COMSATS Institute of Information Technology,
Park Road, Chak Shahzad, Islamabad Pakistan

Android-based Serious Game for Pre-Screening of Parkinson's disease

By

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Supervisor

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Bachelor of Science in Computer Science (2013-2017)

The candidates confirm that the work submitted is their own and appropriate credit has been given where reference has been made to the work of others.

COMSATS Institute of Information Technology,
Park Road, Chak Shahzad, Islamabad Pakistan

Android-based Serious Game for Pre-Screening of Parkinson's disease

A project presented to
COMSATS Institute of Information Technology, Islamabad

In partial fulfillment
of the requirement for the degree of

Bachelors of Science in Computer Science (2013-2017)

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By

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DECLARATION

We hereby declare that this software, neither whole nor as a part has been copied out from any source. It is further declared that we have developed this software and accompanied report entirely on the basis of our personal efforts. If any part of this project is proved to be copied out from any source or found to be reproduction of some other. We will stand by the consequences. No Portion of the work presented has been submitted of any application for any other degree or qualification of this or any other university or institute of learning.

Moiez Imran

S.M. Ibrahim Azam

CERTIFICATE OF APPROVAL

It is to certify that the final year project of BS (CS) "Android Based Serious Game for Pre-Scanning of Parkinson Disease" was developed by **Moiez Imran (CIIT/FA13-BCS-080)** and **S.M. Ibrahim Azam (CIIT/FA13-BCS-093)** under the supervision of "**Prof. Dr. Muaz A. Niazi**" and that in his opinion; it is fully adequate, in scope and quality for the degree of Bachelors of Science in Computer Sciences.

Supervisor

External Examiner

Head of Department

(Department of Computer Science)

Executive Summary

In this era, detection of disease has become costly and time-consuming, making it difficult for people to have different health check-ups to diagnose any disease in their body especially the people who are busy or old aged. Also, it is difficult, costly and time consuming for the research groups to collect and analyse the data of detection of any disease around the world.

"Android-based Serious Game for Pre-Screening of Parkinson's disease" is a system that will provide an easy clinical approved tests to detect Parkinson Disease within the people. Tests will include Static Spiral Test, Dynamic Spiral Test and Balance Test each followed by a demo animated video for better understanding of how to conduct each test. The detection of disease will be done through Artificial Intelligence thus making results more accurate. If person is detected with Parkinson Disease the Android application also provides the feature of locating nearby doctor and hospitals. Also, the system will include a research oriented web portal in which the data collected through the Android application will be used to generate different graphical reports (Gender wise report, Country wise report, Age wise report and etc.) that will help research groups to analyses and have a check over the detection of Parkinson Disease around the globe. Also, an admin web portal is included in the system which will be used by the admin to main user records and Android application.

"Android-based Serious Game for Pre-Screening of Parkinson's disease" system is portable and easy to use, with just an internet connection and an android smartphone a person at any time and any place can have an initial detection of Parkinson Disease by just performing three simple clinical approved tests. Also, the system will help research groups to collect and analyses data for future prediction and advancements in detection of Parkinson Disease.

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Acknowledgement

All praise is to Almighty Allah who bestowed upon us a minute portion of His boundless knowledge by virtue of which we were able to accomplish this challenging task.

We are greatly indebted to our project supervisor "**Prof. Dr. Muaz A. Niazi**". Without their personal supervision, advice and valuable guidance, completion of this project would have been doubtful. We are deeply indebted to them for their encouragement and continual help during this work.

And we are also thankful to our parents and family who have been a constant source of encouragement for us and brought us the values of honesty & hard work.

Moiez Imran

S.M. Ibrahim Azam

Abbreviations

SRS	Software Require Specification
PC	Personal Computer
CNN	Convolutional Neural Network
SDK	Software Development Kit
LR	Linear Regression
SDD	Software Design Document

Table of Contents

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Table Of Figures

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1 Introduction

1.1 Project Vision

The purpose of this application is to identify that if a person is has a Parkinson's disease or not. There are no specific tests available for detection of Parkinson's disease. The neurologist diagnose Parkinson's disease by examining the medical history of the patient, a review of patient's signs and symptoms and a physical examination. So, this application will provide an initial test to the users before referring to a doctor.

1.2 Brief

The project "Android-based serious game for Parkinson Disease" is a system which can detect Parkinson's disease in a person and collect and provide data for Parkinson Disease research groups. The system is divided into three parts as follow:

1. **Android Application**

The android application is developed using Google SDK and Android Studio. The Android application is the main part of our system in which detection of Parkinson Disease within a user will be done. The following are three clinical approved tests that will be used for detection of Parkinson Disease

- Static spiral test
- Dynamic spiral test
- Balance test

It is an artificial intelligence based application which includes two trained models. The first model is trained using Convolution Neural Network (CNN) algorithm and the second model is trained using Linear Regression (LR) model. The CNN model will be used to detect Parkinson Disease in a user for Static and Dynamic spiral test. The LR model will be used to detect Parkinson Disease in a user for Balance test. The CNN algorithm is implemented in Python using PyCharm tool. CNN model has been connected with android application using Flask environment. The LR algorithm is implemented in Java and is embedded in the Android application. Android application has been developed using Object oriented technique.

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2. Admin Portal

The admin portal is developed using ASP.Net and Visual Studio. It is used by the admin to maintain and access the user information and reports.

Admin will be able to view:

- Total number of users registered
- Total number of users logged in
- All user test records
- User's information

3. Research Portal

The research portal is developed using ASP.Net and Visual Studio. The research portal will show different generated reports (Gender wise report, Country wise report, Age wise report and etc.) of Android application collected data of detection of Parkinson Disease to Parkinson researchers in different graphical formats

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We did research about similar apps and try to figure out what difficulties does user face while using the application. All those problems are discussed in the document later on. We have developed the system keeping in mind all the problems founded in other similar system and have solved them. We are utilizing "Incremental Development Model" which allows us to develop the project iteratively in different cycles. Thus, completing the project in a specific number of iterations.

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2 Background and Literature Review

2.1 Introduction to Parkinson Disease

Parkinson's disease (PD) is a progressive neurological disorder characterized by a large number of motor and non-motor features that can impact on function to a variable degree.

A person's brain stops gradually while producing dopamine, a neurotransmitter. Lesser the dopamine level, the person will have lesser ability to move their body and emotions.

Parkinson's disease evolves slowly, and there is current interest in exploring the earliest stages of the disorder, because of new approaches to studying pathogenesis and developing potential neuroprotective treatment.

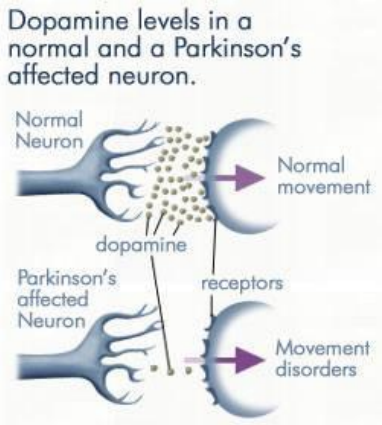

Figure 1: Cause of Parkinson's disease

Pic Credits: image.slidesharecdn.com/

Parkinson's disease is very difficult to diagnose particularly in its early stages. There are no specific medical tests available which can diagnose PD in a patient. The main reason behind it is that the main cause of Parkinson's disease is still unknown. There is no standard diagnostic test for Parkinson's. Researchers are working to develop an accurate "biological marker" such as a blood test or an imaging scan. To date, the best objective testing for PD consists of specialized brain scanning techniques that can measure the dopamine system and brain metabolism. But these tests are performed only in specialized imaging centers and can be very expensive.

There are no specific medical tests available for Parkinson's disease. The neurologist diagnoses Parkinson's disease by examining the medical history of the patient, a review of patient's signs and symptoms and a physical examination.

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Tests can be categorized under two heads:

2.1.1 Invasive Tests

- **Blood Test:**
  Researchers have developed the world's first blood test that can detect the abnormal metabolism of blood cells in people with Parkinson's disease.

  They found that those with Parkinson's had an increased level of phosphorylated alpha-syncline (PAS) compared with non-sufferers.

  But many people with Parkinson's also develop neurological problems that can cause the results to be inaccurate and difficult to diagnose.

2.1.2 Non-Invasive Tests

- **PET Scan:**
  For patients with Parkinson's disease (PD), a PET scan is used to assess activity and function of brain regions involved in movement.

  Positron emission tomography (PET) is a test that uses a special type of camera and a tracer (radioactive chemical) to look at organs in the body.

  A PET scan usually lasts 45-60 minutes. You will first be given the tracer through an IV. After that, the PET scanner, a doughnut-shaped instrument, will move in circles around you. As this is happening, a special camera will take pictures of patterns left by the tracer chemical inside your body.

- **CT Scan:**
  Computed tomography uses X-rays and computers to produce images of inside the body including the brain. This test is used to look for signs of disease like Parkinson's Disease in the body.

  A contrast material may be injected intravenously (into your vein) so the radiologist can see the body structures on the CT image.

- **MRI:**
  Magnetic resonance imaging is a test that produces very clear pictures, or images, of the human body without the use of X-rays and CT-Scan.
  For an MRI test, you lie inside a special machine (scanner) that has a strong magnet. The MRI can show tissue damage or diseases, such as infection or inflammation, or a tumour, stroke, or seizure. Information from an MRI can be saved and stored on a computer for more study. Photographs or films of certain views can also be made.

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2.2 Fact & Figures

There are millions of people who live with Parkinson's disease in the world. Approximately 60,000 Americans are diagnosed with Parkinson's disease each year, and this number does not reflect the thousands of cases that go undetected.i

A survey was conducted in the world's 10 most populous nations which clearly shows a large number of Parkinson's patients and it was estimated that this number will double till 2030. The following picture shows the percentage of patients in a country:

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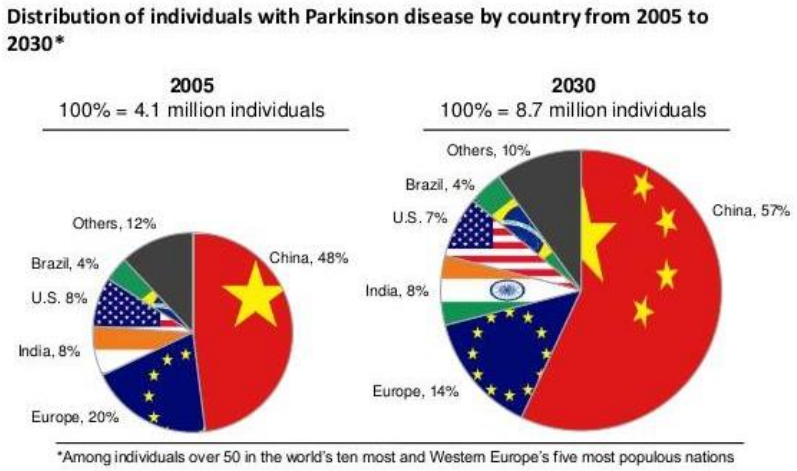

Figure 2: Survey of Parkinson patients

Source: Neurology

According to another survey, the deaths from Parkinson's disease have increased immensely as the years have passed. Following is the graph which clearly shows the increasing number of deaths due to Parkinson's disease.

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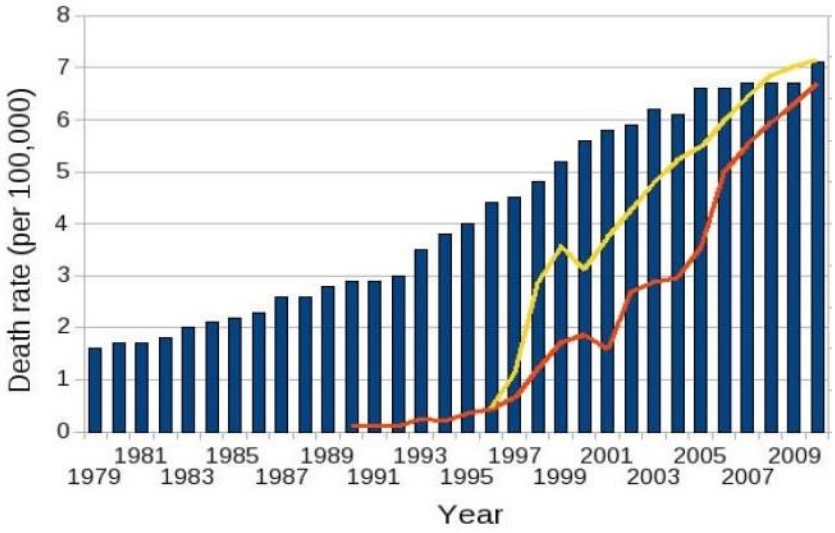

Figure 3: Parkinson's disease patients Death Rate

Pic Credits: www.sott.net

2.3 Related System Analysis

There are no applications available on the play store which can be used to detect Parkinson's disease in a person. Related applications on the google app store are just guiding apps which only tells about the symptoms, medical treatment, and exercises. Following are the available applications with brief description and their weaknesses.

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Name	Price	Last Update	Rating	downloads	Weakness
Parkinson Exercises Mobile	Rs. 397	07-06-2013	5*	100+	• Spiral Test to detect Parkinson Disease is **not working** • App **does not** work on a number of devices
Parkinson test	free	24-10-2015	1.5	1000+	• **No test's** for detecting Parkinson Disease • App is only available in **one language**

Parkinson Toolkit	free	29-07-2011	4.3	10,000+	• **Only Contains information / Techniques** regarding Parkinson Disease • **No test's** for detecting Parkinson Disease
Move app	free	29-04-2015	4.2	100+	• This app **does not diagnose** Parkinson's disease • **Just a guide** for the people

Name	**Static Spiral Test**	**Dynamic Spiral Test**	**Balance Test**	**Disease Detection**	**Multi-Language Support**	**Compatibility With Android Devices**
Parkinson Exercises Mobile	✕	✕	✕	✕	✕	✕
Parkinson test*	✓	✓	✕	✕	✕	✓
Parkinson Toolkit	✕	✕	✕	✕	✕	✓
Move app	✕	✕	✕	✕	✕	✓

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**This application contains spiral technique but this application is not working so currently there are no applications available for detecting Parkinson's disease.*

2.4 Target Solution

Name	Static Spiral Test	Dynamic Spiral Test	Balance Test	Disease Detection	Multi-Language Support	Compatibility With Android Devices
Parkinson Disease Detection App	✓	✓	✓	✓	✓	✓

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2.5 Related Research Papers

2.5.1 Research Paper 1

Research Paper Name: Android application for spiral analysis in Parkinson's disease.

Background: The paper presents an application for spiral analysis in Parkinson's disease (PD).

Problem Statement: The current diagnosis is based on clinical observation which relies on skills and experiences of a trained specialist. Thus, an additional method is desirable to help in the diagnosis process and possibly improve the detection of early PD as well as the measurement of disease severity.

Methodology:

- Time taken is the total time needed to complete the tracing of a spiral
- Average radial error of the tracing of a spiral, in comparison with an ideal spiral, is defined as:

$$\overline{err} = \frac{1}{n} \sum_{i=1}^{n} |err_i|$$

- Standard deviation of the radial error is defined as:

$$SD_{err} = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (err_i - \overline{err})^2}$$

- Maximum radial error is defined as:

$$R_{max} = Max_{i=1}^{n}(|err_i|)$$

- Crossing rate is equal to the total number of err changes from plus to minus and vice versa divides by the total number of sampling points n
- Hemispiral pressure ratio is the ratio between average pressure of the tracing data on the right hemispiral and on the left hemispiral

Result:

	Healthy	PD
Average time (seconds)	48.5	101.8
Standard deviation	± 3.6	± 4.6
Average radial error (pixels)	3.5	6.0
Standard deviation	± 3.0	± 4.9
Maximum radial error (pixels)	10.5	23.7
Crossing rate (percentage)	3.6	10.3
Hemispiral pressure ratio (right/left)	0.91	0.84

Figure 4: Parameter values of healthy and PD patients

Critique: N/A

2.5.2 Research Paper 2

Research paper Name: Improved Spiral Test Using Digitized Graphics Tablet for Monitoring Parkinson's disease

Background: The paper presents an application for spiral analysis of Parkinson's disease (PD) using Static Spiral test and Dynamic Spiral test.

