**A PROJECT REPORT ON**

# Depression Classification Model Using Machine Learning

SUBMITTED TOWARDS THE
PARTIAL FULFILMENT OF THE REQUIREMENTS OF

**BACHELOR OF ENGINEERING (Computer Engineering)**

**BY**


| | |
|---|---|
| Harsimran Singh Dhillon | Exam No:17 |
| Himanshu Garud | Exam No:18 |
| Ojas Ahire | Exam No:19 |
| Aniruddha Kulkarni | Exam No:20 |


**Under The Guidance of**

Prof. N.M. Pagare


**Department of Computer Engineering**
**K. K. Wagh Institute of Engineering Education & Research**
**Hirabai Haridas Vidyanagari, Amrutdham, Panchavati,**
**Nashik-422003**
**Savitribai Phule Pune University**


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**K. K. Wagh Institute of Engineering Education and Research**
**Department of Computer Engineering**

# CERTIFICATE

This is to certify that the Project Titled

## Depression Classification Model Using Machine Learning

Submitted by

| | |
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| Harsimran Singh Dhillon | Exam No:17 |
| Himanshu Garud | Exam No:18 |
| Ojas Ahire | Exam No:19 |
| Aniruddha Kulkarni | Exam No:20 |

is a bonafide work carried out by Students under the supervision of Prof. N.M. Pagare and it is submitted towards the partial fulfilment of the requirement of Bachelor of Engineering (Computer Engineering) Project during academic year 2020-21.

Prof. N.M. Pagare
Internal Guide
Department of Computer Engineering

Prof. Dr. S. S. Sane
Head
Department of Computer Engineering

# Abstract

Depression is becoming major mental illness faced by humans of all ages and genders. The work culture, stressful life, emotional imbalance, family disturbances, and social life is leading to depression. So depression is predicted to rise to the second leading cause of illness as per the identifications of the World Health organization (WHO). Though well trained clinicians, medical and psychological treatments are available for depression treatment, but persons or families are unwilling to speak out or reach doctors about this disorder for various social reasons. Diagnosis of depression disorder includes numerous interviews with patient and family, clinical analysis, questionnaires which is time consuming and also demands well trained clinicians. A Machine learning approach will be used for automation of depression detection. With the help of improvised machine learning techniques like KNN algorithm we will be able to create more efficient and accurate model as compared to previous depression detection models. So acoustic features are used to train a classification model to categorize a human as Depressed or not-Depressed.

# Acknowledgments

*It gives us great pleasure in presenting the preliminary project report on* ***'Depression Classification Model Using Machine Learning'.*** *We would like to take this opportunity to thank our internal guide* ***Prof. Namrata M. Pagare*** *for giving us all the help and guidance we needed. We are really grateful to the internal guide for the constant kind support.*

*We are also grateful to* ***Prof. Dr. S. S. Sane*** *, Head of Computer Engineering Department, K. K. Wagh Institute of Engineering Education and Research, Nashik for his indispensable support, suggestions.*

*In the end, our special thanks again to the internal guide for providing various resources such as laboratory with all needed software platforms, continuous Internet connection, for our Project.*

Harsimran Singh Dhillon
Himanshu Garud
Ojas Ahire
Aniruddha Kulkarni
(B.E. Computer Engg.)

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# CHAPTER 1

# INTRODUCTION

## 1.1 PROJECT IDEA

- Many people suffer from depression which affects their health and lifestyle. People often get confused between being sad or depressed this delays their diagnosis procedure affecting their health. So to overcome this, a user friendly application is created to detect severity of depression at any place or time

## 1.2 MOTIVATION OF THE PROJECT

Globally, more than 264 million people of all ages suffer from depression. Depression is a leading cause of disability worldwide and is a major contributor to the overall global burden of disease [4]. Depression affect one in every 15 adults in a given area and risk in women is twice than men. People consider depression as an insensitive topic and often ignore it under the fact of being sad. This affect their lifestyle and could come along with many health related issues.

## 1.3 LITERATURE SURVEY

One of the major mental illness faced by human of all ages and gender is the depression. Depression affect one in every 15 adults in a given area and risk in women is twice than men [4]. Symptoms include: change in food and habits, loss or gain in weight, loss in concentration, anxiety, hopelessness, feeling of less use, heart diseases, inflammation, sexual health problems, sleep disorder, etc [4]. Human beings are social animal, trained to exhibit only strength and hide the weakness so they are afraid to discussed these problems openly. The diagnosis of depression depression needs one's openness and honesty. The purpose of the application is to detect depression in an individual by using an android device at any place. This application will use diagnostic and assessment tools by using the machine learning techniques to detect depression which includes, interview style assessment, automatic detection using speech, extracting facial features from video. This application can detect the depression and then he can be referred to a trained and experience doctor.

