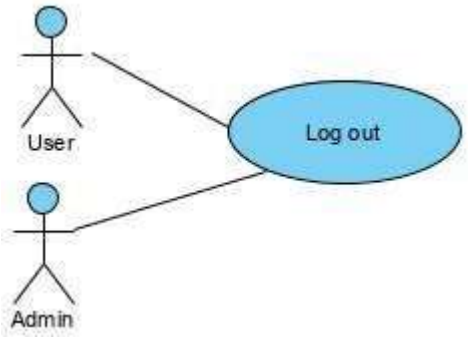


Figure 4.6 Sign In UC-2

Use Case ID:	UC-02		
Use Case Name:	Sign In		
Actors:	User, Admin		
Created By:	Noor, Ammara, Aymen, Amjad	**Last Updated By:**	Noor, Ammara, Aymen, Amjad
Date Created:	27/12/2020	**Date Last Updated:**	27/12/2020
Description:	Allows user to log into his account by entering the username and password.		
Preconditions:	The user must have an existing account in the system.		
Post conditions:	The user will either successfully login or will be asked to re-enter the credentials.		
Normal Flow (primary scenario):	The system first displays a welcome message. The user will then be asked to enter the username and password. The user will enter the credentials and after successful validation the user will log into his account.		
Alternative Flows:	If the user is using the account after a period of six months or more, they will be asked to change the password and then log in. The user may forget his password and choose to change it and then log in.		
Exception flows:	If the user enters incorrect credentials 3 times successively, user will be displayed the reset password option.		

Table 4-3 Use Case Narrative UC 2

4.3.2.3.3 Logout



4.7 Log Out UC-3

Use Case ID:	UC-03		
Use Case Name:	Log Out		
Actors:	User, Admin		
Created By:	Noor,Ammara, Aymen, Amjad	**Last Updated by:**	Noor,Ammara, Aymen, Amjad
Date Created:	27/12/2020	**Date Last Updated:**	27/12/2020
Description:	Allows user to log out of his account.		
Preconditions:	The user must be logged into the system.		
Post conditions:	The user will successfully logout.		
Normal Flow (Primary scenario):	User will click on the logout button provided on the rightmost corner of every screen which will end his session and bring him back to the sign- in page.		
Alternative Flows:	The user does not explicitly logout and closes the website. In this case he will automatically be logged out of the system after a certain time of inactivity.		
Exception flows:	If the system crashes or the server is down, user will not be able to log out.		

Table 4-4 Use Case Narrative UC 3

4.3.2.3.4 DeleteAccount

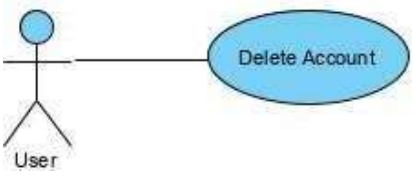


Figure 4.8 Delete Account UC 4

Use Case ID:	UC-04		
Use Case Name:	Delete Account		
Actors:	User		
Created By:	Noor,Ammara, Aymen, Amjad	**Last Updated by:**	Noor,Ammara, Aymen, Amjad
Date Created:	27/12/2020	**Date Last Updated:**	27/12/2020
Description:	Allows user to successfully delete his account.		
Preconditions:	The user must have an existing account in the system and must be logged in.		
Post conditions:	The system will delete user's account and their relevant data from the database.		
Normal Flow (primary scenario):	The system will provide an option of "Delete Account" to the user on Main Screen. User will click on it and confirm the deletion of account because of which his account will be deleted.		
Alternative Flows:	In case the user is inactive for a year, his account will be deleted by the system automatically.		
Exception flows:	If the system crashes or the server is down, user will not be able to complete the action.		

Table 4-5 Use Case Narrative UC 04

4.3.2.3.5 Take Spiral Test

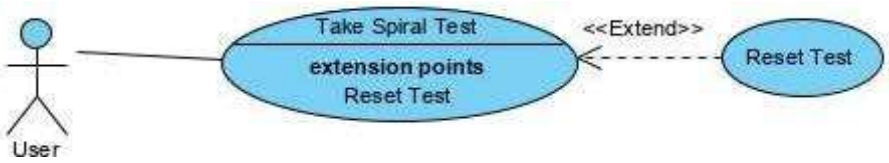


Figure 4-9 Spiral Test UC-5

Use Case ID:	UC-05		
Use Case Name:	Take Spiral Test		
Actors:	User		
Created By:	Noor,Ammara, Aymen, Amjad	**Last Updated by:**	Noor,Ammara, Aymen, Amjad
Date Created:	27/12/2020	**Date Last Updated:**	27/12/2020
Description:	Allows user to take Spiral Test by tracing the spiral and then clicking the submit button.		
Preconditions:	The user must be logged in to account and must have selected the "Spiral Test" option.		
Post conditions:	The user will have taken the spiral test and submitted it.		
Normal Flow (primary scenario):	The user will trace the spiral and then click the "submit button" to successfully take the test.		
Alternative Flows:	The user will trace the spiral and then click the "Reset button" to take the test again and then follow the normal flow.		
Exception flows:	● If the system crashes or the server is down, user will not be able take the spiral test. ● If internet is not available, the user will have to take the test again.		

Table 4-6 Use Case Narrative UC 05

4.3.2.3.6 Take Wave Test

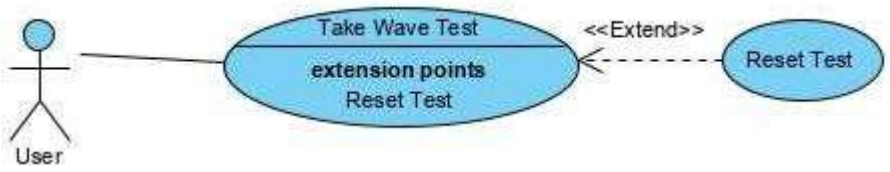


Figure 4-10 Wave Test UC 061

Use Case ID:	UC-06		
Use Case Name:	Take Wave Test		
Actors:	User		
Created By:	Noor, Ammara, Aymen , Amjad	**Last Updated by:**	Noor,Ammara, Aymen , Amjad
Date Created:	27/12/2020	**Date Last Updated:**	27/12/2020
Description:	Allows user to take Wave Test by tracing the wave and then clicking the submit button.		
Preconditions:	The user must be logged in to account and must have selected the "Wave Test" option.		
Post conditions:	The user will have taken the wave test and submitted it.		
Normal Flow (primary scenario):	The user will trace the wave and then click the "submit button" to successfully take the test.		
Alternative Flows:	The user will trace the wave and then click the "Reset button" to take the test again and then follow the normal flow.		
Exception flows:	● If the system crashes or the server is down, user will not be able take the wave test. ● If internet is not available, the user will have to take the test again.		

Table 4-7Use Case Narrative UC 6

4.3.2.3.7 View TestResult

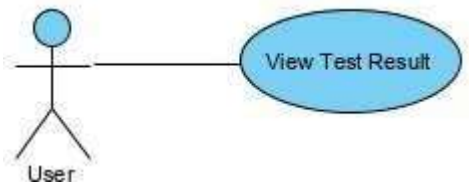


Figure 4-11 View Test Result UC 071

Use Case ID:	UC-07		
Use Case Name:	View Test Result		
Actors:	User		
Created By:	Noor, Ammara, Aymen , Amjad	**Last Updated By:**	Noor,Ammara, Aymen , Amjad
Date Created:	27/12/2020	**Date Last Updated:**	27/12/2020
Description:	User will be able to view the test result indicating if the user has Parkinson's or not alongside the traced test pattern.		
Preconditions:	The user must have taken and submitted the test successfully.		
Post conditions:	The user will be able to successfully view his/her test results.		
Normal Flow (primary scenario):	The user will submit the test after which the users submitted pattern will be digitally processed to extract the key points. These then will be passed through Machine Learning Algorithms to calculate and display the test results.		
Alternative Flows:	NIL		
Exception flows:	● If the system crashes or the server is down, the system will not be able to calculate and display the test result. ● If internet is not available, the user will have to take the test again.		

Table 4-8 Use Case Narrative UC 07

4.3.2.3.8 Download Test Result

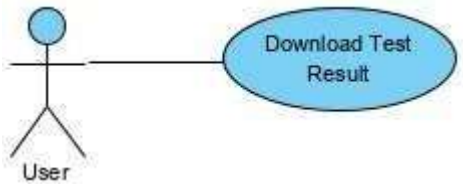


Figure 4-12 Download Test Result UC 08

Use Case ID:	UC-08		
Use Case Name:	Download Test Result		
Actors:	User		
Created By:	Noor, Ammara, Aymen , Amjad	**Last Updated By:**	Noor,Ammara, Aymen, Amjad
Date Created:	27/12/2020	**Date Last Updated:**	27/12/2020
Description:	Users will be able to download the generated test result.		
Preconditions:	The user's test result must have been generated and displayed successfully.		
Post conditions:	The user's test result will be successfully downloaded to the local machine.		
Normal Flow (primary scenario):	The user will click the "Download Test Result" button and the report will be downloaded successfully to the local machine.		
Alternative Flows:	NIL		
Exception flows:	• If the system crashes or the server is down, the system will not be able to download the test result successfully. • If internet is not available, the report will be downloaded after the local machine has been successfully connected to the internet.		

Table 4-9 Use Case Narrative UC 8

4.3.2.3.9 View Progress

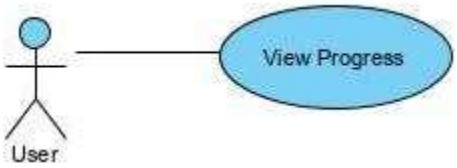


Figure 4.13 View User UC

Use Case ID:	UC-09		
Use Case Name:	View Progress		
Actors:	User		
Created By:	Noor, Ammara, Aymen , Amjad	**Last Updated by:**	Noor,Ammara, Aymen , Amjad
Date Created:	27/12/2020	**Date Last Updated:**	27/12/2020
Description:	Allows the user to view their progress and determine whether the tremors have reduced or worsened. Quantitative analysis of the user's condition alongside a statistical figure will be displayed.		
Preconditions:	The user must have an account and undertaken one or more than one test.		
Post conditions:	The system will display the user's progress report.		
Normal Flow (primary scenario):	After the "View Progress Report" button has been clicked by the user, the system will fetch the previous test results from the database, perform a quantitative analysis and display the progress report successfully on the screen.		
Alternative Flows:	NIL		
Exception flows:	● If the user has not taken any test, the system will display a message of "No Tests Taken!" ● If the system crashes or the server is down, the system will not be able to display the progress report. ● If internet is not available, the report will be displayed after the local machine has been successfully connected to the internet.		

Table 4-10 Use Case Narrative UC 9

4.3.2.3.10 Download Progress Report

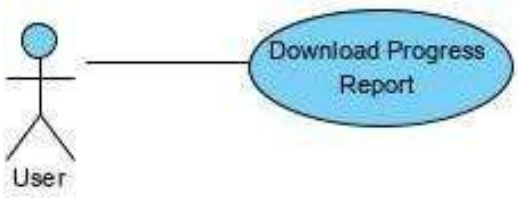


Figure 4-14 Download Progress Results UC

Use Case ID:	UC-10		
Use Case Name:	Download Progress Report		
Actors:	User		
Created By:	Noor, Ammara, Aymen , Amjad	**Last Updated By:**	Noor, Ammara, Aymen , Amjad
Date Created:	27/12/2020	**Date Last Updated:**	27/12/2020
Description:	Allows the user to download the generated progress report.		
Preconditions:	The progress report of the user must have been successfully generated.		
Post conditions:	The user's progress report will be successfully downloaded to the local machine.		
Normal Flow (primary scenario):	The user will click the "Download Progress Repor" button and the report will be downloaded successfully to the local machine.		
Alternative Flows:	NIL		
Exception flows:	● If the system crashes or the server is down, the system will not be able to download the test result successfully. ● If internet is not available, the report will be downloaded after the local machine has been successfully connected to the internet.		

Table 4-11 Use Case Narrative UC 10

4.3.2.3.11 Reset Test

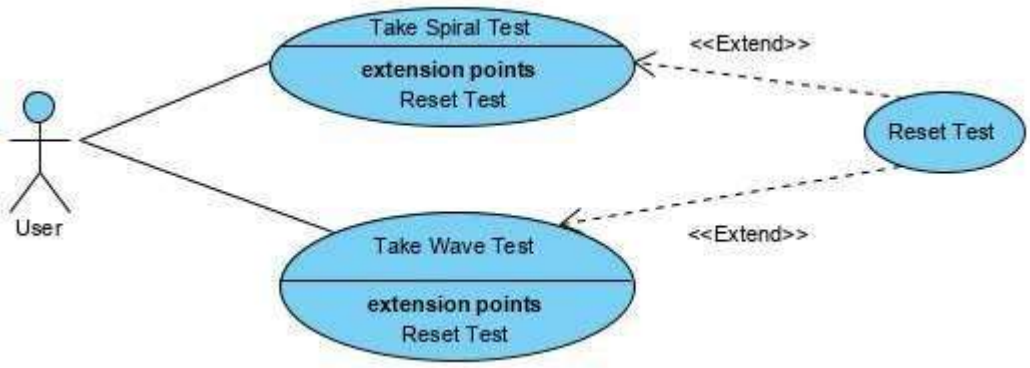


Figure 4.15 Reset Test UC

Use Case ID:	UC-11		
Use Case Name:	Reset Test		
Actors:	User		
Created By:	Noor, Ammara, Aymen , Amjad	**Last Updated By:**	Noor, Ammara, Aymen , Amjad
Date Created:	27/12/2020	**Date Last Updated:**	27/12/2020
Description:	Allows the user to reset the traced pattern and take the test again.		
Preconditions:	The user should be on the selected test screen.		
Post conditions:	The selected test screen will be displayed again with an untraced pattern.		
Normal Flow (primary scenario):	The user will click the "Reset" button and then the traced pattern will be erased displaying the selected test screen along with the pre drawn pattern for the user to trace again.		
Alternative Flows:	The user can also press the reset button without tracing the pattern. In this case, again the selected test screen along with the pre drawn pattern for the user to trace will be displayed.		
Exception flows:	If the system crashes or the server is down, the action will be unsuccessful.		

Table 4-12 Use Case Narrative UC 11

4.3.2.3.12 Remove User

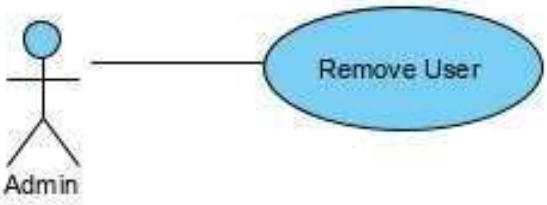


Figure 4-16 Remove User UC

Use Case ID:	UC-12		
Use Case Name:	Remove User		
Actors:	Admin		
Created By:	Noor,Aymen, Ammara, Amjad	**Last Updated By:**	Noor,Aymen, Ammara, Amjad
Date Created:	27/12/2020	**Date Last Updated:**	27/12/2020
Description:	Allows admin to remove current users.		
Preconditions:	The admin must be logged in and the user/s he wishes to remove must already be registered.		
Post conditions:	The admin will have removed the user and his relevant data from the system.		
Normal Flow (primary scenario):	The system will provide an option of "Remove User" to the admin on his dashboard. The system will then display all the currently registered users from who admin can remove any of them.		
Alternative Flows:	Admin can also search a particular user's account by their name and then delete the resultant account/s.		
Exception flows:	If the admin searches for a user's account/information that is not in the system, the system will display an error message. If the system crashes or the server is down, the admin will not be able to complete the action.		

Table 4-13 Use Case Narrative UC 12

4.3.2.3.13 View User

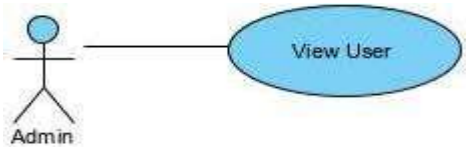


Figure 4-17 View User UC

Use Case ID:	UC-13		
Use Case Name:	View Users		
Actors:	Admin		
Created By:	Noor,Aymen, Ammara, Amjad	**Last Updated By:**	Noor,Aymen, Ammara, Amjad
Date Created:	27/12/2020	**Date Last Updated:**	27/12/2020
Description:	Allows admin to view various data of all users.		
Preconditions:	The admin must be logged in.		
Post conditions:	The system will display certain user's information that admin wishes to see.		
Normal Flow (primary scenario):	The system will provide an option of "View User" to the admin on his dashboard. All Users' data will then be displayed before the admin.		
Alternative Flows:	Admin can also search a particular user's info or filter it based on some attributes and then view the resultant data.		
Exception flows:	□ If admin searches for a user's information that is not in the system, the system will display a message indicating the error. □ If the system crashes or if the server is down,the admin will not be able to complete the action.		

Table 4-14 Use Case Narrative UC 13

4.3.2.3.14 Add User

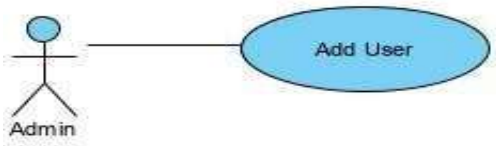


Figure 4-18 Add User UC

Use Case ID:	UC-14		
Use Case Name:	Add User		
Actors:	Admin		
Created By:	Noor,Aymen, Ammara, Amjad	**Last Updated By:**	Noor,Aymen, Ammara, Amjad
Date Created:	27/12/2020	**Date Last Updated:**	27/12/2020
Description:	Allows admin to add new users to the system.		
Preconditions:	The admin must be logged in and the user/s he wishes to add must not already be registered.		
Post conditions:	The admin will register the user and add his relevant information into the system's database.		
Normal Flow (primary scenario):	The system will provide an option of "Add User" to the admin on his dashboard. The system will then display the user registration page where admin will be required to enter credentials in the fields for the successful registration.		
Alternative Flows:	Nil		
Exception flows:	If admin attempts to add an already existing user, system will throw an exception displaying error message. If the system crashes or the server is down, admin will not be able to complete the action.		