Problem Statement: The monitoring of the progression of Parkinson's disease (PD) is held frequently in the clinic and is an inconvenient and time-consuming process since PD is generally observed mostly in elderly people whose physical visits to the clinic are troublesome, and the physical examinations must be performed by trained medical staff.

Methodology: Static spiral test and Dynamic spiral tests were performed by the user x-y-z coordinates, the pressure applied to the screen, stylus grip angle and the time consumed to complete the drawing task.

Change velocity between two consecutive x, y point calculated

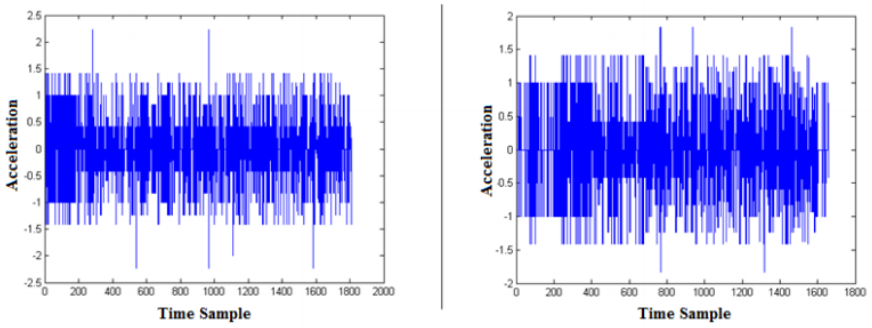
$$V_t = \sqrt{(x_t - x_{t-1})^2 + (y_t - y_{t-1})^2}$$

Acceleration Calculated

$$A_t = V_t - V_{t-1}$$

Result:

Figure shows the acceleration results of SST and DST drawings of a PD patient, where the recordings were of different durations (SST took longer for the patient to complete and thus has more samples).



Instantaneous acceleration of the drawing of a PD patient for the tests (left) SST and (right) DST

Figure 5: Acceleration results of SST and DST drawings

Critique: Tests were developed for only a specific tablet.

2.5.3 Research Paper 3

Research Paper Name: Deep Learning-aided Parkinson's Disease Diagnosis from Handwritten Dynamics

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Background: The research paper is about PD automatic identification by means of a Convolutional Neural Network (CNN), which aims at learning features from a signal extracted during the individual's exam by means of a smart pen composed of a series of sensors that can extract information from handwritten dynamics. Work aimed at building a public dataset to be used by researchers worldwide in order to foster PD-related research.

Problem Statement: Parkinson's disease (PD) automatic identification in early stages is one of the most challenging medicine-related tasks to date, since a patient may have a similar behaviour to that of a healthy individual at the very early stage of the disease.

Methodology:

Different CNN architectures were used to provide a deeper experimental analysis:

1) ImageNet: composed of 5 convolution layers, 5 pooling layers, and 2 normalization layers. It is also constituted by 5 ReLU layers among the convolution ones, 2 inner product layers, 2 dropout layers, 1 softmax loss layer and 1 accuracy layer for testing purposes.

2) CIFAR-10: a quick version is used, composed of 3 convolution layers and 3 pooling layers. It is also constituted by 3 ReLU layers among the convolution ones, 2 inner product layers, 1 softmax loss layer and 1 accuracy layer for testing intentions.

3) LeNet: composed of 2 convolution layers and 2 pooling layers. It is also constituted by 2 inner product layers and a single ReLU layer among the inner product ones. Finally, 1 softmax loss layer and 1 accuracy layer for testing duties.

Result:

	50% / 50% (Train / Test)		75% / 25% (Train / Test)	
	64 × 64	128 × 128	64 × 64	128 × 128
ImageNet	78.41%	77.69%	**80.19%**	**77.53%**
CIFAR-10	75.58%	73.38%	**78.31%**	70.78%
LeNet	54.55%	40.00%	43.64%	40.00%
OPF	**83.77%**	**80.52%**	**79.22%**	**77.92%**

AVERAGE OVERALL ACCURACY OVER THE TEST SET CONSIDERING SPIRAL DATASET.

Figure 6: Average accuracy of test

	50% / 50% (Train / Test)				75% / 25% (Train / Test)			
	64 × 64		128 × 128		64 × 64		128 × 128	
	Control	PD	Control	PD	Control	PD	Control	PD
ImageNet	58.10%	86.03%	56.19%	85.76%	59.52%	**87.95%**	55.48%	85.80%
CIFAR-10	29.76%	**92.77%**	06.31%	**98.53%**	57.38%	86.16%	14.76%	**91.79%**
LeNet	00.00%	75.00%	00.00%	55.00%	00.00%	60.00%	00.00%	55.00%
OPF	**66.67%**	90.18%	**61.91%**	87.50%	**71.43%**	87.50%	**66.67%**	82.14%

AVERAGE CONTROL AND PD PATIENTS ACCURACIES OVER THE TEST SET CONSIDERING SPIRAL DATASET.

Figure 7: Average control and PD patients accuracies

Critique: N/A

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2.5.4 Research Paper 4

Research Paper Name: Convolutional Neural Networks Applied for Parkinson's Disease Identification

Background: The research paper discusses exams to detect Parkinson's Disease make use of handwritten assessment tools, where the individual is asked to perform some predefined tasks, such as drawing spirals and meanders on a template paper. Later, expert analyses the drawings in order to classify the progressive of the disease. In this work interested into aiding physicians in such task by means of machine learning techniques, which can learn proper information from digitized versions of the exams, and them recommending a probability of a given individual being affected by PD depending on its handwritten skills. Particularly interested in deep learning techniques (i.e. Convolutional Neural Networks) due to their ability into learning features without human interaction.

Problem Statement:

The main challenges in computer-assisted Parkinson's disease diagnosis include:

– Different data sources

– To detect PD at the very early stages of the disease

– To monitor the patient at home

– To obtain digitized versions of pretty old exams.

Methodology:

The HandPD dataset 5 was collected at the Faculty of Medicine of Botucatu, S˜ao Paulo State University, Brazil, being composed of images extracted from handwriting exams of individuals divided into two groups: (i) healthy people and (ii) PD patients [25]. The dataset comprises 35 individuals, being 14 patients (10 males and 4 females) and 21 control (healthy) individuals (11 males and 10 females).

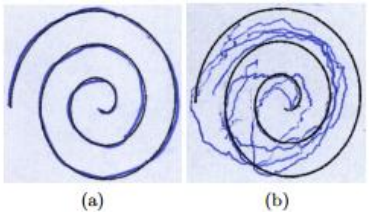

Figure 8: Spiral samples from (a) control and (b) PD patient

The proposed model the selection of suitable hyper-parameters as an image recognition task by means of CNNs. The learning step has three main hyperparameters: the base learning rate

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η, penalty parameter (momentum) α and weight decay λ. Therefore, a three-dimensional search space with three real-valued variables. Roughly speaking, the proposed approach aims at selecting the set of CNN hyper-parameters that minimizes the loss function of the images from the validation set.

Technique	Hyper-parameters
BA	$f_{min} = 0$, $f_{max} = 2.0$ $A = 0.5$, $r = 0.5$
PSO	$c_1 = 1.7$, $c_2 = 1.7$, $w = 0.7$
FA	$\gamma = 1.0$, $\beta_0 = 1.0$ $\alpha = 0.2$

Result:

	Accuracy (%)			Best Hyper-parameters		
	Overall	Control	PD	η	α	λ
Standard	**78.18%**	74.14%	**82.74%**	0.001	0.9	0.0005
RS	72.50%	80.14%	63.87%	0.0048	0.4233	0.0005
BA	**79.62%**	75.43%	**84.35%**	0.0008	0.6437	0.0007
FA	69.85%	**93.71%**	42.90%	0.0009	0.3594	0.0003
PSO	**75.76%**	85.00%	**65.32%**	0.0009	0.5144	0.0004

Average accuracies and best hyper-parameters over the test set considering meander dataset.

Figure 9: Average accuracies and best hyper parameters

Critique: N/A

2.5.5 Research Paper 5

Research Paper Name: Using Convolutional Neural Networks for Image Recognition

Background: Convolutional neural networks (CNNs) are widely used in pattern- and image-recognition problems as they have a number of advantages compared to other techniques. This white paper covers the basics of CNNs including a description of the various layers used. Using traffic sign recognition as an example, it discusses the challenges of the general problem and introduces algorithms and implementation software.It outlines the challenges of using CNNs in embedded systems and introduces the key characteristics of the Cadence Vision P5 digital signal processor (DSP) for Imaging and Computer Vision and software that make it so suitable for CNN applications across many imaging and related recognition tasks.

Problem Statement: Testing the performance of CNN for image recognition and its complexity in embedded systems.

Methodology:

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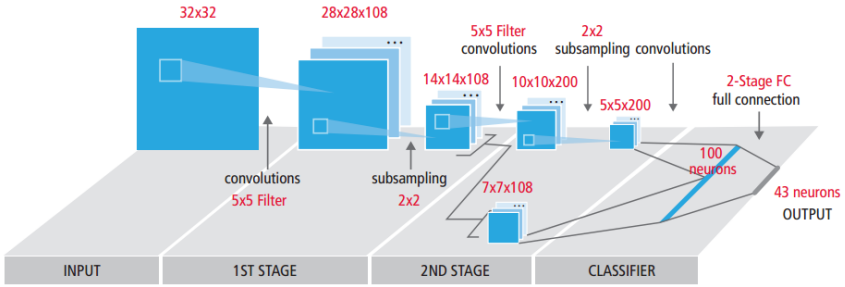

Figure 10: Typical block diagram of a CNN

The German Traffic Sign Recognition Benchmark (GTSRB) was a multi-class, single-image classification challenge held at the International Joint Conference on Neural Networks (IJCNN) 2011, with the following requirements:

• 51,840 images of German road signs in 43 classes (Figures 14 and 15)

• Size of images varies from 15x15 to 222x193

• Images are grouped by class and track with at least 30 images per track

• Images are available as color images (RGB), HOG features, Haar features, and color histograms

• Competition is only for the classification algorithm; algorithm to find region of interest in the frame is not required

Result:

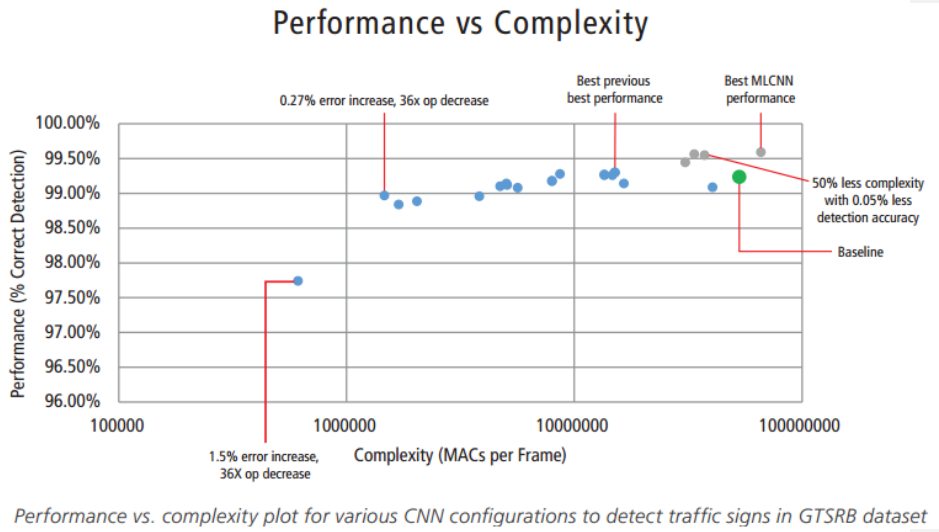

Figure 11: Performance vs. complexity plot of various CNN configurations

The points in blue are for a single-level CNN, whereas the points in red are for a hierarchical CNN. A best-case performance of 99.58% is achieved by the hierarchical CNN.

Critique: N/A

2.5.6 Research Paper 6

Research Paper Name: Predicting Parkinson's Disease Progression with Smartphone Data

Background: With the aging world population, around four to six million people suffer from Parkinson's disease (PD) worldwide. The importance of early detection' and management of PD is apparent from the fact that over 50,000 Americans are diagnosed with Parkinson's every year. With increased proliferation of phones as digital partners in the everyday life of people, these phones hold a wealth of information regarding their daily activities. The information ranges from sensor observations (e.g., captured by accelerometer, GPS, compass and microphone) can be used to detect the symptoms of Parkinson Disease

Problem Statement: Using and testing performance of different classification algorithm for detection of Parkinson Disease

Methodology:

The user holds the smartphone in hand at an upright position. Accelerometer sensor records the reading and is noted.

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Features are extracted e.g., a moving slowly symptom is composed of three features: low acceleration along x, y, and z dimensions of the phone.

The classification algorithm is applied to the feature set.

Result:

Naïve Bayes (Accuracy = 66%)

Predicted =>	Control	PD
Control	25	44
PD	6	75

Bayes Net (Acc. = 74%)

Predicted =>	Control	PD
Control	44	25
PD	13	68

J.48 Decision Tree (Acc. = 72%)

Predicted =>	Control	PD
Control	52	17
PD	24	57

Random Forest (Acc. = 77%)

Predicted =>	Control	PD
Control	57	12
PD	22	59

Random Tree (Acc. = 79%)

Predicted =>	Control	PD
Control	52	17
PD	14	67

Logistic Regression (Acc. = 80%)

Predicted =>	Control	PD
Control	51	18
PD	12	69

Figure 12: Result of Predicting Parkinson's Disease Progression with Smartphone Data

Critique: Structure / Model of classification algorithm used are given.

