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SOFTWARE FOR DIAGNOSING PARKINSON'S DISEASE

SRS REPORT

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Abstract

Parkinson's Disease is a progressive nervous disorder that affects the movement and functions of an individual. Around 10 million people have been affected by Parkinson's and has affected Sri Lanka too, as it is stated around 100 people died due to Parkinson's in the year 2017.

Currently there is no advanced or efficient way to detect/predict Parkinson's in Sri Lanka, as the only ways that are present are the physical examinations and MRI/CT scans, where the former is ineffective in detecting Parkinson's at an early stage and the latter is expensive. Therefore, it would be highly beneficial and efficient if there is an alternative way in detecting Parkinson's.

Our team's idea is to implement a system that would assist the doctors in detecting Parkinson's through the speech data. The system would consist of a Machine Learning Model that would be trained with the speech dataset of the patients that our team would acquire. The system would contain an intuitive and clean User Interface and User Experience for the users (i.e. the doctors, medical staff, etc.).

The following report would consist of a Literature Review on the similar system and technologies available, Requirements Gathering, which is a detailed report focused on the ways that the requirements for the systems were gathered and analyzing the stakeholders, Project Management, which depicts the ways that the product would be developed and the Design, which focuses on the system's design and structure.

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1 Introduction

1.1 Introduction to the problem

Parkinson’s disease (PD) is a slow progressing neuro degenerative disease which affects approximately 1% of people over 60 years of age. There is no known cure for the disease and no laboratory test that can accurately classify patients to be PWP. Thus, there arises an urgent need to find biomarkers to help identify the disease at an early stage. (Sapir *et al,* cited in Hazan *et al.*, 2012)

Studies have suggested that speech abnormalities might be present at early stages of the disease before the classical symptoms of the disease appear. PWP have been identified to have:

· dysphonia (defective use of the voice)

· hypophonia (reduced volume)

· monotone (reduced pitch range)

· dysarthria (difficulty with articulation of sounds or syllables)

(Sakar *et al.*, 2013)

Our aim is to use speech analysis techniques to detect speech anomalies in a patient’s voice which are known to appear in the voice of PWP at an early stage of the disease In this context, with a view to enable early detection using a predictive system we identified two issues with the current state of PD diagnosis

1. The invasive nature of current methods that lead to physical inconvenience to the patient.(Sakar *et al.*, 2013)
2. The lateness of the diagnosis resulting in irreversible nerve damage to the patient by the time of diagnosis (Hazan *et al.*, 2012)

Various studies have shown ways to detect voice abnormalities by analyzing different kinds of voice samples from a patient. And, having a rich enough data set with this kind of information would enable us to build a PD detection model that can be used in a PD detection system. This gives us a chance to address both above-mentioned issues regarding PD diagnosis by developing a system that uses acoustic and classification analysis to help identify PWP individuals at an early stage with little or no hindrance to the patient.

1.2 Background of Parkinson's Disease

Parkinson's disease is a condition that progresses slowly in a person, and affects the nervous system, especially movement (Mayo Clinic, 2018). As age progresses, the health starts to deteriorate, and life becomes quite hard. And a person having Parkinson's would have to suffer a lot, and the said person's family would have to suffer. The exact cause for a person developing Parkinson's is unclear, but researches have stated that genetics might be a factor, as a person, whose family has a history of being affected by Parkinson's, has a considerate risk in developing Parkinson's (NHS Choices, 2019). Some researchers have indicated that environment might affect the chances of developing Parkinson's, such as the place where the person lives, the food the person intakes, the chemicals the person has come across, etc. but these are not proved and provide no confirmatory results (DeNoon, 2002).

Dopamine is a chemical that is secreted and produced by the neurons, in an area of the brain and is mainly responsible for the movement of the body. When these neurons/nerve cells become weakened or becomes non-functional, the amount of dopamine produced become significantly less, and this results in movement problems; this condition is Parkinson's disease (National Institute on Aging, 2017). The statistics regarding Parkinson's Disease are quite staggering, as Parkinson's is the second most common age-related disorder, behind Alzheimer's, and it is estimated that around 7-10 million people are diagnosed with Parkinson's; mostly, people who are older than 50 are affected by Parkinson's and men are more likely to be affected with Parkinson's than the women (Parkinson's News Today, 2017). A person affected with Parkinson's has to face issues both physically, as well as financially, where it costs quite a fortune to treat Parkinson's. There is no definitive cure of the syndrome, but treatments and medications are present to make it easier for a patient affected by Parkinson's. In USA, the total aggregated cost of Parkinson's to individuals, families are $51.9 billion dollars ,both medical costs and non-medical costs such as lost wages, early retirement, etc. (The Michael J. Fox Foundation for Parkinson's Research | Parkinson's Disease, 2019). As it can been seen that treating Parkinson's is quite costly, and the costs start to soar when the Parkinson's syndrome is not detected/diagnosed in a person, before it becomes serious. There are no proper and accurate ways to detect Parkinson's disease currently, such as tests based on biochemical responses, scans, etc. but the detection rather depends on physical tests, such as impaired movements and weak hand to eye coordination. Doctors use scans such as Magnetic Resonance Image (MRI), Computerized Axial Tomography (CAT), Positron Emission Tomography (PET) scans to reject the possibilities of other diseases, rather than directly identifying Parkinson's (Ng, 2019).Therefore, in order to bridge the shortcomings in properly identifying Parkinson's in a patient in the early stages, we have come up with a solution, that predicts whether a person is diagnosed with Parkinson's disease accurately, cost and time efficiently, and we are aiming to achieve this by utilizing Machine Learning.

1.3 Proposed solution

Diagnosing Parkinson's Disease based on the speech pattern of the person.

- This method can be done by analyzing the speech pattern of an individual. The person's speech would be recorded, and the attributes of the speech would be recorded (i.e. frequency, jitter, shimmer, etc.) and then would be evaluated with the dataset and machine learning, and then the diagnosis of the person would be generated (Uci.edu, 2019).
- Dataset for conducting the test: https://data.world/uci/parkinsons.
- As an added feature, we are trying to obtain dataset of some people in Sri Lanka, who are affected by Parkinson's, and try to implement a method to detect Parkinson's based on the national languages (Sinhala or Tamil).

1.3.1 Obtaining Dataset from Sri Lankans.

As an added feature, which is of utmost importance to our project, we are planning to enable our project to analyze and predict the Parkinson's disease among the local people of Sri Lanka, as English is not the primary language. Therefore, in order to bridge the language gap among the local, our team has proposed a solution: that is to train the model with the local languages (Sinhala or Tamil) and to come up with accurate predictions.

Since our team lacks the medical background/knowledge to tackle the issue, we are planning to request assistance from a person with the necessary knowledge base, preferably a Medicine Student or a Trainee Doctor.

1.3.2 Method to obtain the required data

A sample set of around **20-30 patients** affected by Parkinson’s is required in order to train the model. Our team has decided to request permission from the National Hospital of Sri Lanka in order to provide us the necessary speech data required to successfully carry out the project. The speech data would be obtained by utilizing microphones, headphones and a recorder, and to ensure the safety of the patients and to protect the legal and ethical issues of the patients, our team is willing to conduct our recordings within the National Hospital of Sri Lanka, under the supervision of any Doctor or Consultant or any authority figures.

1.4 Project Aim

- **Our aim of the product is to create a system that can accurately predict Parkinson’s disease by analyzing speech patterns.**

Our main aim is to develop a framework which tracks an individual’s speech pattern example to analyze Parkinson's infection. So, the malady can be identified as right on time as could be expected under the circumstances and this item will be valuable for the general population, since many get basic because recently identification of the illness. In this way, with our item we plan to limit hazards so individuals could get brisk truly necessary restorative consideration which will decrease the damages.

1.4.1 Project scope

1.4.2 In scope

Following are some of the expected deliverables / product features that would involve the immediate scope of the project.

- A client-server architecture to host a web application
- Users can attempt a simple test:
    1) User can attempt to read out a paragraph into the device microphone using their voice

● A section of the system would be dedicated on having background information about Parkinson's disease to further educate the user about the disease.

1.4.3 Out of scope

Following are some perceived limitations of the system

● The system does not provide medical advice of any sort after the assessment.
● The system only supports the English language only.
● The system is only relevant to Parkinson's disease.

1.5 Project objectives

1.5.1 Research objectives

Objective ID	**Objective**	**Description**
RO1	Time-efficient	To provide time efficient diagnosis method to identify Parkinson’s disease.
RO2	Accurate	To provide accurate and cost effective diagnosis method to identify Parkinson’s disease.

Table 1.5.1.1 - Research objectives

1.5.2 Operational objectives

Objective ID	**Objective**	**Description**
OO1	User can attempt to rewrite a short pattern	To create a system for the user that they can attempt to rewrite a short pattern on a touch screen using an electronic pen
OO2	User can attempt to rewrite a short paragraph	To create a system for the user that they can attempt to rewrite a short paragraph by using the keyboard input
OO3	User can attempt to read out a paragraph	To create a system for the user that they can attempt to read out a paragraph into the device using their voice.

Table 1.5.2.1 - Operational objectives

1.6 Resource requirements

Language	Use	Description
Java	Front End	Developing android application and the maintenance.
Python	Back End / API	Developing the back end and the RESTful API service. To develop ML program.
HTML	Interface	To Support Angular.
Angular	Interface	To create the user and the admin interface.

R	Machine Learning	To develop ML program.

Table 1.6.1 - Language resources

IDE	Use
IntelliJ	Code Java
PyCharm	Code Python
Visual Studio	Code HTML, Angular

Table 1.6.2 - IDEs that is going to be utilized

Tools	Use
Digital Ocean	Host the system and API
Post Men	Test the RESTful API
Visual Studio	Code HTML, Angular
GitHub	Provide Multiple workspace and resource sharing on development.
Spyder	To Test dataset and build an AI model

Table 1.6.3 - Tools that are going to be utilized

2 Literature review

2.1 Overview & introduction to the problem domain

Speech abnormalities appear in the voice of People with Parkinsonism (PWP) at an early stage of the disease. These abnormalities can be detected using collecting voice samples of patients and analyzing them using modern voice analysis software. This would in turn enable us to build a machine learning classifier that would help us make a tele monitoring software solution to help doctors make Parkinson’s diagnosis. Our goal is to make this project targeting the Sri Lankan patient demographic by supporting the Sinhala Language and getting the input voice data in Sinhala.

In this chapter we will look at some of the relevant literature to the problem including available datasets and Machine learning techniques which will help us decide what tools would be most appropriate to use in our project

2.2 Previous projects on detecting Parkinson’s disease

Over the years Parkinson’s disease have been identified using various methods. Various researches and projects have been done to detect it. Many methods like machine learning and traditional methods have been used. Algorithms play an important part in Machine Learning. Supervised and Unsupervised algorithms are few of the many categories of machine learning algorithms used frequently.

Supervised Machine Learning algorithm

It is the way where an already labelled data can be analyzed to learn a function and give an output for a new unlabeled data. Training the system using datasets until it can give an output on its own. It can be used to solve either classification or regression problems.

Classification problem

A classification problem has a distinct answer and it doesn't have a middle value. We can have a predictor (or predictors) that can be used to give the distinct value as answer. (Medium, 2020)

E.g.: When there's a system to predict Parkinson's disease based on age, Age becomes the predictor and the distinct answer could be "Parkinson's detected" or "Parkinson's not detected". It is a standard to represent output (labels) using integers -1,0,1.

Regression Problem

A Regression problem has a real number (A number containing a decimal value) as an output. There should be an independent variable as well as a dependent variable. Each row can be called as an observation /data point and each column can be called as a predictor/independent variable. (Medium, 2020)

E.g.: When there's an analogy of finding the amount of electricity consumed by a certain electric equipment, Electric equipment name can be the independent variable and the electricity consumed(in a decimal point value) can be the dependent variable.

Unsupervised Machine Learning algorithm

It is the way where no labels are there to teach the system to give an output. It understands the basic structure of the data to give us a deep understanding about data.

2.2.1 Machine Learning Methods to detect Parkinson's disease.

Some of the machine learning methods are clearly mentioned in a research paper by (Bind, Tiwari and Sahani, 2015). Some of the below methods can be used.

1) Artificial Neural Networks(ANN)

Neural networks are networks of stimulated neurons which can be used to recognize patterns. They learn by searching through a space of network weights. It is used to estimate functions which depends on a large number of inputs and which are generally unknown. ANN are linear statistical learning algorithms inspired from the biological neural networks inside the brain and they are generally a system of interconnected neurons which can compute values of Input/Output, ML and pattern recognition.

2) K-NEAREST NEIGHBOURS CLASSIFIER (K-NN)

K-NN is an easy to use and implement supervised machine learning algorithm which can be used to classify both regression and classification problems. It is a 'Lazy type' algorithm based on learning analogy and used to compare test tuples with training test tuples. When tuples are represented as points in n dimensional space, the known tuple locates the nearest unknown tuple by labelling the unknown tuple with the same class label of the known tuple. The k-NN classifier finds the k-training tuple that are nearest to the unknown tuple. So, the k-training tuples are called the k-nearest neighbor classifier of the unknown tuple.

3) SUPPORT VECTOR MACHINES

SVM is a learning method based on statistical learning. It is an algorithm based on Linear and non-linear data. It transforms the original data in a higher dimension, from where it can find a hyperplane for separation of the data using essential training tuples called support vectors. SVM creates a hyper plane or a set of hyperplanes in the higher dimensional space which can be used for classification and regression problems.

4) NAÏVE BAYESIAN CLASSIFIER

Naïve Bayesian classification is called naïve because we can assume it as class condition independent. It means, the effect of an attribute value of given class is independent of the values of the other attributes. This is made to reduce computational costs. It can be very handy in handling large datasets since it's easy to build and has no complicated iterative parameter estimation.

5) Random Forest

Random forest Leo Breiman (2001) is a grouping of decision trees-based classifiers. Each tree is constructed by a bootstrap sample from the data, and it uses a selected set of features from a random set. Both bagging and random variable selection can be used for the process of tree building. When the forest is created, test situations are formed down each tree and each tree make their class prediction. Random forest is used to rank the importance of variables in a regression or classification problem.

6) BAGGING

It is also called as Bootstrap aggregating. It is a machine Learning meta-algorithm to improve the stability and accuracy of ML algorithms used in statistical classification and regression. Over fitting can be avoided and variance also can be reduced by bagging. It also minimizes all the errors caused by noise(caused by target function) ,bias (When algorithms can't learn the target) and variance (Sampling).

7) BOOSTING

Boosting is an ML meta-algorithm for decreasing bias primarily and it can also reduce variance in supervised learning. Boosting is also a family of ML algorithms which can convert weak learners to strong learners. Boosting is a generic algorithm which attempts to make better the prediction power by training weak models in succession which compensates the weaknesses of its predecessors.(Medium, 2020)

2.2.2 Machine Learning Methods that are already Implemented

(Rustempasic and Can, 2013) have proposed an approach where they can detect Parkinson's disease using voice/speech dataset using fuzzy C-means (FCM) clustering and pattern recognition method and they were able to obtain 68.04% accuracy, 75.34% sensitivity and 45.83% specificity.

(Rustempasic and Can, 2013) have proposed a back propagation based approach for the discrimination between healthy and Parkinson diseases affected peoples with the help of artificial neural network(AAN). Boosting was used by filtering technique, and for data reduction principle component analysis was used and they obtained good results with the experiment (Recognition rate of 92%).

Yahia A. et al. (2014) proposed classification algorithm based on Naïve Bayes and K- Nearest Neighbors (KNN).They used Parkinson speech datasets with multiple types of sound recordings to predict Parkinson’s disease. K- Nearest Neighbors performed accuracy 80% and Naïve Bayes classifier performed an accuracy of 93.3% sensitivity 87.5%, and specificity 100%.

Rajnoha, M. *et al.* (2018) proposed an approach to find hypomimia (Expressionless face) from a patient’s static face using parameterization based on face recognition methods in combination with conventional classifiers (random forests, XG- Boost, etc.) .However this approach didn’t outperform the approaches based on video recordings to identify hypomimia.

Drotár, P. *et al.* (2015) in their research proposed to find suitable subset for handwriting features in identifying Parkinson’s disease and to build a predictive model to diagnose PD. Handwritings were collected and In addition to conventional kinematic and spatio-temporal handwriting measures, we also computed novel handwriting measures based on entropy, signal energy, and empirical mode decomposition of the handwriting signals. The accuracy of the classification of PD was as high as 88.13% , with the highest values of sensitivity and specificity equal to 89.47% and 91.89%, respectively.

Dinesh, A. (no date) in his research proposed a model which can diagnose Parkinson’s disease effectively using datasets which consist of voice recordings. The Boosted Decision Tree model was used with an accuracy of 90-95%. It was also discovered through filter-based feature detection that the strongest weighted features were spread1, spread2, and PPE, all three nonlinear measures of fundamental frequency variation in the voice recordings.

A. Sharma et al. (2014) in his research proposed artificial neural network, pattern recognition and support vector machine. It is used to support the experts in the diagnosis of Parkinson disease. Biomedical voice signals of healthy people were used as the dataset for this research and Parkinson disease accuracy was obtained around 85.294%.

Shahbakhi et al. (2014) presented that a Genetic Algorithm (GA) and SVM were used for classification between healthy and people with Parkinson’s. Voice signals that 14 features were based on F0 (fundamental frequency or pitch), jitter, shimmer and noise to harmonics ratio, which are the main factors in voice signal. Results show that classification accuracy 94.50, 93.66 and 94.22 per 4, 7 and 9 optimized features respectively.

Betala E. et al. (2014) proposed a SVM and k-Nearest Neighbor (k-NN) Tele-monitoring of PD patients remotely by taking their voice recording at regular intervals. The age, gender, voice recordings taken at baseline, after three months, and after six months are used as features are assessed. Support Vector Machine was more successful in detecting significant deterioration in UPDRS score of the patients.