- **The PHQ-8 as a measure of current depression in the general popula-**

**tion(2014)[3]:**

The Patient Health Questionnaire (PHQ) is a 3-page questionnaire that can be entirely self-administered by the patient. The PHQ assesses 8 diagnoses, divided into threshold disorders (disorders that correspond to specific DSM-IV diagnoses: major depressive disorder, panic disorder, other anxiety disorder, and bulimia nervosa), and sub-threshold disorders (disorders whose criteria encompass fewer symptoms than are required for any specific DSM-IV diagnoses: other depressive disorder, probable alcohol abuse/dependence, somatoform, and binge eating disorder) .

- **Accuracy of Patient Health Questionnaire-9 (PHQ-9) for screening to detect major depression(2019)[7]:**

  The PHQ-9 is the 9-item depression module from the full PHQ. Major depression is diagnosed if 5 or more of the 9 depressive symptom criteria have been present at least "more than half the days" in the past 2 weeks, and 1 of the symptoms is depressed mood or anhedonia [2]. Other depression is diagnosed if 2, 3, or 4 depressive symptoms have been present at least "more than half the days" in the past 2 weeks, and 1 of the symptoms is depressed mood or anhedonia [2]. One of the 9 symptom criteria ("thoughts that you would be better off dead or of hurting yourself in some way") counts if present at all, regardless of duration. As with the original PRIME-MD, before making a final diagnosis, the doctor is expected to rule out physical causes of depression, normal bereavement, and history of a manic episode. As a severity measure, the PHQ-9 score can range from 0 to 27, since each of the 9 items can be scored from 0 (not at all) to 3 (nearly every day). An item was also added to the end of the diagnostic portion of the PHQ-9 asking patients who checked off any problems on the questionnaire: "How difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?"

- **Tracking depression severity from audio and video based on speech articulatory coordination(2019)[2]:**

To gain the high accuracy we combine the facial features and acoustic features. These extracted features are then cross verified with the score of PHQ-9 questionnaires and then evaluate the final result. Various acoustic features are extracted using COVAREP toolbox and are fuse to enhance the efficiency of classification. For feature selection Principal Component Analysis (PCA) is used. Machine learning algorithms like K Nearest neighbors(KNN), Gaussian Mixture Model(GMM), Support Vector Machine(SVM) are used to detect depression using different speech types and emotions. From the video and image data the facial features, expressions and posture are extracted. Feature engineering in speech includes proper extraction of features frame wise, calculating the statistical measures, feature fusion and their selection based on correlation. 73 baseline Low Level Descriptors(LLD) including Prosodic(2), Voice quality(8) and Spectral(63) features [15] are extracted using COVAREP toolbox for each frame sampled at 10ms interval. Statistical measures- mean, median, variance, kurtosis, skewness, minimum, maximum, standard deviation are calculated on all the features resulting in 584 feature set. Prosodic, Spectral and Voice Quality features are fused and Principal Component Analysis (PCA) is applied to reduce feature space dimension.

# CHAPTER 2

# PROBLEM DEFINITION AND SCOPE

## 2.1 PROBLEM STATEMENT

Globally, more than 264 million people of all ages suffer from depression. Depression affect one in every 15 adults in a given area and risk in women is twice than men. People often get confused between being sad or depressed this delays their diagnosis procedure affecting their health. Depression classification model is a system which is used to diagnose the severity of depression in individuals. This system takes input in the form of image, audio and the answers to the PHQ-9 Questionnaire for predicting the output.

### 2.1.1 Goals and objectives

Goal and Objectives:

- To build a system based on machine learning for predicting the depression levels in people
- To reduce the time required by the doctor for diagnosis by automating the diagnosis procedure

### 2.1.2 Statement of scope

- The inputs to the system will be text, image and audio. The text input is collected from the PHQ-9 questionnaire
- The image data is collected from the camera and the required features are extracted
- The audio samples are collected using pyaudio and the required features are extracted using COVAREP tool

## 2.2 MAJOR CONSTRAINTS

- The system requires 3 data inputs for detecting the depression in individuals, they are:
  - Answers to the PHQ-9 Questionnaire

- Image samples collected during the paragraph reading using camera
- Audio samples collected during the paragraph reading using microphone

## 2.3 METHODOLOGIES OF PROBLEM SOLVING AND EFFICIENCY ISSUES

- The prediction of the depression level is done using machine learning algorithms
- The image and audio samples needs to be compared for feature extraction step, which will require a considerable amount of time. So, the main challenge is to parallelize this comparison to reduce the time required to get the output.
- To make the application as user friendly as possible we need to reduce the lag at each stage which could be achieved using parallel computing or by the use of GPU's

## 2.4 SCENARIO IN WHICH MULTI-CORE, EMBEDDED AND DISTRIBUTED COMPUTING USED

Training and testing of large data set could be heavy task for CPU. This could create a load on CPU and could take more time for processing the data set. So, GPU is needed for parallelizing the processing to speed up this process. Data preprocessing could be done using GPU's to delay the latency and lag for the preprocessing. The feature extraction process from image and audio is time consuming and needs power for faster execution. This heavy processing can be speeded by using the concept of parallel computing by utilizing a GPU.