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3 Analysis

3.1 Detailed Domain Model

3.1.1 Domain Model

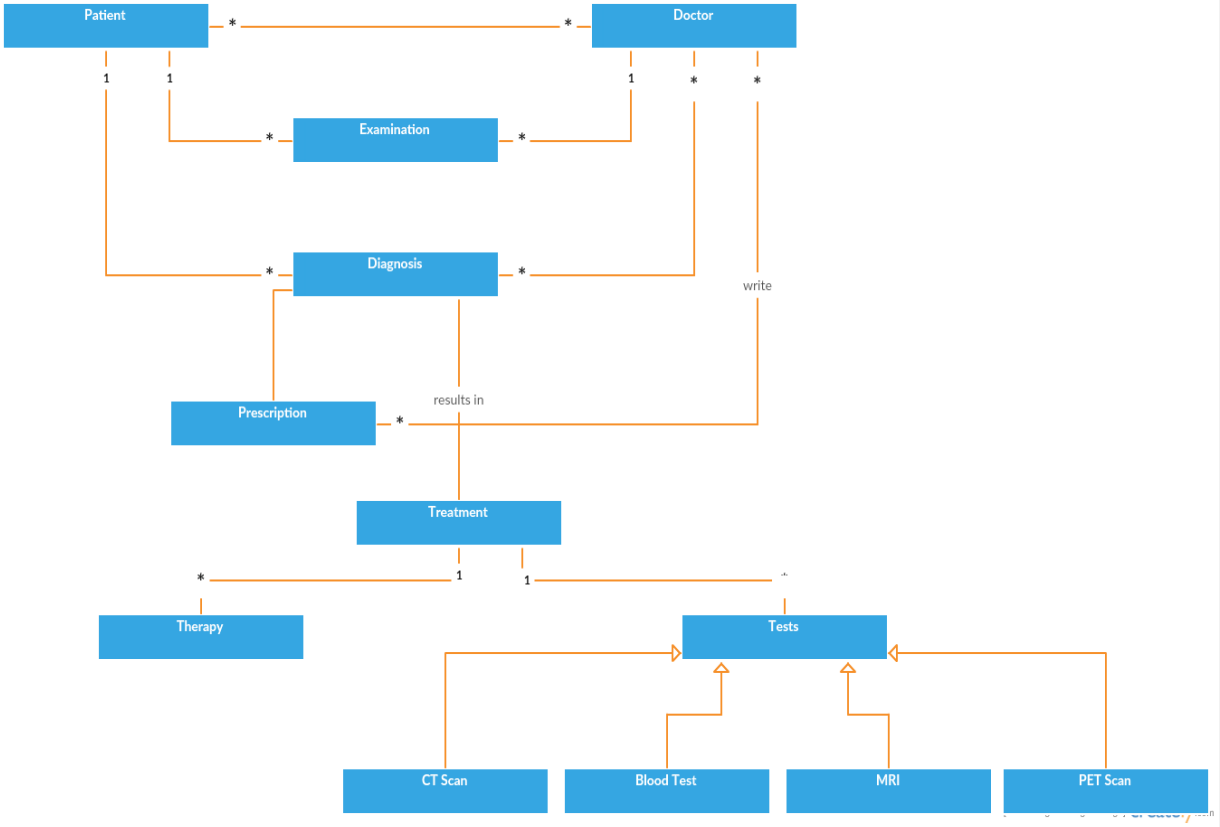

Figure 13: Domain Model Diagram

3.1.2 Domain Model Description

This domain model represents the relationship between different abstract classes of this project. As shown in the figure the class "Patient" and "Doctor" are linked with many to many relationships as there can be multiple patients and doctors of Parkinson's disease. One patient can be examined multiple times while a doctor can also examine a patient more than one time represented by one too many relationships. Similarly, the class "Patient" and "Diagnosis" is represented by one too many relationships as a patient can be diagnosed multiple times. Furthermore, multiple doctors can diagnose a disease multiple times. After diagnosis, the doctor writes prescription and diagnosis also result in "Treatment". Treatment includes "Therapy" or "Tests" which also have a one to many relationships. This is because there can be multiple types of therapies and tests for the treatment of a patient. There are four types of tests which doctors usually conduct namely CT scan, Blood Test, MRI and PET scan. These four abstract classes are linked with the "Test" class.

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3.2 Sequence Diagram

3.2.1 Static Spiral Test

The user will be provided with Static Spiral Test for detection of Parkinson Disease. The users will trace over the generated static spiral test. The following sequence diagram models the collaboration of objects based on a time sequence for performing the static spiral test on an Android device.

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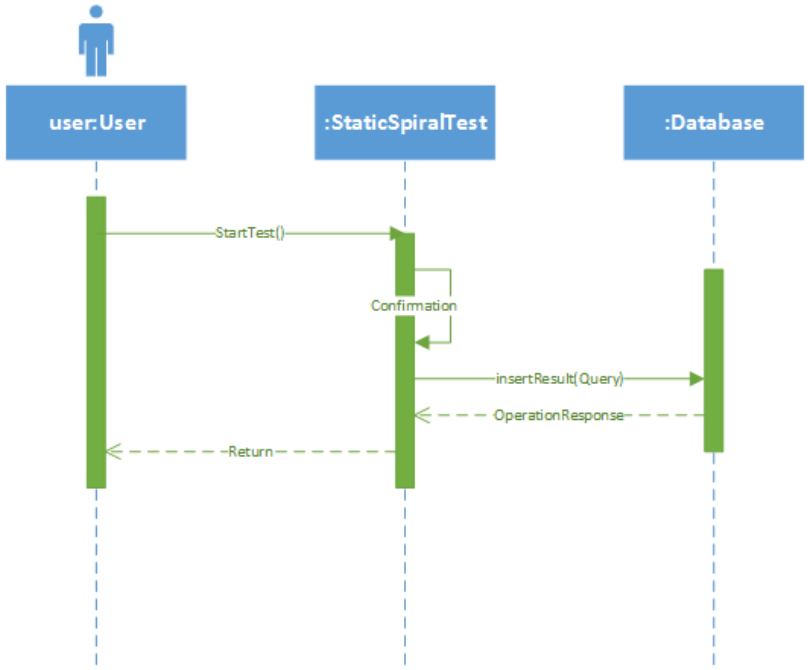

Figure 14: Sequence Diagram for Spiral Test

3.2.2 Dynamic Spiral Test

The user will be provided with Dynamic Spiral Test for detection of Parkinson Disease. In this test, the generated spiral blinks with an interval of 5 seconds. The following sequence diagram models the collaboration of objects based on a time sequence for performing the spiral test on an Android device.

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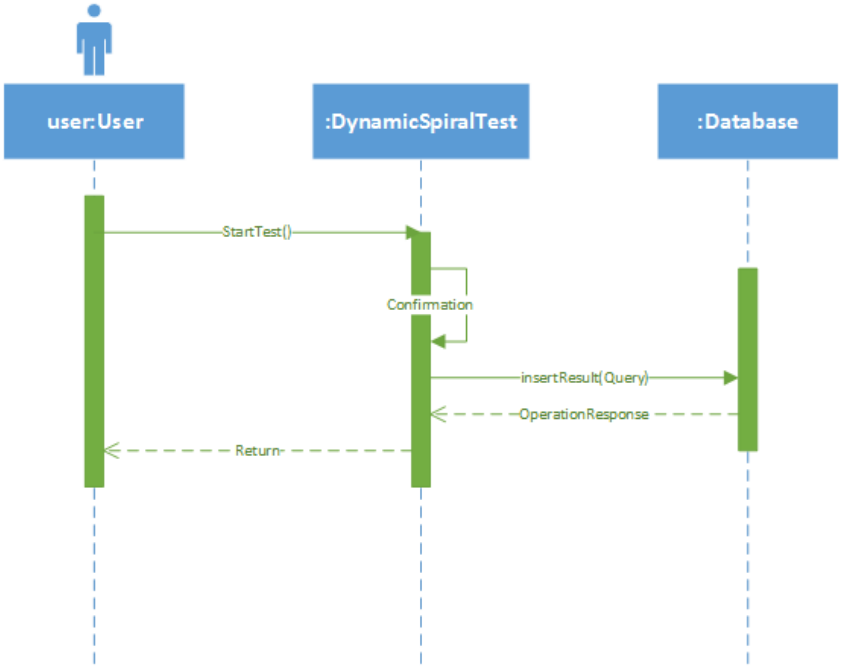

Figure 15: Sequence Diagram for Dynamic Spiral Test

3.2.3 Balance Test

The user will be provided with Balance Test for detection of Parkinson Disease. The user will hold the smartphone in the hand in order to conduct balance test. The following sequence diagram models the collaboration of objects based on a time sequence for performing balance test on an Android device.

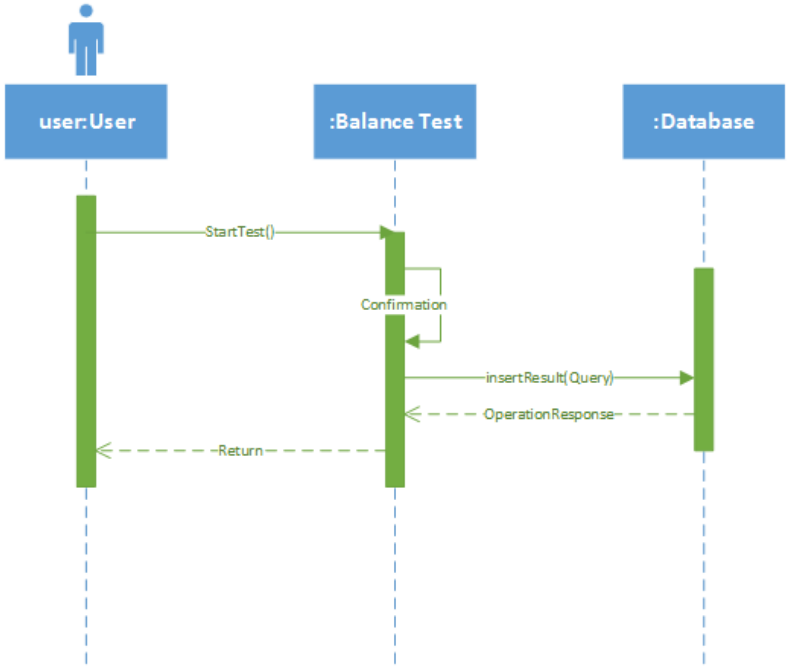

Figure 16: Sequence Diagram for Balance Test

3.2.4 Search Doctor

The user will be provided with an option to search nearby doctors. Nearby doctors will be displayed on Google maps and routing options will also be provided to the user. The following sequence diagram models the collaboration of objects based on a time sequence for searching nearby doctors on the device.

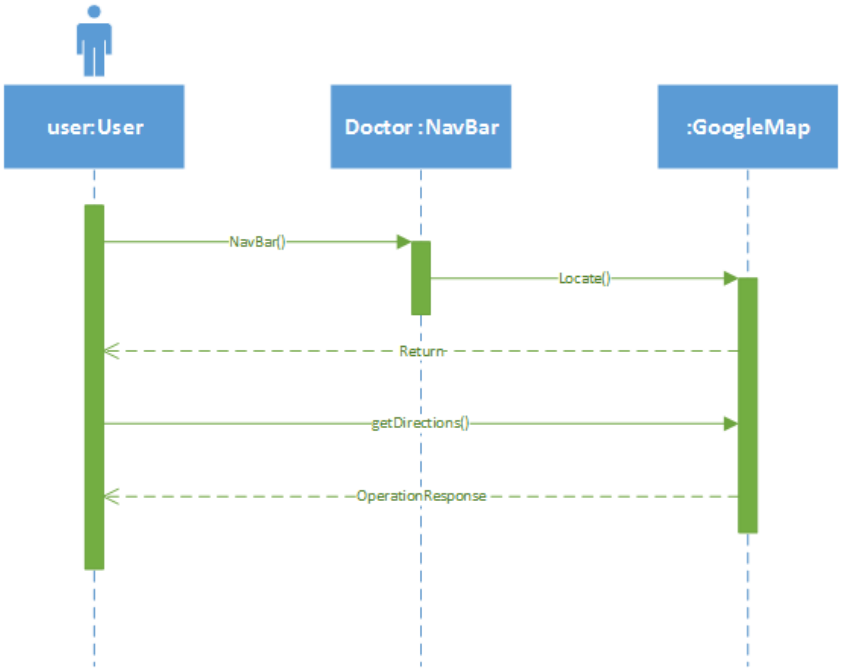

Figure 17: Sequence Diagram for Search Doctor

3.2.5 Search Hospital

The user will be provided with an option to search nearby hospitals. Nearby hospitals will be displayed on Google maps and routing options will also be provided to the user. The following sequence diagram models the collaboration of objects based on a time sequence for searching nearby hospitals on the device.

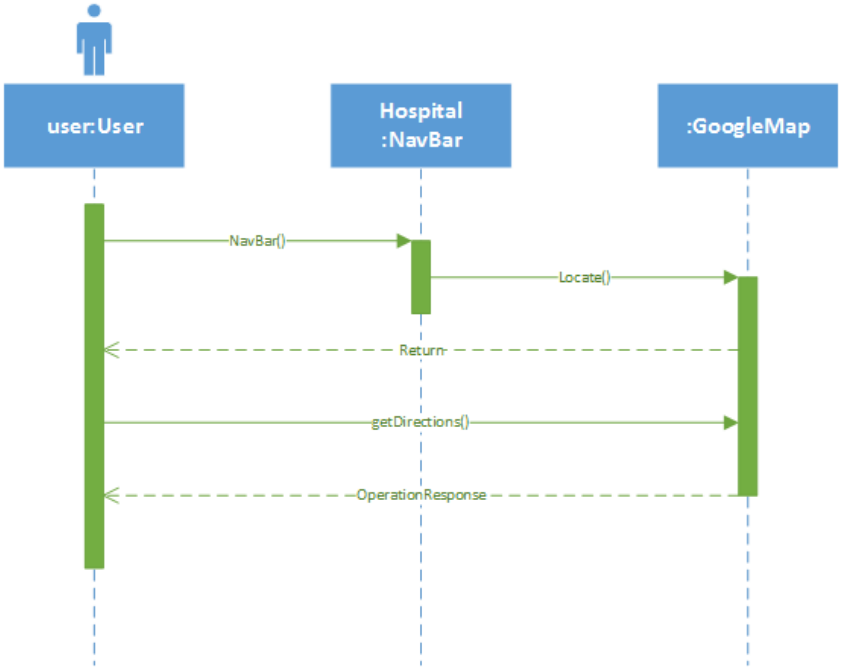

Figure 18: Sequence Diagram for Search Hospital

3.2.6 Animation 1 (Static Spiral Test)

To conduct the Static Spiral Test, the user will be provided with a demo video. The user may watch the full demo and then press 'Next' Button or may skip the demo to jump on the spiral test. The sequence diagram for Animation 1 is given below:

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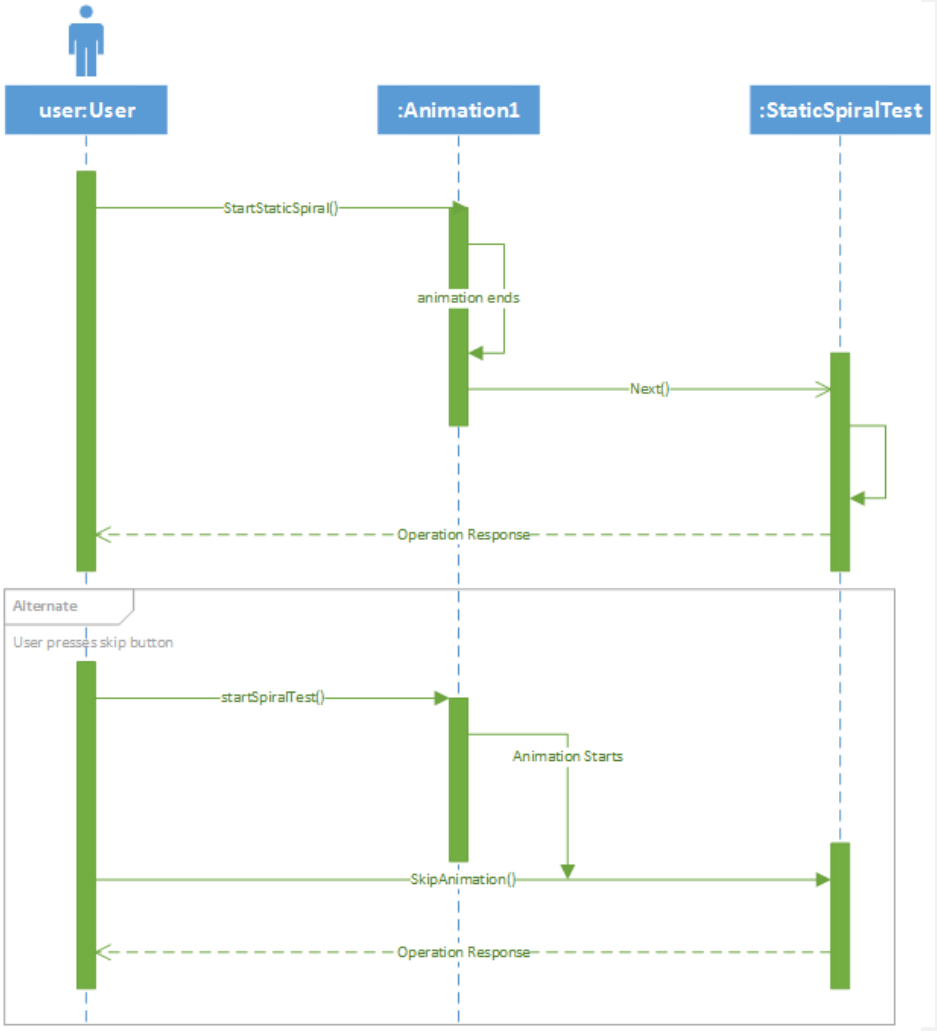