Researchers name	**ML methods**	**Dataset**	**Performance**
Rustempasic, I. and Can, M. (2013).	fuzzy C- means	Speech signal dataset	68.04% accuracy, 75.34% sensitivity and 45.83% specificity
Rustempasic, I. and Can, M. (2013).	artificial neural network (AAN)	Speech signal dataset	Recognition rate of 92 %.
Yahia A. et al. (2014)	Naïve Bayes and K-Nearest Neighbors (KNN)	speech dataset	Accuracy 80% for KNN and Naïve Bayes classifier performed an accuracy of 93.3% sensitivity 87.5%, and specificity 100%.
Rajnoha, M. *et al.* (2018)	Face Recognition pattern with random forests and XG- Boost,	Static face Picture dataset	The decision tree algorithm achieved the best accuracy (67.33 %). The

Drotár, P. *et al.* (2015)	conventional kinematic and spatio-temporal handwriting measures	Handwriting Dataset	Accuracy of 88.3, sensitivity and specificity equal to 89.47% and 91.89%, respectively.
Dinesh, A. (no date)	Boosted Decision Tree model.	speech dataset	Accuracy of 90-95%.
A. Sharma et al. (2014)	artificial neural network, pattern recognition and support vector machine	Speech signal dataset	Accuracy was obtained around 85.294%
Shahbakhi et al. (2014)	Support Vector Machines (SVM)	Speech signal	dataset 94.22% accuracy, 70.12% sensitivity and 92.8% specificity
Betalu E. (2014)	SVM	Age, gender, voice recording	76% accuracy 34% sensitivity

Table 2.2.2.1 - Machine Learning Methods to detect Parkinson’s disease

2.3 Previous projects on prediction systems

To start our project, we first needed an existing dataset with multiple speech recordings or we needed to gather data and make our own dataset. We found two such existing datasets.

The first one was based on Little *et al.*(2009) which explored the usefulness of using dysphonic measurements to discriminate healthy people with PWP. Two types of recordings can be obtained from patients in these types of cases.

1) Running speech (normal sentences)

2) Sustained phonations (vowel sounds)

In this paper they only focused on sustained phonation tests because they believed that while running speech can be used to make a full assessment of vocal impairment, sustained vowel recordings will suffice to identify PD discriminative voice disorders in the patient. The collected data contained 195 sustained vowel phonations from 31 male and female subjects out of which 23 were PWP. The table below details the 22 different features extracted from the collected data.

Feature	**Description**
MDVP: Jitter (%)	Kay Pentax MDVP jitter as a percentage
MDVP:Jitter(Absolute)	Kay Pentax MDVP abs jitter in microseconds
MDVP:RAP	Kay Pentax MDVP Relative Amplitude Perturbation

Jitter:DDP	Average absolute difference of differences between cycles, divided by the average period
MDVP:Shimmer	Kay Pentax MDVP local shimmer
MDVP:Shimmer(dB)	Kay Pentax MDVP local shimmer in decibels
Shimmer:APQ3	Three point Amplitude Perturbation Quotient
Shimmer:APQ5	Five point Amplitude Perturbation Quotient
Shimmer:DDA	Average absolute difference between consecutive differences between the amplitudes of consecutive periods
NHR	Noise-to-Harmonics Ratio
HNR	Harmonics-to-Noise Ratio [37]
RPDE	Recurrence Period Density Entropy
DFA	Detrended Fluctuation Analysis
D2	Correlation dimension

Table 2.3.1 Feature set (Little et al.2009

SVM classification is used in this study to perform PD discrimination after constructing a set of feature vectors from the speech signals. The entire machine learning process used can be summed up into three parts

1) Calculating the features

2) Pre-processing and pre-selection of features (both standard and non-standard)

3) Application of a classification technique to all possible feature subsets and selecting the subset that produces the best performance.

The table below shows the performance of each SVM feature set when it came to discrimination PWP with healthy individuals. It proves their main finding that "non – standard measures significantly outperform the traditional measures in separating healthy controls from PWP in terms of overall correct classification performance"(Sakar *et al.*, 2013)

Feature set (# of measures)	**Correct overall**	True positive	True negative
HNR, RPDE, DFA, PPE (4)	91.4±4.4	91.1±4.9	92.3±7.0
All(10)	90.6±4.1	90.7±4.3	90.4±8.6
RPDE, DFA, PPE (3)	89.5±3.9	89.6±4.3	89.1±8.6
DFA, PPE (2)	88.8±3.8	88.2±4.2	88.0±8.1

PPE (1)	85.6±5.4	85.9±5.5	91.4±4.4
MDVP:Jitter(Abs)(1)	80.6±9.9	80.7±10.1	91.4±4.4
RPDE, DFA (2)	79.2±4.2	79.2±4.5	79.0±7.5
HNR(1)	77.4±2.8	77.6±3.1	76.9±4.1
MDVP:APQ(1)	91.4±4.4	76.8±4.3	76.2±6.5
D2(1)	76.7±1.9	76.9±2.2	76.1±3.1
DFA(1)	75.9±2.8	76.1±3.1	75.4±4.6
RPDE(1)	75.7±1.4	75.9±1.7	75.2±3.0
Jitter:DDP(1)	75.6±2.4	75.7±2.3	75.2±3.6
NHR(1)	75.4±0.0	75.5±0.0	75.0±0.0
Shimmer:DDA(1)	75.4±0.0	75.5±0.0	75.0±0.0

Table 2.3.2 SVM classification performance results (Little et al.2009)

The second dataset we considered was based Sakar *et al*. (2013). The main difference between this dataset and the previous one considered is that this data set contained running speech recordings along with sustained vowel recordings for the feature set. The researchers in this more recent paper found that sustained vowels carry more PD discriminative characteristics, so they modeled their data collection to have 26 different voice samples that reflected vowel sounds very well.

The voice samples in the training set were taken from 20 PWP (6 females, 14 males) and 20 healthy individuals (10 females, 10 male). The recordings contained

- Numbers form 1-10
- 4 Rhymed sentences (Turkish)
- 9 words (Turkish)
- Sustained vowels "a" , "o" and "u"

The test data set consisted of data from 28 PD patients of 62.67 average ages who have had PD for 0-13 years. Each patient was asked to say the sustained vowel "a" and "o" three times making a total of 168 recordings. This dataset is used to validate the results obtained using the training data. These were recorded under the same conditions as in the training set.

Below is a list of the 26 different voice samples we will be collecting with the corresponding frequency-based feature extracted from each sample. The voice analytics software *Praat* would be used to extract the following features from the recorded voice samples.

Jitter (local) Jitter (local, absolute) Jitter (rap)	Frequency Parameters

Jitter (ppq5) Jitter (ddp)	
Number of pulses Number of periods Mean period Standard deviation of period	Pulse Parameters
Shimmer (local) Shimmer (local, dB) Shimmer (apq3) Shimmer(apq5) Shimmer (apq11) Shimmer (dda)	Amplitude Parameters
Fraction of locally unvoiced frames Number of voice breaks Degree of voice breaks	Voicing Parameters
Median pitch Mean pitch Standard deviation	Pitch Parameters

Minimum pitch Maximum pitch	
Autocorrelation Noise-to-Harmonic Harmonic-to-Noise	Harmonicity Parameters

Table 2.3.3 Frequency based features (Sakar et al., 2013)

The classification was done in this research using both K-NN and SVM and the results were compared. They found that rather than using each voice recording of each subject as an independent data sample, “representing samples of a subject with central tendency and dispersion metrics improved the generalization of the predictive model.” (Sakar *et al.*, 2013)

In their results they show that SVM classifier produced higher accuracies than k-NN classifier, the highest being 77.50 %. This was obtained with the s-LOO (summarized leave one out) method by summarizing data using the mean-standard deviation binary combination of central tendency and dispersion metrics. It is worth noting that the highest accuracy obtained here is lesser than the accuracy obtained from the previous study that we compared that used only vowel sounds in their dataset even though the classification methods are quite similar. (Both uses SVMs)

The proposed data set and conclusion.

After comparing the two datasets as above, we thought of adopting the second data set to our project since we were able to make the system for the Sri Lankan patient demographic.

To accommodate Sinhala speaking only patients we need to come up with two separate test and training datasets. We propose a dataset like the one explained above, but we replace the Turkish and English words and sentences with Sinhala ones. The numbers will be read in Sinhala. The sustained vowels will be recorded the same way since the language barrier should not affect the patient’s ability to pronounce the vowels.

To test our model a similar test set to the one mentioned in the original study will be collected under similar conditions to the training set data.

It is important to note that since sustained vowels are found to carry more PD-discriminative information (Sakar *et al.*, 2013), the words and sentences we choose should be picked to reflect as much vowel sounds as possible. Some candidate words and sentences are shown below.

- 4 Rhymed sentences
    1) අය්යා ඊයේ උදේම ඕපනායක ගියේය.
    2) ඕශදී ඊයේ උනු උනු ආප්ප කැවාය
    3) අමර ඕවිට ලග තිබූ ඊතන මිටිය උස්සාගෙන අවේය
    4) ඌරා ඊයේ ඊරීට ආලය පැවාය

- 9 Sinhala words
    - අග්ගලා
    - ඊතලය
    - ආලය
    - උකුස්සා
    - මුරැන්ගා අලය
    - නාගරාජයා
    - නාඉමන
    - අනුරාදපුරය
    - ඉත්තැවා

To make reasonable enough predictions we propose to obtain data from a minimum of 16 PD patients and 16 healthy individuals for the training set and 4 PD patients and 4 healthy individuals for the testing data set. Of course, more test subjects will increase the overall accuracy of our predictions and we can always add new data and refine our model anytime.

As far as the ML approach we are to take, after comparing numerous literature with different ML algorithms and varying accuracy we decided to use the kernel-based extreme learning machine subtractive clustering features weighting approach to do our classification (Ma *et al.*, 2014) since it had the highest accuracy rate out of all the compared techniques. We will ultimately come up with a hybrid system containing our own data set with "Sinhala" language recordings and use machine learning techniques used in Ma *et al.*(2014) to do our classification.

2.4 Previous projects on analyzing audio

The human speech production system comprises of a framework of articulators which, when utilized agreeably, permits a speaker to create an endless run of sounds. The framework is physiologically complex. The lungs, in simplified terms it can be thought of as an air pump giving the fundamental wind stream to stimulate the voice source and vocal tract. The term voice quality envelops a wide extend of voice characteristics extending from whispery to breathy, from remiss to tense, from creaky to falsetto, from stressed to non-stressed, and from low-pitched to high-pitched. In order to get how different voice qualities are created, it is vital to dive into the properties of the voice source (Shue, 2010).

Voice analysis was first used in World War II for military intelligence purposes. Every individual's voice has a unique quality because the anatomy of the vocal cords, vocal cavity, and oral and nasal cavities is specific to the individual. Added to that, to produce words, each person controls the lips, tongue, soft palate and jaw muscles differently (Voice Analysis | Encyclopedia.com, 2019).

Researchers from a variety of medical centers, universities and healthcare companies have collected voice recordings from hundreds of patients over the past few months and fed them to machine learning software that compares voices to those of healthy people, with the aim of establishing patterns that are sufficiently clear to identify vocal disease indicators (Griffin, 2017). The Mayo Clinic has collaborated with Beyond Verbal, an Israeli company to study the voices of coronary artery disease patients using machine learning (AI-Siddiq, 2018). Shinichi Tokuno developed the 'MIMOSYS (Mind Monitoring System)' system which automatically monitors the mental health of the owner of the smartphone from their voice during conversations on the smartphone which captures the emotions whether the person is stressed or depressed from changes in the basic frequency of the voice (Steph Hazlegreaves, 2019).

The German company uses voice analysis to identify ADHD (Attention Deficit Hyperactivity Disorder) in children, gaining more than 90% precision in the detection of previously diagnosed children based on their own speech (Griffin, 2017). Boston-based company worked with the Department of Veterans Affairs to use speech recognition software to track the moods of service members and minimize the suicide rate in military service members (Griffin, 2017). In June 2016, the US Army partnered with MIT’s Lincoln Lab to develop an algorithm that diagnoses mild traumatic brain injury using voice (Griffin, 2017).

3 Project management

3.1 Chapter Overview

In this chapter, the available methodologies that are available to develop our project would be discussed and a suitable methodology would be chosen with justifiable reasons. The team's work plan in tackling the project successfully and the roles of each member would be discussed in this chapter.

3.2 Research methodology

#	Methodology Name	Description
1	Agile Model	This model is useful in developing projects that should be developed within a certain time period. Here, the project is developed in incremental cycles and the results will be released after each cycle. This enables the developers to make updates on the previous releases. Regular updates and late changes can be facilitated in this model.
2	Waterfall Model	One of the earliest models that was implemented and used in the early stage of developments. This is a linear life cycle model, and it is required to complete one phase completely before moving on to the next phase. Very easy to use and understand. But this has limitations: unable to go back to previous phases, therefore cannot change the design of the project during development, and software testing can be done after the development is completed.
3	Rapid Application Development model	In this model, both the functions and the components are built parallelly and this gives a steady and clear output. Time boxing is used in development and then assembled together to form a working prototype. This model requires meticulous and clear planning. This model facilitates

		in increasing the components reusability and this model can be recommended for highly experienced developers.
4	Spiral Model	Spiral model consists of 4 main phases: planning, risk analysis, engineering and evaluation. This model passes through these 4 phases rapidly and it is somewhat similar to Waterfall and Agile models.

Table 3.2.1 - Research methodology

3.2.1 Development Methodology to be used in developing the software.

Our team has decided to create a system in a methodology that would be adapted to frequent changes and to create a working prototype.

Waterfall methodology is not suitable for our style of development, as while in a phase, it would be unable to move to another phase without completing the current phase. Spiral model is similar to the Waterfall model too, therefore that would be unsuitable too.

Both the Agile and RAD methodologies are suitable to develop our project. Our team has decided to follow the Agile model in developing the software, as it is flexible to changes and a basic working prototype would be created with the initial sprint/cycle. RAD is similar to Agile, but since RAD is time-critical and requires developers with high expertise, it would be less useful in using RAD model to develop our project.

Our team would be following the Scrum framework, which is based on the Agile methodology, as it our team could easily monitor and change the system easily according to the working prototype developed after each sprint.

3.3 Work Plan

- The project would be completed in **Sprints**, where one Sprint would take around **1-3 weeks**.
- Before each Sprint, the requirements in the Product Backlog would be discussed, and would be selected to develop the product.
- After each Sprint, Sprint Review and Retrospective would be done, in order to analyze the completed projects, the shortcomings, the strengths and improvements.
- After each Sprint, documentation would be done, detailing the activities and successfully completed objectives.
- Based on the selected methodology, the table below shows the expected work plan.

3.3.1 Activity Schedule

	Task	Start	End	Day
1	Project Initiation	1st Oct 2019	15th Nov 2019	46
2	Literature Review	15th Oct 2019	31st Dec 2019	77
3	Requirement Gathering	1st Nov 2019	31st Dec 2019	60
4	Design	1st Dec 2019	3rd Jan 2020	33
5	Implementation	4th Jan 2020	15th Mar 2020	71
6	Testing and Evaluation	1st Feb 2020	30th Mar 2020	58
7	Documentation and Conclusion	1st Dec 2019	30th Mar 2020	120

8	Additional Task	1st Oct 2019	30th Mar 2020	181

Table 3.3.1 - Activity schedule

3.3.2 Work Breakdown Structure

Please refer to Appendix B for Work Breakdown Structure

3.3.3 Gantt Chart

Please refer to Appendix C for Gantt Chart

3.3.4 Project Roles

Please refer to Appendix D for Project Roles

3.4 Deviations and Risk Mitigation

The following table shows the potential risks and risk mitigation plans for the proposed system

Risk	Priority	Mitigation Plan
Lack of time	High	• Work on extra time. • Start working a little earlier from the planned day
Insufficient knowledge about health domain	High	• Request help from domain experts. • Refer & research from existing research papers and systems.
Unsuitable/ Incorrect Design Approaches	Medium	• Re-analyze and redesign the system. • Seek help from experts

Loss of data/ progress due to Malfunctions	High	• Having 2-3 good backup strategies and backups. • Having continuous backups
Exceeding given deadline	High	• Having proper schedules and abiding by it.

Table 3.4.1 - Deviation & risk mitigation

3.5 Chapter Summary

In this chapter, the methodologies available were discussed and then the suitable methodology was selected – SCRUM methodology, which follows the AGILE principles. Also, the work plan is discussed, which gives a brief idea of the methodology in completing the project. The roles of each team members are discussed. The necessary charts, such as Gantt Chart, Work Breakdown Structure can be viewed in this chapter.

4 Requirements specification

4.1 Chapter introduction

This chapter focuses on how the requirements that are needed to develop the system are gathered and a detailed analysis of the requirements. Identifying the stakeholders with their specific roles are explained. Then the requirement gathering process is discussed, and then, followed by the use case diagrams and its descriptions, the activity diagrams, and then the chapter concludes with the functional and non-functional requirements of the system.

4.2 Requirement gathering techniques

The ways of gathering requirements is requirement elicitation, and here, several options are discussed, with their advantages and disadvantages. This starts with the observations of existing systems, then brainstorming, literature review and questionnaires.

4.2.1 Existing Systems

A literature review on the existing systems is the first step that has to be done in order to gather requirements. The gaps that are found in the existing systems are analyzed and it helps in identifying new requirements that are needed for the project.

Advantages	Disadvantages
·Important components present in the speech detection systems can be identified easily. ·The end product, which satisfies the user’s expectations, developed by the competitors can be found. ·Limitations in the existing systems are identified to bridge the gap and to build the system.	·This process takes a lot of time in order to analyze and discover all the existing systems there is.