## 2.5 OUTCOME

- This application will be able to detect different level of depressions with higher accuracy. This could save time required for the diagnosis done by the doctor

## 2.6 APPLICATIONS

- In companies, to keep a track on the employees health so that performance of the employee is maintained
- In schools and colleges to check whether the students are suffering from depression or not, if yes then the institution could help the students to overcome it with the help of professionals
- Ordinary people at home could check at their convenience and later could refer to a doctor

## 2.7 HARDWARE RESOURCES REQUIRED

- The table 2.1 and 2.2 shows the minimum and the recommended hardware requirements needed to run the application

| Sr. No. | Parameter | Minimum Requirement | Justification |
|---|---|---|---|
| 1 | CPU | Intel dual core or equivalent | Remark Required |
| 2 | RAM | 2 GB | Remark Required |

Table 2.1: Minimum Hardware Requirements

| Sr. No. | Parameter | Recommended Requirement | Justification |
|---|---|---|---|
| 1 | CPU | Intel i3 8th gen/Ryzen 5 or equivalent | Remark Required |
| 2 | RAM | 4 GB | Remark Required |

Table 2.2: Recommended Hardware Requirements

## 2.8 SOFTWARE RESOURCES REQUIRED

Platform :

1. Operating System: Windows and Android
2. IDE: Visual Studio code and Android Studio
3. Programming Language: Python3

# CHAPTER 3

# PROJECT PLAN

## 3.1 PROJECT ESTIMATES

### 3.1.1 Reconciled Estimates

#### 3.1.1.1 Cost Estimate

The model followed is the Constructive Cost Model(CO-COMO) for estimating the effort required in the completion of project. Like all estimation models, the CO-COMO model requires sizing information. This information can be specified in the form of

- Object Point
- Function Point(FP)
- Line of Source Code(KLOC)

For our project, we use the sizing information in the form of Lines Of Source Code.
Estimated lines of code, LOC = 950
Equations:
The initial effort(Ei) in man-months is calculated using equation:
E = $ax(KLOC)^b$
Where, a = 3.0, b = 1.12, for a
semi-detached project
E = Efforts in person-hours
E = 4.5 PM
D = $ax(E)^b$
Where, a = 2.5,
b = 0.35, for a semi-detached project
D = Duration of Project in months
D = 5 Months

#### 3.1.1.2 Time Estimates

C= D * Cp * hrs

Where, C = Cost of project,

D = Duration in hours,

Cp = Cost incurred per person-hour

hrs = hours

Efforts E = 4.5 person-month

Total of 4.5 persons-months are required to complete the project successfully.

Duration of project D = 5 months The approximate duration of project is 5 months.

### 3.1.2 Project Resources

This project would require people with good skills in application development and programming in python. The tools required for making this project are android studio and visual studio code. This project needs 3 different kind of data sets for predicting the output with higher accuracy.

## 3.2 RISK MANAGEMENT

This section discusses Project risks and the approach to managing them.

### 3.2.1 Risk Identification

1. Skill Level: The skill level could be less
2. Image Data Quality: The images may not be of good quality
3. Audio Data Quality: There audio may contain noise
4. Low Performance Speed: Due to large comparison of dataset, the system processing could get slow

### 3.2.2 Risk Analysis

The risks for the Project can be analyzed within the constraints of time and quality

### 3.2.3 Overview of Risk Mitigation, Monitoring, Management

Following are the details for each risk.

| ID | Risk Description | Probability | Impact | | |
|---|---|---|---|---|---|
| | | | Schedule | Quality | Overall |
| 1 | Skill Level | Low | High | High | High |
| 2 | Image Data Quality | Low | Medium | High | High |
| 3 | Audio Data Quality | Medium | Medium | High | High |
| 4 | Low Performance Speed | Medium | Medium | Medium | Medium |