Table 4-15 Use Case Narrative UC 14

4.3.2.3.15 Sequence Diagrams

1. Sign Up

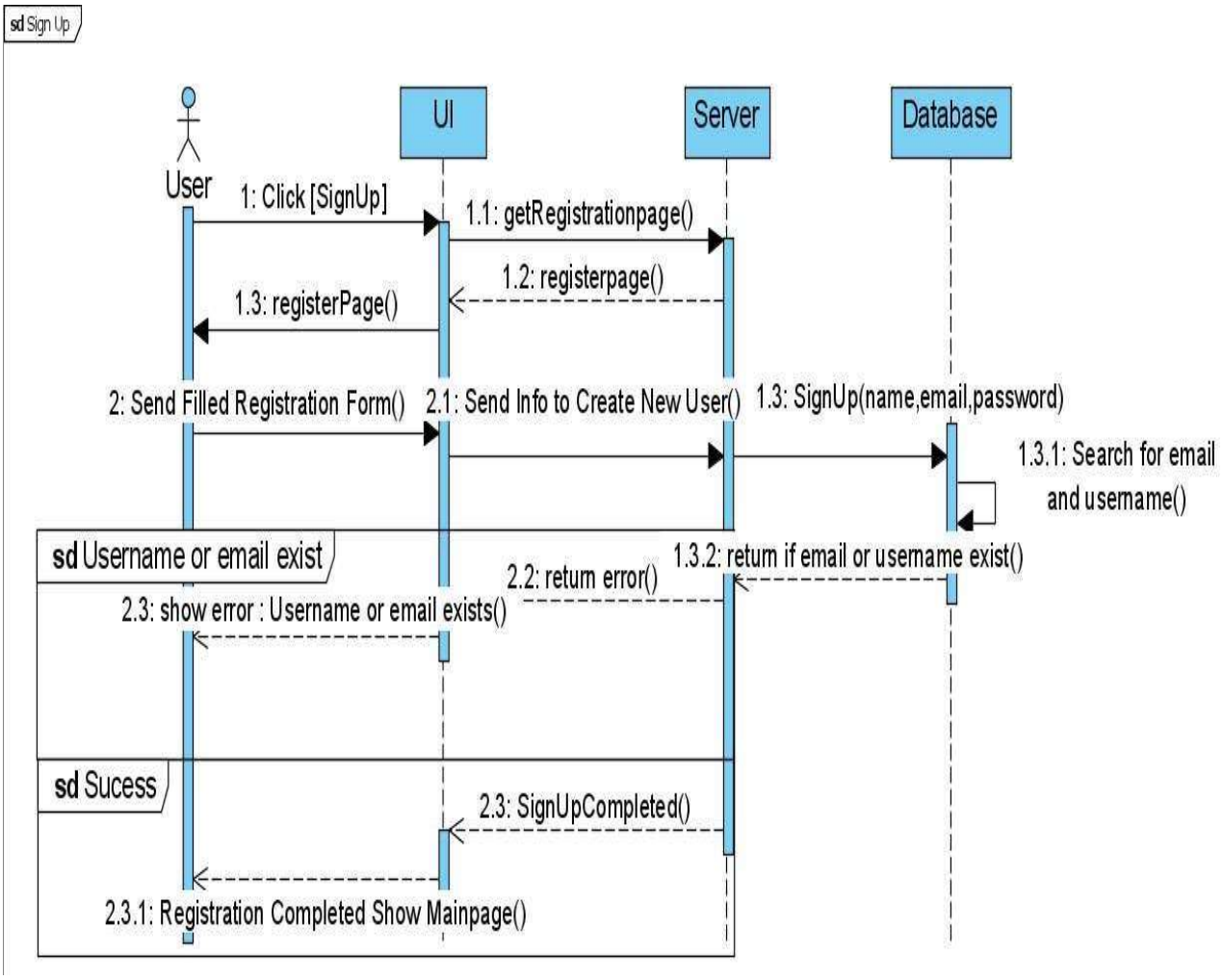


Figure 4-18 Sign Up Seq Diagram

2. Sign In

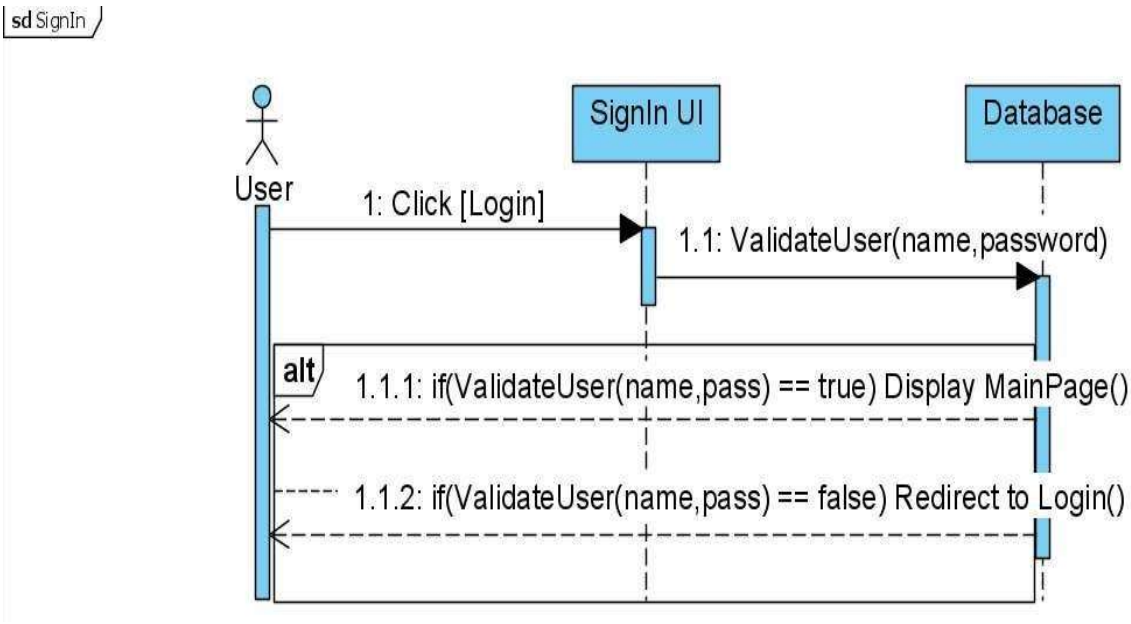


Figure 4-19 Sign In Seq Diagram

F

3. Logout

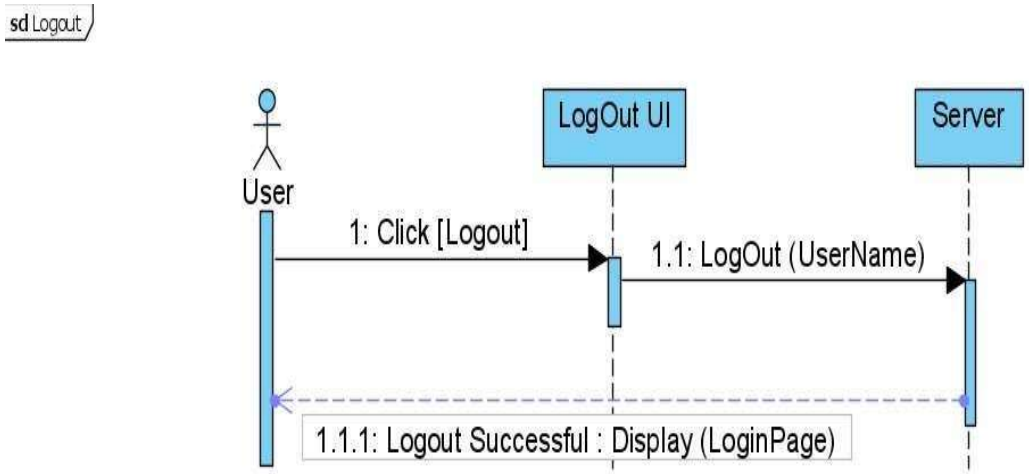


Figure 4.20 Logout Seq Diagram

4. Delete Account

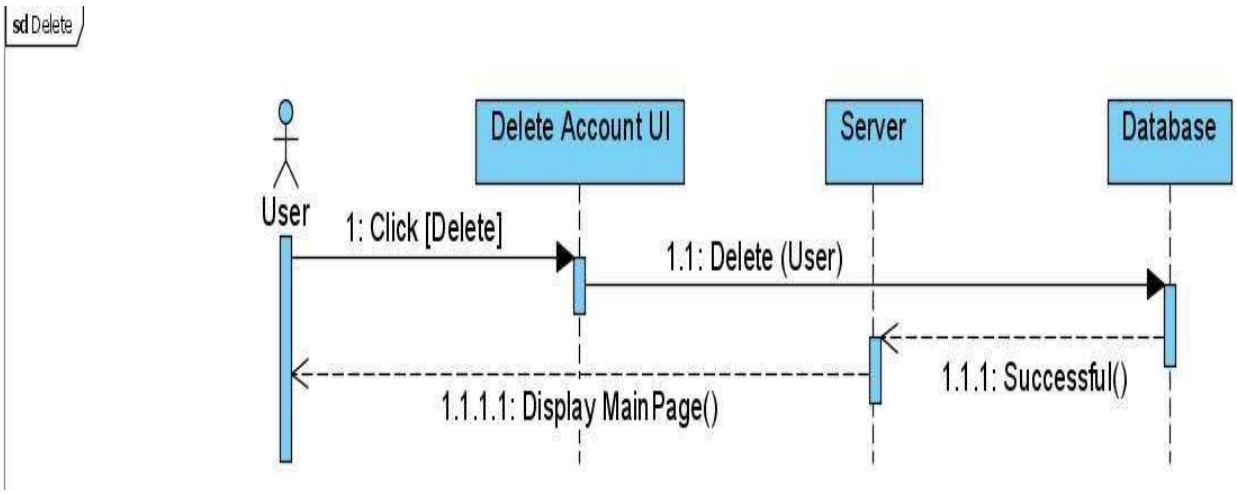


Figure 4-21 Delete Seq Diagram

5. Wave Test

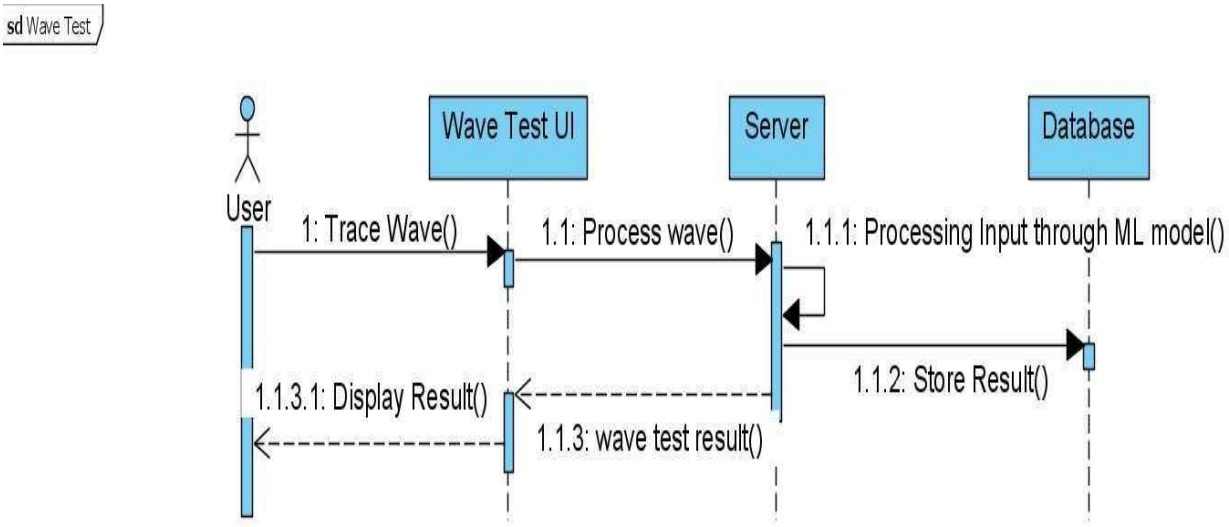


Figure 4-22 Wave Test Seq Diagram 1

6. Spiral Test

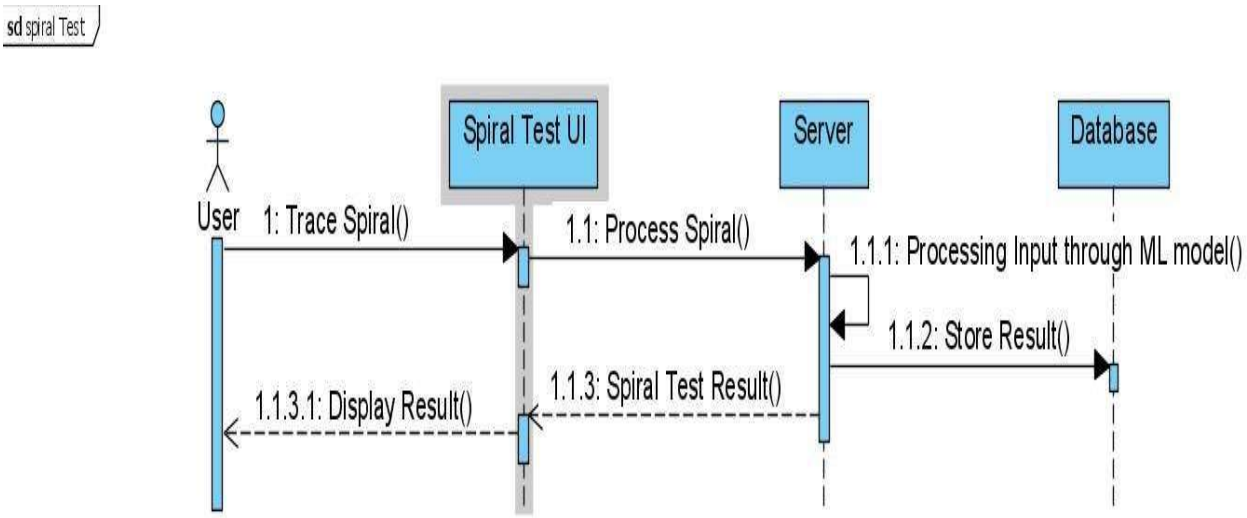


Figure 4-23 Spiral Test Seq Diagram

7. Reset Test

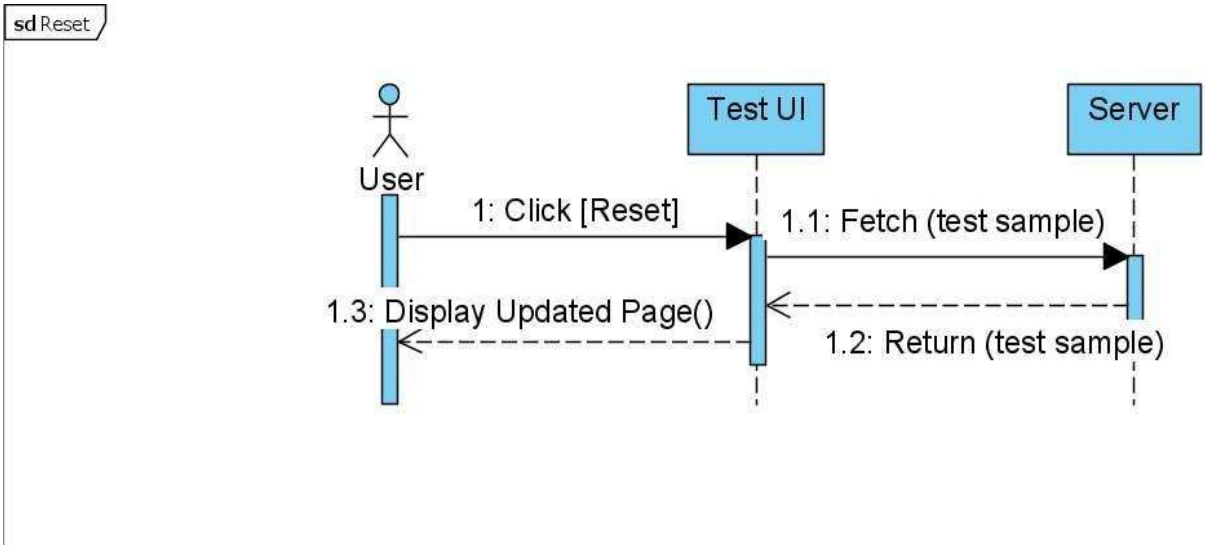


Figure 4-24 Reset Test Seq Diagram

8. Progress Report