Table 4.2.1.1 - Advantages & disadvantages of existing systems

4.2.2 Brainstorming

Brainstorming were conducted by the team in order to discover and analyze new functional requirements for the system.

Advantages	**Disadvantages**
· New requirements for the system was identified, which might not have been identified during research.	· Getting contradicting requirements from each team member, that required a deep group analysis to agree upon the best among the proposed requirements.

Table 4.2.2.1 - Advantages & disadvantages of brainstorming

4.2.3 Literature Review

Literature review was done on the problem domain, the technologies that were used to solve the problem, and the existing work in order to gather requirements.

Advantages	**Disadvantages**

- This enables us to properly identify the advantages of the existing systems/technologies used through good documentation, and also can easily identify the limitations of those existing products/technologies.	· This process takes a lot of time, in order to understand and critically analyze each existing research.

Table 4.2.3.1 - Advantages & disadvantages of literature review

Questionnaire Surveying

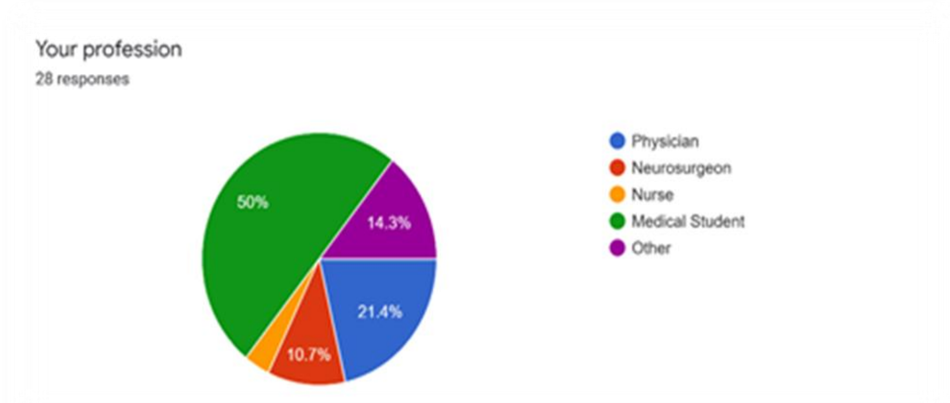
In order to identify the requirements for the target audience of the intended software, questionnaires were prepared and then distributed as an online survey. The survey was created through Google Forms.

Advantages	**Disadvantages**
· Ability to reach a global audience. · Saves time. · Results can be easily analyzed.	· The respondents' active participation affects the accuracy of the results.

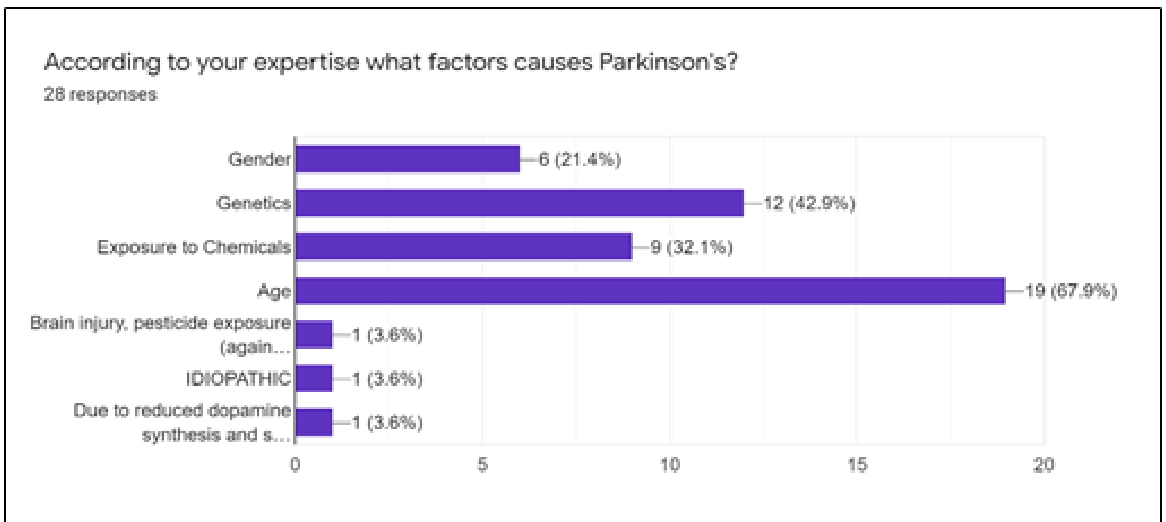
Table 4.2.4.1 - Advantages & disadvantages of questionnaire surveying

4.2.4 Questionnaire Results

Question	Your Profession
Aim of the question	Identifying the target audience for the project (i.e. the people related to the medical field: doctors, medical students, etc.)

Observations	
Major respondents for the questionnaire are the medical students, and about 21% of the respondents were general physicians and 10% were neurosurgeons.	
Conclusion	This question is based in order to identify the main stakeholders of our project: those who are related to the medical field.

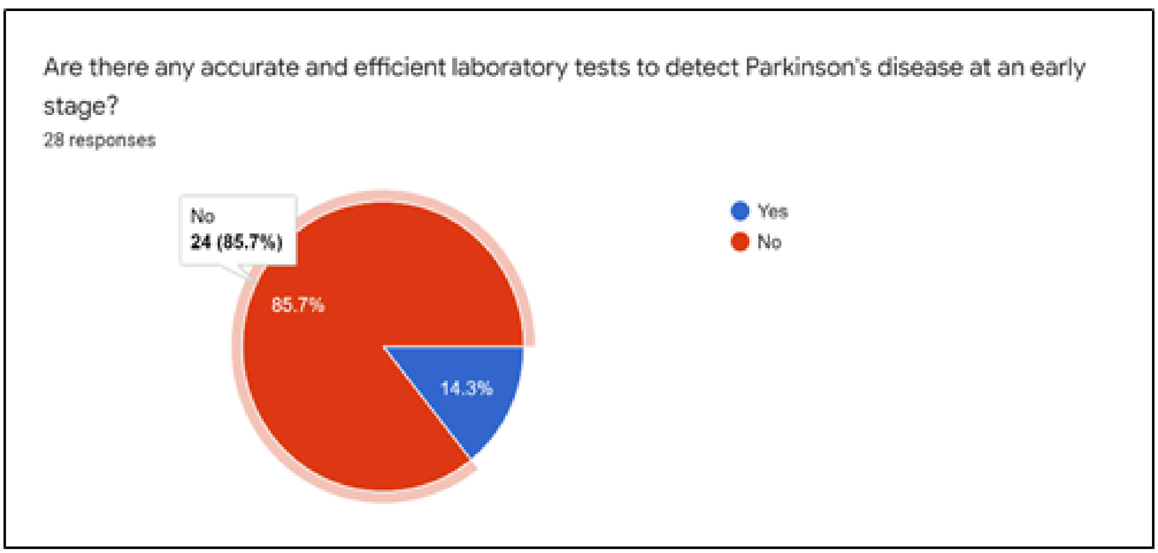
Question	According to your expertise, what factors cause Parkinson's?
Aim of the question	Identifying the factors that might cause a person to get affected by Parkinson's.
Observations	



67% of the total respondents have said that age is a major factor in causing Parkinson's and 42% of the respondents think that genetics play a part in causing Parkinson's. Exposure to chemicals and gender too are chosen by 32% and 21% of the respondents respectively, as factors that might cause Parkinson's.
Conclusion
Age was identified as the major factor in causing Parkinson's, and factors like genetics, gender and chemical exposure might cause Parkinson's too.

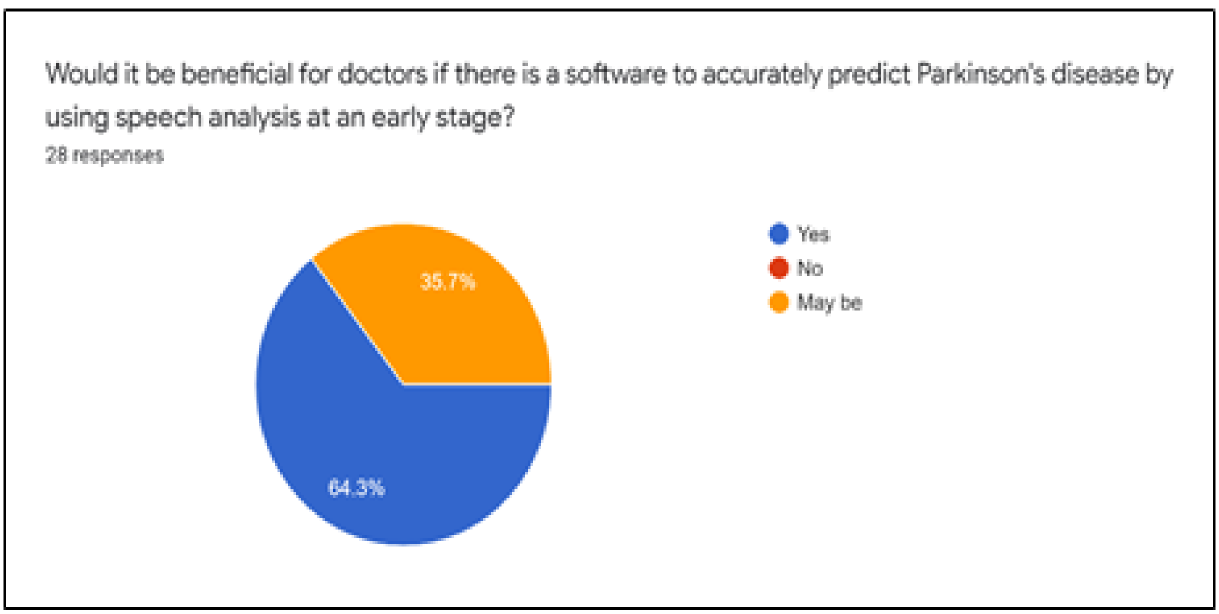
Question	Are there any accurate and efficient laboratory tests to detect Parkinson's disease at an early stage?
Aim of the question	To find out the efficiency and the accuracy of any existing tests in identifying Parkinson's Disease

Observations



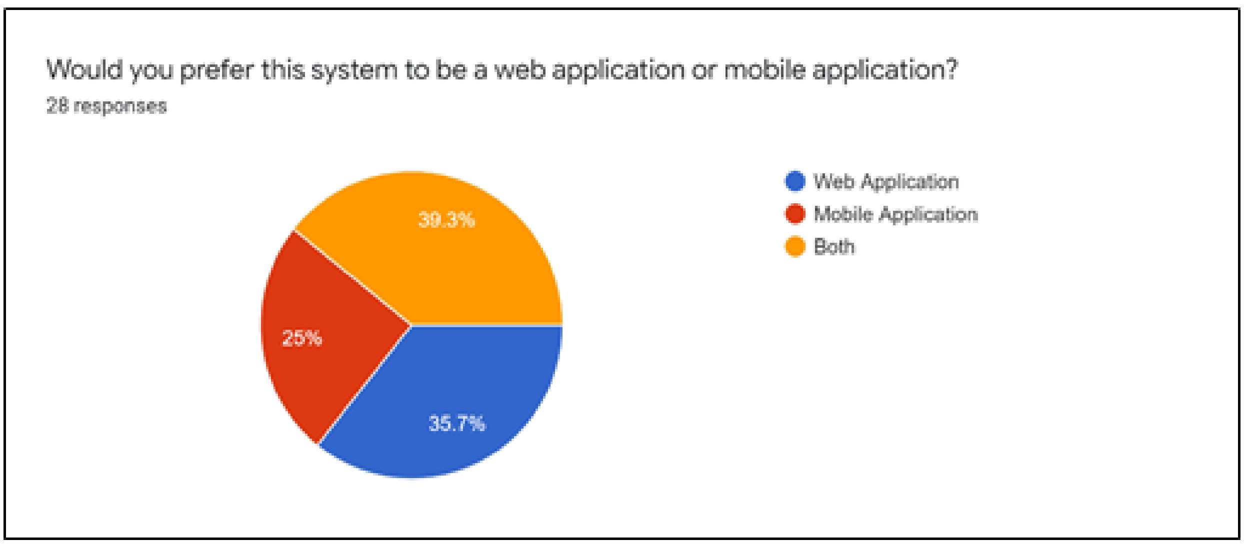
85% of the respondents have responded that there are no existing efficient and accurate tests to identify Parkinson’s test, whereas 14.3% have told there are some tests to identify Parkinson’s.
Conclusion
Currently, there are not many efficient and accurate tests to predict and diagnose Parkinson’s Disease at an early stage.

Question	Would it be beneficial for doctors if there is a software to accurately predict Parkinson’s disease by using speech analysis at an early stage?
Aim of the question	To find out whether it is useful to develop a software to predict/diagnose Parkinson’s Disease
Observations	



There are zero respondents who have answered it is not useful, whereas more than 64% have told it is useful and more than 35% have answered it may be useful in creating such a software.
Conclusion
It is useful for the stakeholders in creating a software that can diagnose/predict Parkinson’s disease at an early stage.

Question	Would you prefer this system to be a web application or a mobile application?
Aim of the question	To find out what kind of system would the stakeholders prefer to use.
Observations	



Majority of the responses(more than 39%) were in favor of creating a system that can be implemented as a web app and as a mobile app, whereas more than 35% prefer a web app only and the remaining prefer only a mobile app.
Conclusion
It is useful for the stakeholders if an application is developed that can be operated both on the web app and on the mobile.

Table 4.2.5.1 - Questionnaire results

4.3 Use case diagram

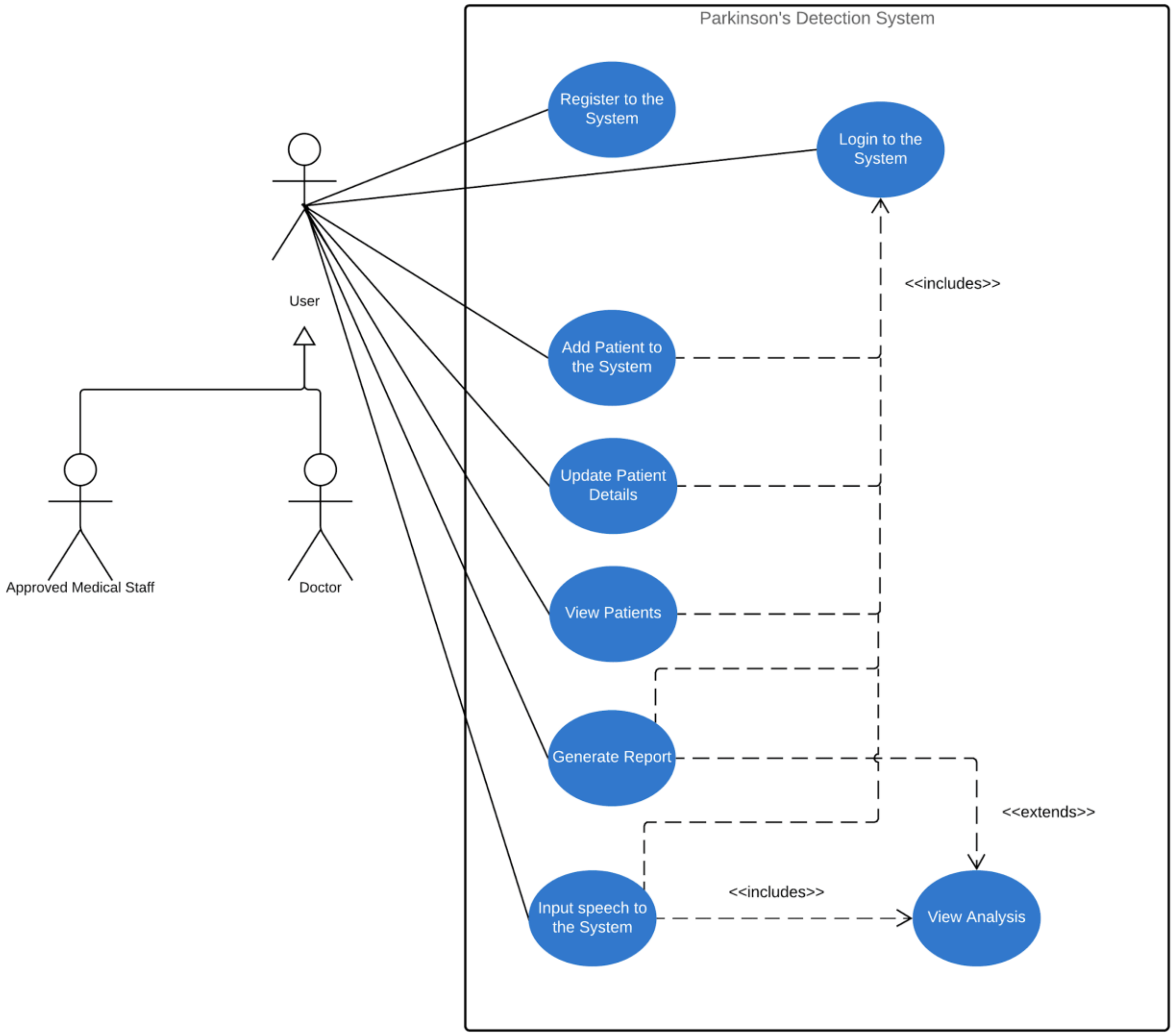


Figure 4.3 - Use case Diagram

4.4 Use case description

4.4.1 Use Case of Registering to the system

Use Case Name	**Register to the System**
Description	Registering your name and details into the system to predict Parkinson’s disease.
Participating actors	Doctor/ Approved medical staff
Preconditions	1) Make sure that the System is running.
Extended use cases	None
Included use cases	Login to the system
Main flow	1) Enter the First name 2) Enter the Last name 3) Enter your Qualifications
Alternative flow	
Exceptional flows	If there’s an error in any credentials, Displaying an error message.
Post conditions	Displaying a message That you have successfully registered into the system.