Table 3.1: Risk Table

| Probability | Value | Description |
|---|---|---|
| High | Probability of occurrence is | $> 75\%$ |
| Medium | Probability of occurrence is | $26 - 75\%$ |
| Low | Probability of occurrence is | $< 25\%$ |

| Impact | Value | Description |
|---|---|---|
| Very high | $> 10\%$ | Schedule impact or Unacceptable quality |
| High | $5 - 10\%$ | Schedule impact or Some parts of the project have low quality |
| Medium | $< 5\%$ | Schedule impact or Barely noticeable degradation in quality Low Impact on schedule or Quality can be incorporated |

| | |
|---|---|
| Risk ID | 1 |
| Risk Description | Skill Level |
| Category | Work Distribution. |
| Source | Project Plan Document. |
| Probability | Low |
| Impact | High |
| Response | Mitigate |
| Strategy | Team members doing the part of the project in which they are good at or doing the course related to the part of project before starting it |
| Risk Status | Identified |

| | |
|---|---|
| Risk ID | 2 |
| Risk Description | Image Data Quality |
| Category | Dataset |
| Source | Input |
| Probability | Low |
| Impact | High |
| Response | Mitigate |
| Strategy | Use good quality of data for training the images |
| Risk Status | Identified |

| | |
|---|---|
| Risk ID | 3 |
| Risk Description | Audio Data Quality |
| Category | Dataset |
| Source | Input |
| Probability | Medium |
| Impact | High |
| Response | Mitigate |
| Strategy | Collecting multiple audio samples |
| Risk Status | Identified |

| | |
|---|---|
| Risk ID | 4 |
| Risk Description | Low Performance Speed |
| Category | Design |
| Source | Input. |
| Probability | Medium |
| Impact | High |
| Response | Mitigate |
| Strategy | Parallel processing could be used |
| Risk Status | Identified |

## 3.3 PROJECT SCHEDULE

### 3.3.1 Project task set

Major Tasks in the Project stages are:

- Task 1: Project Planning
- Task 2: Data cleaning and Preprocessing
- Task 3: Selecting and Training the Model
- Task 4: Application Development
- Task 5: Testing the Application
- Task 6: Documentation

### 3.3.2 Task network

Project tasks and their dependencies are noted in this diagrammatic form.

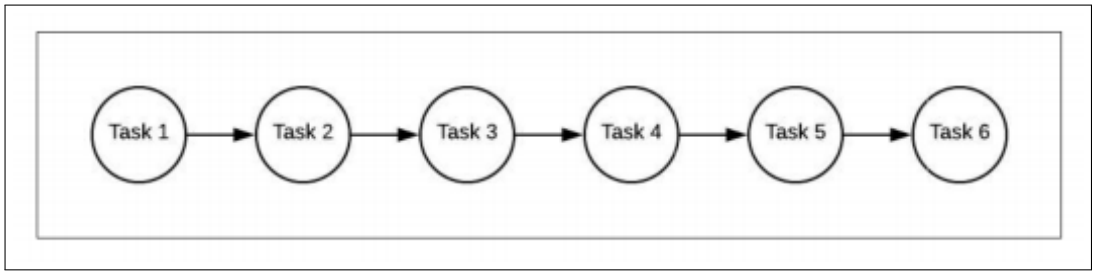


Figure 3.1: Task network graph

### 3.3.3 Timeline Chart

This project is basically divided in 6 different task. Each one followed by the other one.

- $1^{st}$ Aug-$1^{st}$ Oct: This period is given only for planning the project. Why and which platform would be used. How everything would be linked and how each module would execute. Everything related to this is discussed in this time phase

- $2^{nd}$Oct - $10^{th}$Nov : Preprocessing the data is very important for the model to execute properly. The data might contain some blank values or different data types so converting them according to the requirements of the model is very important

- $11^{th}$ Nov- $15^{th}$ Dec: The preprocessed data is then given to our model and then our model is trained. Many models are trained and tested so that we could select the model providing the highest accuracy

- $16^{th}$ Dec-$15^{th}$ Feb: Android application development phase will start and the graphical user interface will be designed which would be user friendly

- $16^{th}$ Feb-$15^{th}$ Apr: This application would be tested by different individuals so that it could help us fix the bugs and resolve the problems

- $16^{st}$ Apr - $10^{th}$ May: Documentation

## 3.4 TEAM ORGANIZATION

The project is planned under the guidance of project guide Prof. Namrata M. Pagare.

### 3.4.1 Team structure

The team consists of 4 members, where the tasks related to the project are roughly distributed equally. The team members and the assigned responsibilities are:

- Harsimran Singh Dhillon : Model design and algorithms implemented for the model

- Himanshu Garud : Model design and algorithms implemented for the model

- Ojas Ahire : Dataset collection and testing

- Aniruddha Kulkarni : Documentation

### 3.4.2 Management reporting and communication

A dedicated time is allotted for communication between team members. In this time duration team members communicate by using google meet an online platform for meetings. Doubts and queries were solved during this meet and progress were noted in log book.