Figure 19: Sequence Diagram for animation 1

3.2.7 Animation 2 (Dynamic Spiral Test)

To conduct the Dynamic Spiral Test, the user will be provided with a demo video. The user may watch the full demo and then press 'Next' Button or may skip the demo to jump on the spiral test. The sequence diagram for Animation 2 is given below:

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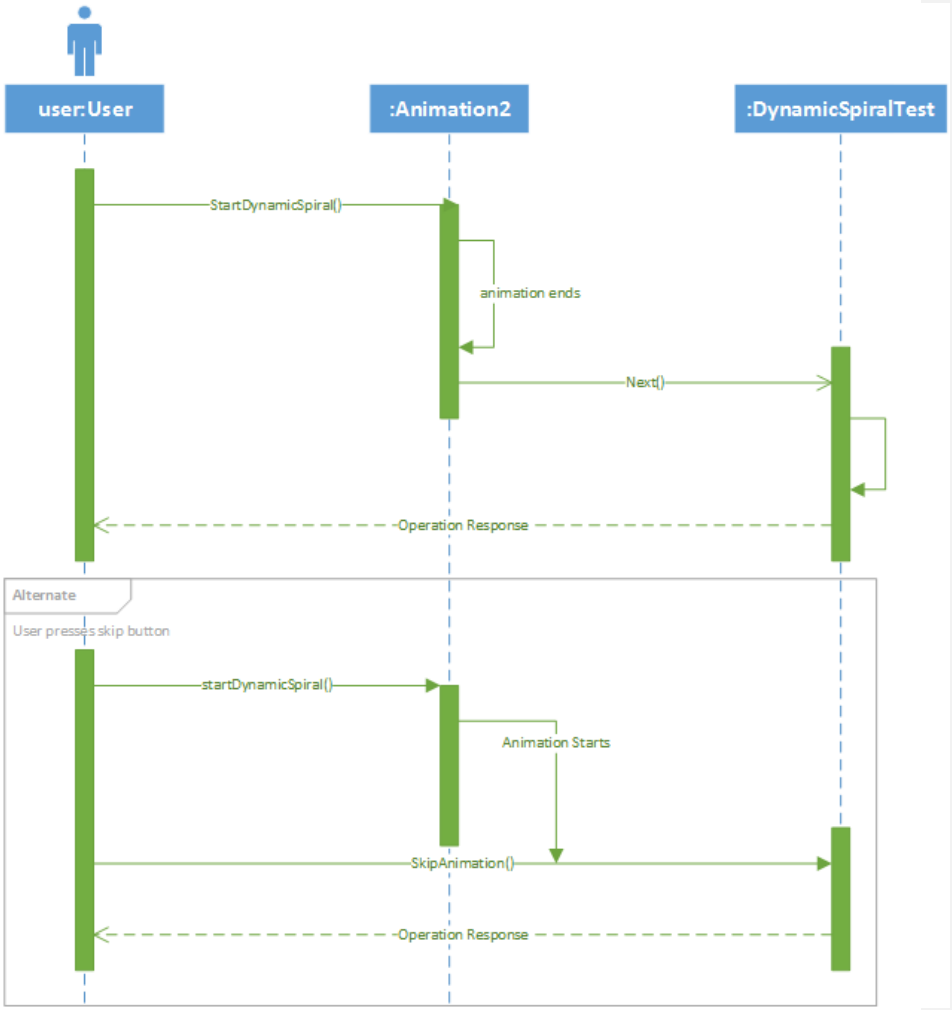

Figure 20: Sequence Diagram for animation 2

3.2.8 Animation 3 (Balance Test)

The user will be provided with a demo video to conduct the Balance Test. The user may watch the full demo and then press 'Next' Button or may skip the demo to jump on balance test. The sequence diagram for Animation 3 is given below:

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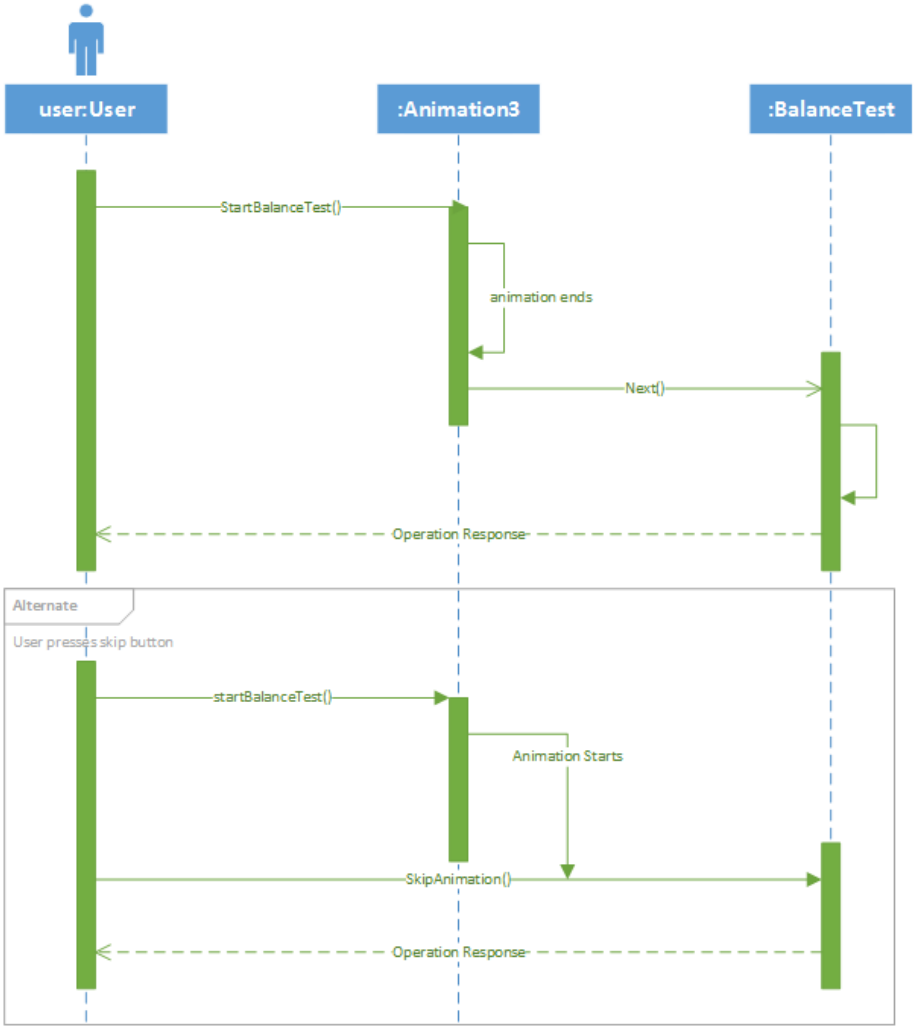

Figure 21: Sequence Diagram for animation 3

3.3 Activity Diagram

3.3.1 Static Spiral Test

The user will be provided with Spiral Test for detection of Parkinson Disease. The following activity diagram shows the steps involved in performing the spiral test on an Android device.

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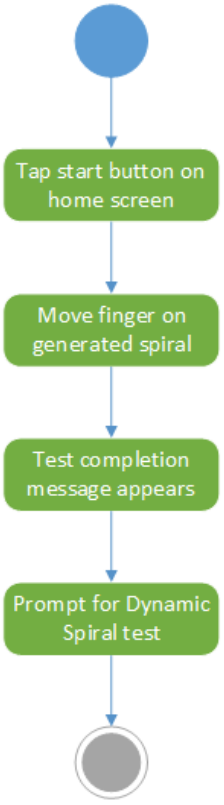

Figure 22: Activity Diagram for Static Spiral Test

3.3.2 Dynamic Spiral Test

The user will be provided with Dynamic Spiral Test for detection of Parkinson Disease. In this test, the generated spiral blinks with an interval of 3 seconds. The following activity diagram shows the steps involved in performing the spiral test on an Android device.

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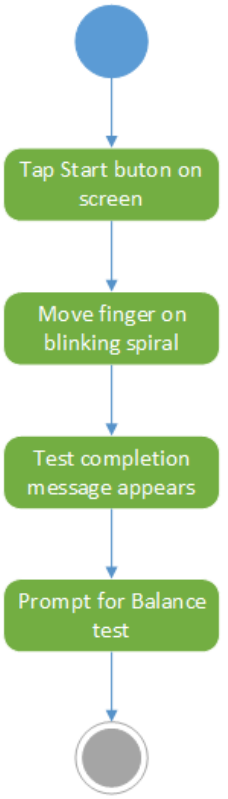

Figure 23: Activity Diagram for Dynamic Spiral Test

3.3.3 Balance Test

The user will be provided with Balance Test for detection of Parkinson Disease. The following activity diagram shows the steps involved in performing the spiral test on an Android device.

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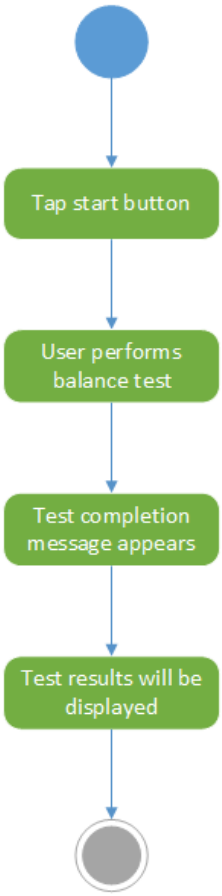

Figure 24: Activity Diagram for Balance Test

3.3.4 Search Doctor

The user will be provided with an option to search nearby doctors. Nearby doctors will be displayed on Google maps and routing options will also be provided to the user. The following activity diagram shows the steps involved in searching nearby doctors on the device.

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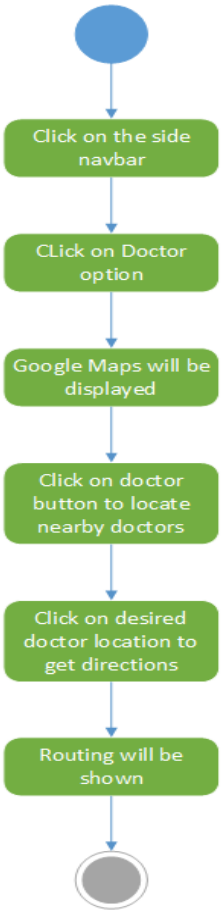

Figure 25: Activity Diagram for Search Doctor

3.3.5 Search Hospital

The user will be provided with an option to search nearby hospitals. Nearby hospitals will be displayed on Google maps and routing options will also be provided to the user. The following activity diagram shows the steps involved in searching nearby hospitals on the device.

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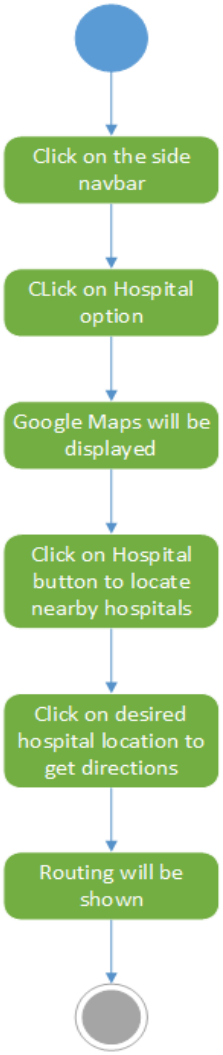

Figure 26: Activity Diagram for Search Hospital

3.3.6 Animation 1

To conduct the Static Spiral Test, the user will be provided with a demo video. The user may watch the full demo and then press 'Next' Button or may skip the demo to jump on the spiral test. The activity diagram for Animation 1 is given below:

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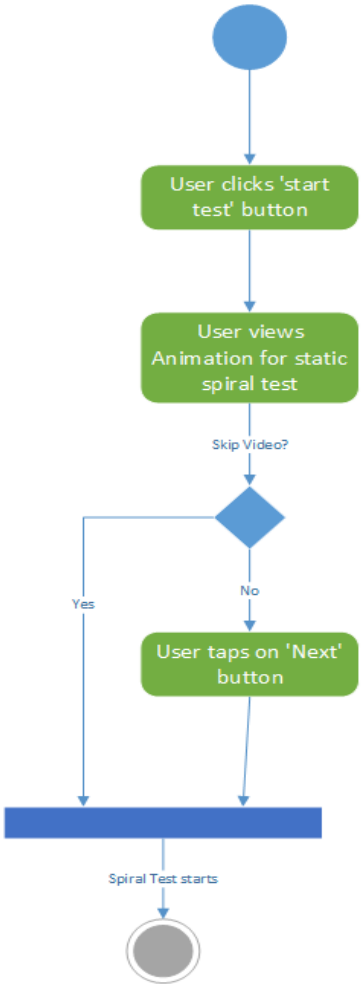

Figure 27: Activity Diagram for Animation1

3.3.7 Animation 2

To conduct the Dynamic Spiral Test, the user will be provided with a demo video. The user may watch the full demo and then press 'Next' Button or may skip the demo to jump on the spiral test. The activity diagram for Animation 2 is given below:

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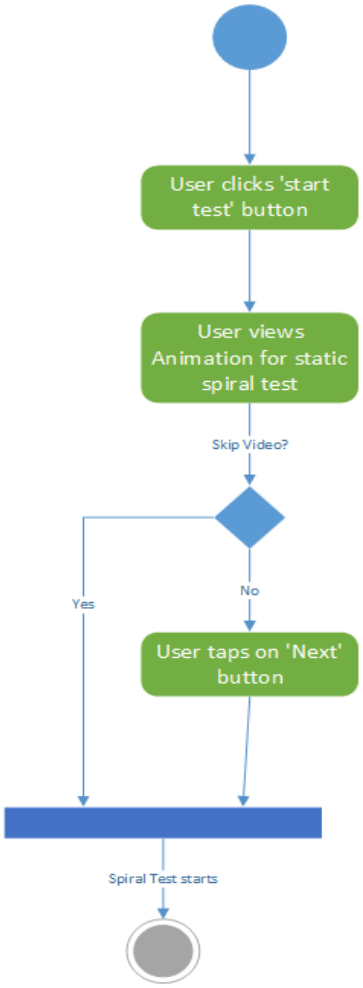

Figure 28: Activity Diagram for Animation2

3.3.8 Animation 3

The user will be provided with a demo video to conduct the Balance Test. The user may watch the full demo and then press 'Next' Button or may skip the demo to jump on balance test. The activity diagram for Animation 3 is given below:

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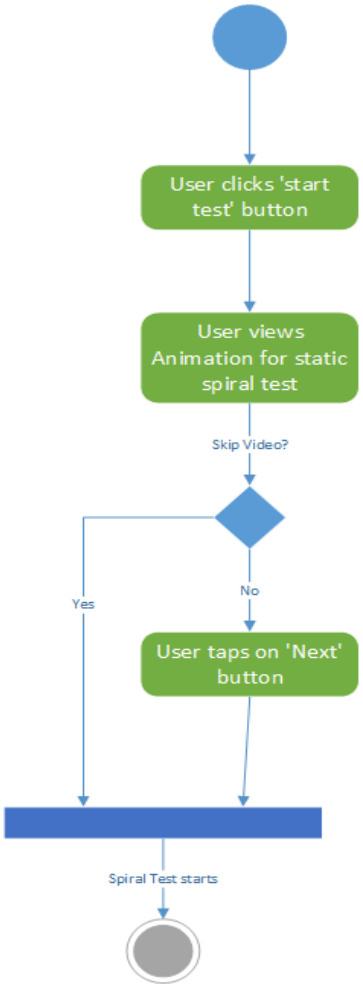

Figure 29: Activity Diagram for Animation3

3.4 State Chart Diagram

The below diagram shows the detailed state transition diagram of our system.