Table 4.4.1.1 – Use Case for registering systems

4.4.2 Use Case of Adding patients to the system

Use Case Name	**Adding Patients**
Description	Adding name and details of the patient to check the voice recordings to detect Parkinson's disease.
Participating actors	Doctor/ Approved medical staff
Preconditions	The user should be registered into the system.
Extended use cases	None
Included use cases	Login to the system
Main flow	1) Entering the patient's First name. 2) Entering the patient's Last name.
Alternative flow	
Exceptional flows	If there's an error in any credentials Displaying an error message.
Post conditions	Displaying a message That you have successfully entered the details of the patient into the system.

Table 4.4.2.1 – Use Case for adding patients

4.4.3 Use Case of Updating patient details in the system

Use Case Name	**Updating patient details**
Description	Updating the patient’s details that are already stored in order to detect Parkinson’s disease.
Participating actors	Doctor/ Approved medical staff
Preconditions	The Patient’s details should be stored in the system.
Extended use cases	None
Included use cases	Login to the system
Main flow	1) Check for the patient’s name. 2) Select the patient’s details you want to update 3) Updating the details.
Alternative flow	
Exceptional flows	If there’s an error in any credentials Displaying an error message.
Post conditions	Displaying a message That you have successfully updated the details of the patient in the system.

Table 4.4.3.1 – Use Case for updating patient’s details

4.4.4 Use Case of viewing patients

Use Case Name	**Viewing Patients**
Description	Viewing patient's details who are added into the system.
Participating actors	Doctor/ Approved medical staff
Preconditions	The Patient's details should be stored in the system.
Extended use cases	None
Included use cases	Login to the system
Main flow	1) Enter patient's name 2) Select the correct patient name. 3) View details.
Alternative flow	
Exceptional flows	If there's an error in any credentials Displaying an error message.
Post conditions	Patient's details and medications should be displayed.

Table 4.4.4.1 – Use Case for viewing patients

4.4.5 Use Case of Generating Reports

Use Case Name	**Generating reports**
Description	Generating a report of the patients who were added into the system.
Participating actors	Doctor/ Approved medical staff
Preconditions	All the Details of the patients should be correct.
Extended use cases	View analysis
Included use cases	Login to the system
Main flow	1) Check for the correct details. 2) Select generate report.
Alternative flow	
Exceptional flows	If there’s an error in any credentials Displaying an error message.
Post conditions	Displaying the generated report of the patients who were added into the system.

Table 4.4.5.1 – Use Case for generating reports

4.4.6 Use Case of inputting Speech to the system

Use Case Name	**Inputting speech**
Description	Inserting speech signals of the patients in to the system in order to detect Parkinson's disease.
Participating actors	Doctor/ Approved medical staff
Preconditions	Patient's details and credentials should be correct.
Extended use cases	None
Included use cases	Login to the system, View Analysis
Main flow	1) Enter the name of the patient. 2) Making sure that the patient's details are correct. 3) Inputting the voice dataset into the system.
Alternative flow	
Exceptional flows	If there's an error in any credentials Displaying an error message.
Post conditions	Displaying a message That you have successfully inserted the speech dataset of the patient into the system.