# CHAPTER 4

# SOFTWARE REQUIREMENT SPECIFICATION

## 4.1 INTRODUCTION

### 4.1.1 Purpose and Scope of Document

This document is very important as it would help the user to have a clear idea about the minimum and recommended hardware and software they need to run this application. The user would have an idea about the input range so that he could use it with more efficiency.

### 4.1.2 Overview of responsibilities of Developer

Different activities including planning the project, preprocessing and training the data set, training the model and selecting the one suitable to the project having the higher accuracy, linking it with the android application and testing the application for various user inputs.

## 4.2 USAGE SCENARIO

This application could be used by companies to keep a track on their employees health condition so that the employee could give his/her best to the company. This application could be used in colleges and schools as many teenagers suffer from depression.

### 4.2.1 User profiles

The profiles of all user categories are described here.

### 4.2.2 Use-cases

All use-cases for the software are presented. Description of all main Use cases using use case template is to be provided.

### 4.2.3 Use Case View

Use Case Diagram. Example is given below

| Sr No. | Use Case | Description | Actors | Assumptions |
|---|---|---|---|---|
| 1 | Employee | Employee of the company | Employee | The program detects the depression level |
| 1 | Student | Student of the college/school | Student | The program detects the depression level |

Table 4.1: Use Cases

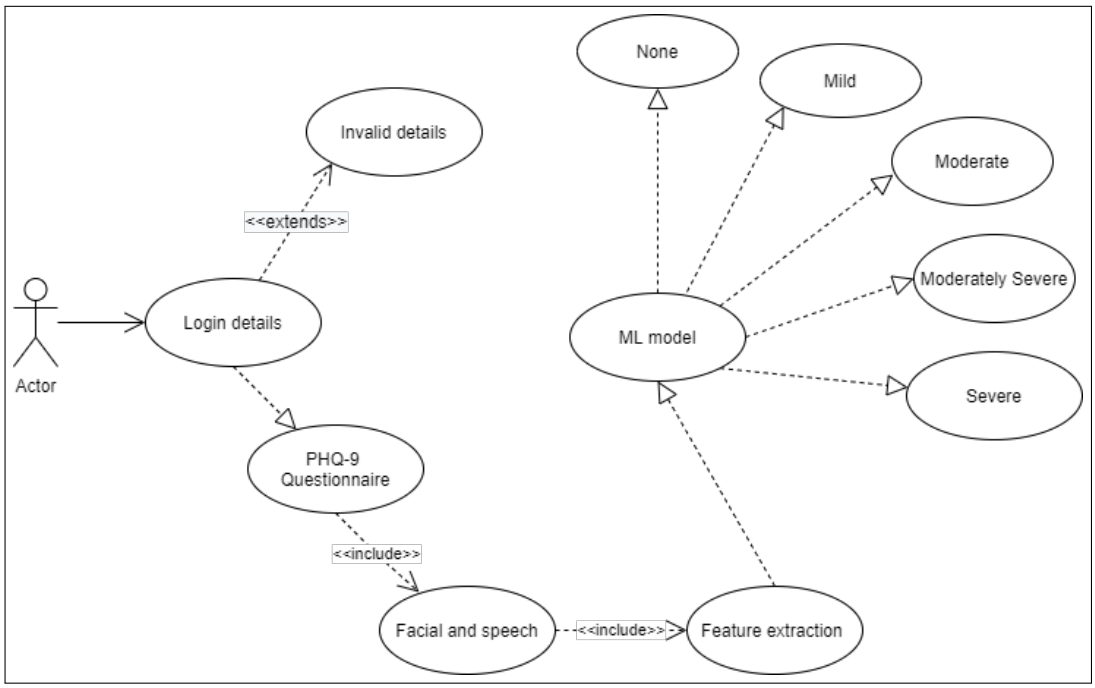


Figure 4.1: Use case diagram

## 4.3 DATA MODEL AND DESCRIPTION

### 4.3.1 Data Description

The data inputs which the application would take will consist of the user details like name, phone number, age, gender and email. These data will be stored in the database and then unique id will be generated which will be used for further references. The answers given to the PHQ-9 questionnaire would be used for feature extraction. The frames captured would be converted into gray scale images and the features of this images would be tracked with the trained images. The audio samples collected during the reading process would be then used to extract specific features which are required to predict the emotion of the person. These features would be given to the model for prediction of the output.