A new user will first have to register himself before using the Android application. For existing users, they can simply log in to the application using their username and password. When the user is successfully logged in, the homepage of the application will be displayed. A start button will be shown on the homepage to start the test. Static spiral test, Dynamic spiral test and then Balance Test will be conducted in a series respectively. After the user had conducted the all the three tests, the system will get back to the homepage.

Moreover, different options will be present in the navigation bar such as test logs, about Parkinson disease, log out, nearby doctors / hospitals etc. Settings will include user profile and change password options for the user to edit his information. The user can log out of the application using the logout button in the navbar.

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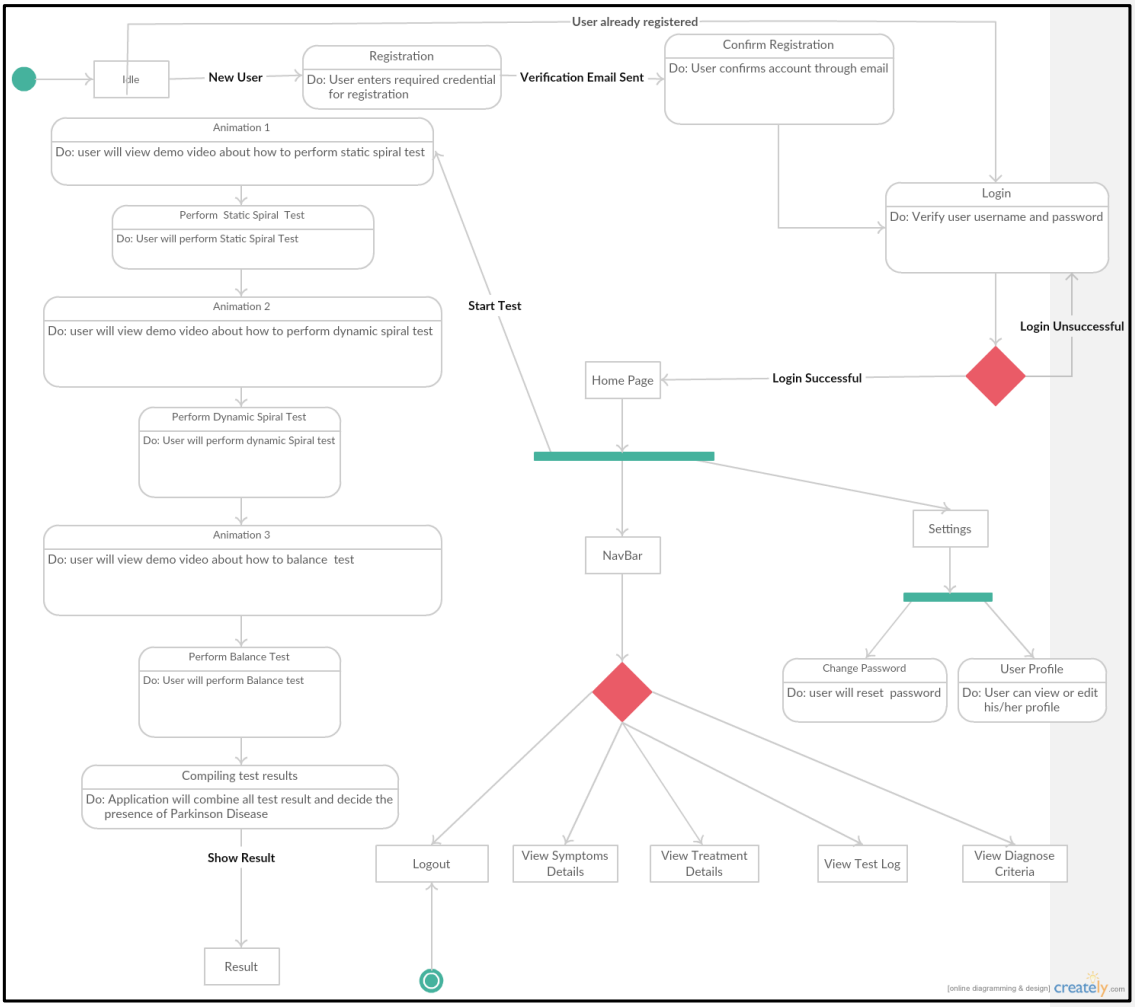

Figure 30: Statechart Diagram of the whole System

3.5 Use Case Diagram

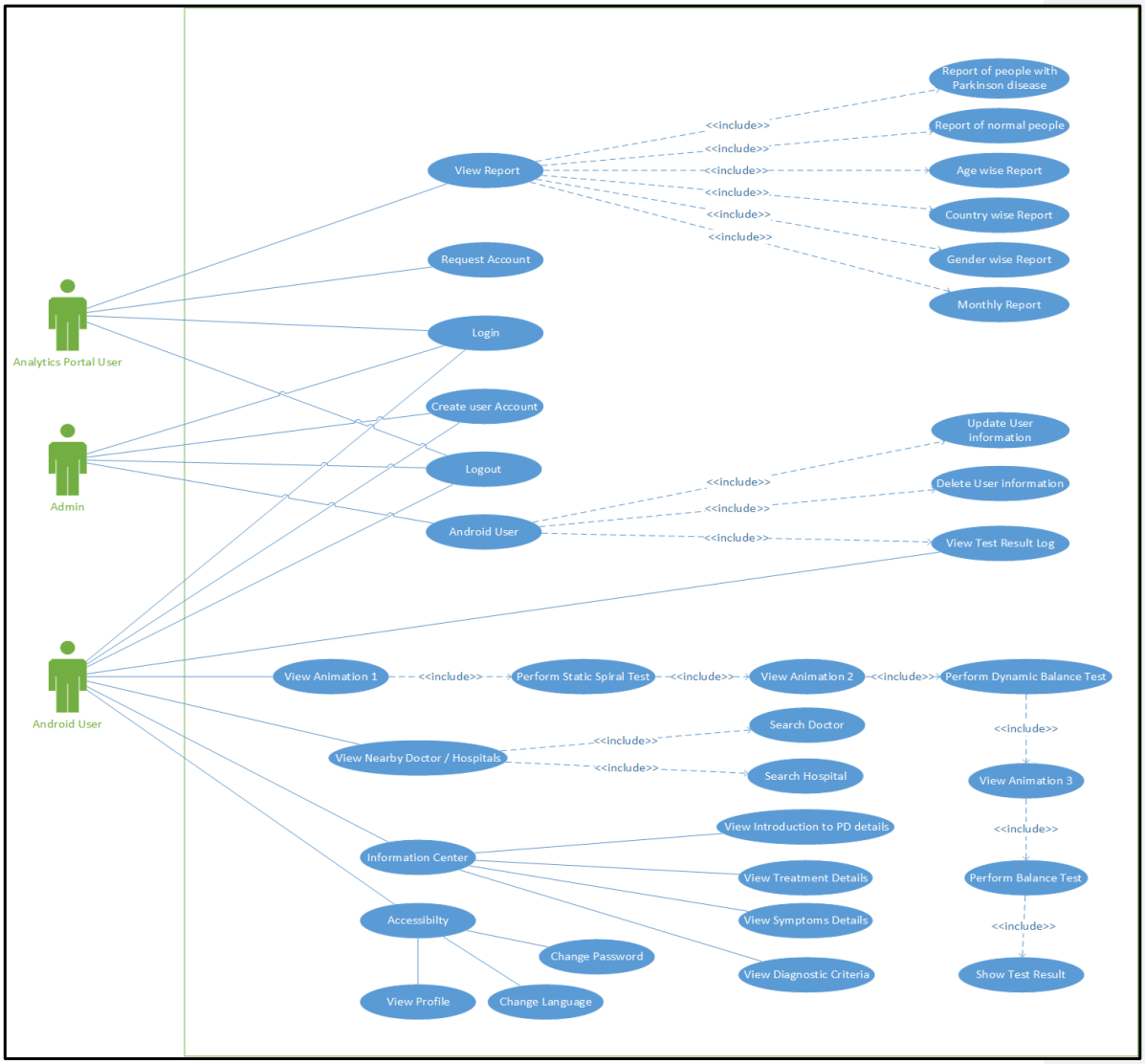

Figure 31: Use Case Diagram

The above diagram shows the detailed use case diagram which represents all the possible use cases of Android user, Admin and Analytics portal user.

The Android user will be able to create user account, log in to the application and logout. To perform Parkinson disease detection tests, the user clicks on Start button and the use case 'View Animation 1' is provoked. It is the demo video for Static Spiral Test. The use case 'View Animation 1' includes another use case namely 'Perform Static Spiral test' to start the static spiral test. After the user has finished static spiral test, demo for second test starts which is identified by the use case 'View Animation 2'. This use case includes another use case called 'Perform Dynamic Spiral Test' to start the dynamic spiral test. When the dynamic spiral test is completed, demo for third test i.e. Balance Test starts identified by the use case 'View Animation 3'. This use case includes another use case namely 'Perform Balance Test' to start balance test. The final use case included is 'Show Test Result' by which the user will be able to view his test result.

Moreover, the Android user has the accessibility option which includes 'Change Password', 'Change Language' and 'View Profile' use cases. Another use case 'Information Centre' includes 'View Introduction to PD ', 'View Symptom details', 'View Treatment details' and 'View Diagnostic criteria' which provides great details about the disease to the user. The user can also view nearby doctors and hospitals represented by the use case 'View Nearby Doctor/Hospital' which includes 'Search Doctor' and 'Search Hospital' use cases.

The admin will be able to log in, create user account and log out as represented in the above figure. The 'Android User' use case includes three more use cases namely 'Update User', Delete User' and 'View Test Result Log'.

The Analytics Web Portal has four use cases which are: 'Login', 'Logout' 'Request Account' and 'View Report'. The 'View Report' use case further includes six use cases namely 'Report of users with PD', 'Report of Normal People', 'Age wise report', 'Country wise report', 'Gender wise report' and 'monthly report'.

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3.6 Use Case Description

3.6.1 List of Android Application Use Cases

Use Case ID	Use Case Name	Use Case Description
ANDR-01	Create Account	The purpose of this use case is to create a user account so that he/she can start using the system
ANDR-02	Login	The purpose of this use case is to allow the user to log into the system.
ANDR-03	View Diagnostic Criteria	This use case allows the user to know about how to carry out each test in the application for detecting Parkinson Disease to get accurate results
AN/DR-04	Perform Static Spiral Test	The purpose of this use case is to diagnose Parkinson Disease using Static Spiral technique
ANDR-05	Perform Dynamic Spiral Test	The purpose of this use case is to diagnose Parkinson Disease using Dynamic spiral technique
ANDR-06	Perform Balance Test	The purpose of this use case is to diagnose Parkinson Disease using Balance test
ANDR-07	Change Password	The purpose of this use case is to change the user's account password if required
ANDR-08	View Test Result Log	The purpose of this use case is to allow user to view the result of each complete test and check the progress.
ANDR-09	View Symptoms Details	The purpose of this use case is to allow user to know about the symptoms that occur due to Parkinson Disease
ANDR-10	View Treatment Details	The purpose of this use case is to allow the user to know about all treatments that are present and also the treatment available in the application for detecting Parkinson Disease.
ANDR-11	Change Language	The purpose of this use case is to allow the user to change the language of the application for ease of use and understanding of application
ANDR-12	Search Doctor	The purpose of this use case is to allow the user to find all Doctor around her/him using GPS Technology.
ANDR-13	Search Hospital	The purpose of this use case is to allow user to find all Hospital around her/him using GPS Technology.

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ANDR-14	View Introduction to Parkinson disease	The purpose of this use case is to allow user to get Information and better understanding about Parkinson Disease.
ANDR-15	Logout	The purpose of this use case is to allow the user to safely log out from the application.
ANDR-16	Log in with Google Account	The purpose of this use case is to allow the user to log into the system using their Google account.
ANDR-17	View Animation 1	The purpose of this use case is to allow the user to view an animated demo of how to perform static spiral test.
ANDR-18	View Animation 2	The purpose of this use case is to allow the user to view an animated demo of how to perform dynamic spiral test.
ANDR-19	View Animation 3	The purpose of this use case is to allow the user to view an animated demo of how to perform balance test.
ANDR-20	View User Profile	The purpose of this use case is to allow the user to view his / her profile details.
ANDR-21	Show Result	The purpose of this use case is to allow the user to view his / her result after successfully performing all the tests.

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3.6.2 Android Application Detailed Use Cases

3.6.2.1 Create Account

Use Case ID:	ANDR -001
Use Case:	Create Account
Actors:	Android User
Description:	The purpose of this use case is to create a user account so that he/she can start using the system
Trigger:	The user taps the "Register" button.
Preconditions:	1. User should have a valid e-mail address
Post conditions:	1. The System will create the user's account and his/her details will be added to the database
Normal Flow:	1. Use Case Starts 2. The user taps the "Register" button. 3. The user then enters his/her Email address. 4. Then enters the desired username and password. 5. Then the user taps on the “sign up” button. 6. Verification email sent to user provided e-mail. 7. User login into his/her email account. 8. User open’s the verification email sent by the application 9. User clicks on the verification email. 10. The user signed up successful. 11. Use Case Ends
Alternative Flows:	1. In step 1 of the normal flow, if the user taps on the “create account with Google” button 1.1. The system will get authentic information from Google related to the users account and create his/her account according to the credentials provided by Google authentication.
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has prior basic experience with Android Applications and is familiar with fundamental working principles of all Android applications.
Notes and Issues:	N/A

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3.6.2.2 Login

Use Case ID:	ANDR -002
Use Case:	Login
Actors:	Android User
Description:	The purpose of this use case is to allow the user to log into the system.
Trigger:	The user taps the application icon.
Preconditions:	1. The user account must exist.
Post conditions:	1. The user will be authenticated and logged in
Normal Flow:	1. Use Case Starts 2. The user will launch the application. 3. The user will enter username. 4. The user will enter the password 5. The user will click on “Login” button 6. User will be logged into the system 7. Use Case Ends
Alternative Flows:	1. In step 1 of normal flow, if the user clicks on the “log in with “Google account” button 1.1. The system will get authentic information from Google related to the user's account and create his/her account according to the credentials provided by Google authentication.
Exceptions:	1. If password or username is incorrect 1.1 The system will prompt an error. 1.2 System will resume from step 3 of normal flow
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has prior basic experience with Android apps.
Notes and Issues:	N/A

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3.6.2.3 View Diagnostic Criteria

Use Case ID:	ANDR -003
Use Case:	View Diagnostic Criteria
Actors:	Android User
Description:	The purpose of this use case is to allow user to let know about how to carry out each test accurately in the application for detecting Parkinson Disease and having better chance for accurate result
Trigger:	User hovers on “Diagnostic Criteria” button.
Preconditions:	1. The user must be logged in.
Post conditions:	1. Information about how to successfully diagnose Parkinson Disease using the application 2. More accurate test result
Normal Flow:	1. Use Case Starts 2. User will click on top navbar button to open navbar 3. The user will click on "Information Center" button and a navbar will fade-out. 4. The user will hover on "Diagnostic Criteria" button. 5. Diagnostic Criteria page will open 6. The user will read about all 3 tests that are available in the application. 7. Use Case Ends
Alternative Flows:	1. If user click "Back" button the system will get to Step 2 of normal flow
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic Android knowledge.
Notes and Issues:	N/A

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3.6.2.4 Perform Static Spiral Test

Use Case ID	ANDR -004
Use Case:	Perform Spiral Test
Actors:	Android User
Description:	The purpose of this use case is to diagnose Parkinson Disease using Static Spiral technique
Trigger:	User clicks on "Next" button.
Preconditions:	1. The user must be logged in. 2. User should have seen the static spiral test demo video
Post conditions:	The first test for detection of Parkinson Disease will be completed
Normal Flow:	1. Use Case Starts 2. User will click on “Start” button on Animation 1 video 3. Spiral Test will start 4. Spiral shape will be generated on screen 5. User will move the finger over the each generated image 6. Confirmation message for test completed will be shown 7. Message dialog will appear with “Next Test” button 8. Use Case Ended
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	ANDR-017
Special Requirements:	N/A
Assumptions:	1. User read about how to carry out test before taking the test 2. User should view the demo video 3. User carry out test correctly 4. User reads Diagnose Criteria before start test
Notes and Issues:	N/A