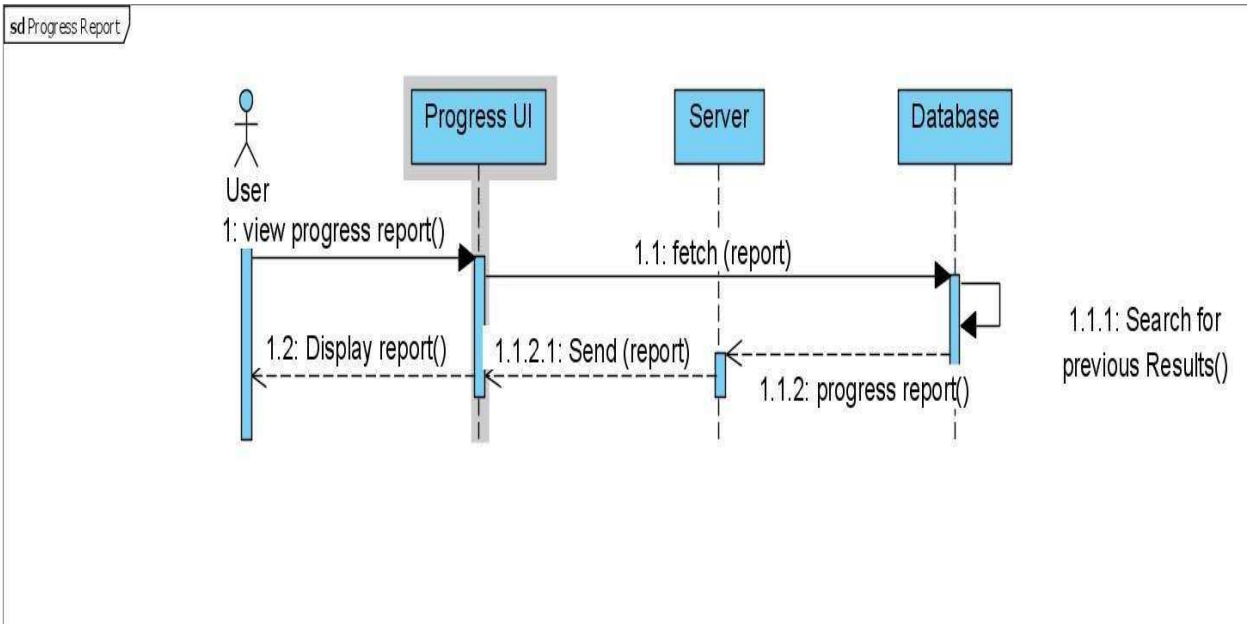


Figure 4-24 Progress Report Seq Diagram

9. Download Test Result

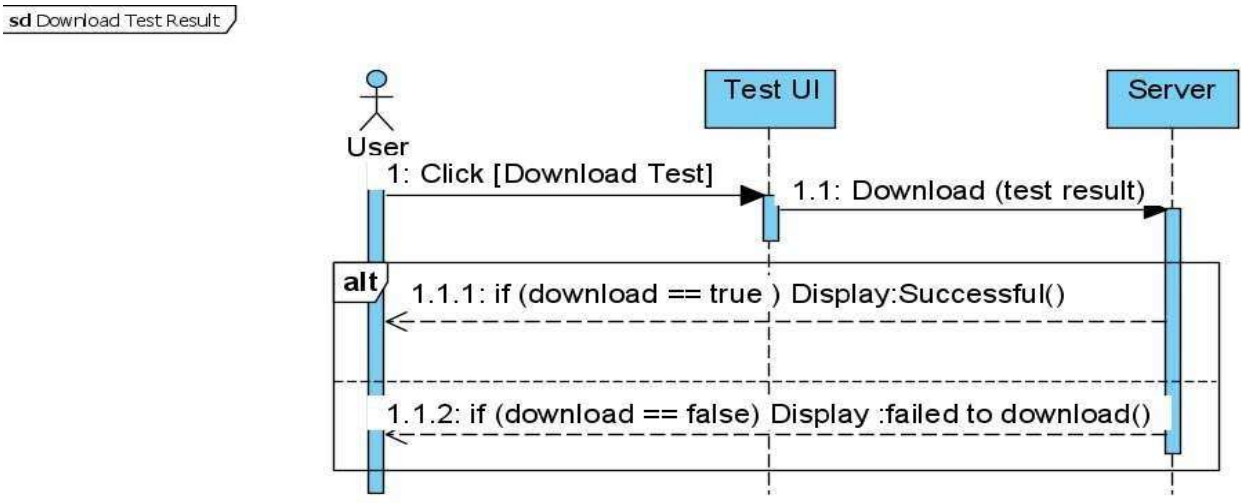


Figure 4-25 Download Result Seq Diagram

10. Download Progress Report

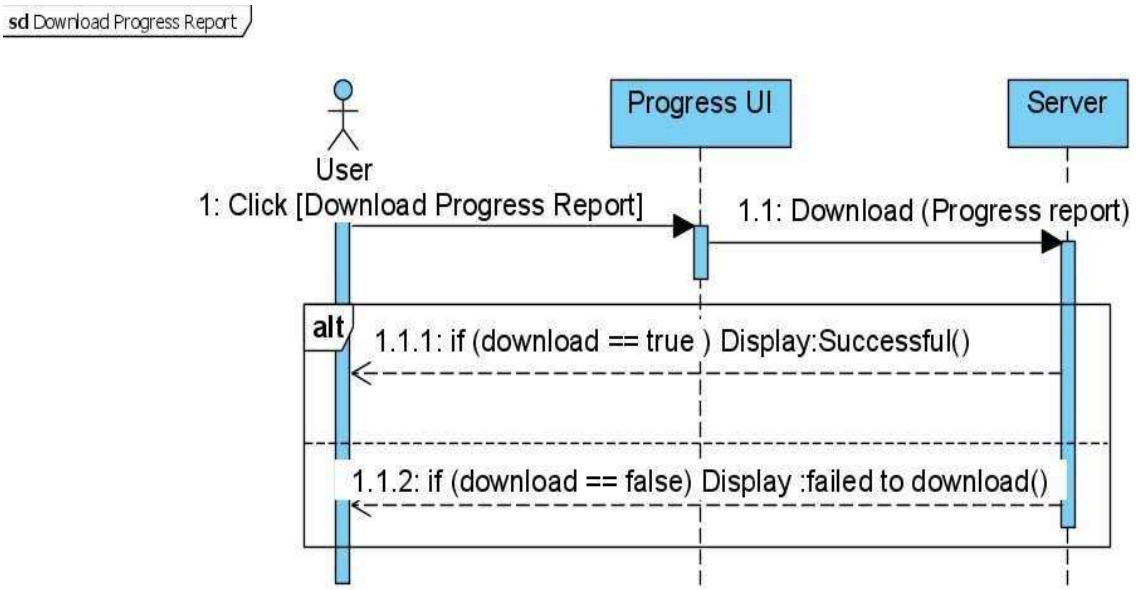


Figure 4-25 Download Progress Seq Diagram

Figure

11. Add User

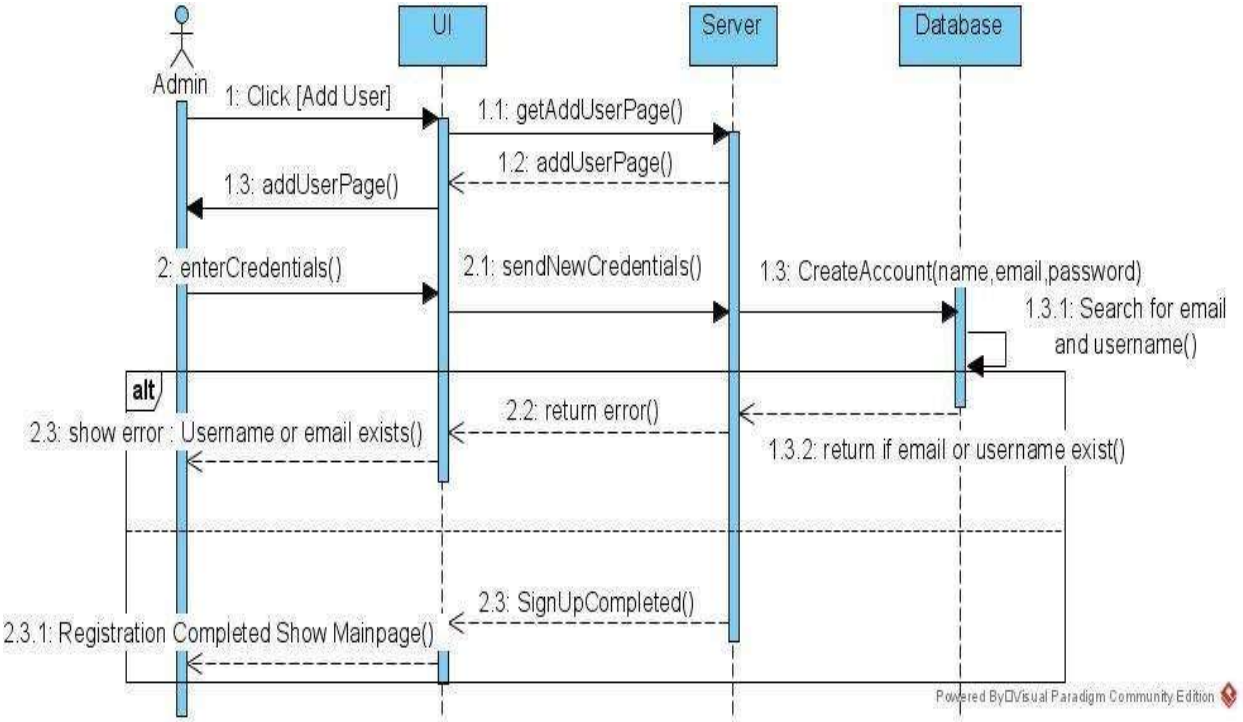


Figure 4.26 add User Seq Diagram

12. View User

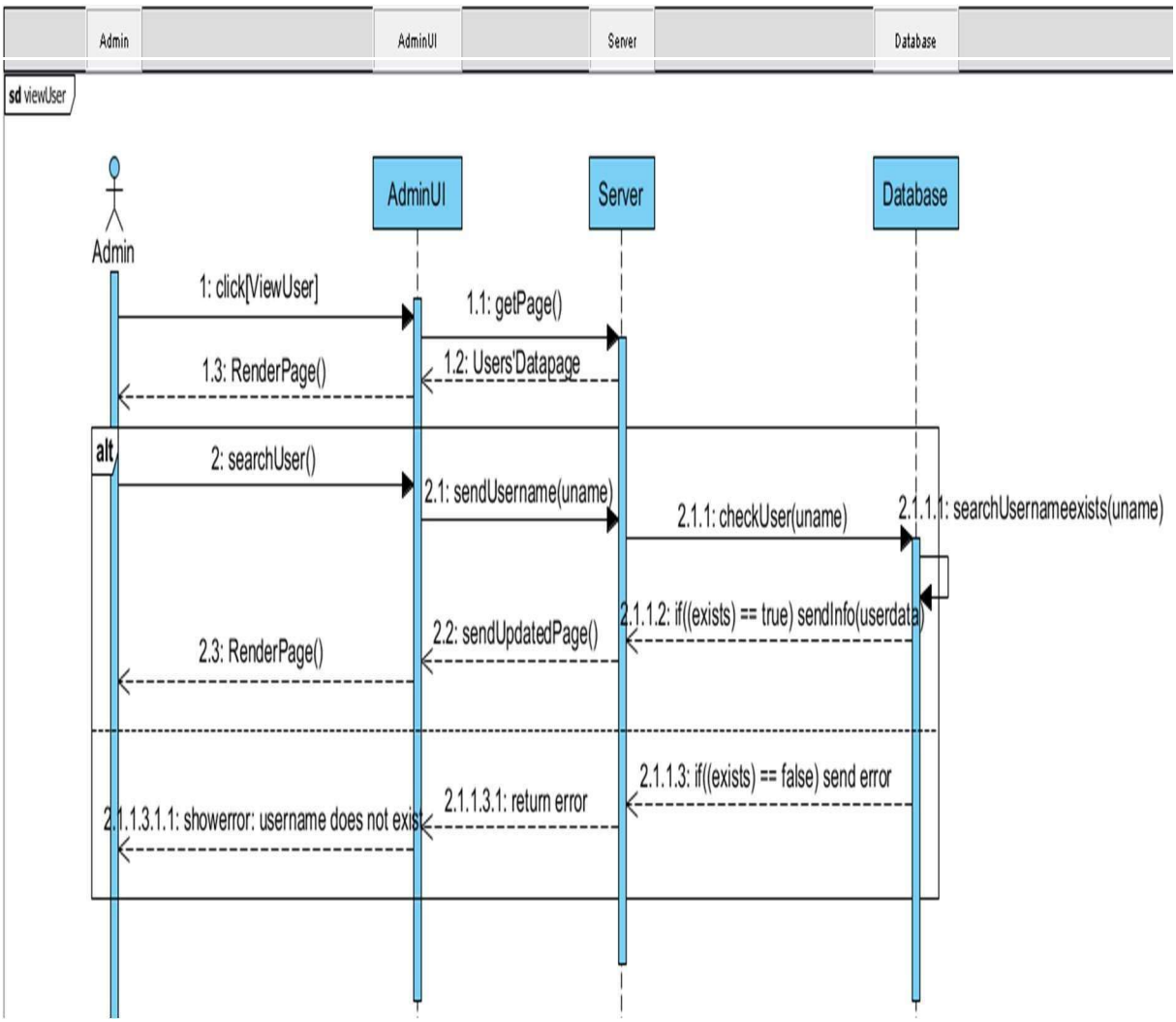


Figure 4-27 View User Seq Diagram

13 Remove User

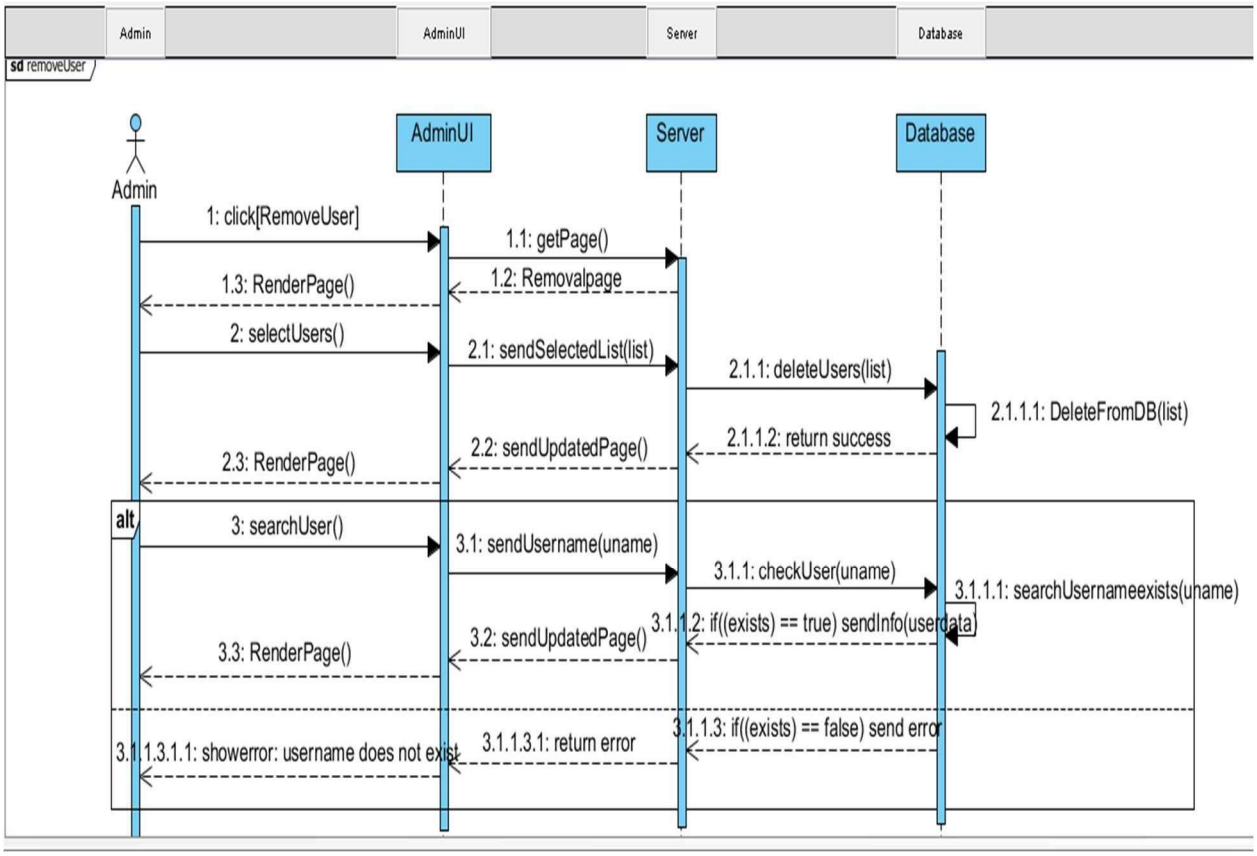


Figure 4.28 Remove User Seq Diagram

4.3.2.3.16 Activity Diagrams:

1. **Sign Up:**

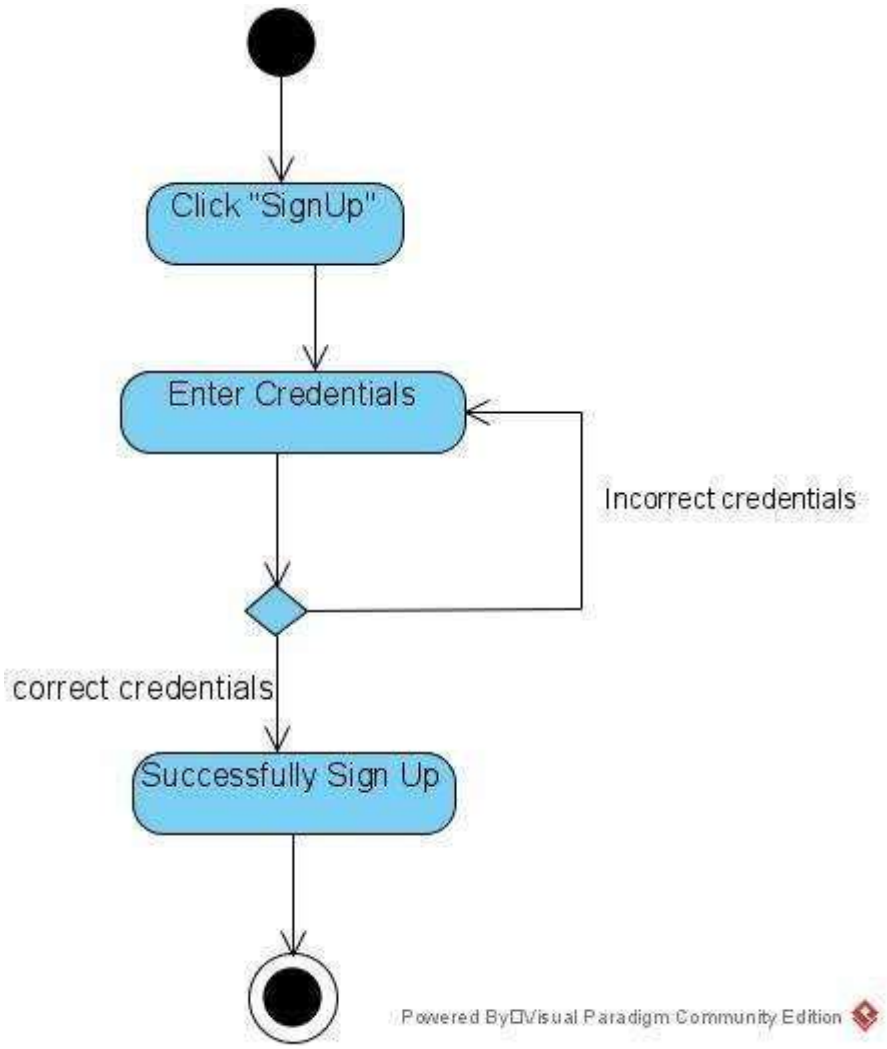


Figure 4-29 Sign Up Activity Diagram

2.Wave Test:

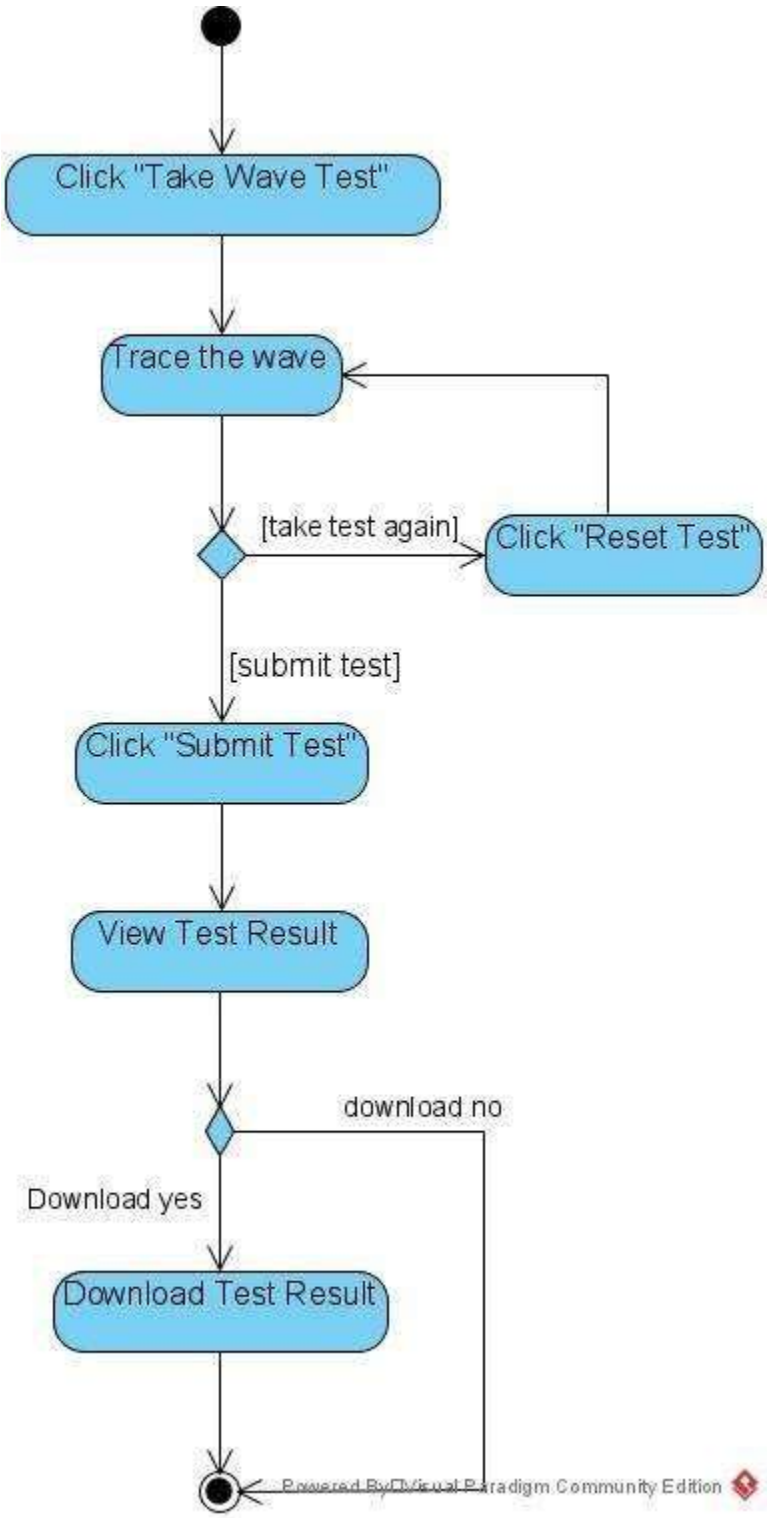


Figure 4-30 Wave Test Activity Diagram

3.Spiral Test:

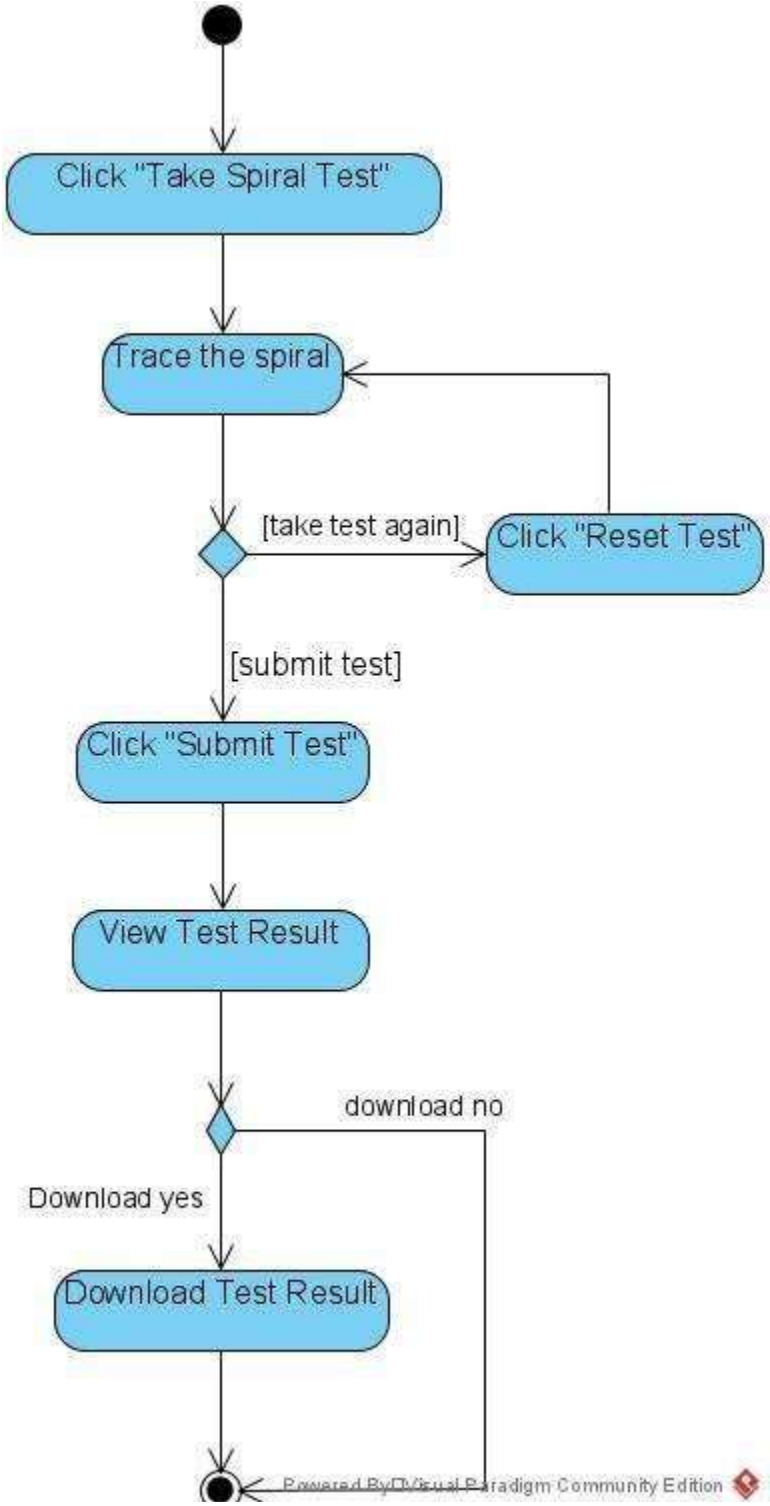


Figure 4-31 Spiral Test Activity Diagram

4.Progress Report:

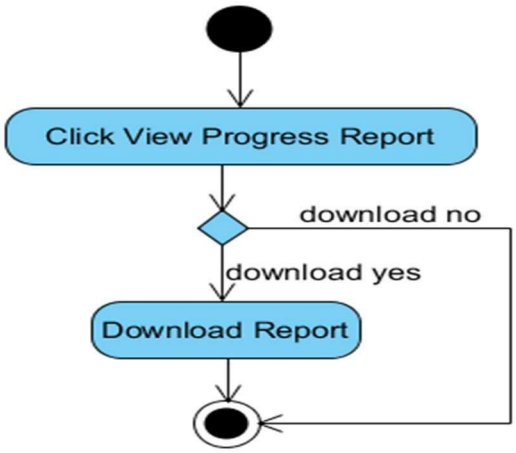


Figure 4-32 Progress Report Activity Diagram

5.View User:

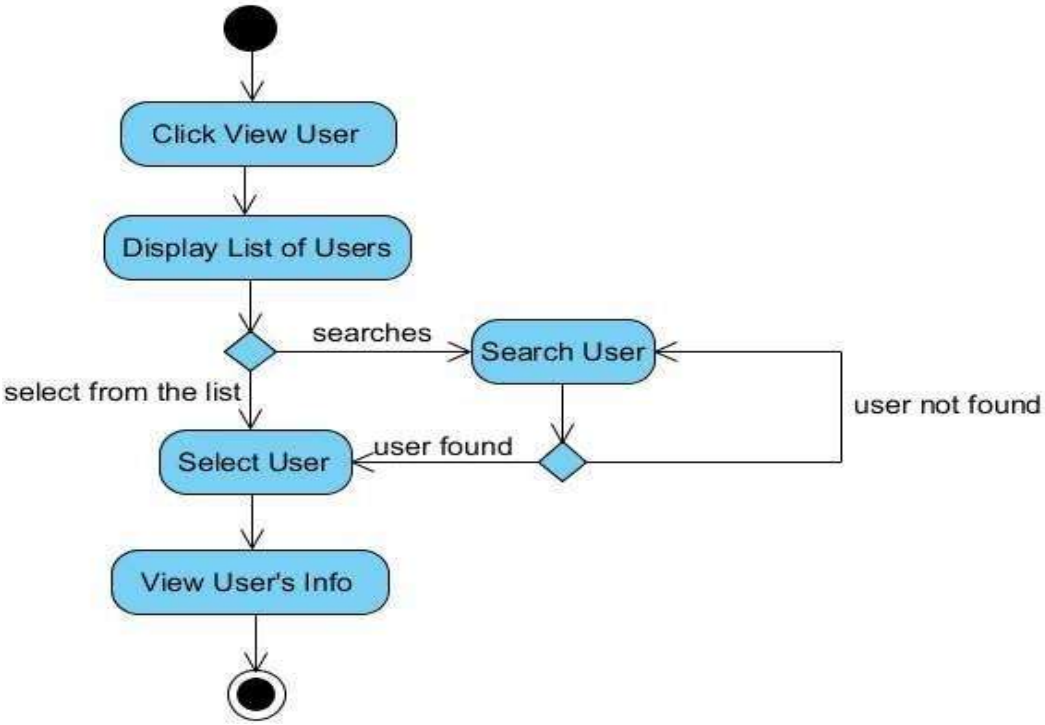


Figure 4-33 View User Activity Diagram

6.Add User:

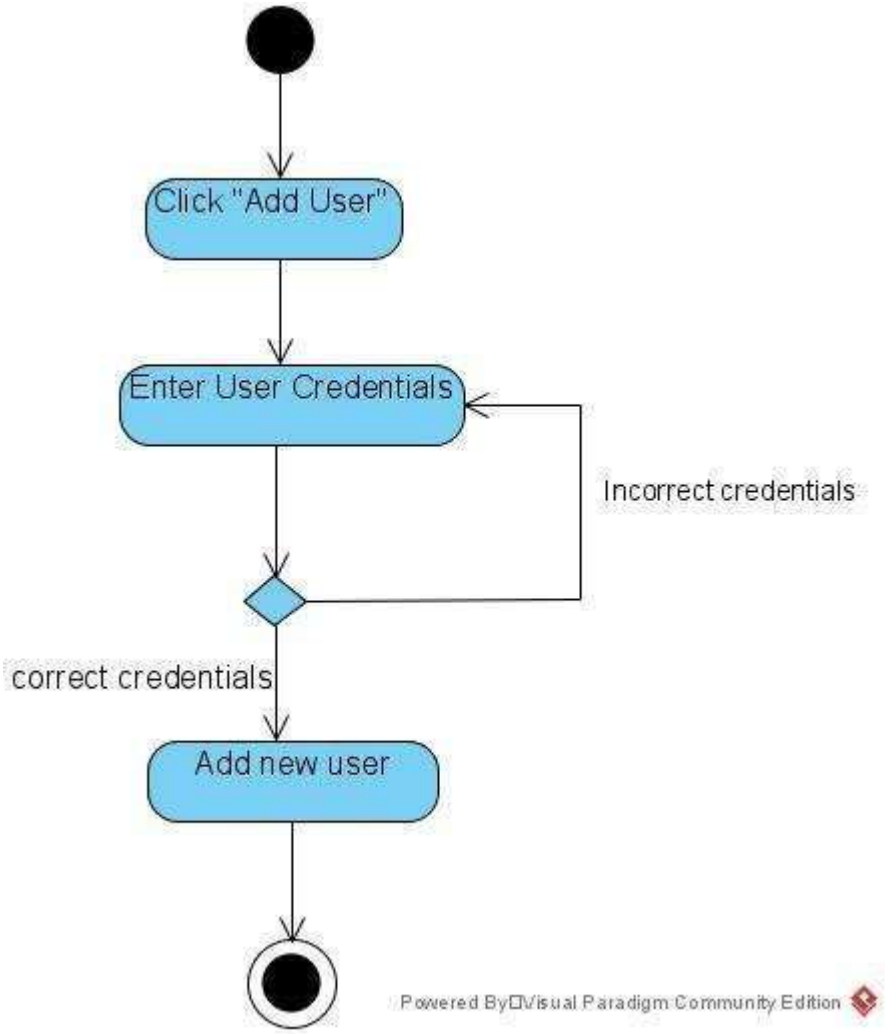


Figure 4-34 Add User Activity Diagram

7.Remove User:

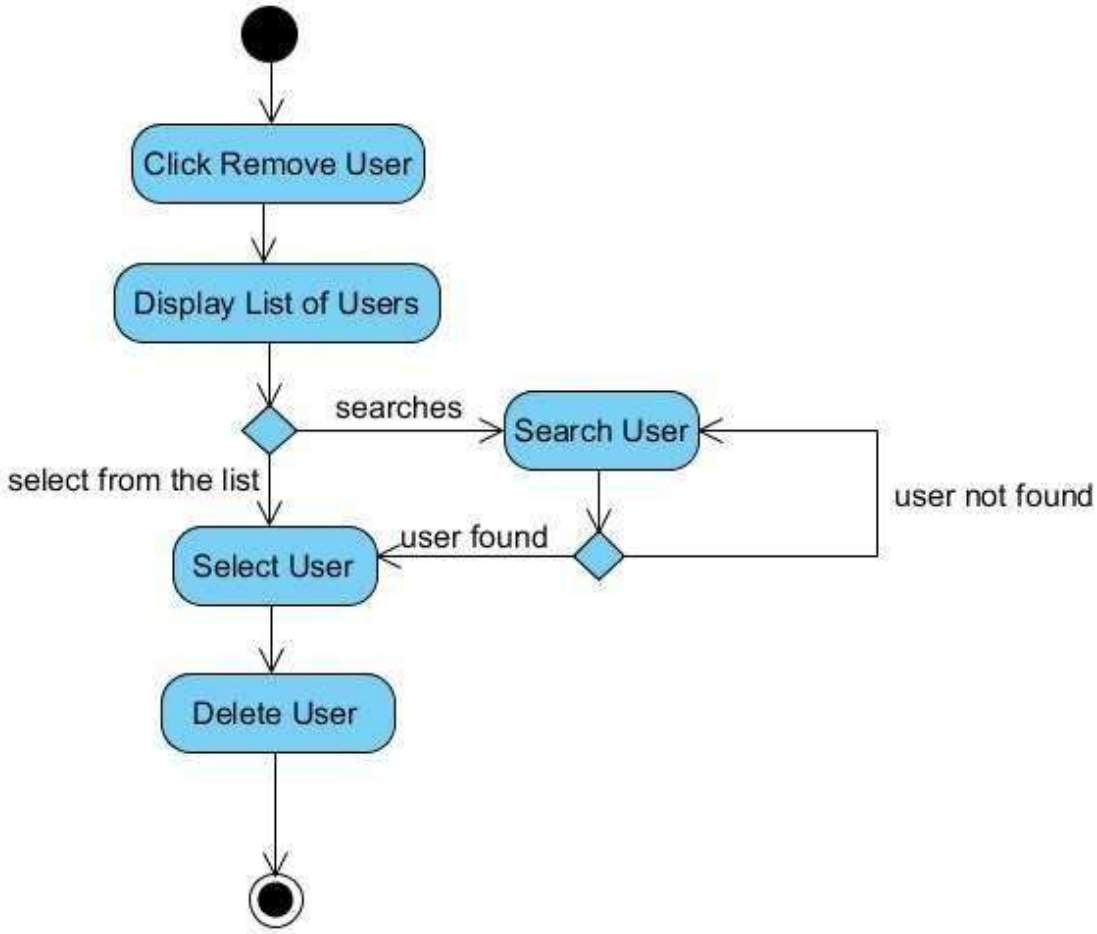


Figure 4-35 Remove User Activity Diagram

4.3.3 DESIGN RATIONALE

The design chosen for Tremor Detect is a Hybrid Architectural Design consisting of MVC and Client/Server architecture.

MVC or Model View Controller Architecture [5] has been chosen because of separation of concern. Separation of concern means we divide the system into Model, Controller and View. The model only deals with the database and is separated from the view and controller. It does not have to deal with user interface or data processing. The only two things that a View has to do is to show data to the user on the User Interface and send requests to the controller. The controller interprets the user's request in a more meaningful intuitive fashion by processing it and sending it to the appropriate module.