Table 4.4.6.1 – Use Case for inputting speech to the system

4.5 Activity Diagram

4.5.1 Add patient

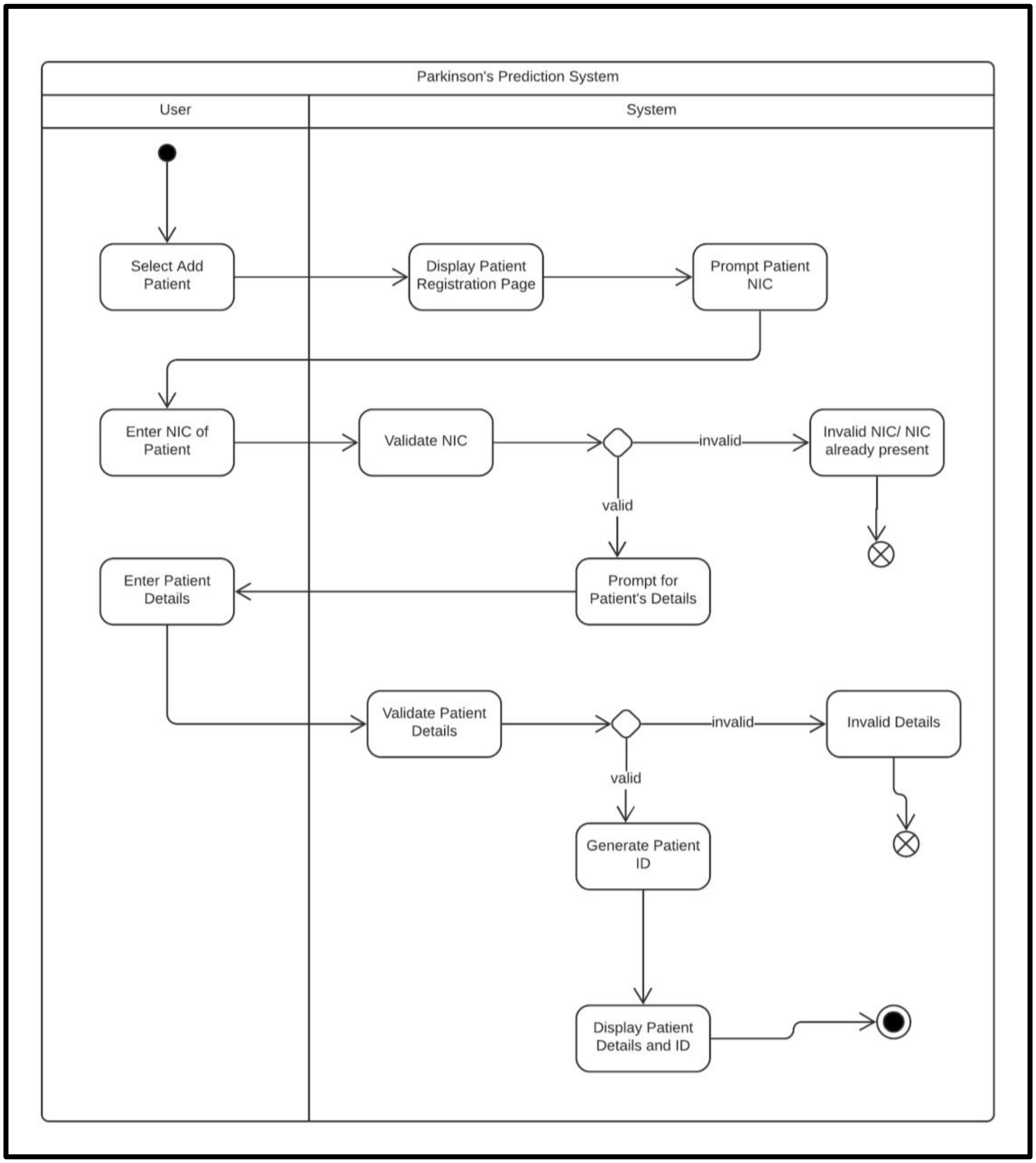


Figure 4.5.1 - Add Patient

4.5.2 Input speech to the system

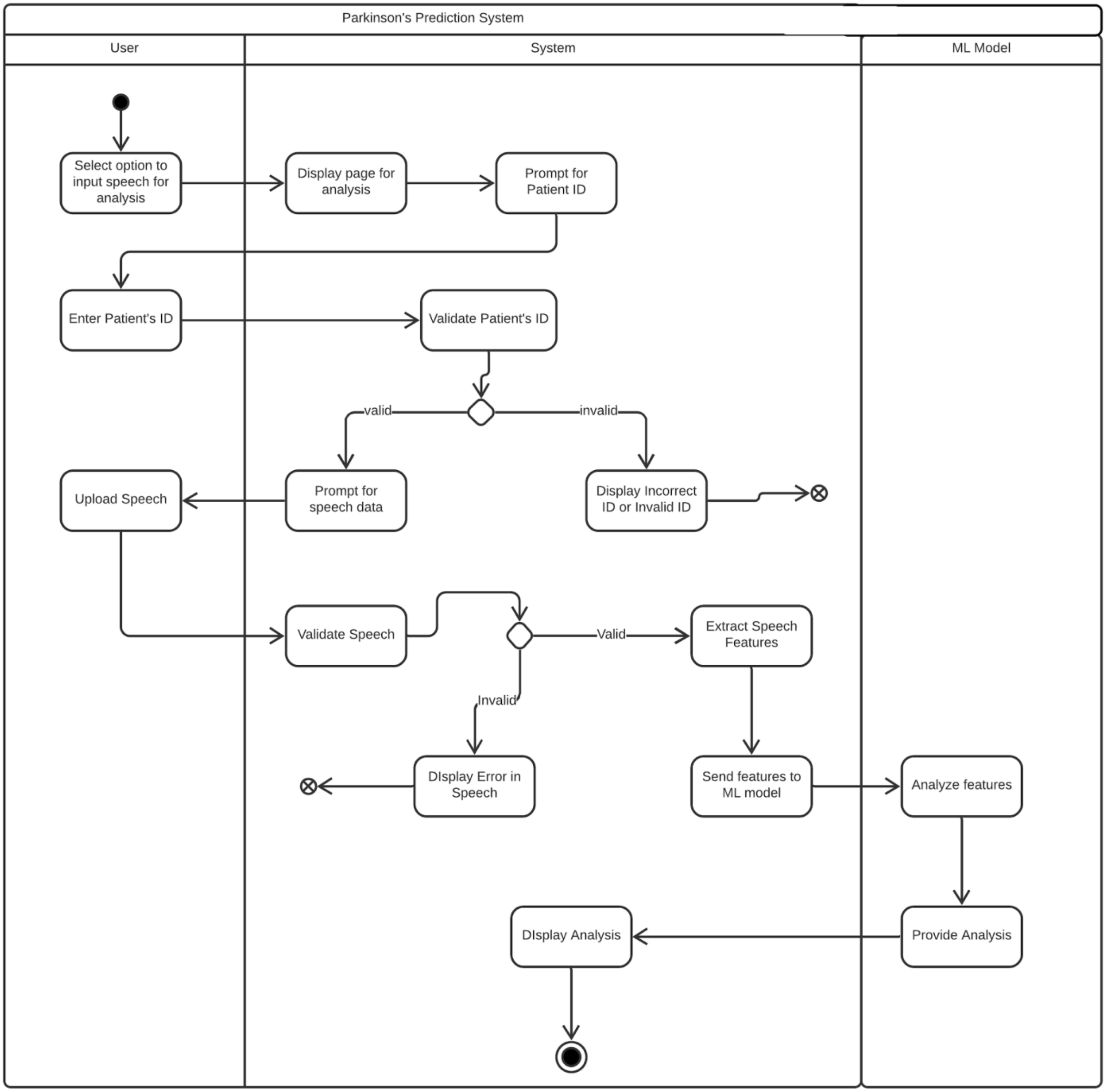


Figure 4.5.2.1 - Input speech to the system

4.5.3 Login

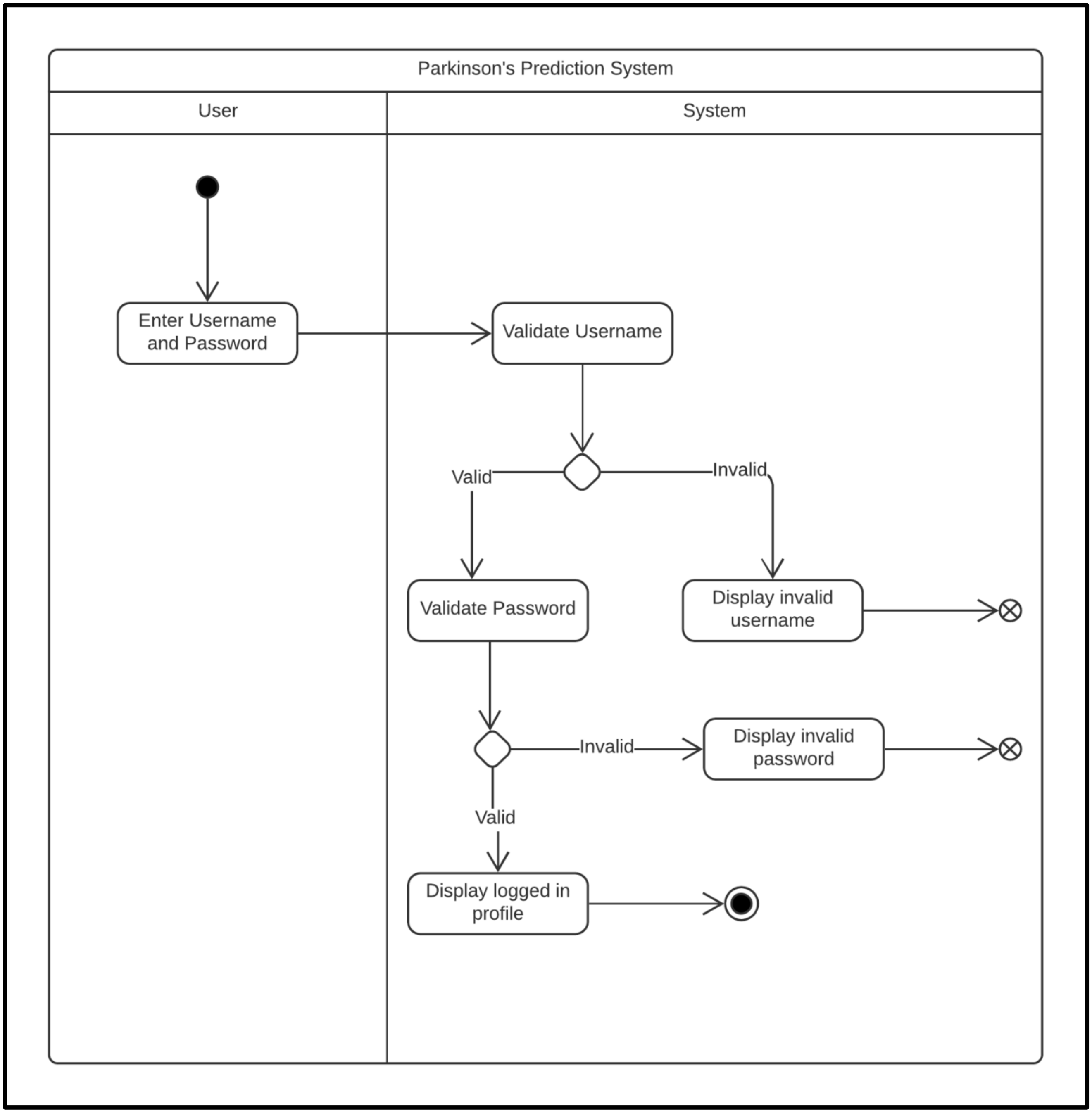


Figure 4.3.3 - Login

4.5.4 Registration

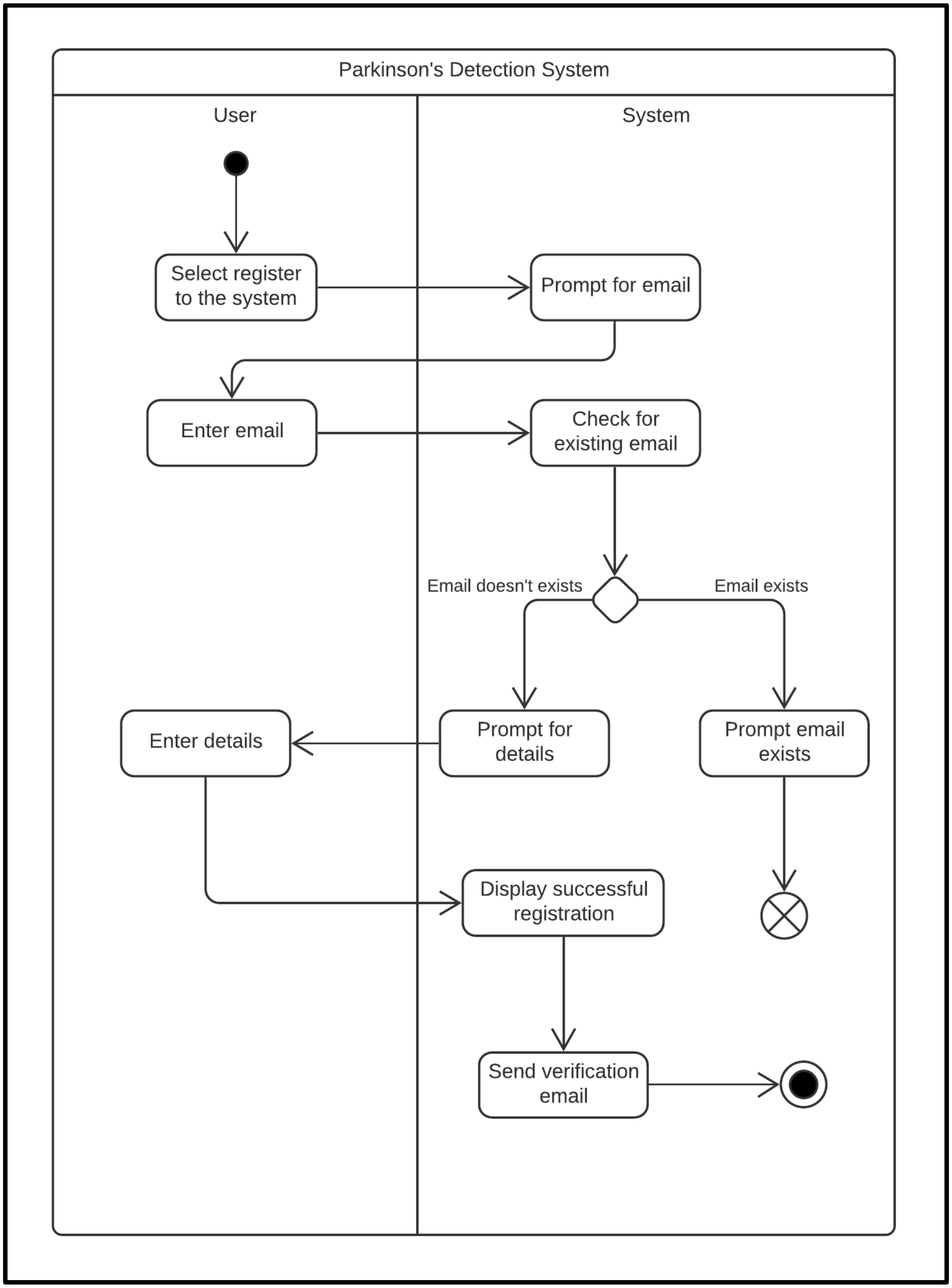


Figure 4.5.4 - Registration

4.6 Stakeholder Analysis

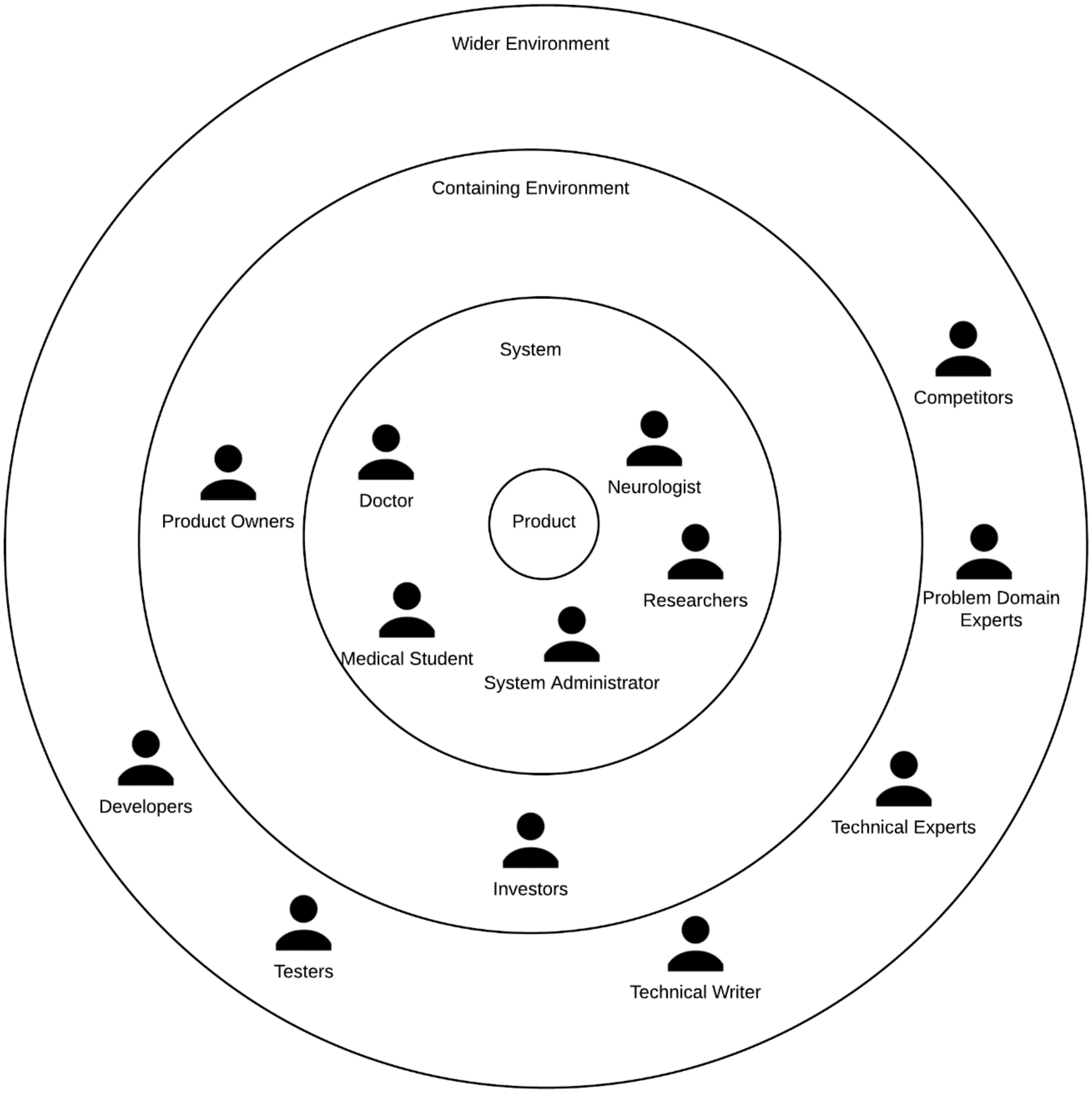


Figure 4.6 - Stakeholder analysis

Stakeholder	Role	Benefits
Doctor Neurologist Medical Student Researcher	Operational - Maintenance	Detect abnormalities in speech and predict whether Parkinson's is present, using the system.
System Administrator	Operational - Administration	Maintains the system by installing, monitoring and upgrading the software.
Product Owners	Functional Beneficiary	The owner for whom the software for predicting Parkinson's is developed for.
Investors	Financial Beneficiary	Invests to make profits and increase the user base.
Problem Domain Experts	Expert	Provide expert knowledge on the problem domain, that is on Parkinson's.
Technical Experts	Expert	Provides expert knowledge on the technologies and methodologies that can be utilized for the project
Technical Writer	Operational - Support	Creates the documentation for the system.
Developers	Financial - Beneficiary	Creates the system
Testers	Quality Regulator	Tests the system before deployment to ensure maximum quality.

Competitors	Negative Stakeholders	Creates system that has features directly related to the proposed product, which creates competition.

Table 4.6.1 - Stakeholder analysis

4.7 Requirement Specifications

Under this section, the requirements of the system are identified and prioritized according to these levels.

Priority Level	Description
Critical	Core functionality of the system
Important	Not essential, but necessary
Desirable	Not necessary, but a feature that would beautify/strengthen the system.

Table 4.7.1.1 - Requirements specifications

4.7.1 Functional requirements

#	Requirement	Description	Priority Level
FR1	Must analyze the speech of the patient	The system should analyze the speech of the patient, that was input by the doctor, and provide accurate predictions.	Critical

FR2	Register and login to the system	The doctor should be able to register and log in to the system, in order to use it.	Important
FR3	Add and Update Patient Details	The doctor should be able to add and update patient details in the system; the patients are the ones whom the doctor is going to diagnose for Parkinson's Disease.	Important
FR4	View Patient's Details	The doctor should be able to view the diagnosis reports of the patients for further diagnosis or prescriptions.	Important
FR5	Bridge the Language Gap when designing the User Interface	The interface could be designed with all the 3 languages (English, Sinhala and Tamil), therefore the user won't have any problems in using the system.	Desirable
FR6	An introductory session for the user	There could be an introductory session for the user by helping him to get familiarized with the system.	Desirable
FR7	Dark mode	Adding a Dark Mode for the system could help the user when using the system in low light and also beautify the UI of the system.	Desirable

Table 4.7.2.1 - Functional requirements

4.7.2 Non-functional requirements

#	Requirement	Description	Priority Level
NFR1	Accuracy	The system should accurately predict whether a patient has Parkinson's.	Important

NFR2	Performance	The system should present the predictions in a short time.	Important
NFR3	Maintainability	The system should be designed in a way that is easy to add features or remove bugs without major issues.	Important
NFR4	Usability	The system should be simple and clear enabling it to be used by anyone without an IT background.	Important
NFR5	Security	The system should be secure in order to protect and preserve the Doctor and Patient details that it is storing	Important
NFR6	Maintainability	Sufficient and clear documentations should be present in order for the new developers or testers to be familiarized with the system easily.	Important

Table 4.7.3.1 - Non-functional requirement

4.7.3 Chapter Summary

Under this chapter, various ways that was used to gather the necessary requirements to successfully build the system was discussed, and the advantages and disadvantages in each method was seen. The use case diagram was displayed, which represents a clear idea of the product. Activity diagrams were drawn too, in order to provide a clear representation of some of the use cases of the system. Finally, stakeholder analysis was done, analyzing each and stakeholder who could possibly affect the system.

5 Design

5.1 Chapter Overview

This Chapter focuses on the Design aspects of the system. It covers design decisions as well as diagram used in creating the system. The design diagrams involved are High level, low level designs, system architecture, class diagram, System process flow diagram, sequence diagram and UI wireframes.

5.2 Design Goals

Design Goal	**Description**
Correctness	The predicted results should provide the correct predictions whether the person has Parkinson’s disease or not up to a certain good accuracy level
Performance	Process of Predicting the results should be within a minimum time.
Security	Since the data is regarding patients, the security of data access should be high to reduce ethical risks.

Table 5.2 .1- Design goals

5.3 Rich picture diagram

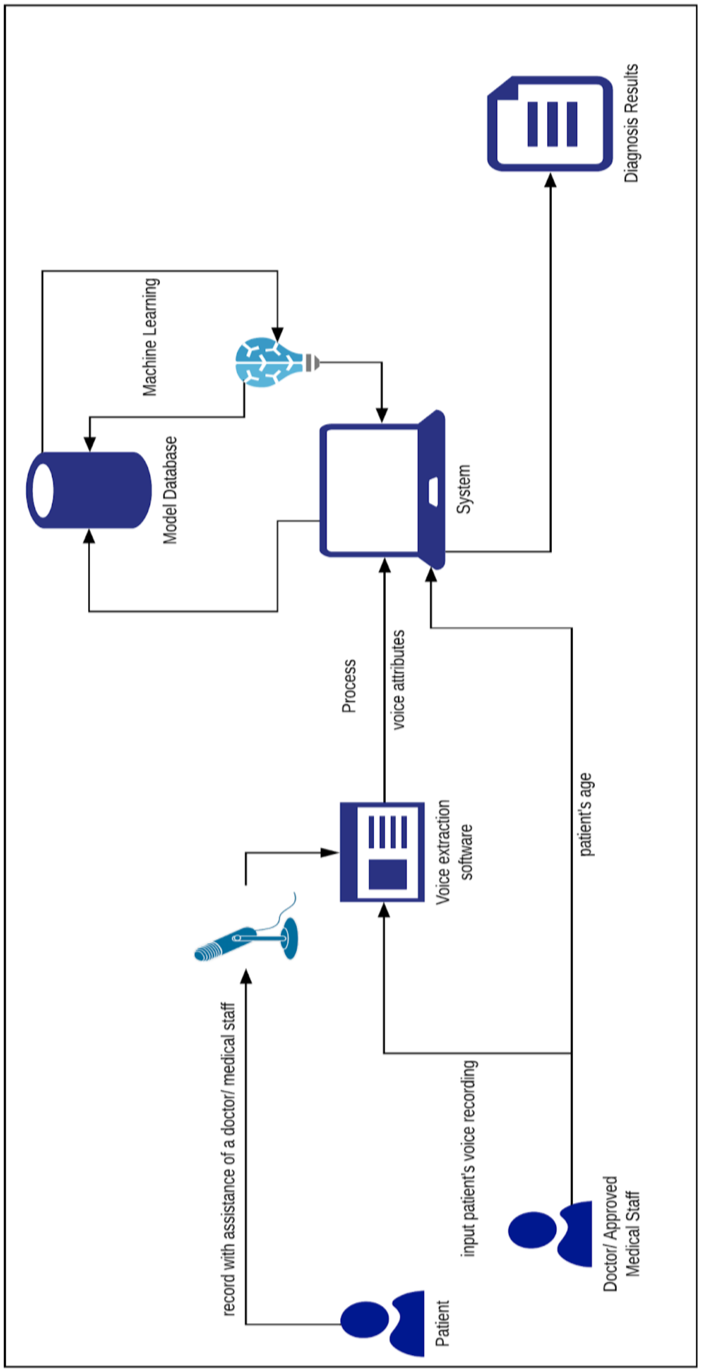


Figure 5.3 - Rich picture diagram

The user obtains the input speech data to the system, and then the system processes the input data with the help of using the Machine Learning algorithm. Diagnosis is performed and a detailed analysis would be generated by the algorithm, and the result would be sent to the system and the user would be able to view the generated result and decide based on the analysis.

5.4 Machine Learning Design

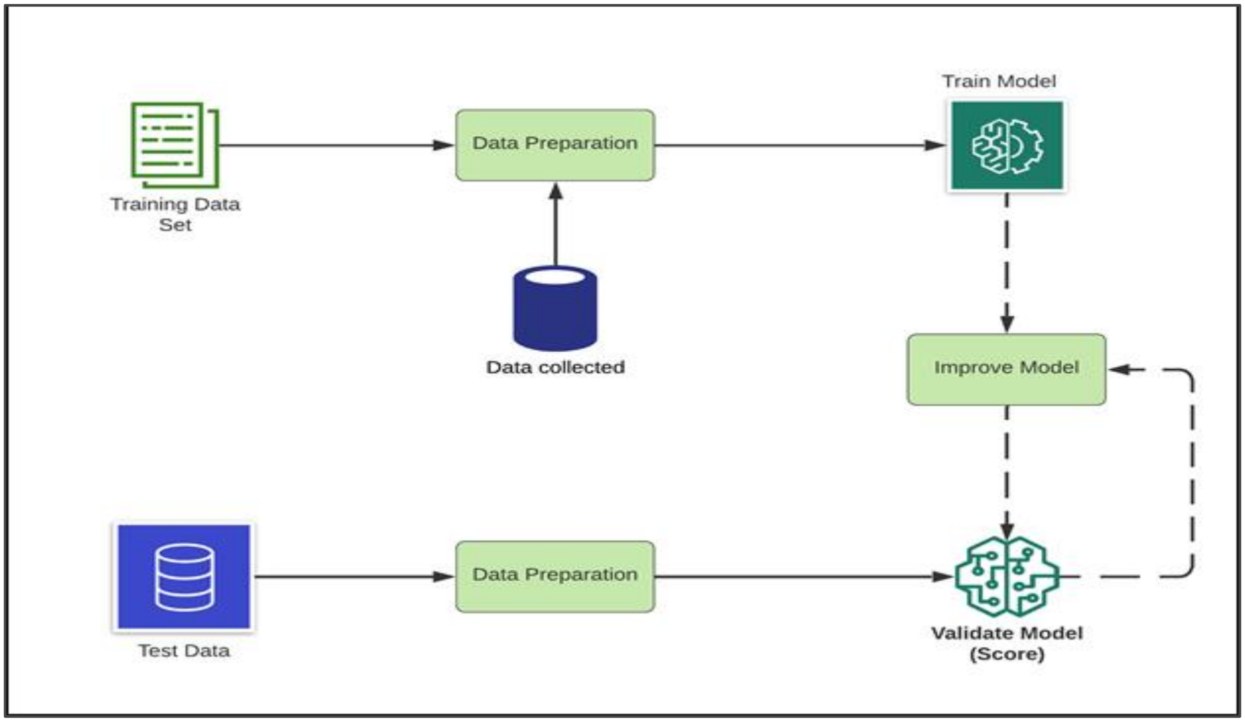


Figure 5.4 - Machine learning design

Above is a representation of how our intended model for Machine Learning would be trained. Initially, the data from the training dataset would be extracted and would be used to train the model and then would be improved. The data which we are collecting (i.e. the speech data of native patients affected by Parkinson's disease) would be used to train the model. Then the model's accuracy would be calculated and then improved until the accuracy is high.

In order to test the model's validity, test dataset would be used to validate the model and check for any bugs/inaccuracies.