### 4.3.2 Data objects and Relationships

PHQ-9 answers, images and audio are the major data objects which are used along with the user details to store the data.

## 4.4 FUNCTIONAL MODEL AND DESCRIPTION

### 4.4.1 Data Flow Diagram

#### 4.4.1.1 Level 0 Data Flow Diagram

The use will open the application and then will enter the user details such as the user name, age, gender. From this the age and gender will be taken into the consideration, as depression level are different for different age group and different gender.

#### 4.4.1.2 Level 1 Data Flow Diagram

In this level the user will answer the PHQ-9 questionnaire and even they would be told to read a passage while keeping their camera and mic on. This will allow us to capture frames of camera and audio samples of the user.

#### 4.4.1.3 Level 2 Data Flow Diagram

The data collected from level 1 is then preprocessed and then given to our model for predicting the output.

### 4.4.2 Description of functions

The data input to the application will consist of user details, answer to the PHQ-9 questionnaire, facial expressions and voice quality of the user. From the registration page various user details like name of the user, age, gender. This is necessary step as we collect the important information like his/her gender, age, etc . As depression level is different for different age group and different gender. After this user will have to answer the PHQ-9 questionnaire. Each question would have four options and the user has to select one from them. After the completion of this process the

user would be directed to another page where in the user has to read a paragraph while keeping their camera and microphone on. This is done to capture the frames of the camera and the users audio sample. Now this collected data would be given as an input to our model, which will then predict the output. For Example Refer 4.2

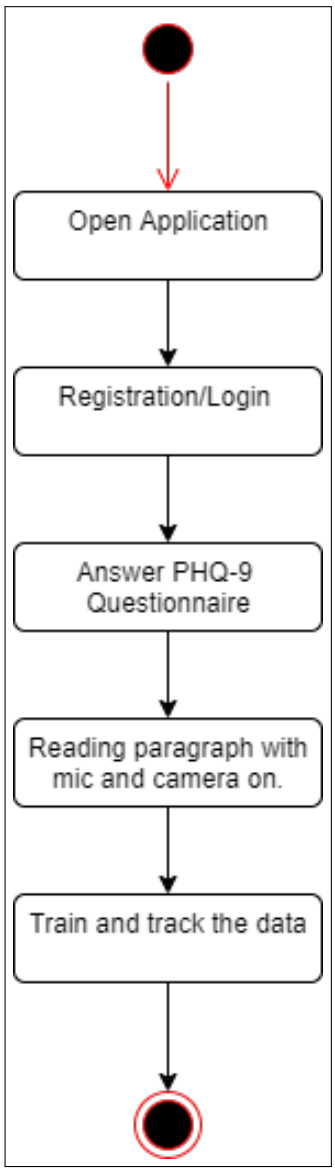


Figure 4.2: Activity diagram

### 4.4.3 Activity Diagram:

- The Activity diagram represents the steps taken.

### 4.4.4 Non Functional Requirements:

- Interface Requirements
  - Operating System: Windows 7/8/9/10
  - tools used: Android Studio, Visual Studio, GCP/AWS.
  - language used: Python, Java/Kotlin.
- Performance Requirements
  - System will perform with more efficiency if proper dataset is provided.
  - Will perform better if it has proper internet connection.
  - Application will perform smoothly if the recommended hardware specification meets.
- Software quality attributes

  There are few software quality attributes which describes the quality of proposed system and they are as mentioned below.
  - Availability
  - Correctness
  - Usability

### 4.4.5 State Diagram:

State Transition Diagram

Fig.4.3 shows the state transition of the application. After running the application a registration page would appear in front of the user. The registration page would require name, age, gender, phone number, email-id. After successful registration it will direct the user to a page where the user will be asked set of 9 questions also known as PHQ-9 questionnaire. After successful completion of this phase the user will be asked to read a paragraph by keeping his/her microphone and camera on. This would help us to capture the frames and audio samples for further process of feature extraction. This data then would be preprocessed and then given to our depression detection model to predict the output.