Controller is the main connector component that connects the browser to the model and the model to the view.

Client Server [6] divides Tremor Detect into two parts, 'client' and 'server'. The central functionality is provided by the server part of the architecture i.e., the machine learning processing will be done by the server instead of the client that will make the application more efficient. The requests are made to the server, these requests are then accepted,the server then performs the required tasks and results are sent to the client.

Clearly, components can do their work independently containing all the required functionality within themselves. This results in an architecture that has high cohesion**.**

Furthermore, there is not much interaction between the components, after the completion of the work by a component, it will communicate its state to the other components. Consequently, that component will come into action. That led us to **low coupling**.

4.4 Data Design

4.4.1 Data Description

The major part of Tremor Detect deals with Machine Learning Model that will be trained and tested through the pre-available dataset. Tremor Detect uses a database to store user and admin account information and necessary test result data for report generation.

4.4.1.1 Database

Tremor Detect will store data pertaining to user account and tests taken in the database. Following diagram presents the entities in the database and their attributes. The relationship between the attributes is also depicted in the diagram.

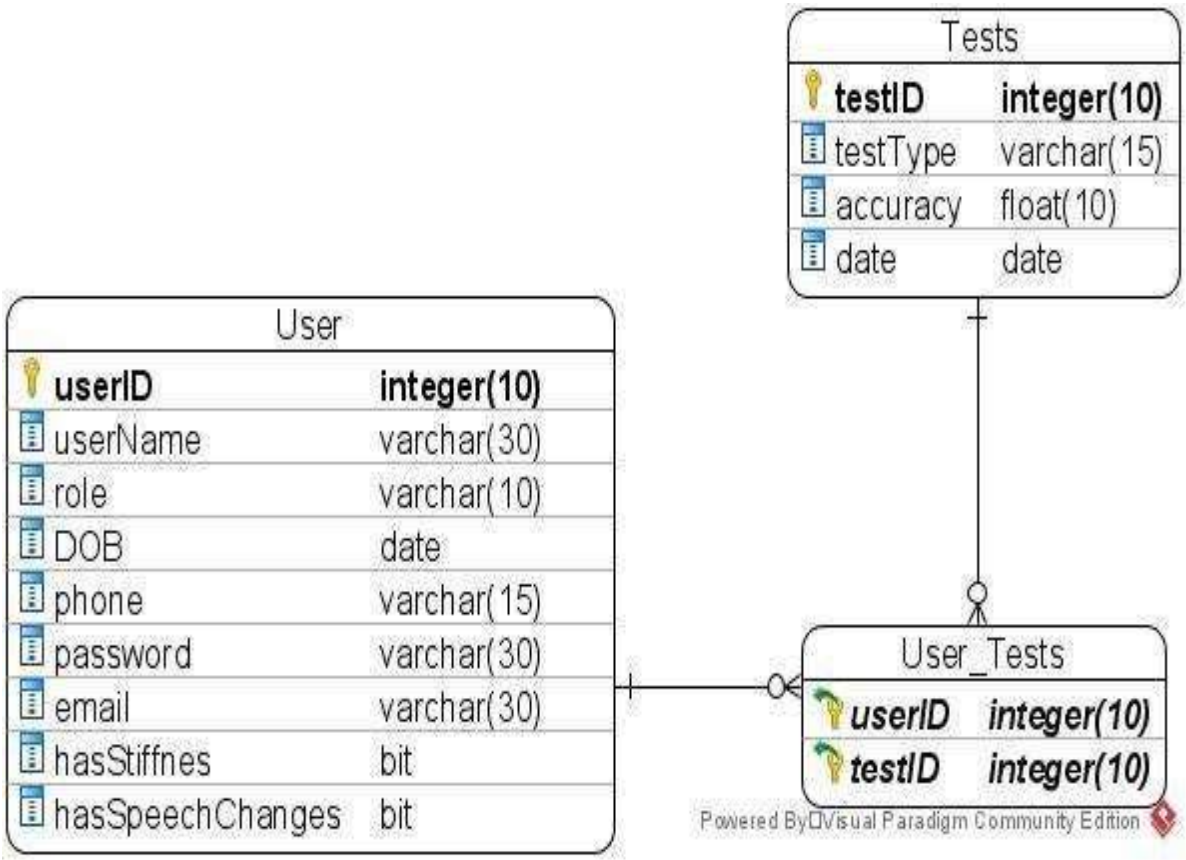


Figure 4-36 ER Diagram of Tremor Detect

4.4.1.2 Dataset

The dataset for Tremor Detect has been taken from an online resource called Kaggle. The Dataset consists of visual elements i.e., images that are 204 in number. This dataset is then split into the training dataset to train the model and testing dataset to test the working of the model.

- **Spiral DataSet:** Total images = 102, training set = 72 and testing set = 30
- **Wave DataSet:** Total images = 102, training set = 72 and testing set = 30

Each testing dataset consist of 30 hand drawn images taken from 15 healthy people and 15 Parkinson's patients.

Each Training dataset consist of 72 images taken from 36 healthy people and 36 Parkinson's patients.

```
.
├── dataset
│   ├── spiral
│   │   ├── testing
│   │   │   ├── healthy [15 entries]
│   │   │   └── parkinson [15 entries]
│   │   └── training
│   │       ├── healthy [36 entries]
│   │       └── parkinson [36 entries]
│   └── wave
│       ├── testing
│       │   ├── healthy [15 entries]
│       │   └── parkinson [15 entries]
│       └── training
│           ├── healthy [36 entries]
│           └── parkinson [36 entries]
```

Figure 4-37 Dataset for training and testing

4.4.2 DATA DICTIONARY

The following table lists alphabetically the system entities along with their types and description.

Entity	**Field**	**Type**	**Null**
Tests	Test_id	Integer	No
	testType	Varchar	
	Accuracy	Float	No
	Date	date	No
User	userID	Integer	No
	userName	Varchar	No
	role	Varchar	No
	DOB	Varchar	No
	Password	Varchar	No
	Email	Varchar	No
	Phone	Varchar	No
	hasStiffness	Bit	No
	hasSpeechChanges	Bit	No
User_Tests	userID	Integer	No
	testID	Integer	No

Table 4-16 Data Dictionadry

The list of Objects and their attributes along with methods and method parameters is explained below:

4.4.2.1 User Class

Attributes

- UserID
- Username
- Password
- DOB
- Email
- Phone

Methods and its parameters

- SignIn(username , password) allows the user to log into Tremor Detect.
- logOut() allows the user to log out of Tremor Detect.

4.4.2.2 Admin Class

Admin class inherits the User class along with its attributes and methods. There are three separate methods in Admin class.

Methods and its parameters

- **viewUser()** allows the admin to view user information.
- **addUser()** allows the admin to add a user
- **removeUser()** allows the admin to remove user

4.4.2.2.1 PD_User Class

PD_User class inherits the User class along with its attributes and methods. There are two separate attributes and five separate methods in PD_User class.

Attributes

- hasStiffness
- hasSpeechChanges

Methods and its parameters

- SignUp() allows the user to create and account in Tremor Detect.
- Delete() allows the user to delete their account.
- takeSpiralTest() allows the user to take Spiral Test.
- takeWaveTest() allows the user to take Wave Test.
- viewProgressReport() allows the user to track their condition and view their progress.

4.4.3 Test Class

Attributes

- test_id
- test_type
- date
- userID
- accuracy

Methods and its parameters

- **SubmitTest()** sends the traced spiral for Digital Image Processing.
- **ResetTest()** erases the drawn pattern and loads the original sample image again.
- **imageProcessing()** processes the input pattern to extract useful information.
- **runMLmodel()** sends the processed image to the trained Machine Learning Models.
- **displayResult()** indicates whether the user has Parkinson or not by displaying the quantitate test result.
- **downloadTestResult()** downloads the test result to the user's local machine.

4.4.4 Spiral Test Class

Spiral Test class inherits the test class along with its attributes and methods. There are two separate methods in Spiral test class.

Methods and its parameters

- **getSpiralSample()** fetches and displays the spiral sample on the screen.
- **traceSpiral()** , through this method the user can trace the sample spiral to take the test.

4.4.5 Wave Test Class

Wave Test class inherits the test class along with its attributes and methods. There are two separate methods in Wave test class.

1.1.5.1Methods and its parameters

- **getWaveSample():** fetches and displays the wave sample on the screen.
- **traceWave():**through this method the user can trace the sample wave to take the test

4.4.6 Progress Report Class

Attributes

- date
- userID

Methods and its parameters

- **fetchResults()** fetches the user's tests result from the database.
- **plotGraph()** analyses the fetched results to plot a graph displaying user's progress.
- **displayReport()** displays the user's progress report.
- **downloadReport()** downloads the user's progress report to the local machine.

4.5 COMPONENT DESIGN

A closer look will be taken at each component of Tremor Detect in detail through a component diagram. The component diagram shows two major components; the web application and the server which shows several subcomponents.

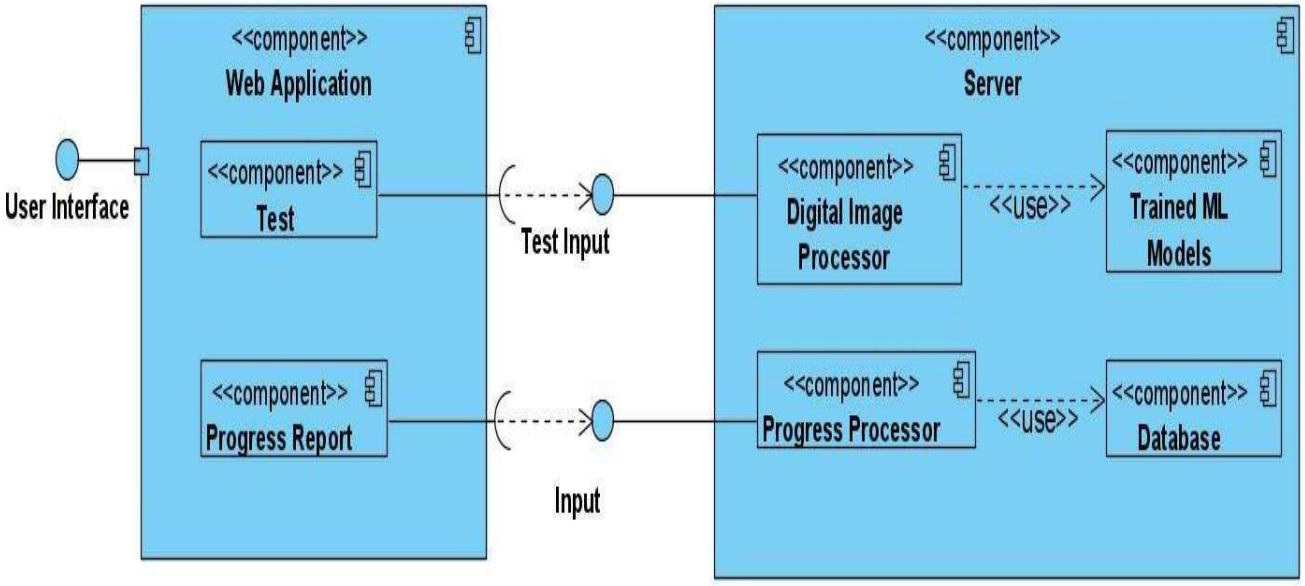


Figure 4-38 Component Design

4.5.1 WEB APPLICATION

4.5.1.1 Test

Identification	Name: Test Location: Web Application Module
Type	Component
Purpose	The test component of Tremor Detect takes input of the user for Parkinson's disease detection through tremors. Following are the functional requirements (as specified in SRS Document) related to test component of Tremor Detect 1. The user will be able to correctly view the test page. 2. The test page will display a clear and complete pattern of reasonable size. 3. Page will not refresh while the user is tracing the pattern. 4. User will be able to reset and draw the pattern again. 5. User shall be able to submit the test. 6. On submission, the application will check if the pattern is traced completely.
Function	Detect input in the form of a pattern traced by the user and returns the user's test result retrieved from another component.
Subordinates	This component has no subcomponents.
Dependencies	Test depends on component other components (Digital image processor and ML Models) for displaying test result.
Interfaces	The User interface and test input are linked with this component.
Resources	**Hardware:** Touch Interface **Software:** Web Browser.
Processing	The processing required for this component is receiving the user's input and sending it to digital image processor.
Data	Inputs (hand drawn pattern)

Table 4-17 Component Description: Test

4.5.1.2 Progress Report

Identification	Name: Progress Report Location: Web Application Module
Type	Component
Purpose	User will be able to track their progress and see whether their tremors have reduced or not by reviewing their previous test results in the form of a statistical report. Following are the functional requirements (as specified in SRS Document) related to Progress report component of Tremor Detect. 1. User will be able to view the Progress Tracking button and select it. 2. System will download the specified document to the user's local machine.
Function	This component displays the progress report to the user to enable them to download and view the report.
Subordinates	This component has no subcomponents.
Dependencies	This component depends on progress processor in the server module.
Interfaces	The user interface is linked with Progress Report component. This component also interfaces with the progress processor component.
Resources	**Software:** Web Browser
Processing	The processing required for this component is receiving the data from progress processor component, displaying it and downloading it on user's command
Data	Progress report

Table 4-18 Component Description: Progress Report

4.5.2 SERVER

4.5.2.1 Digital Image Processor

Identification	Name: Digital Image Processor Location: Server Module
Type	Component
Purpose	This component will process the input image from the Test component, extract useful information through digital image processing techniques and sends it to the Trained ML model component. Following are the functional requirements (as specified in SRS Document) related to Digital Image Processor component of Tremor Detect. System should be able to process image and extract accurate key points.
Function	This component processes user's traced pattern and sends to trained ML model for tremor detection.
Subordinates	This component has no subcomponents.
Dependencies	This component depends on Trained ML model's component for detection of Parkinson's disease in the server module.
Interfaces	This component interfaces with the Test component.
Resources	**Software:** Python
Processing	The processing required for this component is receiving the user's traced pattern from Test component and applying digital image processing techniques on it.
Data	Traced user pattern, Extracted key points

Table 4-19 Component Description: Digital Image Processing

4.5.2.2 Trained ML Model

Identification	Name: Trained ML Model Location: Server Module
Type	Component
Purpose	This component will run the extracted key points through ML Model and detect Parkinson's disease with an accepted accuracy. Following are the functional requirements (as specified in SRS Document) related to Trained ML Model component of Tremor Detect. 1. ML models should be trained and tested correctly 2. System should be able to produce accurate result using the key points based on the trained ML model.
Function	This component will use the trained ML model to predict the Parkinson's disease based on the detected tremors.
Subordinates	This component has no subcomponents.
Dependencies	This component has no dependencies.
Interfaces	This component has no interfaces.
Resources	**Software:** Python
Processing	The processing required for this component is to run the trained ML model on the extracted image information and generate a confusion matrix.
Data	Extracted key points, Confusion matrix

Table 4-20 Component Description: Trained ML

4.5.2.3 Progress Processor

Identification	Name: Progress Processor Location: Server Module
Type	Component
Purpose	This component fetches user's test results and after analysis generate a report. Following are the functional requirements (as specified in SRS Document) related to Progress Processor component of Tremor Detect. 1. The application should be able to access the database and fetch previous test results. 2. Accurate Quantitative analysis of the user's condition will be calculated based on previous tremor detection tests.
Function	This component will create a report using date of the test performed and its result by fetching the required data from the database. Separate graphs for spiral and wave test.
Subordinates	This component has no subcomponents.
Dependencies	This component depends on database for creating the report.
Interfaces	This component interfaces with the Progress Report component.
Resources	**Software:** Python
Processing	This component performs statistical analysis on the fetched data.
Data	Date of the test performed Test results

Table 4-21 Progress Processor

4.5.2.4 Database

Identification	Name: Database Location: Server Module
Type	Component
Purpose	This component stores user account information and the test results required in creating progress report. Following are the functional requirements (as specified in SRS Document) related to Database component of Tremor Detect. 1. The database will be able to store the entered information. 2. The database will be able to validate the username of the respective user and their password
Function	This component is essential for storing user's account information and test results which will result in separate progress report generation for every user.
Subordinates	This component has no subcomponents.
Dependencies	This component has no dependencies.
Interfaces	This component has no interfaces.
Resources	**Software:** SQL
Processing	Database will perform various queries in response to certain inputs from the application.
Data	User's Account Information, User's Test Results

Table 4-22 Component Description:Database

4.6 HUMAN INTERFACE DESIGN

4.6.1 OVERVIEW OF USER INTERFACE

A successful user experience requires that a balanced approach should be carried out during the development lifecycle. This depicts a need that the focus should not only be on implementing the required functionality to complete a specific task but also on how the functionality is communicated to the user though a user friendly interface.

The GUI of Tremor Detect ensures the essential principles of UI Design

Principle of structure: The organization of UI should be in such a way that combines related things together and separates unassociated features

Principle of simplicity: System interface should be easy to understand and use.

Principle of visibility: All the functions of the system will be communicated through the UI of the system. The UI should not be cluttered by too many alternatives.

Principle of reuse: For a clean design without ambiguity, it is recommended to use similar tags to perform similar functions.

4.6.2 SCREEN OBJECTS AND ACTION

Sign In screen

The sign-in screen has the following objects and associated actions.

- Username field
- Password field
- Sign in button
- Sign up button

The username and password fields must be filled in by the user in order to sign in to an existing account. The sign in button logs the user into their account after verification of credentials. The sign-up button will allow a new user to go to the sign-up screen.

Sign Up screen

The sign-up screen has the following objects and associated actions.

- Name field
- Email field
- Password field
- Sign up button
- Sign in button

The username, password and email fields must be filled in by the user in order to create a new account. The sign-up button creates the new user account and saves the user credentials into the database. The sign-in button will allow an existing user to go back to the sign in screen.

Main Screen

The Main screen has the following objects and associated actions.

- Spiral Test Button
- Wave Test Button
- View Progress Button

The spiral and wave test button allow the user to navigate to the spiral test and wave test screens respectively. The view progress button will display the view progress screen.

Spiral Test Screen

The Spiral Test screen has the following objects and associated actions.