5.5 High level architecture diagram

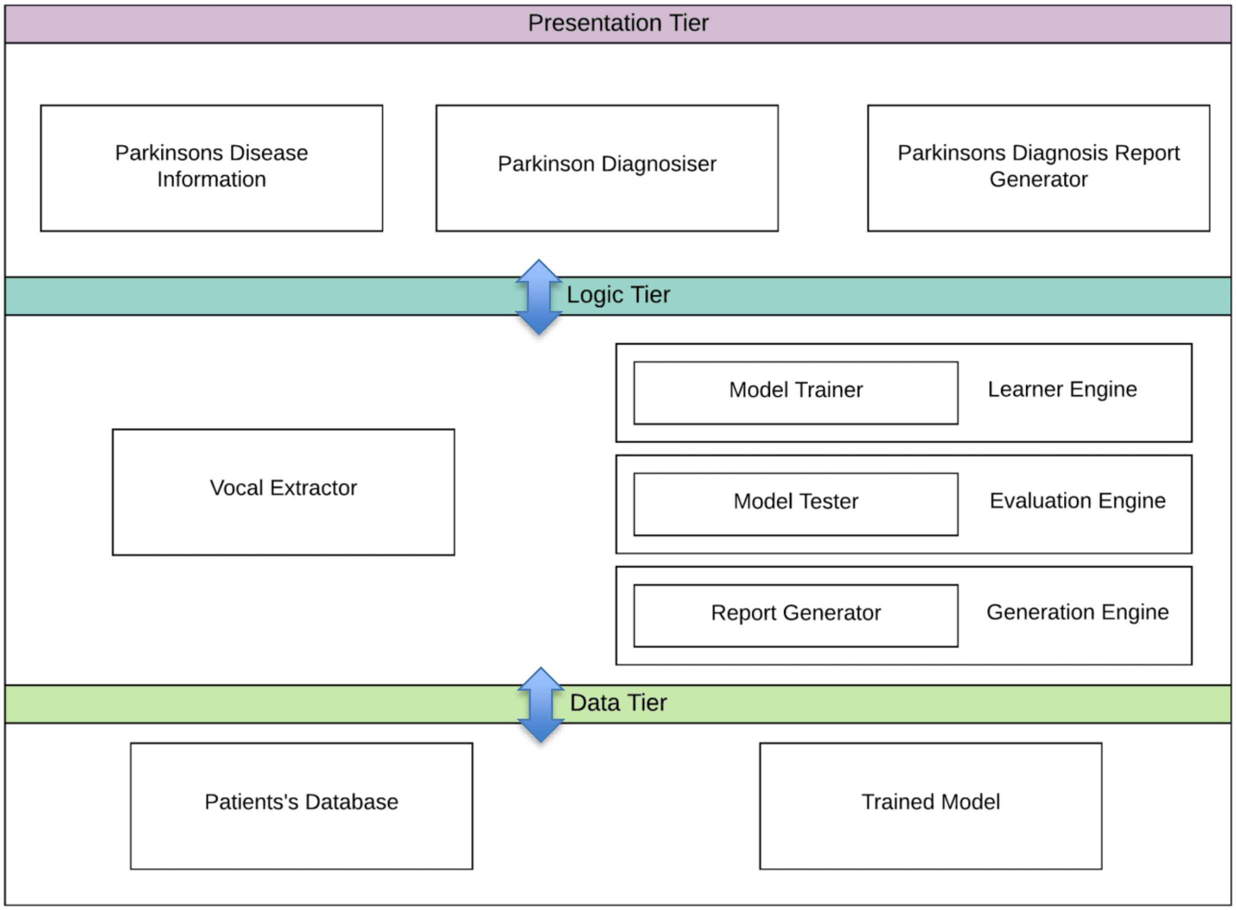


Figure 5.5 - High level architecture diagram

In the presentation tier, three components are given. They are

- Parkinson's Disease Information – This component gives information and news feed about Parkinson's Disease.
- Parkinson's Disease Diagnosis – This component is about inputting speech and finding out the diagnosis results
- Parkinson's Diagnosis Report Generator – Used to generate a report of the person including patient ID and their diagnosis results.

The core components of the logic tier are given below,

- Vocal Extractor – Using a voice analyzing API to analyze the patient's speech and get the attributes
- Model Trainer – To train the model with person with and without Parkinson's disease
- Model Tester – To test whether the, the results correct and accurate.
- Report Generator – To generate report of person's diagnosis results

The components in the Data Tier are,

- Patients' Database
- Trained Model

5.6 Class Diagram

The Class Diagram for our system contains of 9 classes, where the 4 main classes are the VoiceParameter, Logger, Database (for connection), and User. VoiceParameter class has a composition relationship with 5 classes: Pulse, Voice, Pitch, Harmonicity, and Frequency, which makes up the VoiceParameter class.

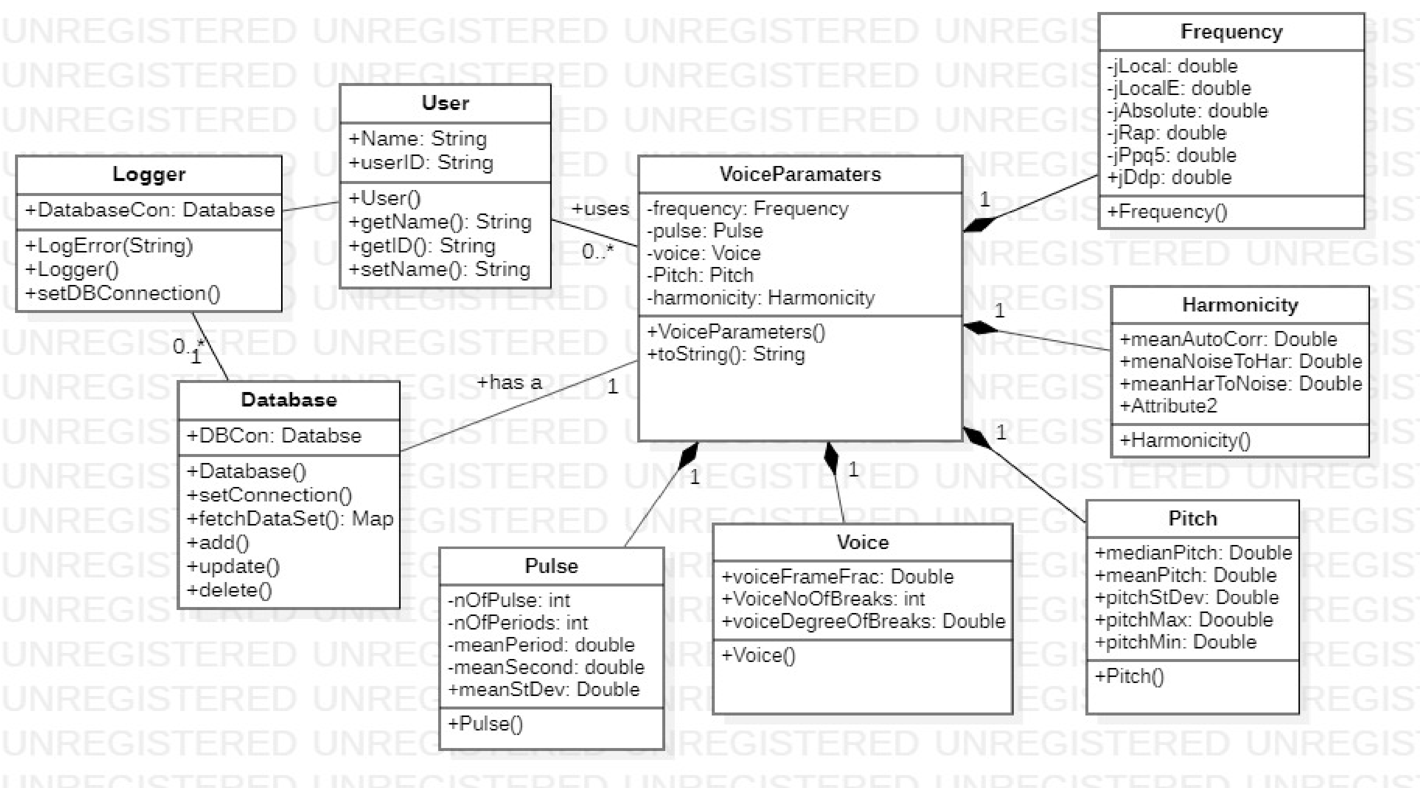


Figure 5.6.1 – Class Diagram

5.7 System process flow diagram

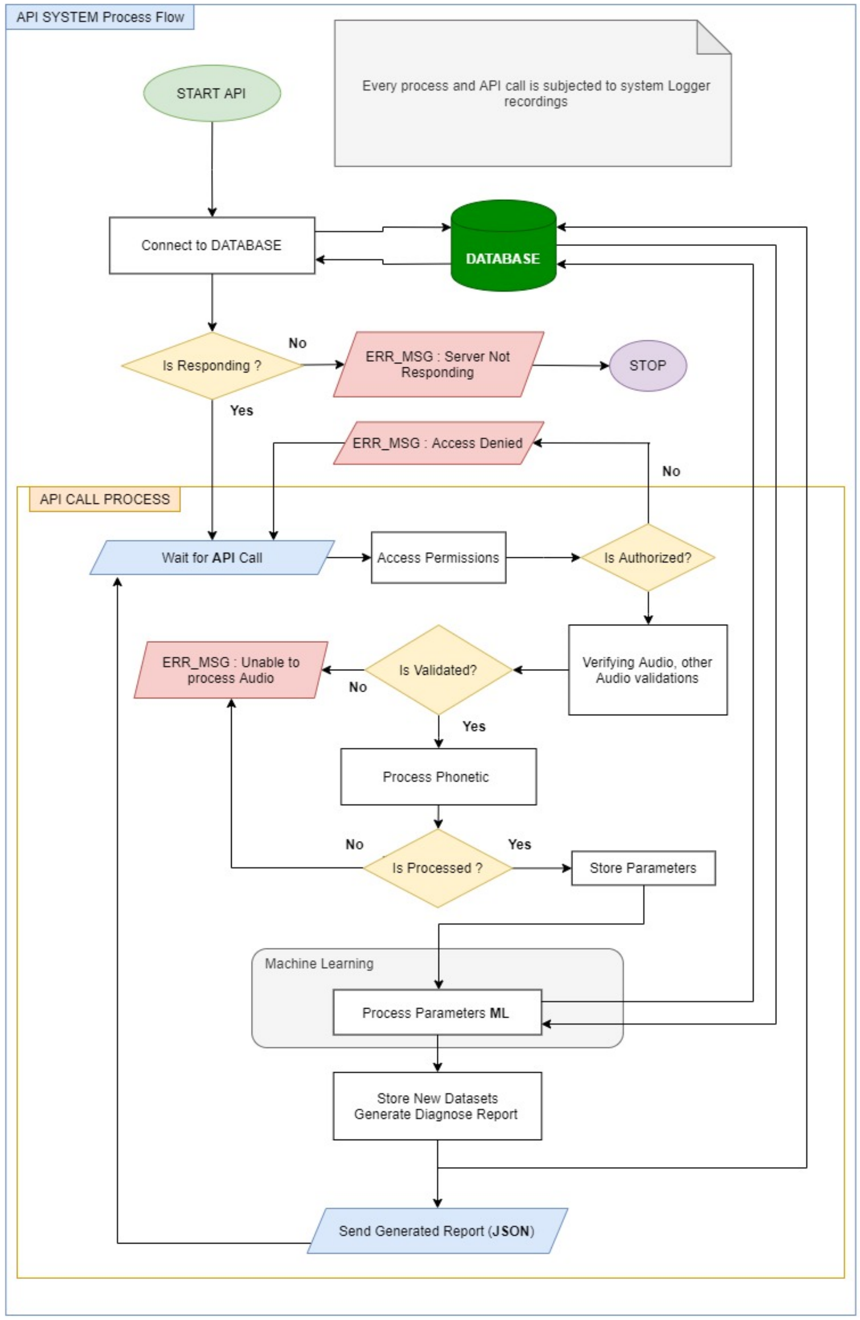


Figure 5.7.1 - System process flow diagram

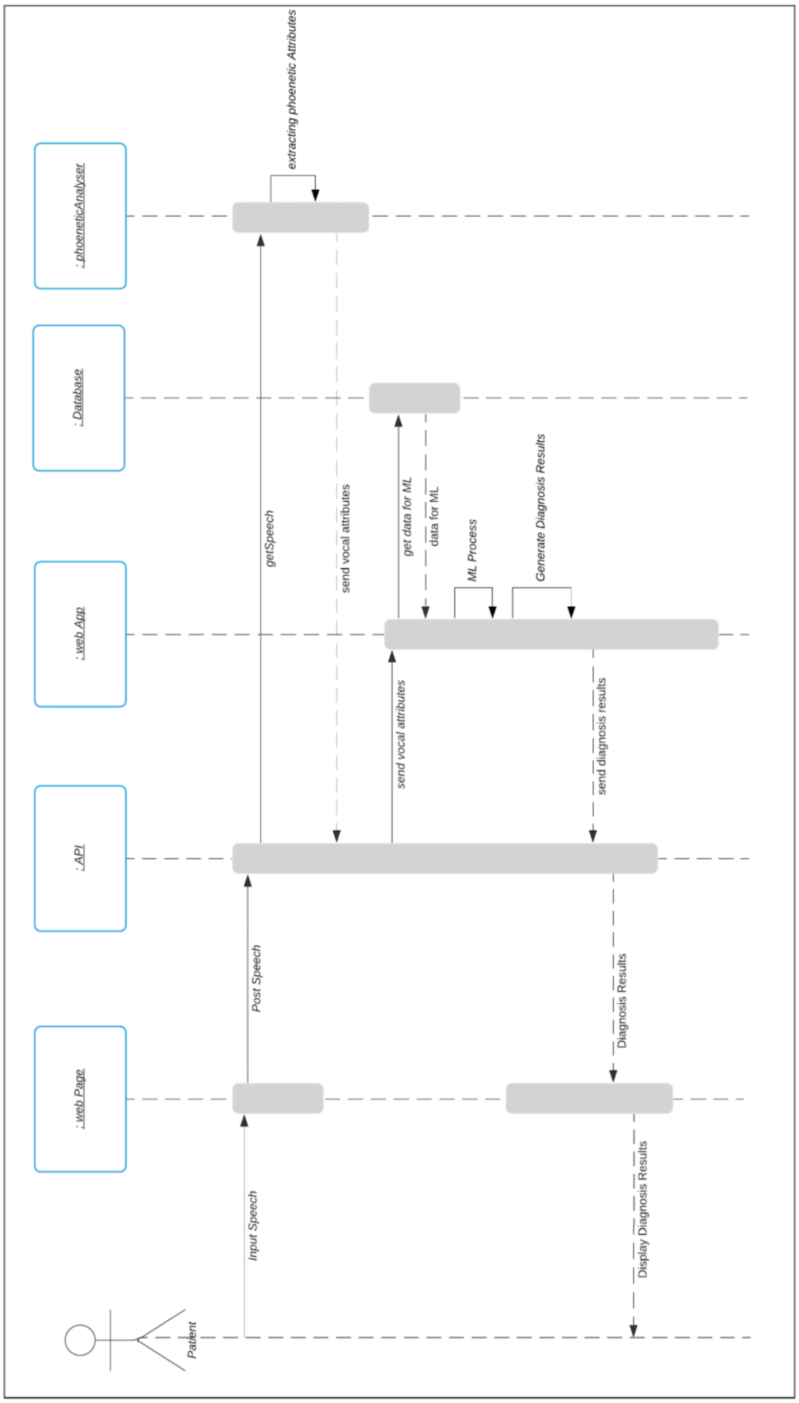
The flow chart given above visualizes the workflow of the core functionality that is the machine learning, and the components engaged with machine learning process.

5.8 Sequence Diagram

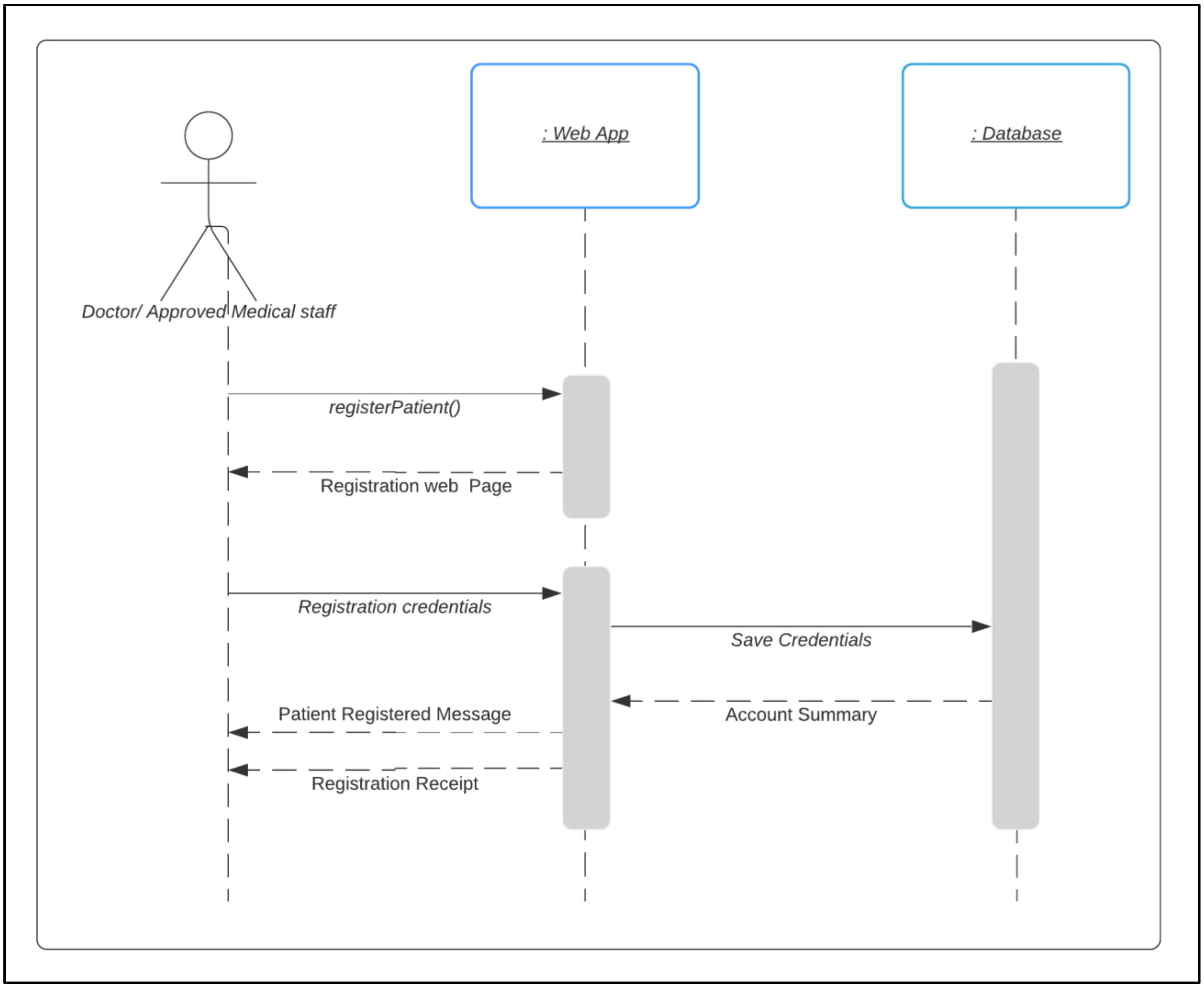
5.8.1 Sequence Diagram for Inputting Speech and ML results

The below sequence diagram depicts the communication that occurs in between speech input of the patient and user getting the diagnosis results. The speech analyzing application is connected through API to get phonetic attributes to the web application. So after inputting the speech, the ML will be done inside the web Application with the help of database and then the user will get diagnosis results.