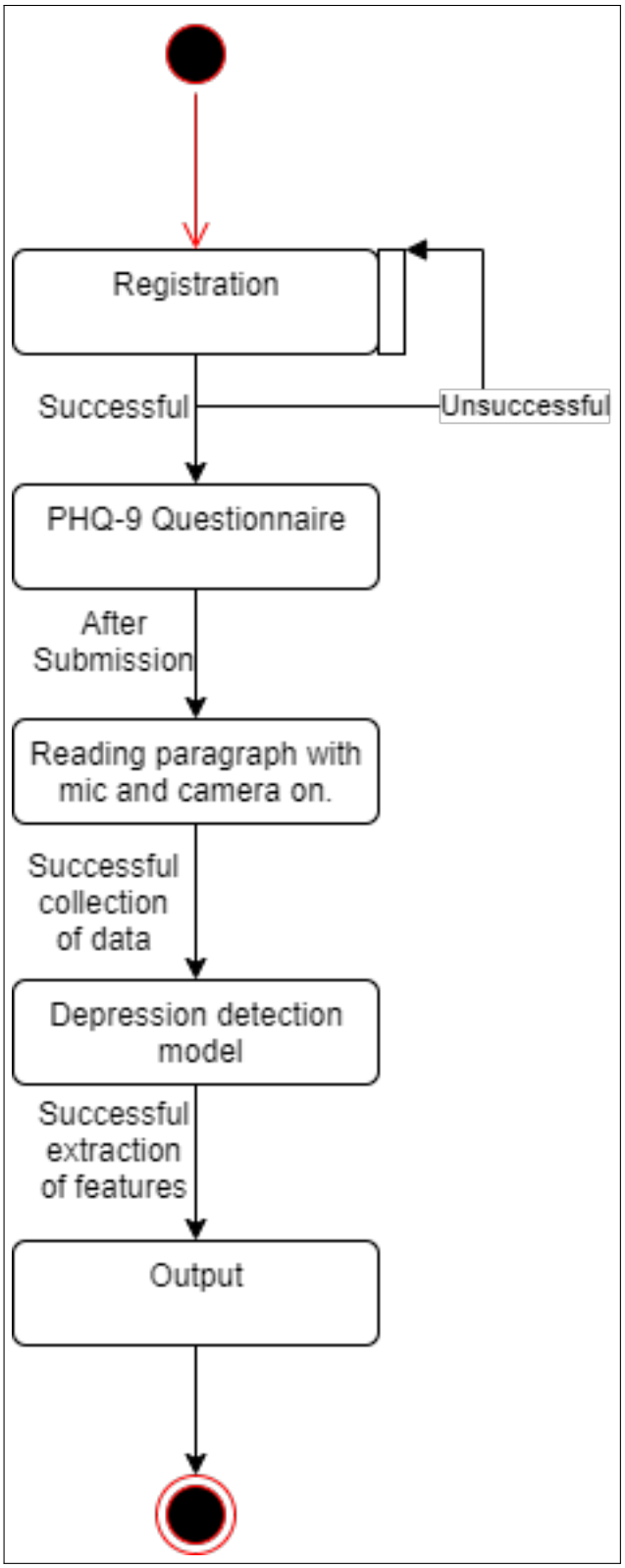


Figure 4.3: State transition diagram

### 4.4.6 Software Interface Description

Android application is linked with cloud platform to run and execute large dataset efficiently.

# CHAPTER 5

# DETAILED DESIGN DOCUMENT

## 5.1 ARCHITECTURAL DESIGN

The block diagram of the system is shown below in figure 5.1. The system architecture includes 3 inputs out of which 2 are taken simultaneously. The user would insert their details and then answering to the 9 questions. These 9 questions are predefined and would be on their lifestyle, the answers given by the user are then given to the feature extraction block. The user is then asked to read a paragraph while turning their mic and camera on. The camera would be turned on and the frames would be captured after every 2-3 secs and the sentiment of the person at that particular frame would be captured. This would allow the application to predict the emotions and mood in the reading process. This process is very important to understand their sentiments. These captured emotions are given to feature extraction blocks so that we could extract only the required features which would help us in predicting the output. Their are different features which are required by the image model and the audio model. These features are extracted separately and then given to the model for predicting the output. This model would predict the output out of the 5 possibilities of depression severity levels. This would help the user to know that what level of depression they are facing so that they could get treatment accordingly.