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3.6.2.5 Perform Dynamic Spiral Test

Use Case ID:	ANDR -005
Use Case:	Perform Dynamic Test
Actors:	Android User
Description:	The purpose of this use case is to diagnose Parkinson Disease using Dynamic Spiral technique
Trigger:	User clicks on "Next" button.
Preconditions:	1. The user must be logged in. 2. User should have seen the static spiral test demo video 3. User has completed static spiral test
Post conditions:	1. The second test for detection of Parkinson Disease will be completed
Normal Flow:	1. Use Case Starts 2. User will click on “Next” button on Animation 2 video 3. Dynamic Spiral Test will start 4. Spiral shape will be generated on screen 5. User will move the finger over the each generated image 6. Spiral shape will blink while the user moves the finger over it 7. Confirmation message for test completed will be shown 8. Message dialog will appear with “Next Test” button 9. Use Case Ended
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	ANDR-018
Special Requirements:	N/A
Assumptions:	1. User read about how to carry out test before taking the test 2. User should view the demo video 3. User carry out test correctly 4. User reads Diagnose Criteria before start test
Notes and Issues:	N/A

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3.6.2.6 Perform Balance Test

Use Case ID:	ANDR -006
Use Case:	Perform Balance Test
Actors:	Android User
Description:	The purpose of this use case is to diagnose Parkinson Disease using Balance test
Trigger:	User clicks on "Next" button.
Preconditions:	1. The user must be logged in. 2. User should have seen the spiral test demo video 3. User has completed dynamic spiral test
Post conditions:	1. The third test for detection of Parkinson Disease will be completed
Normal Flow:	1. Use Case Starts 2. Balance Test will start when the spiral test has finished. 3. The user will stretch his arm and place the mobile horizontally in the open palm hand for about 1 minute. 4. Accelerometer sensor in the mobile phone will detect the movement of the hand. 5. Confirmation message for Balance test completed will be shown 6. Message dialog will appear with “Next Test” button 7. Use Case Ended
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	ANDR -019
Special Requirements:	N/A
Assumptions:	1. User read about how to carry out test before taking the test 2. User carry out test correctly 3. User reads Diagnose Criteria before start test
Notes and Issues:	N/A

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3.6.2.7 Change Password

Use Case ID:	ANDR -007
Use Case:	Change Password
Actors:	Android User
Description:	The purpose of this use case is to change the user's account password if required
Trigger:	User taps on "Settings" button.
Preconditions:	1. The user has already an account. 2. The user did not create the account using sign up with Google account feature.
Post conditions:	1. The users account password will be updated
Normal Flow:	1. Use Case Starts 2. User taps on the "settings" button. 3. Then he/she will tap on "My account". 4. User taps on change password button. 5. Enter the previous password. 6. Enter new password. 7. The user will enter new password again to confirm it. 8. Then tap update button. 9. Use Case Ends
Alternative Flows:	N/A
Exceptions:	1. In the 4th step of normal flow if the user enters the incorrect previous password 1.1. The Application will prompt the user about incorrect previous password 1.2. Then the user case will restart from step 4 of normal flow. 2. In the 6th step of normal flow if the new password re-entered does not match the new password entered in step 4. 2.1 The Application will prompt the user about the password mismatch. 2.2 Then the user case will restart from step 4 of normal flow.
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has prior basic experience with Android Applications and is familiar with fundamental working principles of all Android applications
Notes and Issues:	N/A

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3.6.2.8 View Test Result Log

Use Case ID:	ANDR -008
Use Case:	View Test Result Log
Actors:	Android User
Description:	The purpose of this use case is to allow user to view the result of each complete test which will allow user to check the progress.
Trigger:	User hovers on “Test Log” button.
Preconditions:	1. The user must be logged in. 2. At least one test should have been done.
Post conditions:	1. User completed test’s records will be shown to user
Normal Flow:	1. Use Case Starts 2. User will click on top navbar button to open navbar 3. The user will hover on "Test Log" button and a navbar will fade-out. 4. Test log page will open 5. The user will view the information of his/her complete test's records. 6. Use Case Ends
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic Android knowledge.
Notes and Issues:	N/A

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3.6.2.9 View Symptoms Detail

Use Case ID:	ANDR -009
Use Case:	View Symptoms Detail
Actors:	Android User
Description:	The purpose of this use case is to allow user to let know about the symptoms that occur due to Parkinson Disease
Trigger:	User hovers on “Symptoms” button.
Preconditions:	1. The user must be logged in.
Post conditions:	1. Information about Parkinson Disease Symptoms will be shown to user
Normal Flow:	1. Use Case Starts 2. User will click on top navbar button to open navbar 3. The user will click on "Information Center" button and a navbar will fade-out. 4. The user will hover on "Symptoms" button. 5. Symptoms page will open 6. User will have option of different types of symptoms 7. User will click on one of the symptoms 8. User will read about the symptom 9. Use Case Ends
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic Android knowledge.
Notes and Issues:	N/A

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3.6.2.10 View Treatment Detail

Use Case ID:	ANDR -010
Use Case:	View Treatment Detail
Actors:	Android User
Description:	The purpose of this use case is to allow the user to let know about all treatments that are present and also the treatment available in the application for detecting Parkinson Disease.
Trigger:	User hovers on “Treatment” button.
Preconditions:	1. The user must be logged in.
Post conditions:	1. Information about Parkinson Disease treatment will be shown to user
Normal Flow:	1. Use Case Starts 2. User will click on top navbar button to open navbar 3. The user will click on "Information Center" button and a navbar will fade-out. 4. User will hover on “Treatment” option 5. Treatment page will open 6. User will have option of different types of treatments 7. User will click on one of the treatment 8. User will read about the treatment 9. Use Case Ends
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic Android knowledge.
Notes and Issues:	N/A

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3.6.2.11 Change Language

Use Case ID:	ANDR -011
Use Case:	Change Language
Actors:	Android User
Description:	The purpose of this use case is to allow the user to change the language of the application for better ease of use and understanding of application
Trigger:	User hovers on "Setting" button.
Preconditions:	1. The user must be logged in.
Post conditions:	1. Application texts will be converted into language chosen
Normal Flow:	1. Use Case Starts 2. User will click on "Setting" button 3. User will click on "Change Language" field 4. Change language page will be shown consisting of different language 5. User will select a language 6. A confirmation message will be displayed. 7. User clicks "Yes" button to confirm the language change 8. Application return to setting 9. Use Case Ends
Alternative Flows:	1. In step 5 of the normal flow, if the desired language is not present 1.1. User will press "Setting" button 1.2. Use Case resumes on step 8 of normal flow 2. In step 6 of normal flow, user taps "No" button 2.1. Use Case resumes on step 4 of normal flow
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic Android knowledge.
Notes and Issues:	How many types of language will the application support?

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3.6.2.12 Search Doctor

Use Case ID:	ANDR -012
Use Case:	Search Doctor
Actors:	Android User
Description:	The purpose of this use case is to allow user to find all Doctor around her/him using GPS Technology.
Trigger:	User hovers on “Search Doctors” button.
Preconditions:	1. The user must be logged in. 2. GPS enabled 3. Internet Connection
Post conditions:	1. Nearby Doctors will be located on the map. Routing to the Selected Doctor from user current location.
Normal Flow:	1. Use Case starts 2. User hover on the side nav bar. 3. User click on the doctor option 4. Google Map will open 5. User will click on Doctor button to locate nearby Doctors 6. User will select the most near Doctor from his/her current location 7. User will click on routing button 8. Google maps will figure out the shortest path to the selected Doctor. 9. Routing will be showed to the user 10. Use Case ends
Alternative Flows:	1. In step 5, if the internet is not connected 1.1. Dialog box displays message "No Internet connection" 1.2. Application will return to home screen
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	User should be familiar with Google Maps
Notes and Issues:	N/A

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3.6.2.13 Search Hospital

Use Case ID:	ANDR -013
Use Case:	Search Hospital
Actors:	Android User
Description:	The purpose of this use case is to allow user to find all Hospitals around her/him using GPS Technology.
Trigger:	User hovers on “Search Hospital” button.
Preconditions:	1. The user must be logged in. 2. GPS enabled 3. Internet Connection
Post conditions:	1. Nearby Hospital will be located on the map. Routing to the Selected Hospital from user current location.
Normal Flow:	1. Use Case starts 2. User hover on the side nav bar. 3. User click on the hospital option 4. Google Map will open 5. User will click on Hospital button to locate nearby Hospital 6. User will select the most near Hospital from his/her current location 7. User will click on routing button 8. Google maps will figure out the shortest path to the selected Hospital. 9. Routing will be showed to the user 10. Use Case ends
Alternative Flows:	1. In step 5, if the internet is not connected 1.1. Dialog box displays message "No Internet connection" 1.2. Application will return to home screen
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	User should be familiar with Google Maps
Notes and Issues:	N/A

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3.6.2.14 View Introduction to Parkinson Disease

Use Case ID:	ANDR -014
Use Case:	View Introduction to Parkinson Disease
Actors:	Android User
Description:	The purpose of this use case is to allow user to get Information and better understanding about Parkinson Disease
Trigger:	User hovers on “Introduction” button.
Preconditions:	1. The user must be logged in.
Post conditions:	1. User has information about Parkinson Disease
Normal Flow:	1. Use Case Starts 2. User will click on top navbar button to open navbar 3. The user will click on "Information Center" button and a navbar will fade-out. 4. User will hover on “Introduction” button 5. Introduction page will open 6. User will view the Introduction Page 7. Use Case Ends
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic Android knowledge.
Notes and Issues:	N/A

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3.6.2.15 Logout

Use Case ID:	ANDR -015
Use Case:	Logout
Actors:	Android User
Description:	The purpose of this use case is to allow the user to safely log out from the application
Trigger:	User clicks on “Logout” button.
Preconditions:	1. The user must be logged in.
Post conditions:	1. The user will be logged out of the system and will require his credentials
Normal Flow:	1. Use Case Starts 2. User will click on top navbar button to open navbar 3. The user will scroll down the navbar until he/she reaches the bottom of navbar. 4. The user will press the log out option. 5. The system will be safely logged out. 6. Use Case Ends
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic Android knowledge.
Notes and Issues:	N/A

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3.6.2.16 Log in with Google Account

Use Case ID:	ANDR -016
Use Case:	Log in with Google Account
Actors:	Android User
Description:	The purpose of this use case is to allow the user to log into the system using their Google account.
Trigger:	The user taps the application icon.
Preconditions:	1. User Google account must exist.
Post conditions:	1. The user will be authenticated and logged in
Normal Flow:	1. Use Case Starts 2. The user will launch the application. 3. The user will click on “Login with Google account” button 4. User will be logged into the system 5. Use Case Ends
Alternative Flows:	
Exceptions:	1. If password or username is incorrect 1.1. The system will prompt an error. 1.2. System will resume from state 1 (Login Page)
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has prior basic experience with Android apps.
Notes and Issues:	N/A

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3.6.2.17 View Animation 1

Use Case ID:	ANDR -017
Use Case:	View Animation 1
Actors:	Android User
Description:	The purpose of this use case is to allow the user to have knowledge about how to perform static spiral test
Trigger:	User click on "Start" button on home screen
Preconditions:	1. User must be logged in
Post conditions:	1. User will have a knowledge how to conduct static spiral test
Normal Flow:	1. Use Case Starts 2. User will view to a demo video about performing static spiral test 3. Use Case Ends
Alternative Flows:	1. In step 2 is user press "Skip" button 1.1 Static Spiral Test will start
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has prior basic experience with Android apps.
Notes and Issues:	N/A

3.6.2.18 View Animation 2

Use Case ID:	ANDR -018
Use Case:	View Animation 2
Actors:	Android User
Description:	The purpose of this use case is to allow the user to have knowledge about how to perform dynamic spiral test
Trigger:	User click on "Next Test" button
Preconditions:	1. User must be logged in 2. User has completed static spiral test
Post conditions:	1. User will have a knowledge how to conduct dynamic spiral test
Normal Flow:	1. Use Case Starts 1. User will view to a demo video about performing dynamic spiral test 2. Use Case Ends
Alternative Flows:	1. In step 2 is user press "Skip" button 1.1 Dynamic Spiral Test will start
Exceptions:	N/A
Includes:	N/A

Special Requirements:	N/A
Assumptions:	The user has prior basic experience with Android apps.
Notes and Issues:	N/A

3.6.2.19 View Animation 3

Use Case ID:	ANDR -019
Use Case:	View Animation 3
Actors:	Android User
Description:	The purpose of this use case is to allow the user to have knowledge about how to perform balance test
Trigger:	User click on "Next Test" button
Preconditions:	1. User must be logged in 2. User has completed dynamic spiral test
Post conditions:	1. User will have a knowledge how to conduct balance test
Normal Flow:	1. Use Case Starts 2. User will view to a demo video about performing balance test 3. Use Case Ends
Alternative Flows:	1. In step 2 is user press "Skip" button 1.1 Balance Test will start
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has prior basic experience with Android apps.
Notes and Issues:	N/A

3.6.3 List of Web Portal Use Cases

Use Case ID	Use Case Name	Use Case Description
WEB-01	Login	The purpose of this use case is to allow the user to log into the system.
WEB-02	Login Request	The purpose of this use case is to allow the user to request login session from the system.
WEB-04	View Android user test result log	The purpose of this use case is to allow user to view all test result of Android application users test log.
WEB-05	View Report of people diagnosed with Parkinson Disease	It will allow the user to view the report in form of a chart about how many Android users are detected with Parkinson Disease which will be helpful for research group of Parkinson Disease
WEB-06	View report on Android user undetected with Parkinson Disease	The purpose of this use case is to allow user to view the report in form of a chart about how many Android application users are undetected with Parkinson Disease will we helpful for research group of Parkinson Disease
WEB-07	View Report of gender wise detected Parkinson disease	The purpose of this use case is to allow the user to view report about how many Android application users are detected with Parkinson Disease respect to their gender which will we helpful for research group of Parkinson Disease
WEB-08	View country wise report of detected Parkinson disease patients	The purpose of this use case is to allow the user to view report in form of a chart about how many Android application users are detected with Parkinson Disease respect to their country
WEB-09	View Monthly Reports	The purpose of this use case is to allow user to view report in form of a chart about monthly patients detected with and without the disease
WEB-10	View Yearly Reports	The purpose of this use case is to allow user to view report on yearly statistics in form of a chart
WEB-11	Change Password	The purpose of this use case is to change the admin's account password if required
WEB-12	Logout	The purpose of this use case is to allow the user to safely log out from the application

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WEB-13	Update Android User Information	The purpose of this use case is to allow user to update Android application user information on request.
WEB-14	Delete Android User Account	The purpose of this use case is to allow user to delete android application user account.