Figure 5.8.1 - Sequence Diagram for Inputting Speech and ML results

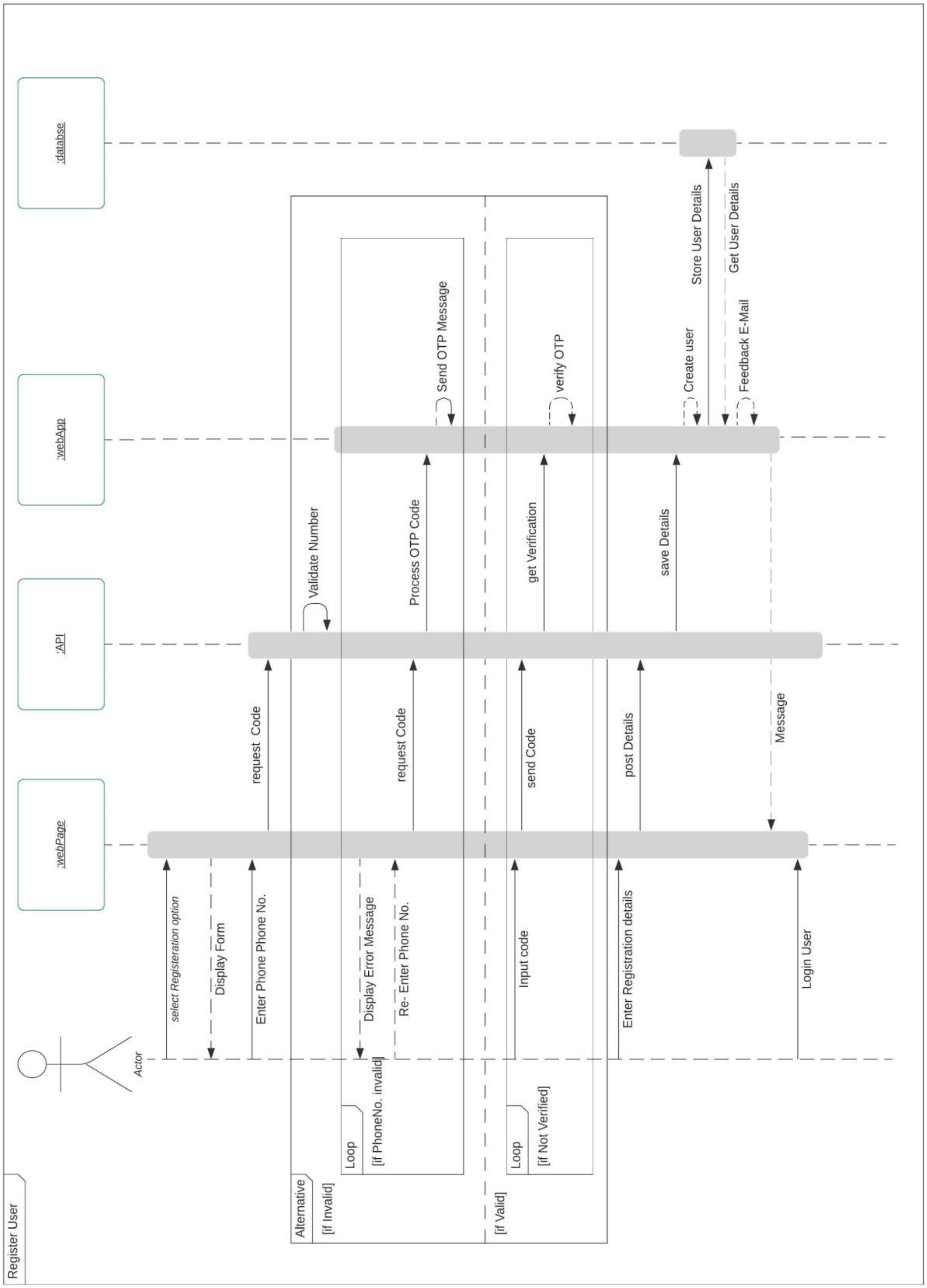


5.8.2 Sequence Diagram for Registering Patient

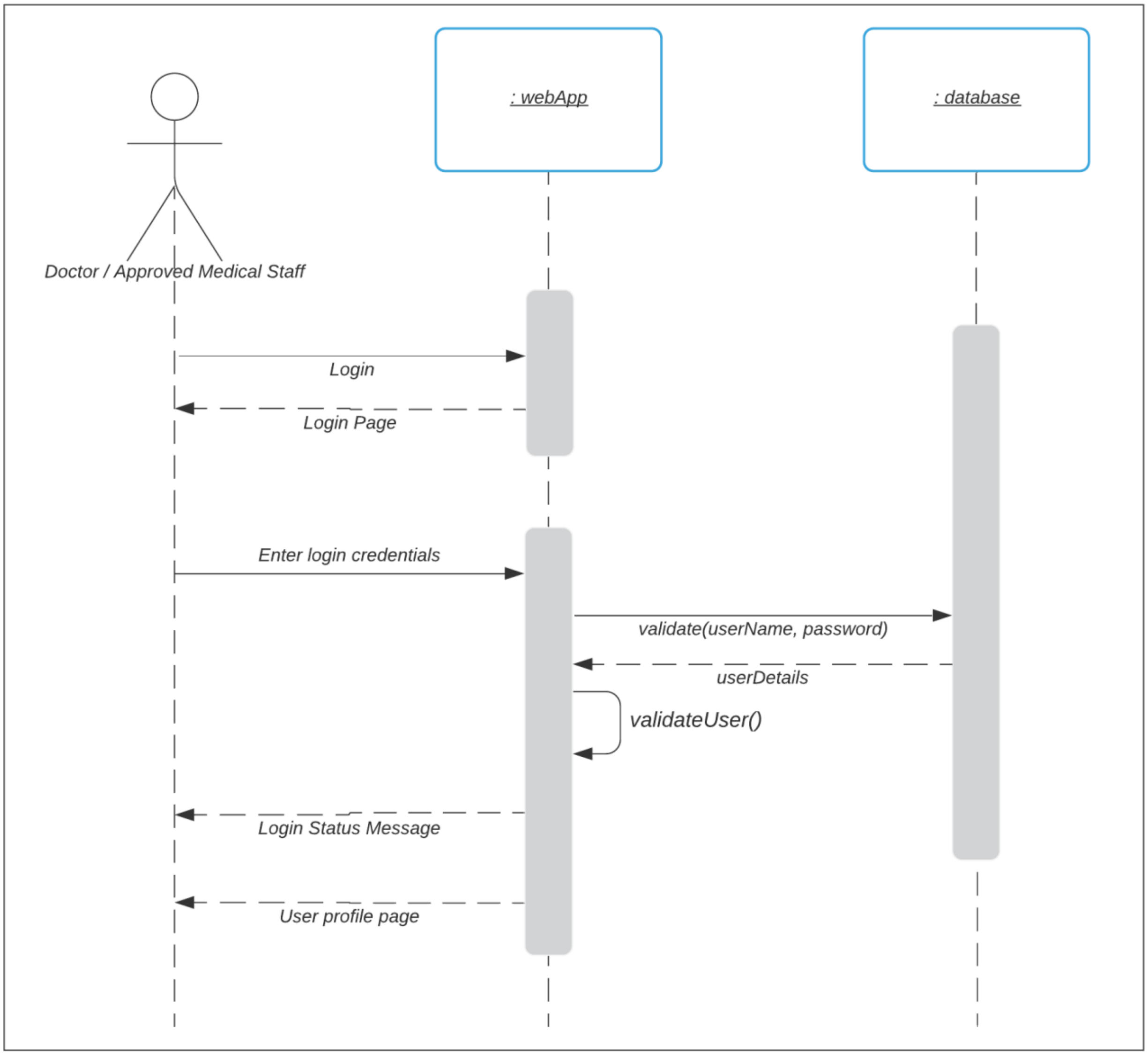


The above sequence diagram shows the communication done when registering a patient. First of all, to register the patient, the user who can be a doctor or approved medical staff should be logged into their profiles. After logged in, the patient will be registered to the system and the patient will be given a unique patientID.

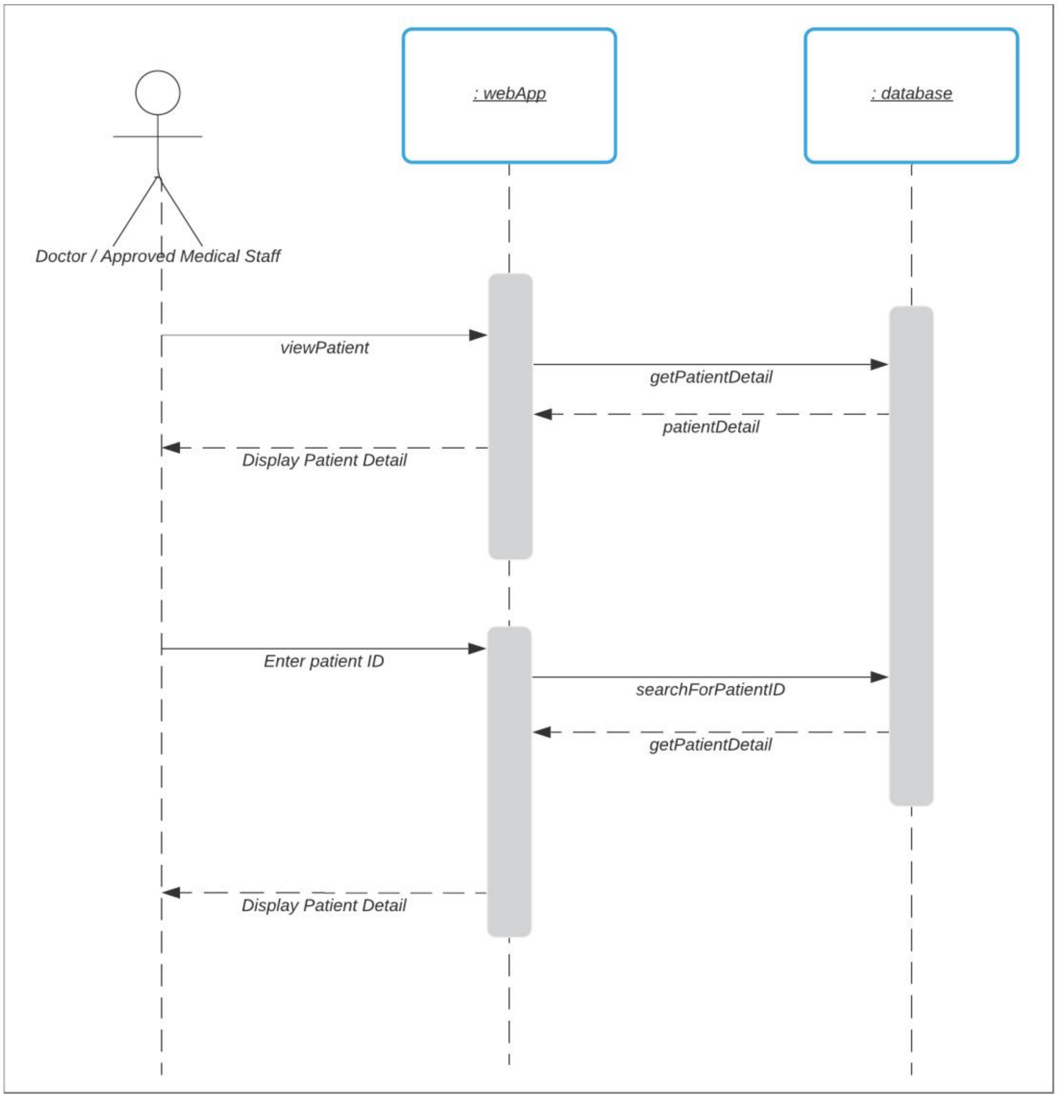
5.8.3 Sequence Diagram for Registering User



5.8.4 5.8.4 Sequence Diagram for login for user



5.8.5 Sequence Diagram for Viewing patient detail



5.9 Chapter Summary

This chapter documented the design components of the system. Design goals were clarified initially. Then rich picture diagram is given visualizing the core functionality of the system. Machine Learning Design and High Level architecture design is given visualizing the ML process and Phases of the system respectively. Class diagram is designed to implement the core functionality of the system. Then System process flow and sequence diagram is documented to indicate the workflow and sequential communication between the components. Finally UI wireframes are designed as well.

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Appendix

Appendix A - Questionnaire

Detecting Parkinson's disease by speech analysis

We are the team Kodemen, a group of Level 5 students from Informatics Institute of Technology. We are aiming to create a software solution for detecting Parkinson's disease by using speech analysis.

This survey would enable us to collect information for the idea of our Software Development Group Project. Please be kind enough to spare few minutes and support us in order to make this project a success.

* Required

1. **Your profession** *

   Mark only one oval.

   - Physician
   - Neurosurgeon
   - Nurse
   - Medical Student
   - Other

2. **According to your expertise what factors causes Parkinson's?** *

   Check all that apply.

   - [ ] Gender
   - [ ] Genetics
   - [ ] Exposure to Chemicals
   - [ ] Age
   - [ ] Other: ______________

3. **What is the main symptom used to identify Parkinson's disease? ***

Check all that apply.

- [ ] Impaired posture and balance
- [ ] Decrease of unconscious movements
- [ ] Speech abnormalities
- [ ] Hand tremor
- [ ] Slowed movement
- [ ] Writing abnormalities
- [ ] Other: ____________________

4. **Are there any accurate and efficient laboratory tests to detect Parkinson's disease at an early stage? ***

Mark only one oval.

- Yes
- No

5. **If your answer is yes, please explain the tests that is used to detect Parkinson's**

____
____
____
____
____

6. **Would it be beneficial for doctors if there is a software to accurately predict Parkinson's disease by using speech analysis at an early stage? ***

Mark only one oval.

- Yes
- No
- May be

7. **Would you prefer this system to be a web application or mobile application?** *

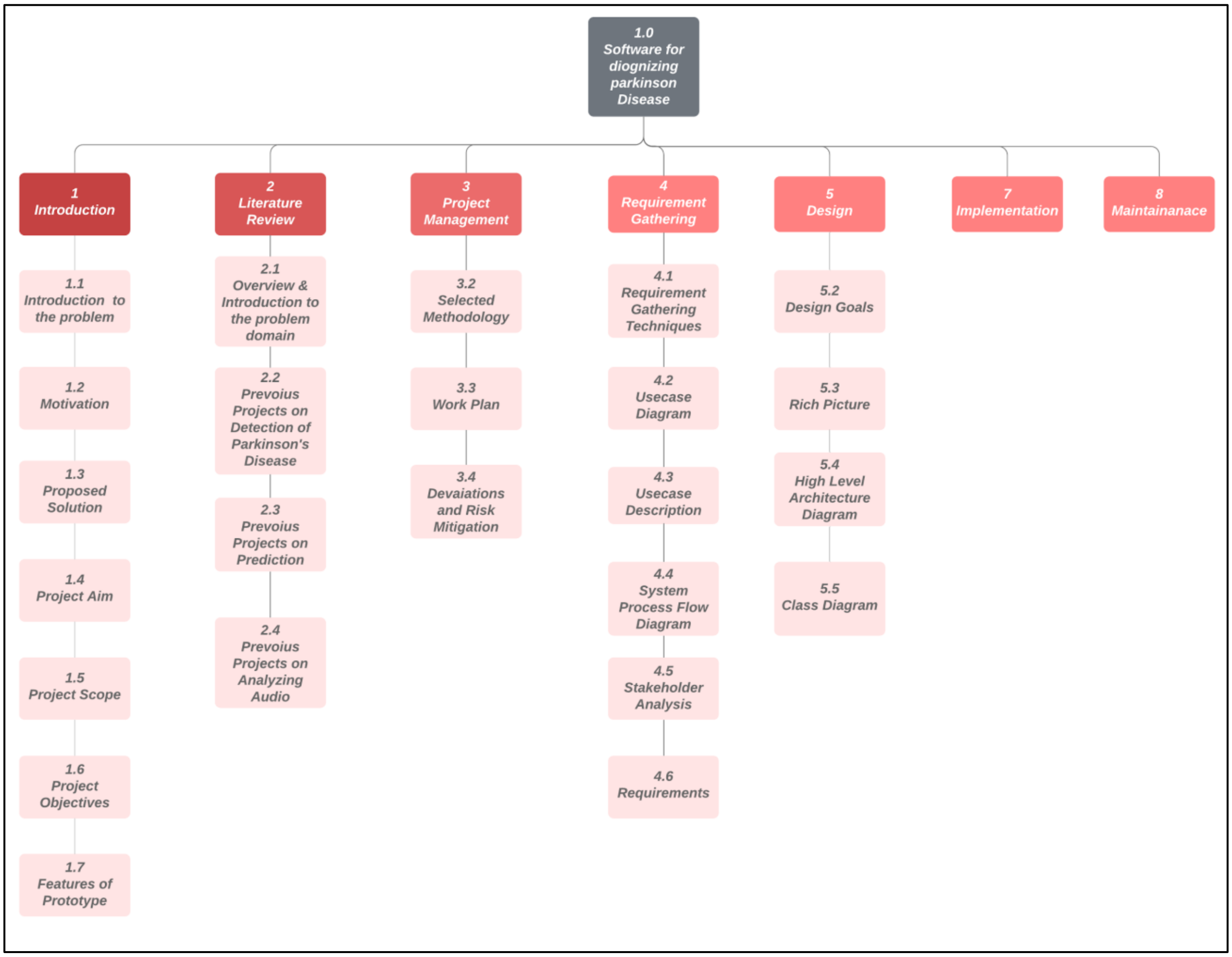
Mark only one oval.

