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# Depression Detection using BDI, Speech Recognition and Facial Recognition

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**Abstract:** *Mood of human beings is something that defines the inherent emotions of a person. Detection of mood is very important in such cases. For the detection, some android applications are being designed so that using the speech signals mood of a person is determined. Texts, speech inputs, facial expressions are considered. Then depending on the result doctors or the experts examine the type of mood whether happy, depressed or sad. BDI scores are then calculated and found what the type of mood is. Depression is a global growing cause for concern and is a major contributor in terms of total years lost due to disability. This makes it easy to determine type of mood. Depression is one of the most prevalent disorders, typically associated with negative emotions, such as sadness and helplessness.*

*BDI (Beck Depression Inventory) is test done on computer to detect depression on a certain scale. Speech signals are made up of voiced, unvoiced and silence intervals, which can be estimated by segmenting the sampled signals based on their energy values. Facial expressions are the captured keeping in mind a certain gesture of the human face. By using these three tests we can effectively determine the depression level of a certain person.*

**Keywords:** *Depression detection, machine learning, speech recognition, BDI, image processing.*

## I. INTRODUCTION

Depression is something that every person faces at some point of time. A depressed person should be helped and consulted in order to avoid any disaster. Depression sometimes may lead to self-hate and the person facing depression may do something very wrong. Therefore, depression in a person needs to be detected and the person should be provided with a proper solution. BDI (Beck Depression Inventory) is a depression detection test. It is nothing but a set of questions asked to a person and by analyzing his answers, his level of depression is detected, on a certain scale probably. There have been various variations in this system like improvisation of the questions, inclusion of speech inputs by the person giving the test. These inclusions sure have improved the accuracy than the previous systems but are not the best. By adding a few more functionalities and applying more efficient algorithms than the previous will give a more accurate and precise output. Adding a facial recognition feature will give a more improved output because of the direct facial interaction with the person.

The main principle of this work is to detect depression of a person more accurately and provide the person with some required consultancy. It basically been built so that the depression detection can be performed on a regular intervals and not when the person is fully depressed. The main aim is to monitor one's depression on a regular basis. This basically implies "Precaution is better than Cure". This system will detect depression on its starting stages and notify the person accordingly. This system comprises of a series of different test that a person gives and accordingly results are generated. The proposed system uses Machine Learning algorithms to detect depression. Different algorithms and datasets are provided for various tests. The proposed system is reliable because it uses better datasets and better Machine Learning algorithms. Machine Learning is a better option because as the system gets new input, it on its own predicts the class of the new input. The model learns from previous data included in datasets to compute more accurate, reliable and repeated results.

## II. LITRATURE SURVEY

In the previous research works, BDI (Beck Depression Inventory) was applied in the systems. The set of questions were been asked by the system and the person has to answer the questions. By analyzing the answers given by a person various algorithms were applied to get the person's depression level. But the accuracy in these systems were not promising. The reasons being- the questions been asked were not all good, the algorithms applied to detect depression levels were not promising, etc. There have been various improvisations in the questions, but using only BDI [2] for detect depression was not enough. There has be more. A number of developments have taken place in these systems.

The research of depression in social network [3] in psychology comes in two types: one is to discover disciplines of a crowd of depressed users, the other is to look into a specific case elaborately observes linguistic markers of depression through collecting posts by depressed and non-depressed individuals from Internet forum.

Paper by Ahmad Rauf Subhani, Wajid Mumtaz, Mohamad Naufal b Mohamad Saad, Nidal Kamel [1] described an effective system that used BDI and Speech recognition as a form of input. In this system, the person gives the BDI test as well as gives a speech input. BDI tests use the same concept as mentioned above whereas the speech recognition part classifies the text taken as speech input into its correct class. This system did outstand the previous one but it had its flaws too.

Limiting with just speech recognition was not enough. The accuracy can be improved further by applying various more algorithms and features. Also the algorithms used were not efficient enough. They needed improvement.

### III. FINDINGS

To improve the accuracy, we can add an additional feature of Facial recognition in the system. Adding an extra feature to track input will increase the accuracy in general because we get to inspect a whole new aspect of the person. In this system, we are going to track the lips of the person in order to get the result. A dataset in the form images will be provided so that the system can perform Machine Learning operations on the input (Lip position).

Also we can use different and efficient Machine Learning algorithms to improve the analyses and get more accurate results. We can use K-means clustering for BDI test, Naïve Bayes for text classification of Speech input.