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3.6.4 Web Portal Use Cases

3.6.4.1 Login

Use Case ID:	WEB -001
Use Case:	Login
Actors:	Admin
Description:	The purpose of this use case is to allow the user to log into the system.
Trigger:	The user opens the portal.
Preconditions:	1. The user account must exist.
Post conditions:	1. The user will be authenticated and logged in
Normal Flow:	1. Use Case Starts 2. The user will open the portal. 3. The user will enter username. 4. The user will enter the password 5. The user will click on “Login” button 6. User will be logged into the system 7. Use Case Ends
Alternative Flows:	N/A
Exceptions:	1. If password or username is incorrect 1.1. The system will prompt an error. 1.2. System will resume from step 3
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has prior basic experience of a computer.
Notes and Issues:	N/A

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3.6.4.2 Login Request

Use Case ID:	WEB -002
Use Case:	Login Request
Actors:	Analytical Portal User
Description:	The purpose of this use case is to allow the user to request login session from the system.
Trigger:	The user opens the portal.
Preconditions:	1. User must have a valid email address.
Post conditions:	2. The user will be authenticated and allowed to use the portal
Normal Flow:	1. Use Case Starts 2. The user will open the portal. 3. User will enter a valid email address 4. The user will click on “Request Login” button. 5. User will be logged into the system after the admin's permission 6. Use Case Ends
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has prior basic experience of a computer.
Notes and Issues:	N/A

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3.6.4.3 View Android Application User Test Result Log

Use Case ID:	WEB-003
Use Case:	View Android Application User Test Result Log
Actors:	Admin, Analytics Portal User
Description:	The purpose of this use case is to allow user to view all test result of Android application user.
Trigger:	User hovers on “Users Test Log” button.
Preconditions:	1. The user must be logged in.
Post conditions:	1. User will be able to view all Android application users test log
Normal Flow:	1. Use Case Starts 2. User will click on “Users Test Log” button 3. All Android user will be shown to the user 4. User will select an android user 5. Android User Test Log will be shown to the user 6. Use Case Ends
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic knowledge to operate a portal.
Notes and Issues:	N/A

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3.6.4.4 View Report of people diagnosed with Parkinson Disease

Use Case ID:	WEB -004
Use Case:	View Report of people diagnosed with Parkinson Disease
Actors:	Analytical Portal User
Description:	The purpose of this use case is to allow user to view the report in form of a chart about how many Android application users are detected with Parkinson Disease which will we helpful for the research group of Parkinson Disease
Trigger:	User hovers on “Reports” button.
Preconditions:	1. The user must be logged in.
Post conditions:	1. User will be able to view chart form report of Android application user detected with Parkinson Disease
Normal Flow:	1. Use Case Starts 2. User will click on “Report” button 3. The user will view the PD Detected Chart. 4. Use Case Ends
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic knowledge to operate a portal.
Notes and Issues:	Google Chat API will be used for showing report

3.6.4.5 View report on Android user undetected with Parkinson Disease

Use Case ID:	WEB -005
Use Case:	View report on Android user undetected with Parkinson Disease
Actors:	Analytical Portal User
Description:	The purpose of this use case is to allow user to view the report in form of a chart about how many Android application users are undetected with Parkinson Disease. It will be helpful for research groups of Parkinson Disease
Trigger:	User hovers on “Reports” button.
Preconditions:	1. The user must be logged in.
Post conditions:	1. User will be able to view chart form report of Android application user undetected with Parkinson Disease
Normal Flow:	1. Use Case Starts 2. User will click on “Report” button 3. The user will click on "Parkinson undetected Population" button. 4. The user will view the Parkinson undetected Population Chart. 5. Use Case Ends

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Alternative Flows:	N/A
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic knowledge to operate a portal.
Notes and Issues:	Google Chat API will be used for showing report

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3.6.4.6 View Report of gender wise detected Parkinson disease

Use Case ID:	WEB -006
Use Case:	View Report of gender wise detected Parkinson disease
Actors:	Analytical Portal User
Description:	The purpose of this use case is to allow the user to view report in form of a chart about how many Android application users are detected with Parkinson Disease respect to their gender (Male/Female) which will we helpful for research group of Parkinson Disease
Trigger:	User hovers on “Reports” button.
Preconditions:	1. The user must be logged in.
Post conditions:	1. The user will view the report on Parkinson Disease respect to gender.
Normal Flow:	1. Use Case Starts 2. User will click on “Report” button 3. The user will view the report on Parkinson Disease respect to gender. 4. Use Case Ends
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic knowledge to operate a portal.
Notes and Issues:	Google Chat API will be used for showing report

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3.6.4.7 View Report of country wise detected Parkinson disease

Use Case ID:	WEB -007
Use Case:	View Report of country wise detected Parkinson disease
Actors:	Analytical Portal User
Description:	The purpose of this use case is to allow the user to view report in form of a chart about how many Android application users are detected with Parkinson Disease respect to their country which will we helpful for research group of Parkinson Disease
Trigger:	User hovers on “Reports” button.
Preconditions:	1. The user must be logged in.
Post conditions:	1. The user will view the report on Parkinson Disease respect to country.
Normal Flow:	1. Use Case Starts 2. User will click on “Report” button 3. The user will view the report on Parkinson Disease respect to country. 4. Use Case Ends
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic knowledge to operate a portal.
Notes and Issues:	Google Chat API will be used for showing report

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3.6.4.8 View Monthly Reports

Use Case ID:	WEB -008
Use Case:	View Monthly Reports
Actors:	Analytical Portal User
Description:	The purpose of this use case is to allow user to view report in form of a chart about monthly patients detected with and without the disease
Trigger:	User clicks on “Report” button.
Preconditions:	1. The user must be logged in.
Post conditions:	1. User will be able to view report on monthly overview over the total statistical report generated
Normal Flow:	1. Use Case Starts 2. User will click on “Report” button 3. User will view the report on monthly overview over the total statistical report generated 4. Use Case Ends
Alternative Flows:	N/A

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Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic knowledge to operate a portal.
Notes and Issues:	Google Chat API will be used for showing report

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3.6.4.9 View Yearly Report

Use Case ID:	WEB -009
Use Case:	View Yearly Report
Actors:	Analytical Portal User
Description:	The purpose of this use case is to allow user to view report on yearly statistics in form of a chart
Trigger:	User clicks on “Report” button.
Preconditions:	1. The user must be logged in.
Post conditions:	1. User will be able to view report on yearly overview over the total statistical report generated
Normal Flow:	1. Use Case Starts 2. User will click on “Report” button 3. User will view the report on yearly overview over the total statistical report generated 4. Use Case Ends
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic knowledge to operate a portal.
Notes and Issues:	Google Chat API will be used for showing report

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3.6.4.10 Change Password

Use Case ID:	WEB -010
Use Case:	Change Password
Actors:	Admin
Description:	The purpose of this use case is to change the admin's account password if required
Trigger:	Admin clicks on "Settings" button.
Preconditions:	1. Admin is logged in
Post conditions:	1. The admin's account password will be updated
Normal Flow:	1. Use Case Starts 2. Admin clicks on the "settings" button. 3. Then he/she will click on "My account". 4. User clicks on change password button. 5. Enter the previous password. 6. Enter new password. 7. Admin will enter new password again to confirm it. 8. Then clicks update button. 9. Use Case Ends
Alternative Flows:	
Exceptions:	1. In the 5th step of normal flow if the admin enters the incorrect previous password 1.1 Dialogue box will prompt the user about incorrect previous password 1.2 Then the use case will restart from step 5 of normal flow. 2. In the 7th step of normal flow if the new password re-entered does not match the new password entered in step 6. 2.1 A dialogue box will prompt the user about the password mismatch. 2.2 Then the use case will restart from step 5 of normal flow.
Includes:	N/A
Special Requirements:	N/A
Assumptions:	N/A
Notes and Issues:	N/A

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3.6.4.11 Logout

Use Case ID:	WEB -011
Use Case:	Logout
Actors:	Admin, Analytics Portal user
Description:	The purpose of this use case is to allow the user to safely log out from the application
Trigger:	User clicks on “Logout” button.
Preconditions:	1. The user must be logged in.
Post conditions:	1. The user will be logged out of the system and will require his credentials to log in again
Normal Flow:	1. Use Case Starts 2. User will click on top menu bar button to show options 3. The user will press the logout button. 4. The system will be safely logged out. 5. Use Case Ends
Alternative Flows:	N/A
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic computer knowledge.
Notes and Issues:	N/A

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3.6.4.12 Update Android User Information

Use Case ID:	WEB -012
Use Case:	Update Android User Information
Actors:	Admin
Description:	The purpose of this use case is to allow user to update Android application user information on request.
Trigger:	User clicks on “Update User Information” button.
Preconditions:	1. The user must be logged in. 2. Android application user must account must exist
Post conditions:	1. Android application user information will be updated
Normal Flow:	1. Use Case Starts 2. User will click on “Update User Information” button 3. User will enter email address of Android application user 4. Android application user information will be shown to user 5. User will click “Edit” button 6. User will update Android application user information 7. The user will click "Save" button. 8. Android application user information will be updated.

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	9. Homepage of web portal will open 10. Use Case Ends
Alternative Flows:	1. In the 7th step of normal flow if user click on "Cancel" button 1.1 Use Case will resume from step 9
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic knowledge to operate a portal.
Notes and Issues:	N/A

3.6.4.13 Delete Android User Account

Use Case ID:	WEB -013
Use Case:	Delete Android User Account
Actors:	Admin
Description:	The purpose of this use case is to allow user to delete android application user account.
Trigger:	User clicks on "Delete User account" button.
Preconditions:	1. The user must be logged in. 2. Android application user must account must exist
Post conditions:	1. Android application user account will be deleted
Normal Flow:	1. Use Case Starts 2. User will click on "Delete user account" button 3. User will enter email address of Android application user 4. Android application user information will be shown to user 5. User will click "Delete" button 6. The Android application user account will be deleted. 7. Homepage of web portal will open 8. Use Case Ends
Alternative Flows:	1. In the 5th step of normal flow if user click on "Cancel" button 1.1 Use Case will resume from step 7
Exceptions:	N/A
Includes:	N/A
Special Requirements:	N/A
Assumptions:	The user has basic knowledge to operate a portal.
Notes and Issues:	N/A

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4 Design

4.1 Class Diagram

The below picture (figure 32) shows the detailed class diagram of the system.

Firstly there is a generic class Person with attributes userId, username, password and email. From the Person interface, three classes are inherited namely user, admin and researcher. The user is the user of Android application whose attributes include name, age, country, address and record. Other attributes such as userId, username and password are inherited by the person interface.

The user can perform test which is represented by a one to many relations in the diagram. The test class is connected with three classes by a composition link. These classes are Static Spiral Test, Dynamic Spiral Test and Balance Test which is the main functionality of the application. Furthermore, user can view test logs represented by one to many relationship. Moreover, user class is connected with Google Maps class by which user can search for nearby doctors and hospitals. Routing options will also be available.

Admin class is inherited from Person having attributes of name and contact. Admin will be able to add, update and delete the user. This class is connected with the Reports class with a composition link. Reports class generates reports of the user tests. The Researcher class is also connected with the Reports class. The researcher will also be able to view user test reports.

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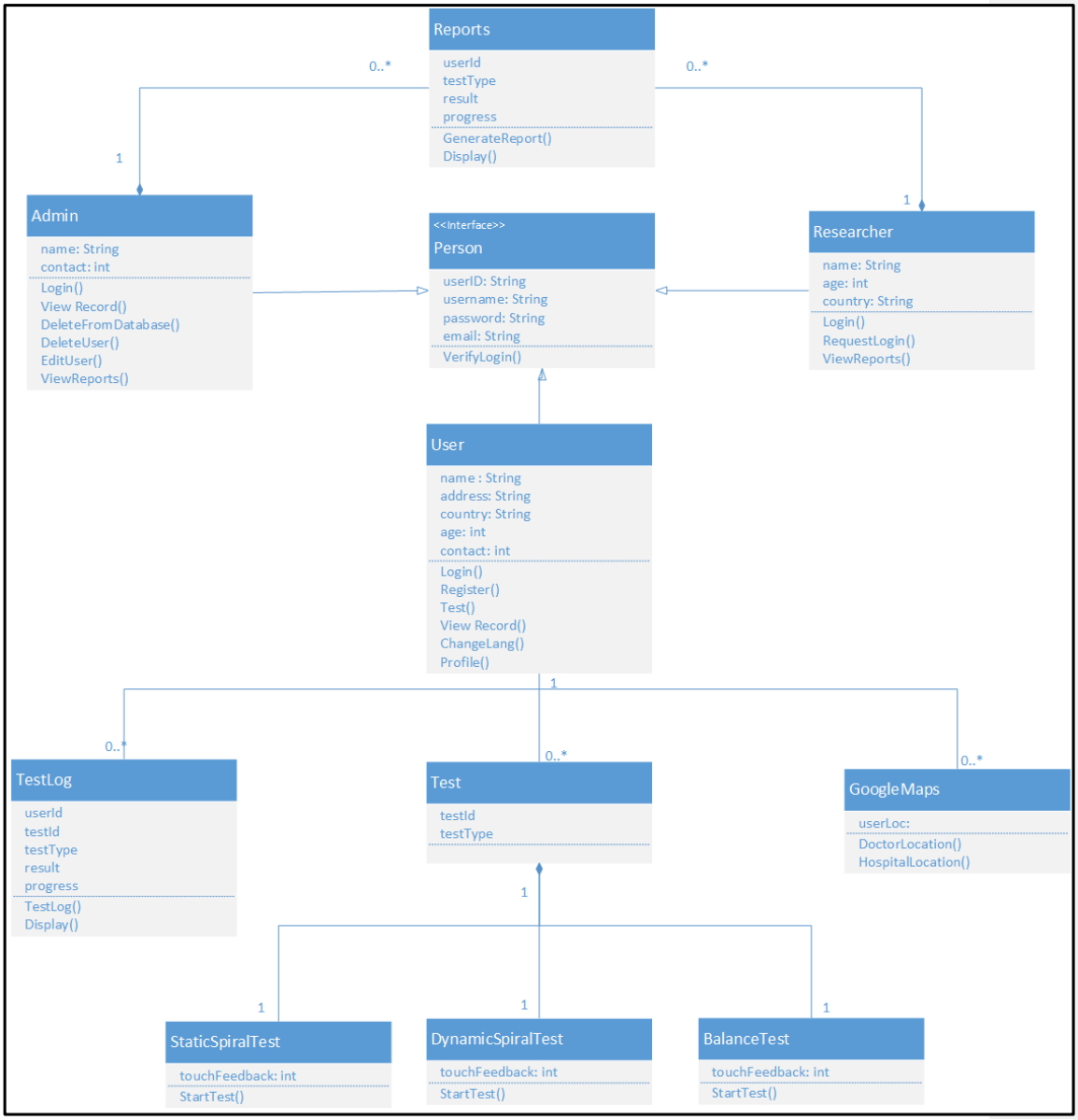

Figure 32: Detailed Class Diagram of the System

4.2 System Architecture

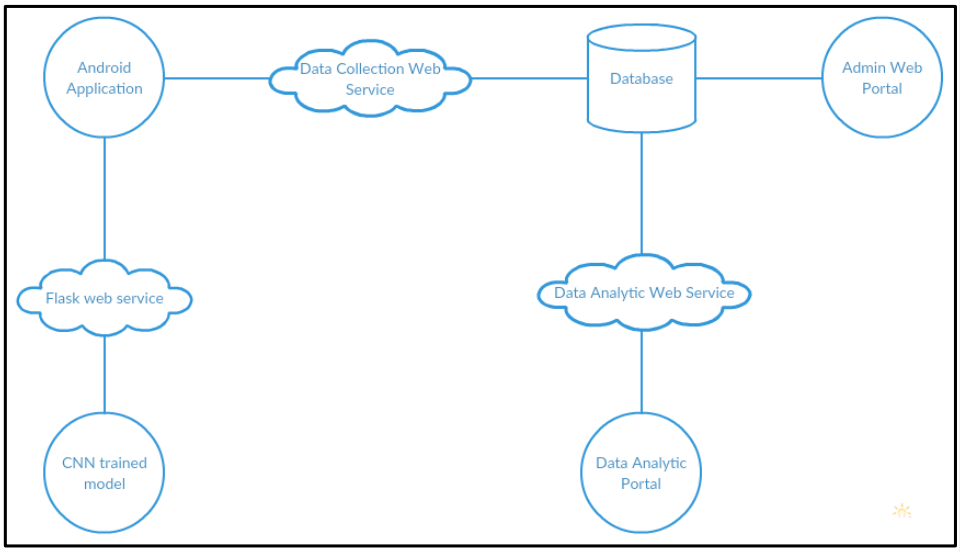

Figure 33: Module Diagram

The above figure shows the whole architecture of the system. The Android application and two portals are linked with the Database using Data Collection Web Services. The Android Application sends and receives user and test data to/from the database. Similarly, the Admin Web Portal sends and receives user and test data to/from the database. The Data Analytics Portal only retrieves data from the database to display on the portal.