- Web Application
- Mobile Application
- Both

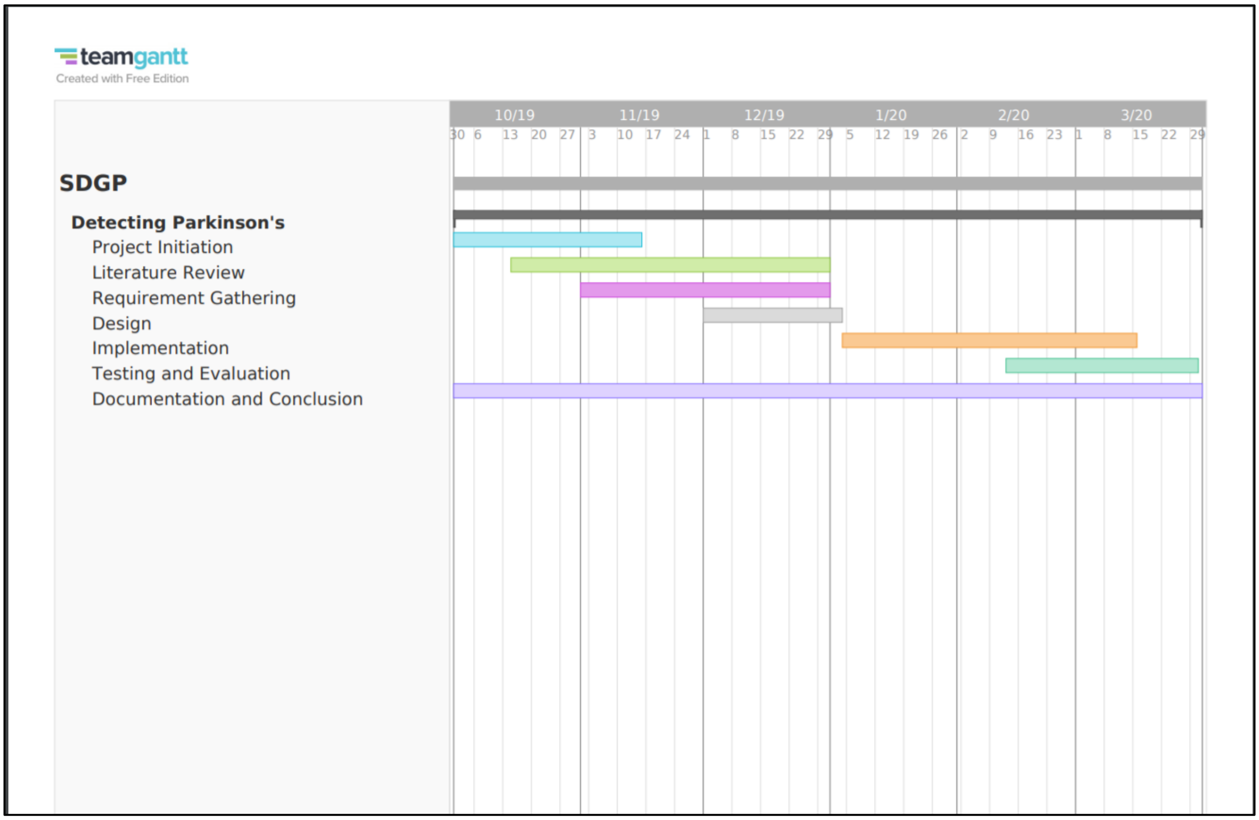
8. **Would you like to suggest any special features you expect in this sort of a system?**

____

Appendix B - Work breakdown structure



Appendix C - Gantt chart



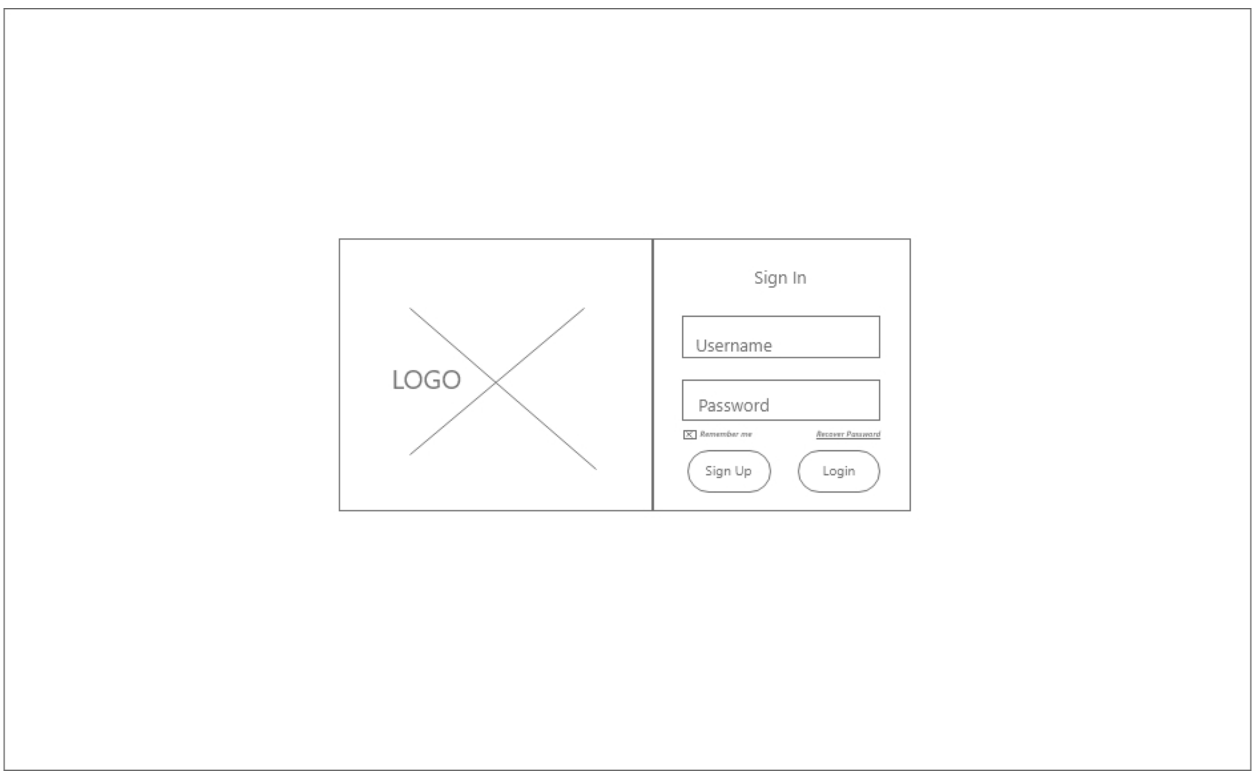
Appendix D - Project Roles

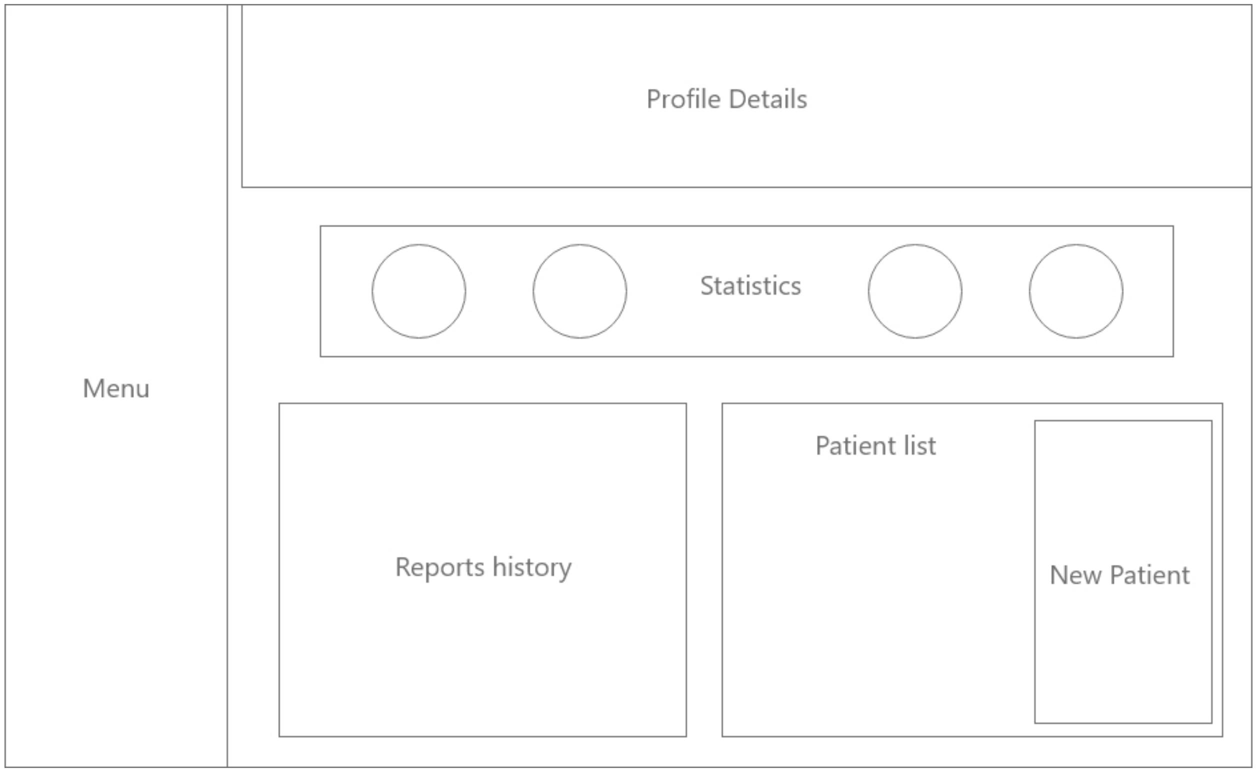
Role		Responsibility	Objectives
SCRUM Master		Naseef N	• Maintaining the AGILE principles among the group. • Identifying the strengths and weaknesses of the group and acting on it • Monitoring the Sprints and the objectives.
		Vaseekaran V	
Development Team	Data Science (Lead)	Rajeev K	• Lead the team in Data Science.

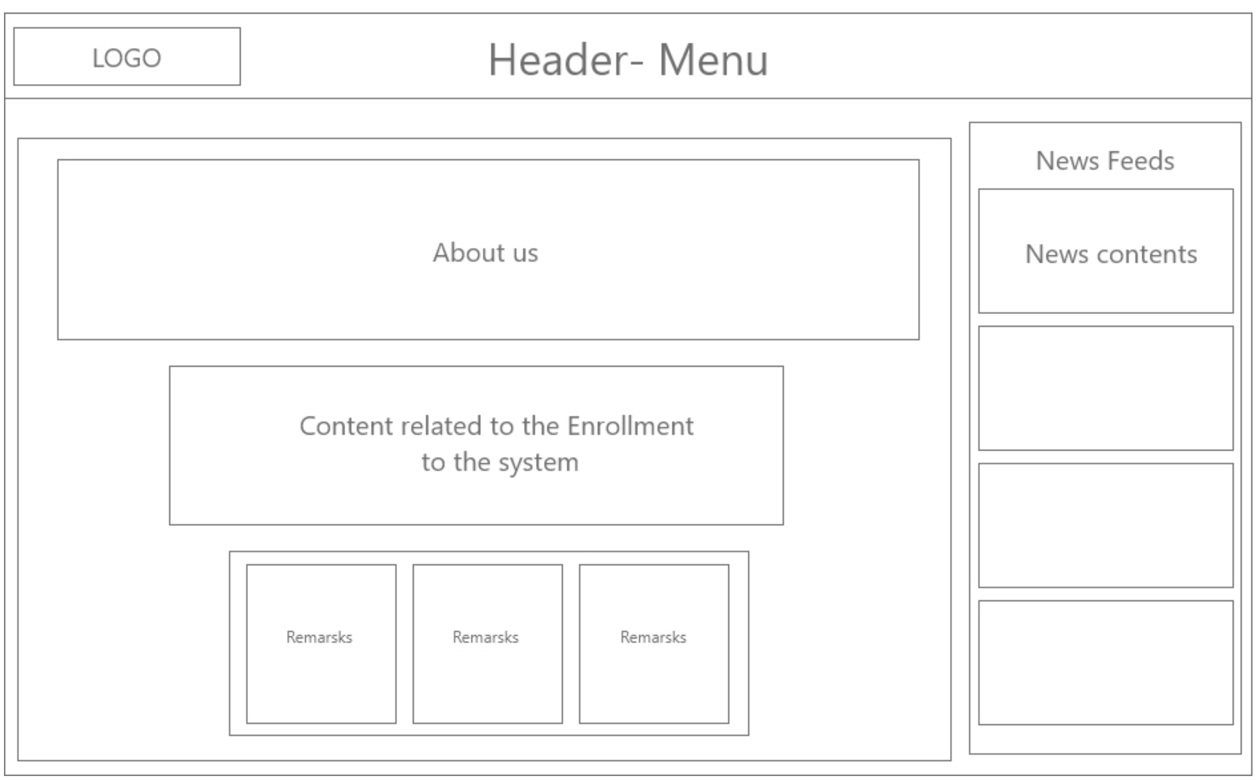
			• Learn data modelling.
	Data Science	Vaseekaran V	• Learn data modelling • Assist the team in server-side development.
	Client-Side Development (Lead)	Ashfaq K	• Lead the team in designing the UI/UX. • Assist the team in server-side development.
	Client-Side Development	Sarvetha N	• Learn client-side development (Angular/React). • Assist the team in server-side management.
	Server-Side Development (Lead)	Naseef N	• Lead the team in designing the back-end of the system. • Assist the team in data science.
	Server-Side Development	Ashfak A	• Learn server-side development. • Assist the team in Client-side development (React/Angular)
	Blockchain Features (Optional)	Ashfak A (Lead)	• Lead the team in additional improvement to project using blockchain. • Research for possible ways to effectively utilize blockchain to the system
		Vaseekaran V	• Research for possible ways to effectively utilize blockchain to the system

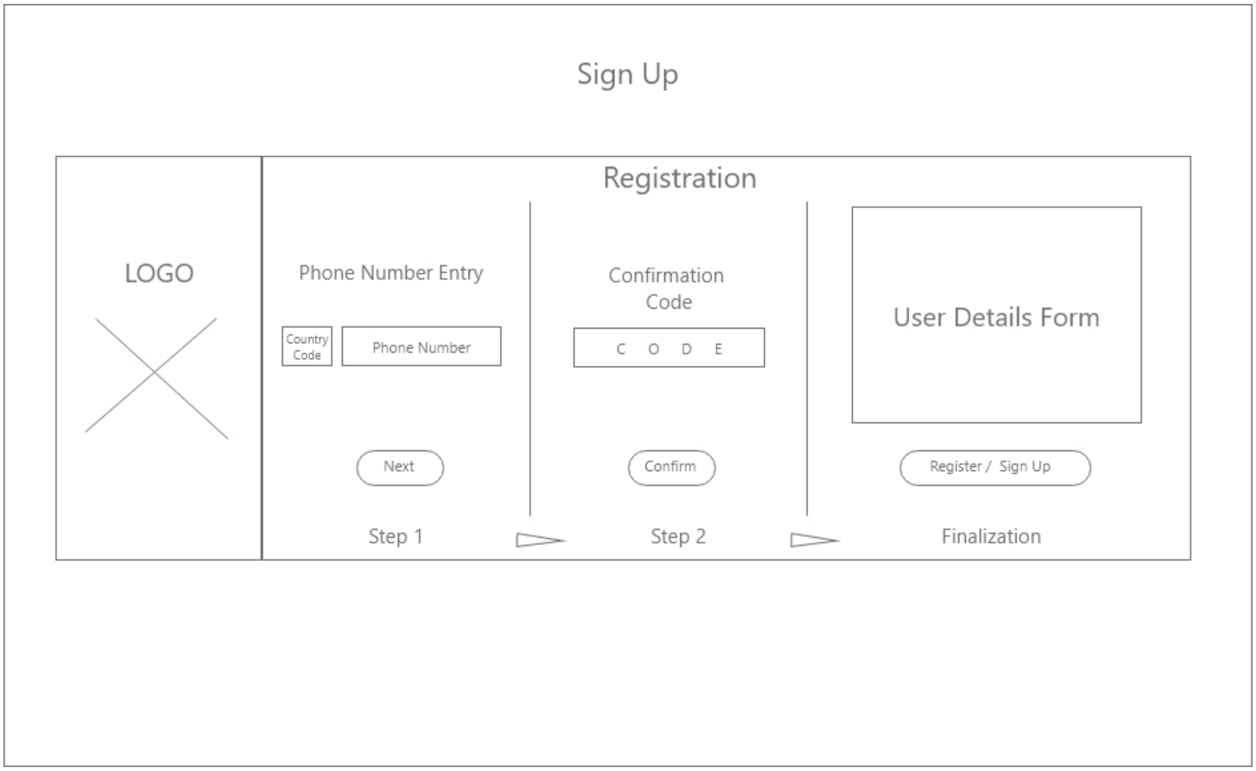
	Documentation	Sarvetha N (Lead)	• Lead the team in the documentation of the project. • Properly document each sprint and sprint retrospective.
		[Rest of the team]	• Properly document the necessary details after each sprint.

Appendix E - UI wire frame




Profile Details
Statistics
Menu
Patient list
Reports history
New Patient


LOGO
Header- Menu
News Feeds
About us
News contents
Content related to the Enrollment to the system
Remarsks
Remarsks
Remarsks


Sign Up
Registration
LOGO
Phone Number Entry
Country Code
Phone Number
Next
Step 1
Confirmation Code
C O D E
Confirm
Step 2
User Details Form
Register / Sign Up
Finalization

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