### IV. PROPOSED ARCHITECTURE

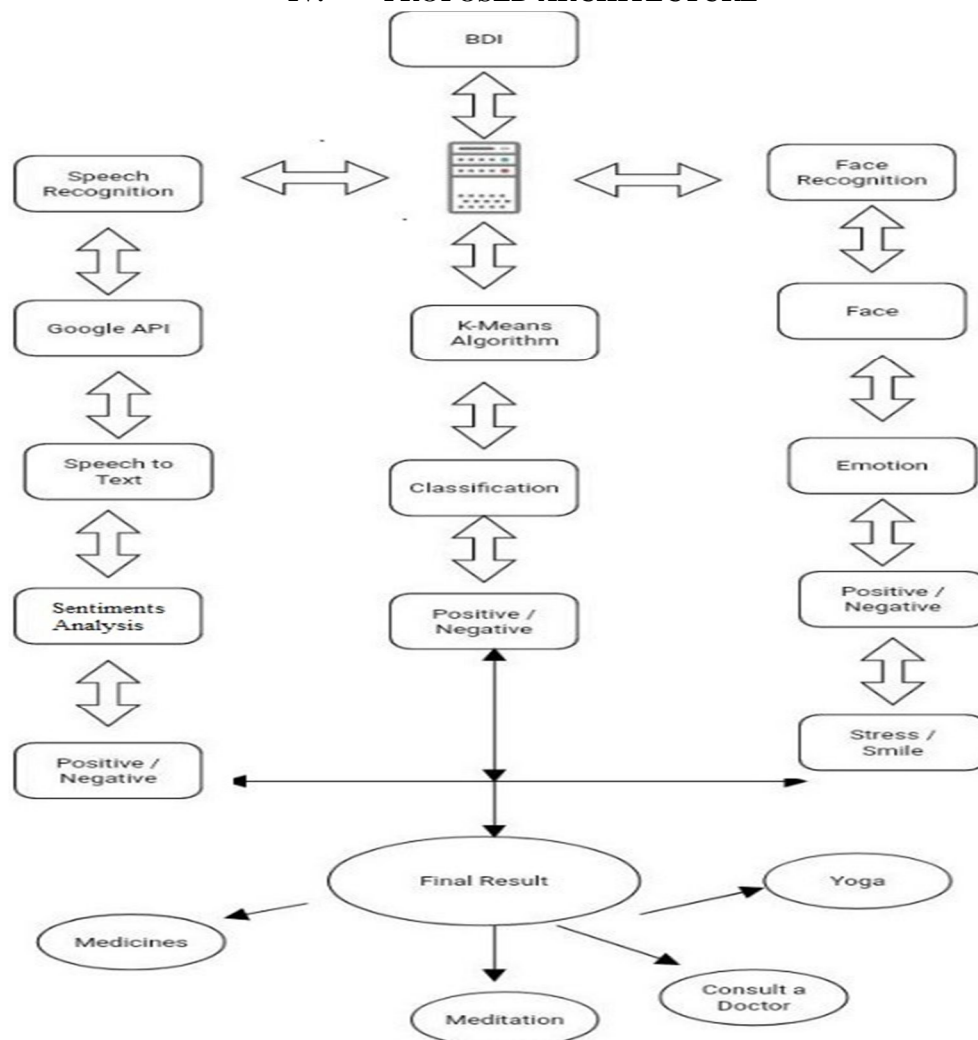


Fig. 1. Depression Detection System Architecture

In this system, the focus is totally on the Machine Learning algorithms and the datasets as they are going to decide the accuracy of the results. The datasets are important because the better the dataset better the output.

The hardware required for this system is a microphone to get speech inputs, a camera for facial recognition, etc. The pre-installed microphone of the PC (laptops) can be directly used. Also the camera of the PC itself can be used or a webcam can be used. The software required are Netbeans editor. The languages used are Java and Servlet. Also Apache Tomcat is used as a server.

### V. PROPOSED SYSTEM

The system provides a Machine Learned result to the user using the pre-defined datasets. There are three types of tests in the system. The user has to give these three tests and accordingly the results of every test will be recorded. At the end, the results of these three are calculated together and a single result is provided. The result will be in a form of a scale, scale of depression level. Depending on this final result, a suggestion is provided. The suggestions can be of any type like whether the user should consult a doctor, whether the user should try meditation, etc. This system is designed keeping in mind that these tests will be taken in regular intervals as the depression detection should be done on regular intervals too. A depressed person might not have a will to take this test or maybe he/she might not give the test properly.

In this system, we use Speech inputs, BDI (Beck Depression Inventory) and facial recognition.

#### A. Algorithms

- 1) *Naïve Bayes*: The Machine Learning algorithm used for speech input's result is Naïve Bayes classifier. Naïve Bayes classifier are probabilistic classifiers that are dependent on feature set. In our system, Naïve Bayes classifier is used to classify the speech to text converted input using text classification.
- 2) *K-means*: The Machine Learning algorithm used to calculate the BDI test result is K-means clustering algorithm. K-means is a method of vector quantization that uses cluster analysis to calculate the result in data mining. In our system, the user is asked a set of questions and according to his answers, clustering are formed of positive and negative answers and at the end, the biggest cluster is considered as the output.
- 3) *Facial recognition*: The algorithm used for Facial recognition is Digital image processing and Matlab software. The user faces towards the camera and his/her emotion/facial expression is captured. Then the above mentioned tools track the lip positions of the user. The scanned input is compared with the dataset and proper classification is done.