- Sample Spiral pattern
- Reset Button
- Submit Button

The sample spiral allows the user to trace the pattern to perform the spiral test. The reset button clears the traced spiral so that the user can trace the sample spiral again. The submit button sends the traced spiral for digital image processing and after passing them through ML models displays the result on the result screen.

Wave Test Screen

The Wave Test Screen has the following objects and associated actions.

- Sample Wave pattern
- Reset Button
- Submit Button

The sample wave allows the user to trace the pattern to perform the wave test. The reset button clears the traced wave so that the user can trace the sample wave again. The submit button sends the traced wave for digital image processing and after passing them through ML models displays the result on the result screen.

Test Result Screen

The Test Result Screen has the following objects and associated actions.

- Test Result
- Download Button

The test result will indicate whether the user has Parkinson's disease or not. The download button will download the test result to the user's local machine.

Progress Report Screen

The Progress Report Screen has the following objects and associated actions.

- Statistical figure
- Test Result and date
- Download button

The Progress report will display the users progress through a statistical figure and a table displaying the test results and date. It will allow the user to see whether their condition has improved or worsened and thus stay motivated to continue their treatment. The download button will download the progress report to the user's local machine.

Admin Dashboard

The Admin Dashboard has the following objects and associated actions.

- View User
- Add User
- Remove User

The Admin Dashboard will allow the admin to manage users. The admin can view users' information. He has the accessibility to add new users and to remove current users.

4.7 REQUIREMENTS MATRIX

Requirement #	Requirement	Component
4.1.3.1	The user will be able to successfully connect to the web application's server.	Server
4.1.3.2	The user shall be able to clearly view and click the create account button.	View
4.1.3.3	The user shall be able to enter mandatory fields and submit information.	View
4.1.3.4	The database shall be able to save the entered information.	Model
4.2.3.1	The user shall be able to clearly view and select the Login button.	View
4.2.3.2	The user shall be able to enter their respective username and password.	View
4.2.3.3	The database shall be able to validate the entered username and password.	Model
4.3.3.1	The system shall allow user to delete their account	View, Model
4.3.3.2	The system shall delete all the information of the user from the database.	Model
4.4.3.1	The system shall allow user to log out from the application.	View
4.4.3.2	The system shall display the main log in page after user logs out	View
4.5.3.1	User shall be able to view and select spiral test.	Test

4.5.3.2	User shall be able to clearly view the spiral test page	Test
4.5.3.3	Spiral test page will display a clear and complete spiral of reasonable size.	Test
4.5.3.4	Page will not refresh while the user is tracing the spiral.	Test
4.5.3.5	The user shall be able to reset and draw the spiral again.	Test
4.5.3.6	User shall be able to submit the test.	Test
4.5.3.7	The database shall be able to store the traced spiral.	Model
4.5.3.8	On submission, the application will check if the spiral is traced completely.	Test
4.6.3.1	User shall be able to view and select a wave test.	Test
4.6.3.2	User shall be able to view the wave test page.	Test
4.6.3.3	Wave test page will display a clear and complete wave of reasonable size	Test
4.6.3.4	Page will not refresh while the user is tracing the wave.	Test
4.6.3.5	The user shall be able to reset and draw the wave again.	Test
4.6.3.6	User shall be able to submit the wave test	Test

4.6.3.7	The database shall be able to store the traced wave.	Model
4.6.3.8	On submission, the application will check if the wave is traced completely.	Test
4.7.3.1	ML models will be trained and tested correctly.	Trained ML Model
4.7.3.2	System will be able to process image and extract accurate key points.	Digital Image Processor
4.7.3.3	System will be able to produce accurate result using the key points based on the trained ML model.	Trained ML Model
4.8.3.1	User shall be able to clearly view and click the Progress Tracking button.	Progress Report
4.8.3.2	The application shall be able to access the database and fetch previous test results.	Controller
4.8.3.3	Accurate Quantitative analysis of the user's condition will be calculated based on previous tremor detection tests	Progress Processor
4.8.3.4	Simple and easily understandable figure will be displayed showing the user's progress.	Progress Report
4.9.3.1	User should be able to view the test result.	View
4.9.3.2	The system should be able to accurately determine the result.	Server
4.9.3.3	System should display result in easily understandable quantitative term.	View

4.10.3.1	System will download the specified document to the user's local machine.	Controller
4.10.3.2	The downloaded document will be understandable by the user.	View, Server
4.11.3.1	The admin shall be able to view users' information	View, Model
4.11.3.2	The admin shall be able to add new users in the system.	View, Model
4.11.3.3	The admin shall be able to delete current users.	View, Model
4.11.3.4	The admin shall be able to search the users through a search bar.	View, Model

Table 4-23 Req Matrix

CHAPTER

5 METHODOLOGY

5.1 Introduction

This chapter explains the methodology of Tremor Detect. It will cover the finer points of the type of research conducted, collection and analysis of the data gathered, the tools and materials used for research and the rationale for choosing these methods. This chapter covers the methodology techniques for two phases, the requirements specification phase and implementation phase.

5.2 Requirements Specifications

5.2.1 Research Conduction through Surveys

The idea of Tremor Detect gained merit because of the customer surveys which were carried out during the requirement gathering phase. This helped gain insight into the daily lives of people suffering from PD and how their lives could be improved. All findings implied that there is a dire need for such a solution that enables early detection.

Surveys were conducted through Google Survey Forms which gathered the following statistics of responses. According to the survey:

- 68.6% claimed that they know someone affected by PD.
- 35.3% people said that it was very difficult for them to find a neurologist while 15.7% are still looking for one.
- 66.7% had to travel outside their city to see a neurologist.
- 72.5% claimed to have spent a large amount on travel expenses.
- 92.2% voted that a PD detection application will prove to be very useful.

5.2.2 Rationale for Adopted Approach

Google Surveys were used to reach a large audience. They are a great market research tool that not only allow easy creation of online surveys but also help to make a more informed decision. Moreover because of the ongoing pandemic, google surveys proved to be a convenient

approach.

5.3 Solution Methodology

Based upon the customer survey, we opted for an exhaustive approach that would focus on early detection. Since the earliest symptom of PD is mild tremors in hands, the proposed solution consists of digitization of the popular tests that have been used by doctors for several years.

5.3.1 Spiral and Wave Tests

The earliest symptom of Parkinson's Disease is tremors in hands. Handwriting and sketching are the abilities that are the first to be affected by Parkinson's Disease and so they serve as an early diagnostic approach. The tracing of a specific pattern like a spiral or wave can be used to distinguish healthy people from PD. There have been a few clinical researches that associate the sketching of the patterns in the early stages of the PD. Nonetheless, these sketches were performed on paper and these were qualitative in nature and subjective to the doctor's opinion. Owing to technological advancement, digital devices can be used to to perform the tracing of the patterns and these can be interpreted easily by the machine in a more quantitative and accurate way. Upn analysis, it can be seen that a few characteristics of the traced spiral/wave pattern can be used to distinguish healthy people and PD patients.

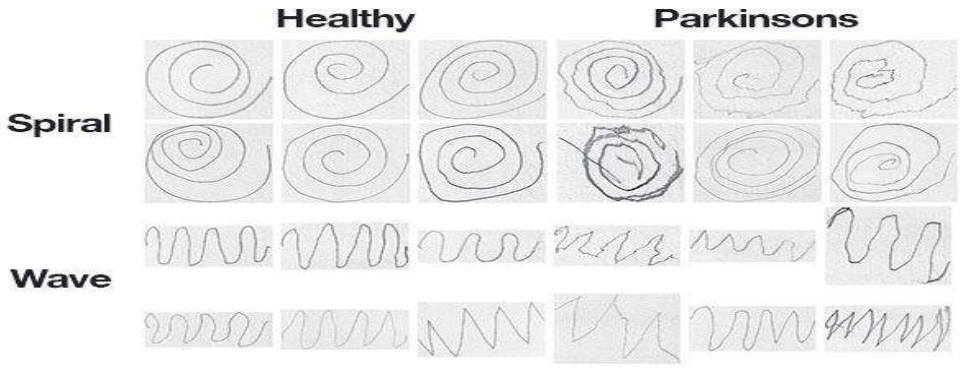


Figure 5.1 Spiral and Wave Tests

5.3.2 Dataset Acquisition

Dataset required for training Machine learning model was acquired from Kaggle. Both Spiral

and Wave test's dataset consists of 102 images of sketches from PD and healthy people. Training data contained sketches of 36 healthy and 36 PD affected people. Whereas testing data contained sketches of 15 healthy and 15 PD affected people.

5.3.3 Machine Learning Model Selection

Different models were evaluated for adoption namely, CNN, Random Forest Classifier and Logistic Regression. We will go through them one by one.

5.3.3.1 Convolutional Neural Network

A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm mainly used to perform tasks on images. The input is an image and an importance or a priority is assigned through weights and biases to different features in the image. Little preprocessing is required to a convolutional neural network as compared to other machine learning algorithms. However, a large dataset is required to train CNN and to produce effective results [7].

5.3.3.2 Logistic Regression

Logistic regression is one of the most common machine learning classification algorithm. It is used to predict the probability of a dependent variable. The target variable i.e., (variable to be predicted) should be binary meaning that it should take two values 0 or 1. Logistic regression will predict the values of dependent variables (when it is 1) as a function of independent variables. For accurate results there should be minimum correlation between the independent variables [8].

5.3.3.3 Random Forest Classifier

Random Forest Classifier is a type of an ensemble algorithm. Algorithms that combine at least two algorithms for classification of objects and then perform voting to finalize classification are called ensemble algorithms.

In the case of Random Forest, decision tree is used as a base classifier. A set of decision trees is created using data that is randomly selected from the training set. Voting is performed after getting results from different decision trees for final verdict. [9].

5.3.3.4 Rationale for Model Selection

Out of the above researched models, Random Forest Classifier was chosen for the following reasons:

- Using a number of decision trees makes the Random Forest algorithm highly accurate.
- Random Forest avoids the overfitting problem by averaging the predictions thus removing biases.
- Random Forest can be used to both classify and predict target variables.
- Missing values are easily handled by Random Forest either by using mean values or calculating weighted averages.
- This model works best with the limited datasets.

CHAPTER

6 SYSTEM IMPLEMENTATION

This chapter will cover the details of Tremor Detect system along the pseudo code of the different components and modules. Functionality of each module is discussed in detail.

6.1 Pseudocode

6.1.1 Web Application UI

```
if Login is
Successful Begin
    Show menu
    End
    Else
    Print 'Invalid Username/Password'
```

6.1.2 Take Spiral/Wave Test

Begin

If User resets

Reset image

Endif

If User submits

If image traced

Extract Feature Vectors using HOG

Predict through ML model

Retrieve and save result

Show result

Endif

Else

Print "User needs to trace image"

Endif

6.1.3 Progress Tracking

Begin

Retrieve test data from database

Plot spiral test graph

Plot wave test graph

End

6.1.4 Download Progress Report/Test Result

Begin

Retrieve data

Create a pdf report

Download report to host machine

End

6.1.5 Delete

Begin

Get current user

Delete tests related to current user

Delete current user

Redirect to Login

End

6.1.6 Admin

Begin

Display user list

Display test list

If delete user selected

Delete selected user

If add new user

Create new user

If view user

Display selected user's data

End

CHAPTER

7 ANALYSIS AND EVALUATION

7.1 Introduction

Appropriate strategies, process and methodologies used to plan, execute and manage testing of the "Tremor Detect" are covered in the test plan document. It will ensure that Tremor Detect fulfills customer requirements at an approbated level.

Manual Testing was also conducted i.e., without the use of any automated tool or any script. In Manual Testing, the tester plays the role of an end-user and tests the software to debug any errors or unexpected bugs. Each Unit is separately tested and then will be integrated with other units. Thus Unit Testing and Integration testing will be followed. Black Box testing is carried out incase of unit and for combined units Acceptance or integration Testing is done.

Test Scope includes testing all the functionalities outlined in the requirement doucment.

Software Testing which is dependent on the testing method can be carried out at any time during the development process. However, the majority of the testing is performed after requirements have been specified and these requirements have been implemented and coded.

Each test has a defined pass/fail criteria. The document explains in detail the approach carried out by testing.

7.2 Approach

Acceptance test plan will help in the execution of acceptance testing. After the execution of all the test cases, a test report is summarized to show the quality of Tremor Detect. Following test approaches will be used in test execution:

1. **Unit test**. Unit Testing is performed and executed by the developers. Separate verification is done in regards to the implementation of each module and individual component.

2. **Integration test**. The execution of integration test cases is done after the unit test is passed above the defined quality threshold. After the integration of all the modules, the whole product is tested through black-box testing. [10].

3. **Positive and negative testing design technique**. This approach involves the

combination of unit test and integration test. Test cases are designed in obvious scenarios, ensuring that all functional requirements will be satisfied. What's more, different test cases will also be designed to show how any invalid operation will cause a reaction in the system.

7.3 Features to be tested

Following Features will be tested:

1. Admin will be able to login and register new users.
2. Admin will be able to view user data and test lists.
3. Admin will be able to remove users.
4. User will be able to log in.
5. User will be able to sign up.
6. User will be able to delete user account.
7. User will be able to logout.
8. User will be able to take spiral and wave tests.
9. User will be able to submit and reset their test.
10. User will be able to view progress report.
11. User will be able to download test result and progress report.
12. ML models will determine test results with an average of 75% accuracy.

7.4 Item Pass/Fail Criteria

The section Test Deliverables include the details of the test cases.. Following the principles outlined below, a test item would be categorized as pass or fail.

1. Preconditions are satisfied and met.
2. Inputs performed as specified.
3. Output determines if the test case has been passed or failed.

7.5 Testing tasks

1. Develop test cases.
2. Execution of the tests based on the developed test cases for Tremor Detect.
3. Reporting of the defects from the executed test cases if present.
4. Provision of complete test report.
5. managing the changes in the later stage of project development.

7.6 Test Deliverables

1. Test cases
2. Output from tools

7.7 Responsibilities

All developers of the project Tremor Detect will be responsible for the completion of all components testing and integration testing tasks.

7.8 Staffing and Training Needs

Basic knowledge of the testing strategies and techniques is required for the testing of the project. The developer must be aware about the techniques such as Black Box testing and integration testing. All the developers will participate in the development and testing of the project through continuously testing each other's work.

7.9 Schedule

7.9.1.1 Important Dates

1. Unit Testing and integration testing was completed by the end of April 2021.
2. Acceptance Testing was completed by 12th May 2021

7.10 Test Cases

7.10.1 Unit and Component Level Testing

Test Case Number	01
Test Case Name	Admin Login
Description	Testing Admin Login. Admin will be able to login by giving his details and view list of users and tests.
Testing Technique	Unit testing, White Box Testing
Preconditions	Web application should be running.
Input Values	Enter username, password and click “Login”
Steps	1. Open the web application. 2. Go to admin dashboard 3. Enter details 4. Click on ‘Login’ button.
Expected output	Admin should be logged in.
Actual output	Admin is logged in successfully.
Status	Test case passed successfully.

Table 7-1 Test Case 1

Test Case Number	02
Test Case Name	Add new user
Description	Admin will register new user along with details
Testing Technique	Component testing, White Box Testing
Preconditions	Web application should be open and admin should be successfully logged in.
Input Values	Enter user's name, username, Contact number, Email and password and enter additional user information and click 'Submit form'
Steps	1. Open the web application. 2. Login as admin. 3. Click add user. 4. Enter user details 5. Click on the 'Submit Form' button.
Expected output	User should be added to the database.
Actual output	User is successfully registered.
Status	Test case passed successfully.

Table 7-2 Test Case 2

Test Case Number	03
Test Case Name	Remove user
Description	Admin will remove user.
Testing Technique	Component testing, White Box Testing
Preconditions	Web application should be open and admin should be successfully logged in.
Input Values	Select the user through user's unique email address.
Steps	1. Open the web application. 2. Login as admin. 3. Click remove user.
Expected output	User should be deleted from the database.
Actual output	User is successfully deleted
Status	Test case passed successfully.

Table 7-3 Test Case 3

Test Case Number	04
Test Case Name	User Login
Description	Testing User login. User will be able to login by giving their credentials.
Testing Technique	Component testing, White Box Testing
Preconditions	Web application is open
Input Values	Enter username, password and click 'Login'
Steps	1. Open the web application 2. Login page is displayed. 3. Enter details 4. Click on 'Login' button.
Expected output	User should be logged in.
Actual output	User is logged in successfully.
Status	Test case passed successfully.

Table 7-4 Test Case 4

Test Case Number	05
Test Case Name	Delete Account
Description	User will be able to delete their account and user's information will be deleted from the database.
Testing Technique	Component testing, White Box Testing
Preconditions	Web application should be open and the user should be successfully logged in.
Input Values	Click delete account button
Steps	1. Open the web application. 2. User will login. 3. Click delete account.
Expected output	User should be deleted from the database.
Actual output	User is successfully deleted
Status	Test case passed successfully.

Table 7-5 Test Case 5

Test Case Number	06
Test Case Name	User Signup
Description	New User will register themselves into the system by adding relevant details.
Testing Technique	Component testing, White Box Testing
Preconditions	Web application should be running and signup screen be displayed.
Input Values	User's name, username, Contact number, Email and password, additional should be entered and then the user should click submit.
Steps	1. Open the web application. 2. Click Sign up 3. Enter user details 4. Click on the 'Submit Form' button.
Expected output	User should be added to the database.
Actual output	User is successfully registered.
Status	Test case passed successfully.

Table 7-6 test case 6

Test Case Number	07
Test Case Name	User Logout
Description	Testing User logout. User will be able to logout from their accounts.
Testing Technique	Component testing, White Box Testing
Preconditions	Web application is open and the user is logged in.
Input Values	Click logout button
Steps	1. Open the web application 2. Login page is displayed. 3. User will log in. 4. Click on 'Logout' button.
Expected output	User should be logged out.
Actual output	User is logged out successfully.
Status	Test case passed successfully.