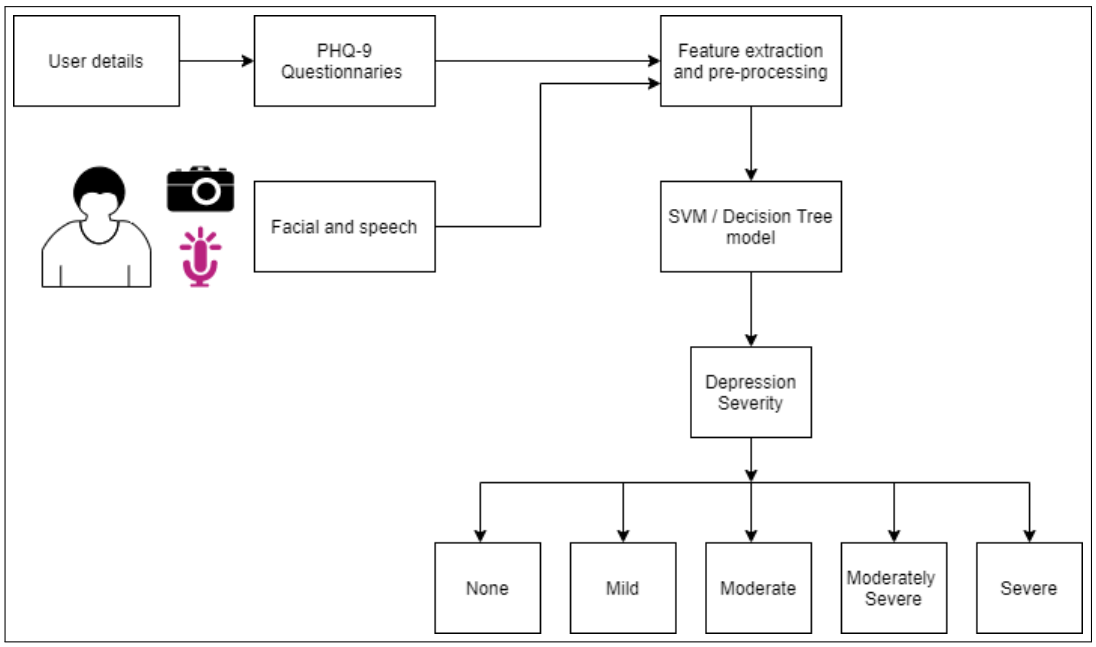


Figure 5.1: Architecture diagram

## 5.2 DATA DESIGN

Text, image and audio are the 3 different kind of data which are stored using 3 different data structures.

### 5.2.1 Internal software data structure

DIAC-WOZ dataset and faction expression dataset are used to train the depression classification model.

### 5.2.2 Global data structure

PHQ-9 answers, images and audio samples of the user which are used to track and predict the output of the model.

### 5.2.3 Database description

DAIC-WOZ dataset for acoustic features and facial expression dataset.

# CHAPTER 6

# SUMMARY AND CONCLUSION

Depression is a major problem faced by many people in today's world. More than 264 million people from all ages suffer from depression. Unlike sentiments it is not visible in external appearance, so many of the people don't even know that they are suffering from depression. One of the major cause of suicides occurring is depression, so detecting depression in people is very important. This project will detect depression with higher accuracy, so people could do the treatment as soon as possible without more affecting their health. Depression reduces productivity so many companies could use this project to keep a track on their employees health condition and could help them getting the treatment on time.

This project is divided into 2 parts, one is the PHQ-9 questionnaire and the other one is audio and visual samples collected while reading a paragraph. These 2 parts are very important to attain higher accuracy in determining the output. Output with less accuracy could create a false alarm so for higher accuracy these 2 steps should be done properly. With a good internet connectivity and good quality of camera and microphone, this application would be able to run efficiently with less lag possible.

# REFERENCES

[1] N. Cummins, S. Scherer, J. Krajewski, S. Schnieder, J. Epps, and T. F. Quatieri *"A review of depression and suicide risk assessment using speech analysis,"* Speech Communication, vol. 71, pp. 10–49, 2015

[2] J. R. Williamson, D. Young, A. A. Nierenberg, J. Niemi, B. S. Helfer, and T. F. Quatieri, *"Tracking depression severity from audio and video based on speech articulatory coordination,"* Computer Speech Language, vol. 55, pp. 40–56, 2019.

[3] K. Kroenke, T. W. Strine, R. L. Spitzer, J. B. Williams, J. T. Berry, and A. H. Mokdad, *"The phq-8 as a measure of current depression in the general population,"* Journal of affective disorders, vol. 114, no. 1-3, pp. 163–173, 2014.

[4] https://www.who.int/news-room/fact-sheets/detail/depression

[5] https://www.kaggle.com/ashishbansal23/emotion-recognition

[6] G. Degottex, J. Kane, T. Drugman, T. Raitio, and S. Scherer, *"Co-varep—a collaborative voice analysis repository for speech technolo- gies,"* 2014 ieee international conference on acoustics, speech and signal processing (icassp). IEEE, 2014, pp.960–964.

[7] Brooke Levis, doctoral student1, Andrea Benedetti, associate professor2, Brett D Thombs *"Accuracy of Patient Health Questionnaire-9 (PHQ-9) for screening to detect major depression"* Published 09 April 2019

# ANNEXURE A

# MATHEMATICAL MODEL

# ANNEXURE B

# PLAGIARISM REPORT

# ANNEXURE C

# PAPER PUBLISHED (IF ANY)

# ANNEXURE D

# SPONSORSHIP DETAIL (IF ANY)