Furthermore, a trained CNN (convolutional neural network) model is linked to the Android application using Flask Web Service to examine user test result on runtime and decide whether or not the user is has a Parkinson's disease.

4.3 Entity Relation Diagram

In this project, we are using MS SQL Server Database to store user and application data. The following diagram of Entity Relation Diagrams (Figure 34) shows all the entities and the relationships between them. The user performs tests whose results are saved in the database. The results can be viewed by the user himself, admin and researcher in the form of reports. The admin can view, edit and delete users and can view the tests results generated by user.

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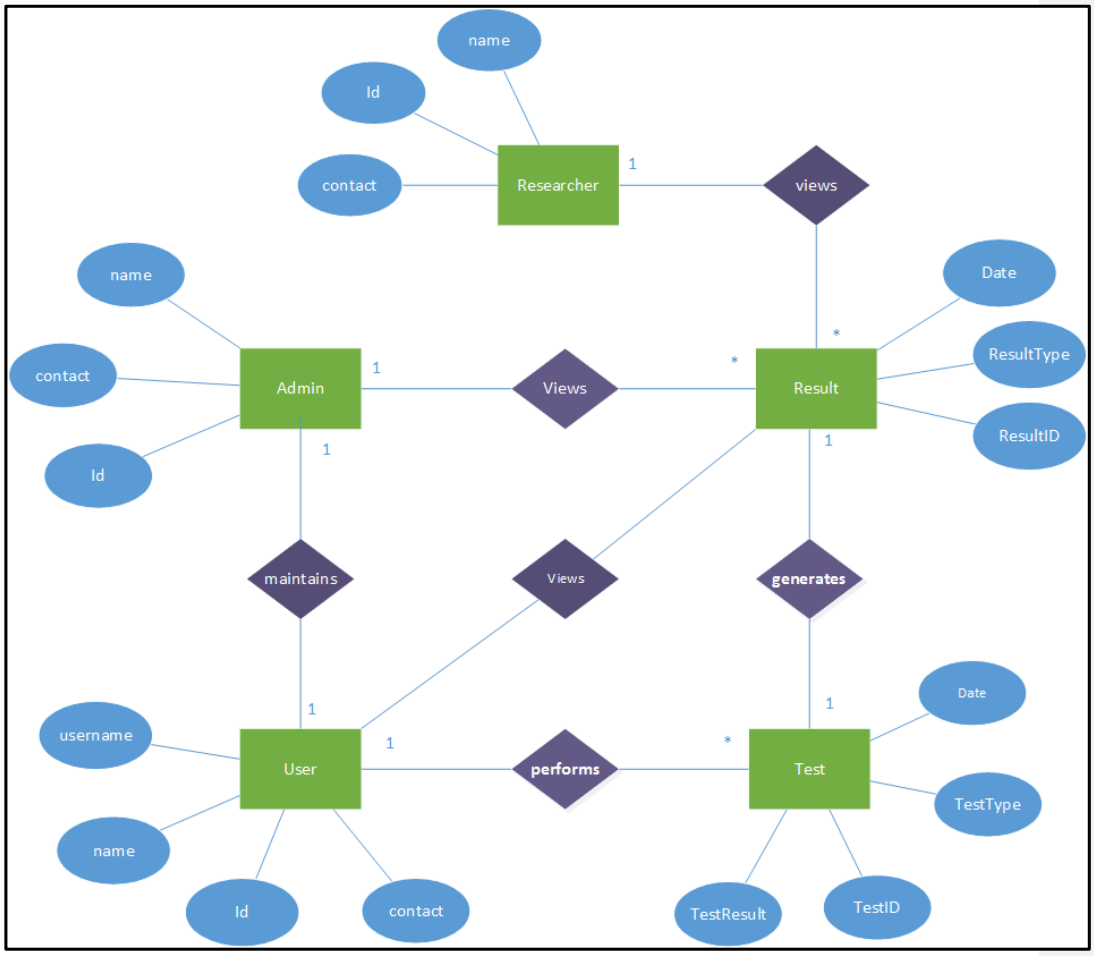

Figure 34: Entity Relation Diagram

5 Testing Plan

5.1 Test Cases

5.1.1 Android Test Cases

5.1.1.1 Test Case for Login

Test Case ID	**TC-01**	
Test Case Name	Login	
Testing Environment	1. Sony Xperia Z2, 3GB Ram, Android OS v6.0.1 (Marshmallow). 2. Huawei P8 lite, 2GB Ram, Android OS v5.0.1 (Lollipop). 3. Sony Xperia Z, 2GB Ram, Android OS v4.4 (KitKat).	
Tested By: Developer Team		**Date:** 16/4/2017
Test Data	Email, Password	
Pre-Condition	1. User is registered 2. The Internet is working	
Test Verification	This test verifies the user has an account, if not user should register.	
Actions		**System Response**
1. The user will enter email. 2. The user will enter password. 3. The user will click on login button.		1. The system will connect to the database. 2. The system will verify the email and password from the database and user will be log in. 3. The system will show a message "Invalid Username / Password" if the verification fails.
Result	The user was log in the application for entering correct credentials.	

5.1.1.2 Test Case for User Registration

Test Case ID	**TC-02**	
Test Case Name	User Registration	
Testing Environment	1. Sony Xperia Z2, 3GB Ram, Android OS v6.0.1 (Marshmallow). 2. Huawei P8 lite, 2GB Ram, Android OS v5.0.1 (Lollipop). 3. Sony Xperia Z, 2GB Ram, Android OS v4.4 (KitKat).	
Tested By: Developer Team		**Date:** 16/4/2017
Test Data	Email, Password, Username, Country, Gender, Age, Contact Number	
Pre-Condition	1. The Internet is working	

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Test Verification	This test verifies the user has an account, if not user should register.
Actions	**System Response**
1. The user will enter email. 2. The user will enter password. 3. User will enter Username 4. User will select Country 5. User will enter Age 6. User will select Gender 7. User will enter Contact Number 8. The user will click on Sign Up button.	1. The system will connect to the database. 2. The system will store the user credential in the database. 3. The system will show a message "Register Successful".
Result	1. The user was registered

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5.1.1.3 Test Case for User Login using Google Account

Test Case ID	**TC-03**
Test Case Name	User Login using Google Account
Testing Environment	1. Sony Xperia Z2, 3GB Ram, Android OS v6.0.1 (Marshmallow). 2. Huawei P8 lite, 2GB Ram, Android OS v5.0.1 (Lollipop). 3. Sony Xperia Z, 2GB Ram, Android OS v4.4 (KitKat).
Tested By: Developer Team	**Date:** 16/4/2017
Test Data	Email, Password
Pre-Condition	1. The Internet is working
Test Verification	This test verifies the user can access the application using Google account.
Actions	**System Response**
1. The user will click on login with google account button.	1. The system will call Google login API 2. The system will allow login if the return from Google login API is OK
Result	The user login the application

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5.1.1.4 Test Case for View Nearby Doctor and Hospital

Test Case ID	**TC-04**
Test Case Name	View Nearby Doctor and Hospital
Testing Environment	1. Sony Xperia Z2, 3GB Ram, Android OS v6.0.1 (Marshmallow). 2. Huawei P8 lite, 2GB Ram, Android OS v5.0.1 (Lollipop). 3. Sony Xperia Z, 2GB Ram, Android OS v4.4 (KitKat).
Tested By: Developer Team	**Date:** 16/4/2017

Test Data	
Pre-Condition	1. The Internet is working 2. GPS activated
Test Verification	This test verifies the user can locate all the nearby doctor and hospitals.

Actions	**System Response**
1. User will click on "Nearby Doctor and Hospital" button 2. User will click on "Doctor" button to locate nearby doctors 3. User will click on "Hospital" button to locate nearby hospitals	1. The system will call Google Maps API. 2. The system will retrieve data from Google Maps API and Google Places web service. 3. The system will display the nearby location on the map.
Result	The user is shown nearby doctors and hospital on the map.

5.1.1.5 Test Case for View Test Log

Test Case ID	**TC-05**
Test Case Name	View Test Log
Testing Environment	1. Sony Xperia Z2, 3GB Ram, Android OS v6.0.1 (Marshmallow). 2. Huawei P8 lite, 2GB Ram, Android OS v5.0.1 (Lollipop).
Tested By: Developer Team	**Date:** 16/4/2017
Test Data	
Pre-Condition	1. The Internet is working 2. User login
Test Verification	This test verifies the user can have a check how often he/she performs test and the percentage of test passed and failed.

Actions	**System Response**
1. User will click on "View Test Log" button	1. The system will connect to database. 2. The system will retrieve all test result of the user. 3. The system will display the test results
Result	1. The user is shown the result of all disease detection test done along with date. 2. Percentage of tests passed or failed

5.1.1.6 Test Case for Change Language

Test Case ID	**TC-06**
Test Case Name	Change Language
Testing Environment	1. Sony Xperia Z2, 3GB Ram, Android OS v6.0.1 (Marshmallow). 2. Huawei P8 lite, 2GB Ram, Android OS v5.0.1 (Lollipop).

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Tested By: Developer Team		**Date:** 18/4/2017
Test Data		
Pre-Condition	1. User Login	
Test Verification	This test verifies the user can change application language for ease of application use.	
Actions		**System Response**
1. User will click on “Change Language” button 2. User will select the language 3. User will click on “Save” button		1. The system will change the application language into the language chosen by the user
Result	The application language is changed	

5.1.1.7 Test Case for Perform Static Spiral Test

Test Case ID	**TC-07**	
Test Case Name	Perform Static Spiral Test	
Testing Environment	1. Sony Xperia Z2, 3GB Ram, Android OS v6.0.1 (Marshmallow). 2. Huawei P8 lite, 2GB Ram, Android OS v5.0.1 (Lollipop). 3. Sony Xperia Z, 2GB Ram, Android OS v4.4 (KitKat).	
Tested By: Developer Team		**Date:** 18/4/2017
Test Data	User-drawn spiral shape	
Pre-Condition	1. User login 2. User has read about how to carry out tests properly activity	
Test Verification	This test verifies that user spiral is drawn and detection of disease in static spiral test.	
Actions		**System Response**
1. User will click on “Start” button 2. User will trace the over the generated spiral shape 3. User will complete the spiral test 4. User will click on “Next” button		1. The system will draw the spiral trace of the user over the generated spiral 2. The system will store the user drawn spiral in form of image. 3. The system will then pass the store image to the convolutional neural network for detection of Parkinson disease. 4. The system will store the result (Parkinson or Non-Parkinson) from the convolutional neural network.
Result	1. User spiral is drawn 2. User-drawn spiral is stored as image 3. Detection of Disease in static spiral test	

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5.1.1.8 Test Case for Perform Dynamic Spiral Test

Test Case ID	**TC-08**	
Test Case Name	Perform Dynamic Spiral Test	
Testing Environment	1. Sony Xperia Z2, 3GB Ram, Android OS v6.0.1 (Marshmallow). 2. Huawei P8 lite, 2GB Ram, Android OS v5.0.1 (Lollipop).	
Tested By: Developer Team		**Date:** 20/4/2017
Test Data	User-drawn spiral image	
Pre-Condition	1. User login 2. User has read about how to carry out tests properly activity 3. User has performed Static Spiral Test	
Test Verification	This test verifies that user spiral is drawn and detection of disease in dynamic spiral test.	
Actions		**System Response**
1. User will trace the over the generated spiral shape 2. User will complete the dynamic spiral test 3. User will click on “Next” button		1. The system will draw the spiral trace of the user over the generated spiral 2. The system will blink the spiral for every 10 millisecond time interval 3. The system will store the user drawn spiral in form of image. 4. The system will then pass the store image to the convolutional neural network for detection of Parkinson disease. 5. The system will store the result (Parkinson or Non-Parkinson) from the convolutional neural network.
Result	1. User spiral is drawn 2. User-drawn spiral is stored as image 3. Detection of Disease in static spiral test	

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5.1.1.9 Test Case for Perform Balance Test

Test Case ID	**TC-09**	
Test Case Name	Perform Balance Test	
Testing Environment	1. Huawei P8 lite, 2GB Ram, Android OS v5.0.1 (Lollipop). 2. Sony Xperia Z, 2GB Ram, Android OS v4.4 (KitKat).	
Tested By: Developer Team		**Date:** 20/4/2017

Test Data	AverageX acceleration, AverageY acceleration, AverageZ acceleration and Threshold
Pre-Condition	1. User login 2. User has read about how to carry out tests properly activity 3. User has performed Dynamic Spiral Test 4. Accelerometer sensor
Test Verification	This test verifies that user has performed balance test and whether the user has Parkinson disease or not.

Actions	**System Response**
1. User will stretch the arm while holding his phone for 15 sec	1. The system will activate phone accelerometer sensor 2. The system will show the changing X, Y, Z values 3. The system will calculate and store the AverageY acceleration, AverageY acceleration, AverageZ acceleration and Threshold values in the database 4. The system will compare the user threshold value with the Parkinson patient threshold and Non-Parkinson patient threshold. 5. The System will show a message " Parkinson detected" or "Parkinson not detected" to user on the basis of the following condition • User threshold < Non-Parkinson threshold • User threshold > Parkinson threshold • User threshold > Non-Parkinson threshold && User threshold < Parkinson threshold

Result	Balance test is working using accelerometer sensor 1. Calculate AverageX acceleration, AverageY acceleration, AverageZ acceleration and Threshold values stored in database 2. Detection of Parkinson Disease

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5.1.2 Web Portal Test Cases

5.1.2.1 Test Case for Login

Test Case ID	**TC-10**	
Test Case Name	Login	
Testing Environment	1. Google Chrome 2. Mozilla Firefox	
Tested By: Developer Team		**Date:** 18/4/2017
Test Data	Email, Password	
Pre-Condition	1. User is registered to the system	
Test Verification	This test verifies that the user registered to the system can easily log in and carry on his/her tasks.	
Actions		**System Response**
1. Enter email 2. Enter password 3. Click on login button		1. Homepage should open 2. User be able to perform his/her task
Result	The result went as expected	

5.1.2.2 Test Case for Add User

Test Case ID	**TC-11**	
Test Case Name	Add User	
Testing Environment	1. Google Chrome 2. Mozilla Firefox	
Tested By: Developer Team		**Date:** 18/4/2017
Test Data		
Pre-Condition	1. Admin has access to the system 2. Admin is logged in	
Test Verification	This test verifies that the admin can add new users to the system.	
Actions		**System Response**
1. Click on users 2. Click on add users 3. Enter information 4. Click on Add button		1. List of users is displayed 2. Form is displayed to enter information 3. User is added

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Result	The result went as expected

5.1.2.3 Test Case for Delete User

Test Case ID	**TC-12**	
Test Case Name	Delete User	
Testing Environment	1. Google Chrome 2. Mozilla Firefox	
Tested By: Developer Team		**Date:** 18/4/2017
Test Data	UserID	
Pre-Condition	1. Admin has access to the system 2. Admin is logged in	
Test Verification	This test verifies the user can change application language for ease of application use.	
Actions		**System Response**
1. Click on users 2. Click on Delete users 3. Enter user ID 4. Click on the delete button		1. List of users is displayed 2. User is deleted from the list
Result	The result went as expected	

5.1.2.4 Test Case for View User

Test Case ID	**TC-13**	
Test Case Name	View User	
Testing Environment	1. Google Chrome 2. Mozilla Firefox	
Tested By: Developer Team		**Date:** 18/4/2017
Test Data		
Pre-Condition	1. User Login	
Test Verification	This test verifies that the admin can view all the users that are registered in the system.	
Actions		**System Response**
1. Click on users		1. List of users is displayed
Result	The result went as expected	

6 References

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