Table 7-7 Test Case 7

Test Case Number	08
Test Case Name	Reset Test.
Description	Testing Reset Test. User will be able to reset their traced pattern.
Testing Technique	Unit testing, White Box Testing
Preconditions	Web application is open and the user is logged in and taking the Spiral/Wave test.
Input Values	Select Spiral or Wave Test. Trace the pattern and click reset button
Steps	1. Open the web application 2. Login page is displayed. 3. User will log in. 4. Select test from the menu page. 5. Trace the pattern 6. Click Reset.
Expected output	Trace pattern should disappear and the original sample pattern should be displayed.
Actual output	Traced pattern erased and original sample displayed successfully.
Status	Test case passed successfully.

7.10.2 Integration Testing

Test Case Number	09
Test Case Name	Take Spiral/Wave Test.
Description	Testing Spiral/Wave Test. User will be able to select the desired test, trace the pattern and submit it successfully.
Testing Technique	Integration testing, Black Box Testing
Preconditions	Web application is open and the user is logged in.
Input Values	Select Spiral or Wave Test. Trace the pattern and click submit button
Steps	1. Open the web application 2. Login page is displayed. 3. User will log in. 4. Select test from the menu page. 5. Trace the pattern 6. Click Submit.
Expected output	Test should be submitted and user's result is displayed with an average of 75% accuracy.
Actual output	Test was submitted and result was displayed successfully and accurately.
Status	Test case passed successfully.

Table 7-8 Test Case 8

Test Case Number	10
Test Case Name	Download Test result
Description	Testing Download Test result. User will be able to download Test result.
Testing Technique	Integration Testing, Black Box Testing
Preconditions	Web application is open and the user is logged in and taking the Spiral/Wave test.
Input Values	Select Spiral or Wave Test. Trace the pattern and click reset button
Steps	1. Open the web application 2. Login page is displayed. 3. User will log in. 4. Select test from the menu page. 5. Trace the pattern 6. Click Reset.
Expected output	Trace pattern should disappear and the original sample pattern should be displayed.
Actual output	Traced pattern erased and original sample displayed successfully.
Status	Test case passed successfully.

Table 7-9 Test Case 10

Test Case Number	11
Test Case Name	Download Progress Report
Description	Testing Download Progress Report. User will be able to download Progress Report.
Testing Technique	Integration Testing, Black Box Testing
Preconditions	Web application is open, the user is logged in and Progress Report has been generated.
Input Values	Click the download progress Report button.
Steps	1. Open the web application 2. Login page is displayed. 3. User will log in. 4. Select Progress Report from the menu page. 5. Click Download Button.
Expected output	The Progress Report should be downloaded to the user's local machine.
Actual output	Progress Report was downloaded successfully.
Status	Test case passed successfully.

Table 7-10 Test Case 11

CHAPTER 8 FUTURE WORK

A system of this magnitude always needs continuous work to evolve. There are a lot of possible changes and additions that can be done to the system to improve its performance and functionalities. The system has been made in a modular fashion which enables integrating new features very easy.

8.1 Extended Scope

8.1.1 Parkinson's Recovery platform through video games

In the last decade, the physical exercises which have been carried out by kinetic therapeutic methods, by machine technologies or with the participation of sensory inputs, have become increasingly appreciated in managing the recovery phase of Parkinson's disease. The extended scope also includes using real-time video games in the web application. These games can include grip strength, dexterity and coordination. These can be used as a rehabilitation method for people suffering from Parkinson's disease.

8.1.2 Transforming Tremor Detect into a complete telehealth platform

Adding more features to transform Tremor Detect into an Electronic Health Record System. These features include but are not limited to:

- A Doctor Portal
- Video conferencing feature for the doctor and the patient.
- Separate portal and accounts for staff like nurses etc.
- Online chats in real-time between the patient and the doctor.
- A patient's pharmacy where prescriptions can be submitted.

Chapter

9 Conclusion

9.1 Overview

The purpose of this project is to develop a web application for users to detect Parkinson's at an early stage so that treatment can be started early with more effectiveness. The goal is to help people detect Parkinson's from the comfort of their homes through easy-to-use interface. Tremor Detect not only aims to detect Parkinson's but also provides an interactive snap shot of the patient's condition in the form of a progress report. This will motivate patients to continue their exercise and actually see the progress they make. The application provides two popular tests which have been used by doctors for many years. The test results are obtained through trained ML models which detect Parkinson's with 75% accuracy. Through Tremor Detect, we intend to advance diagnostic and progress measurement approaches for people with Parkinson's by reducing the need for routine clinic visits.

9.2 Objectives Achieved

The Project helped to achieve the objectives of learning software development process/cycle, Agile development, Web Development, handling network issues and integration of databases. We have learned how to define, refine and reduce scope. We gained an understanding on how to define a problem statement from literature review. Reading from a research article about different Parkinson's diagnosis methods and defining a problem statement to work on.

It also helped us understand what problems are faced when developing a project in the industry. It helped us gain understanding in Artificial Intelligence and Machine learning. Moreover, we learned how different technologies should be used together to achieve efficient result. Our precision and recall metrics are very high considering the small training dataset that we had.

CHAPTER

10 BIBLIOGRAPHY

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APPENDIX A

USER MANUAL

USER MANUAL

Table of Contents

1 GENERAL INFORMATION

This section explains in general terms the system **Tremor Detect** and the purpose for which it is intended.

1.1 System Overview

Tremor Detect is a web application for early detection for Parkinson's Disease. The system is developed according to the need for early detection of Parkinson's Disease as it has no cure. The system includes two digitized detection tests, the Spiral Test and the Wave Test. Moreover, a progress tracking feature is available for quantitative analysis of the user's condition.

1.2 Organization of the manual

The user's manual covers the following five sections: General Information, System Summary, Getting Started, Using the System.

1. **General Information** section explains the general terms about Tremor Detect and the purpose for which it has been developed.
2. **System Summary** section provides a general overview of the system. The summary outlines the system requirements, system's configuration, user access levels and system's behavior in case of any contingencies.
3. **Getting Started** section covers the steps to setup the system and configure it for the first time. System's stetting are briefly covered in this section.
4. **Using the System** section explains in details about the system functions.

2 SYSTEM SUMMARY

This section provides a general overview of Tremor Detect. The summary outlines the system requirements, system's configuration, user access levels and system's behavior incase of any contingencies.

2.1 System Configuration

Tremor Detect is a web application that requires an internet connection and an internet browser to work. No external hardware or third-party software tools are required to run Tremor Detect.

2.2 User Access Levels

There are two user levels for Tremor Detect:

- **Potential PD User:**
  This is the main user access level. This type of user will be able to take Spiral/Wave Test, track progress and download their results.

- **Admin:**
  The admin will manage the web application. He will be allowed to view users' data and update them accordingly.

2.3 Contingencies

In case of any errors or system crashes, the database will not be affected, and user records will remain safe. If web application crashes, the changes made to the application will not be saved on the server database.

3 GETTING STARTED

The Getting Started section explains how to run and use the web application. The section also briefly presents Tremor Detect's menu.

3.1 Running Web Application

The web application can be started by:

- Ensuring a stable internet connection.
- Opening the web browser.
- Go to www.TremorDetect.com

3.2 System Interface

3.2.1 Login

It will allow the user to ***Login*** by entering email and password.

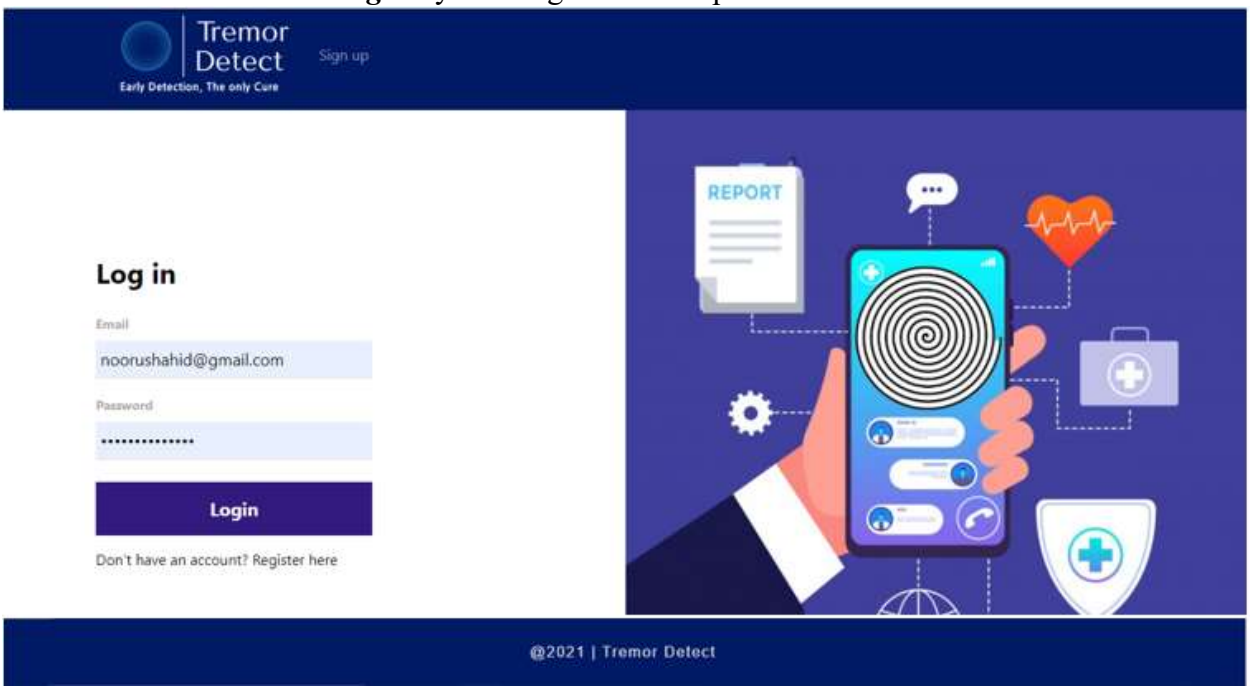


Figure 3.1 Login Screen

3.2.2 Sign Up

If user doesn't have a account, they can create one by going to the ***SignUp*** screen.

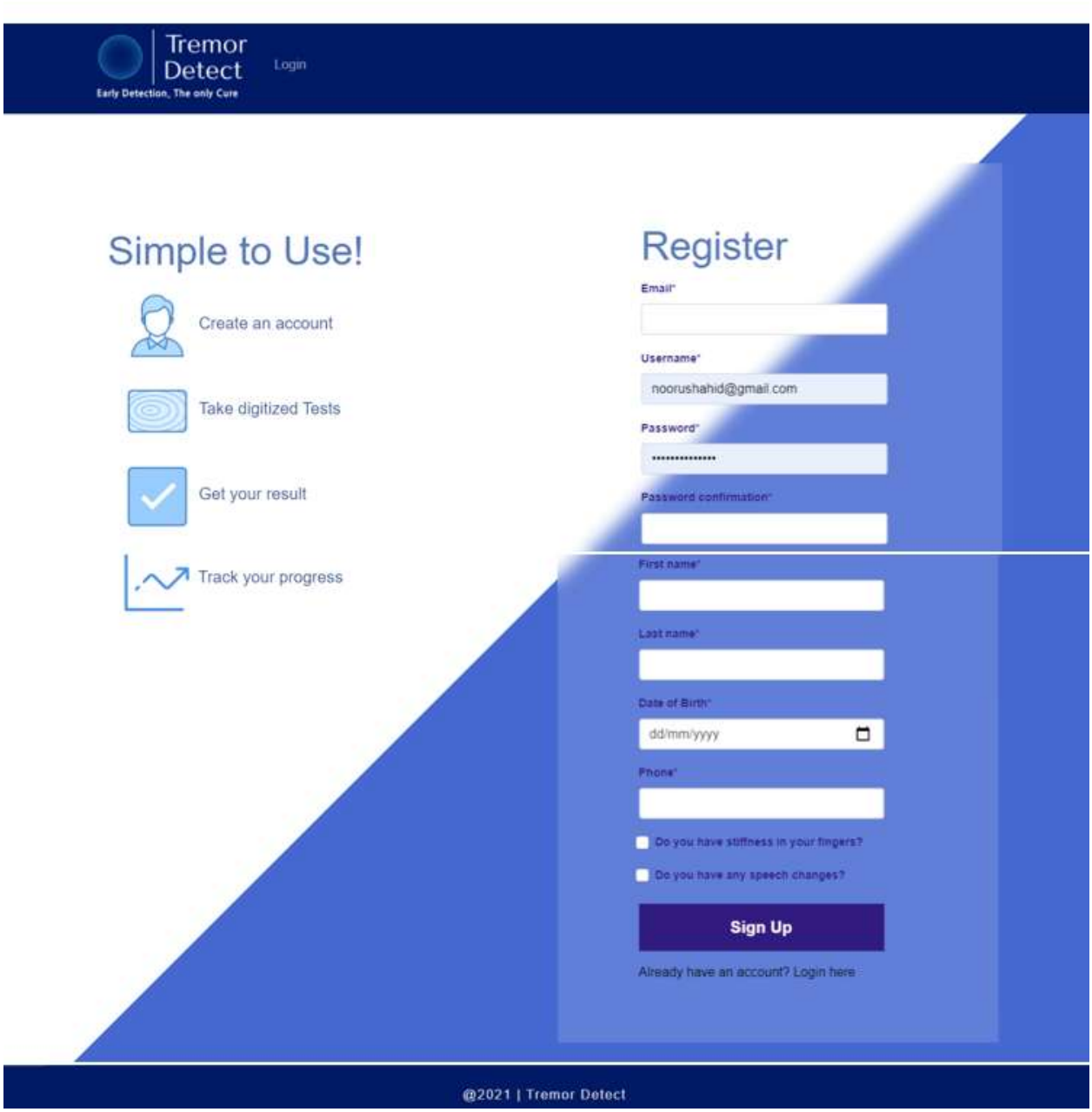


Figure 3.2 Sign Up Screen

3.2.3 Menu

After logging in, the user will be directed to the Menu Screen.

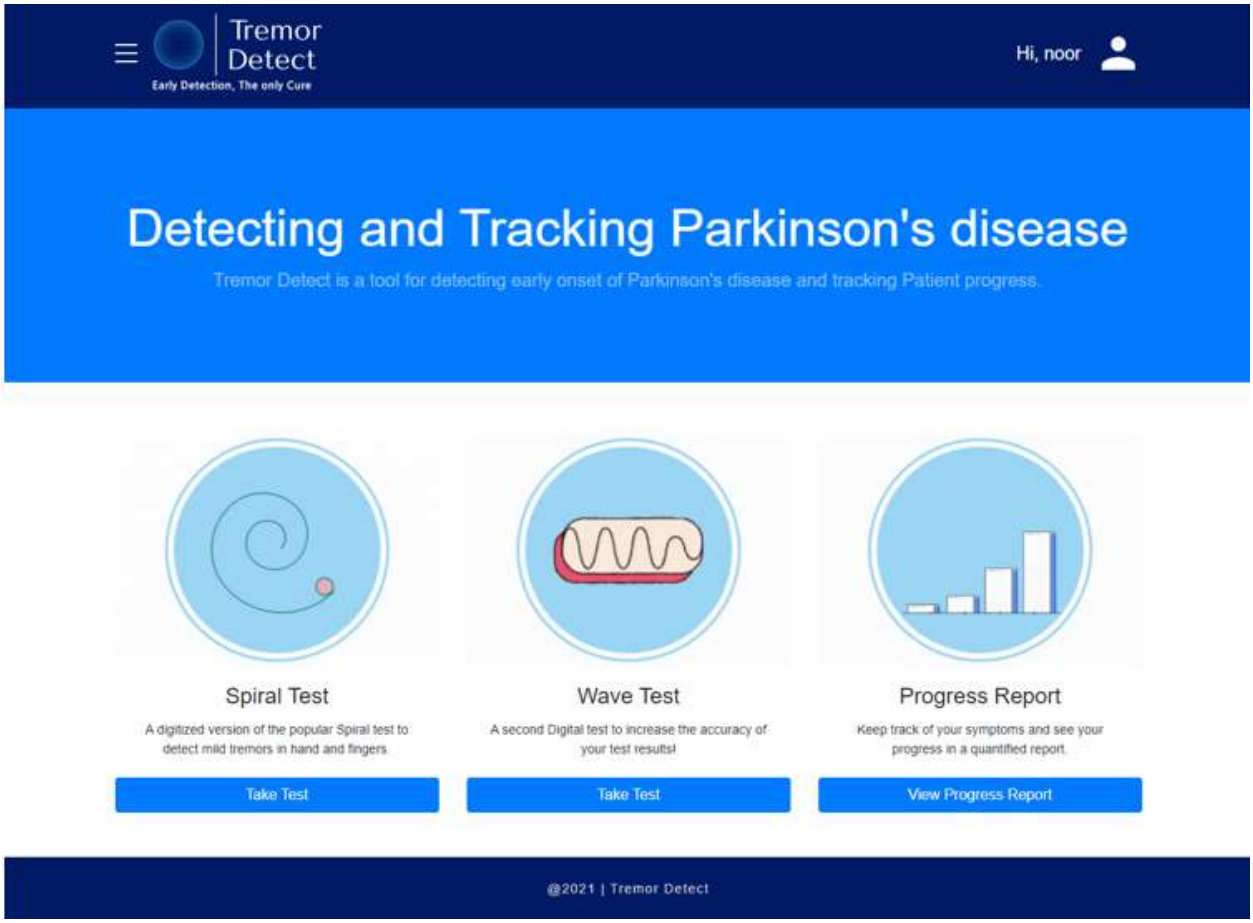


Figure 3.3 Main Menu

3.2.4 Take Spiral Test

The user will trace the pattern on the sample Spiral through touch or mouse. The test will be submitted by clicking *Submit* Button. The user can also reset the test.

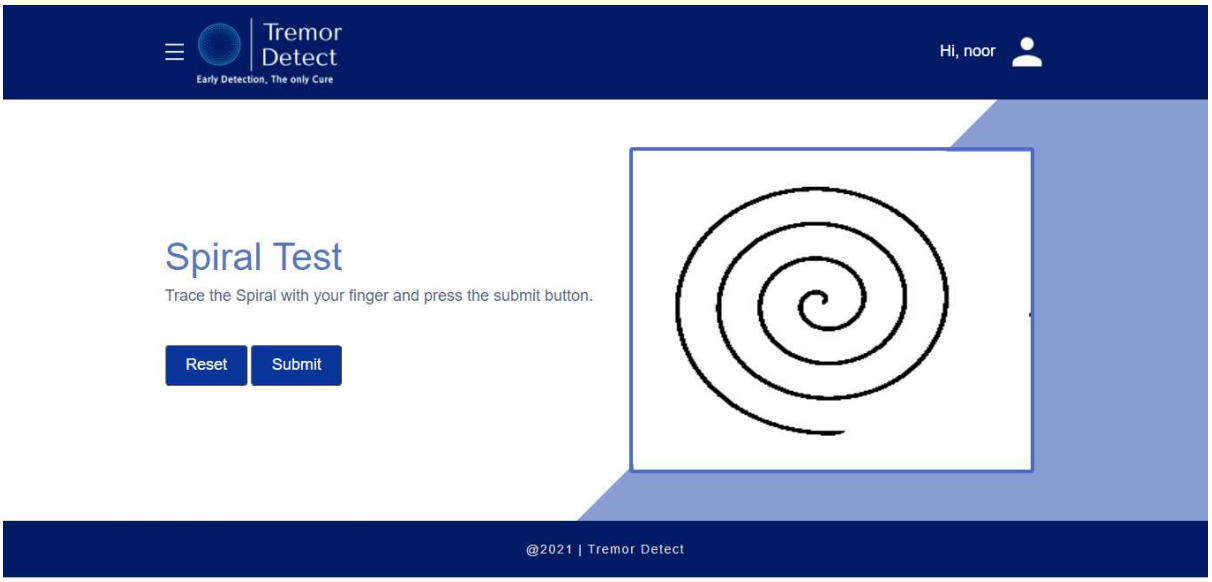


Figure 3.4 Spiral Test

3.2.5 Take Wave Test

The user will trace the pattern on the sample Wave through touch or mouse. The test will be submitted by clicking *Submit* Button. The user can also reset the test.

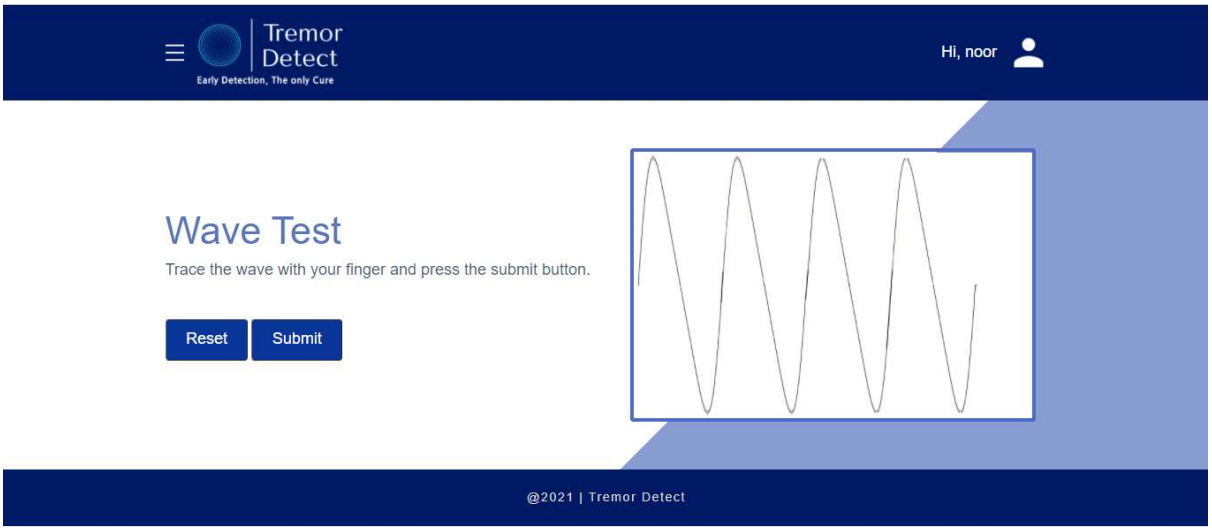


Figure 3.5 Wave Test

3.2.6 Test Result

The test result will include the test type, result and date of the test along with the traced pattern.

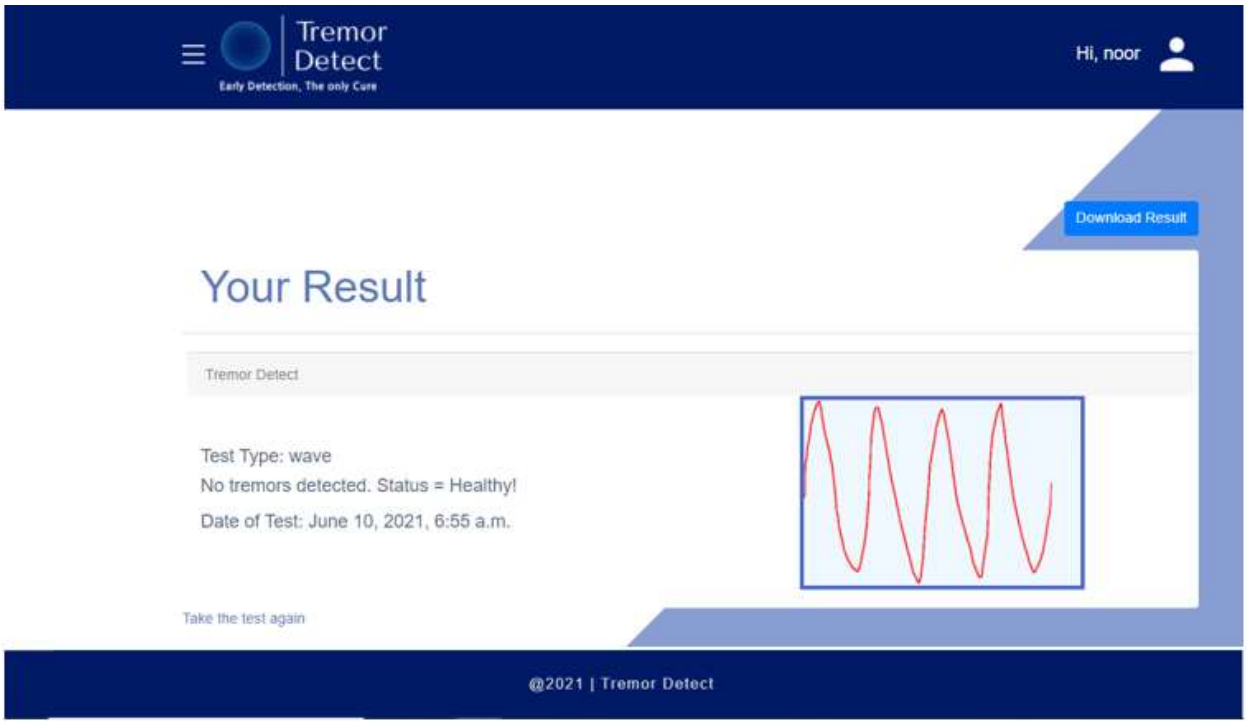


Figure 3.6 Test Results

3.2.7 Download Test Result

The test result will be downloaded in PDF Format that will include the test type, result and date of the test along with the traced pattern.

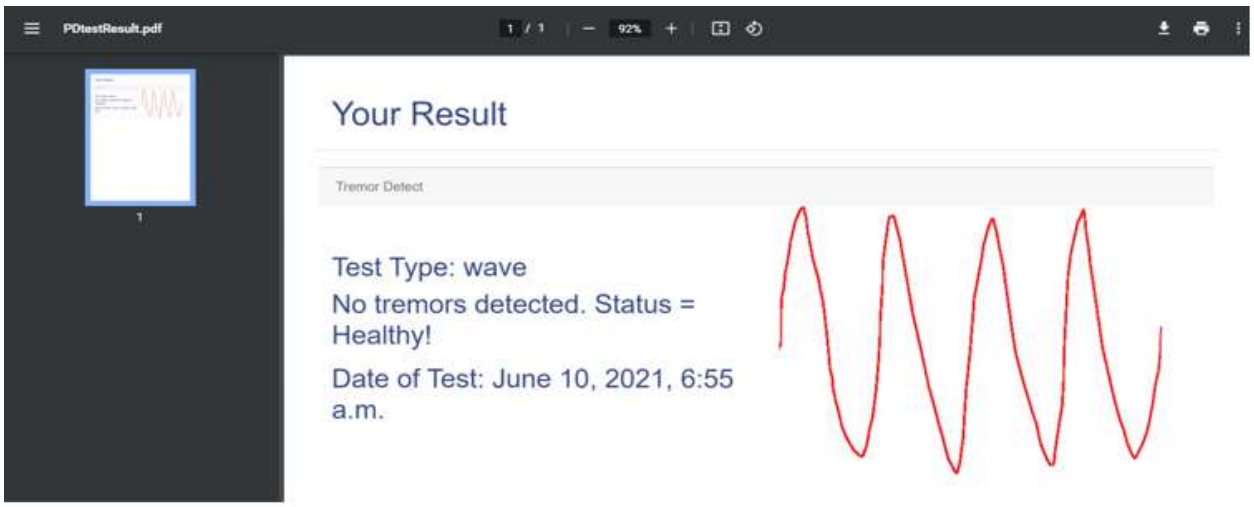


Figure 3.7 Download Test Results

3.2.8 Progress Report

The progress Report will include two graphs. One of Spiral Test and one of Wave Test.

Figure 3.8 Progress Report

3.2.9 Download Progress Report

A PDF Report will be downloaded that will include both Spiral and Wave Test graphs.

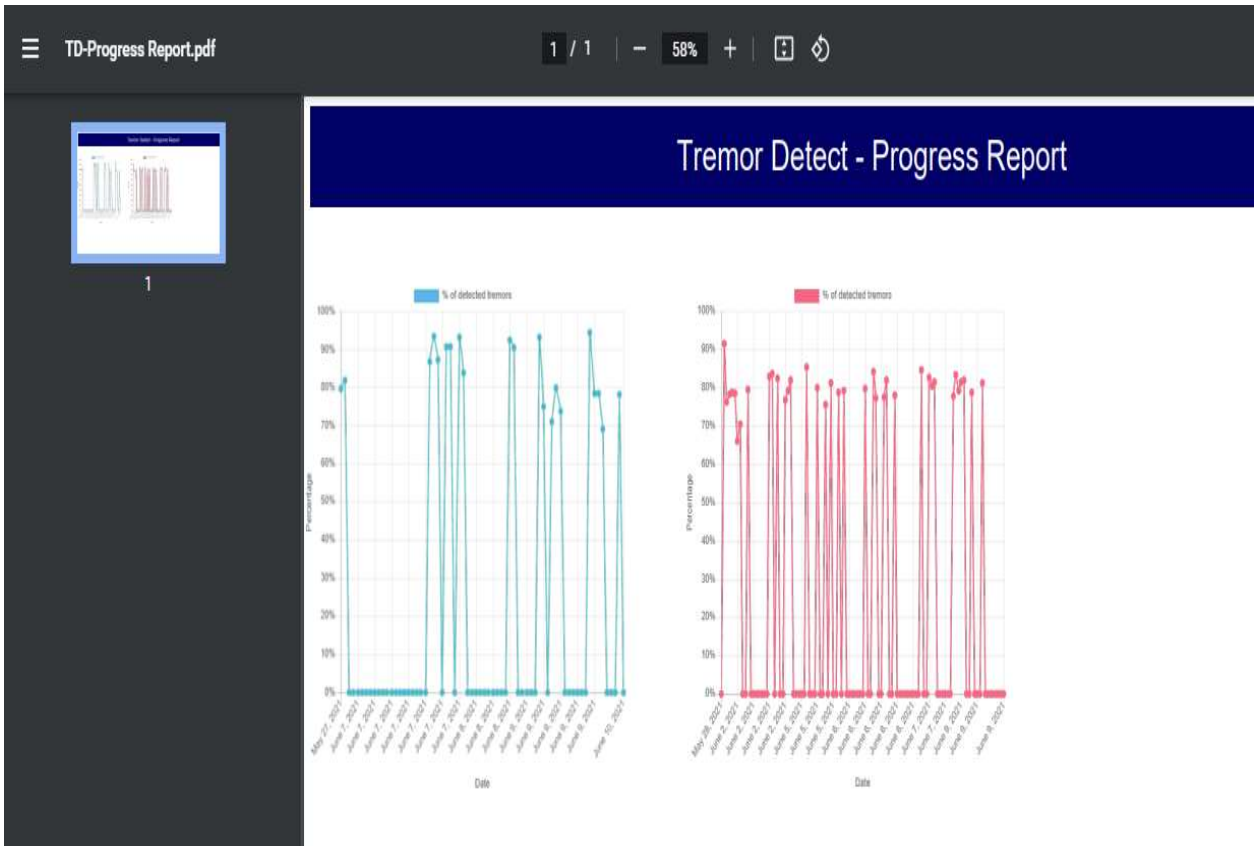


Figure 3.9 Download Progress Report

4 USING THE SYSTEM

This section provides a description of how to use the system functions.

4.1 Login

- This option enables the user and admin to login if he is already registered.
- It asks for:
  - Username
  - Password
- The user will click on the Login button and his details will be authenticated through the server database.

4.2 Sign Up

- This option enables the user to create a new account to use Tremor Detect.
- To create account the user should enter:
  - First Name
  - Last Name
  - Username
  - Email Address
  - Phone Number
  - Date of Birth
  - Additional Information about Parkinson's Disease Symptoms
- The user will click on the Sign-Up button and his details will be saved in the database and a new account will be created.

4.3 Delete Account

- This option enables the user to delete their account of Tremor Detect.
- By clicking on the user icon on the top right corner of the screen, a drop down lost will appear.
- From the list select Delete Account.
- The user and its relevant information will be deleted from the database.
- The web application will be redirected to login page.

4.4 Take Spiral/Wave Test

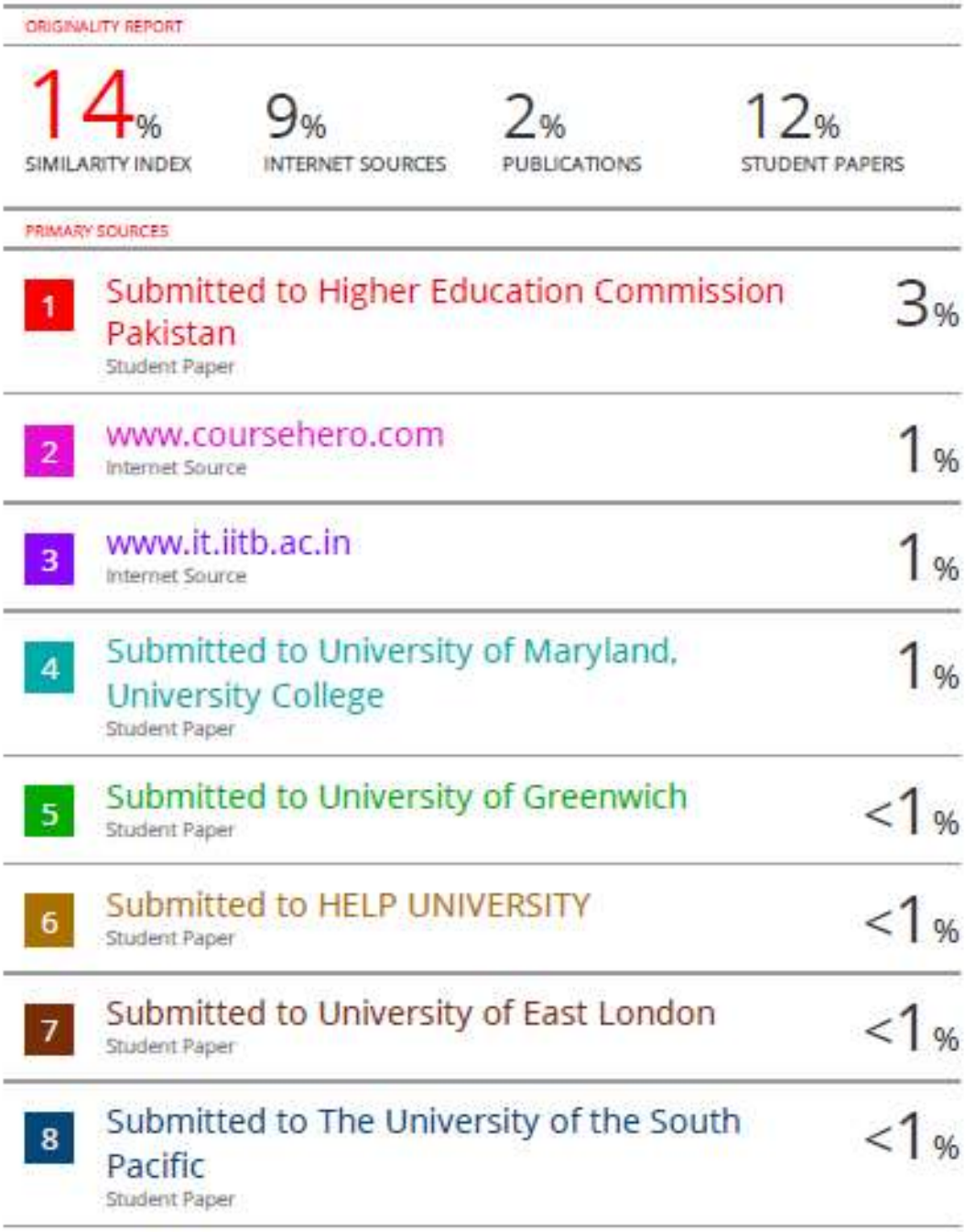
- The user can take a Spiral or a Wave Test by selecting it from the menu screen.
- The user will trace the sample pattern with touch or mouse.
- The traced input can be erased by *Reset* Button.
- The test will be submitted by clicking the *Submit* button.
- The result will be displayed after submitting the test.
- The result can be downloaded in PDF Format by clicking *Download* Button.

4.5 Track Progress

- The user can track their progress by selecting Progress Report from the menu screen.

- The report will include two separate graphs for Spiral and Wave tests.
- The progress Report can be downloaded in PDF Format by clicking *Download* Button.

APPENDIX B



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