### VI. METHODOLOGY

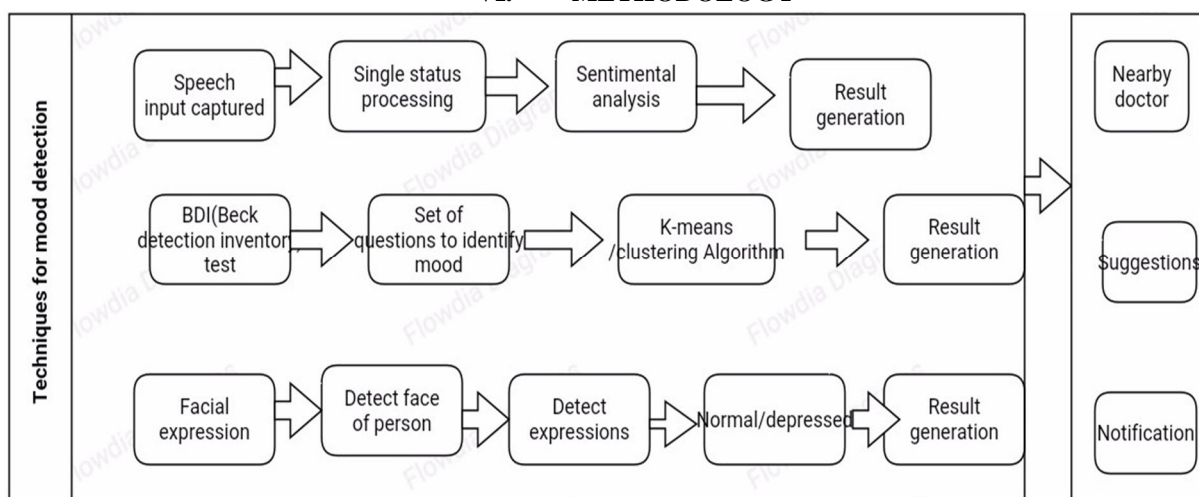


Fig. 2. Phases of System

This system has two levels: 1. User level, 2. Admin level.

At Admin level authority, the admin can track the user details, update it and delete it. The admin login is secured with a username and password. The admin has the responsibility to maintain the users.

At user level, first the user has to login to the system with a specific username and password. If the user is new to the system, then he/she has to first register and then login to the system. After successfully logging in the user has to give the three tests.

**A. Tests**

**1) Speech recognition**

- a) *Step 1:* User is asked his/her 'status' and according to his/her feeling the user has to say something so that the system can take speech input. (The status needs been spoken in English language only).
- b) *Step 2:* The speech input from user is caught. Speech to text conversion is done using Google APIs. This text is then given as an input to the Naïve Bayes algorithm.
- c) *Step 3:* Text classification is done in this part using Naïve Bayes algorithm which is a probabilistic classifier and accordingly, result is generated.
- d) *Step 4:* Text classification is done here and accordingly the status is classified as positive or negative.
- e) *Step 5:* The result of this test is stored for the time-being and is used again later.

For example, if the text input is 'good', then using Naïve Bayes classifier, its probability is calculated. The probability is calculated on the basis of dataset. Here, 'good' has 0.8 probability in positive and 0.2 in negative. Probability of positive is high, so text is classified as positive.

- 2) *BDI test:* The second test is on BDI. Here the BDI questions are asked to the user and the user has to answer these questions honestly. These questions are in the format of MCQs.

- a) *Step 1:* The user is asked a set of questions. He/she has to answer those questions.
- b) *Step 2:* Any answer the user gives, is placed in its correct position on the Graph (dataset) and using those positions clusters are formed of closely related data.
- c) *Step 3:* Every time the user answers a new questions, its answer is stored in the right cluster. In this way the size of the cluster grows.
- d) *Step 4:* At the end, the cluster with maximum size is considered as the output.
- e) *Step 5:* The result of this test is again stored for the time-being and used again later.

**3) Facial recognition:**

The third test is facial recognition test. In this test, the user's facial recognition is done keeping in mind the 'lip-position'. The user lip area is scanned and the positions are recognized. Using the dataset for facial recognition, the result for this test is calculated and stored.

**B. Mathematical Function**

$S = \{s, e, X, Y, F_{main}, \text{Success}, \text{Failure}\}$

where  $s =$  Start State

$e =$  End State

$X = \{\text{Set Of Inputs}\} = \{x_1, x_2, x_3\}$

where  $x_1 =$  Speech

$x_2 =$  Text

$x_3 =$  Facial Expression

$Y = \{\text{Set of Outputs}\} = \{y_1, y_2, y_3\}$

where  $y_1 =$  Sentimental analysis (Status)

$y_2 =$  BDI score (Question and Answer)

$y_3 =$  Depressed/Smile

$F_{main} = \{\text{Set of procedure}\} = \{f_1, f_2, f_3, f_4, f_5, f_6\}$

Where  $f_1 =$  Take  $x_1$  Input

$f_2 =$  Give  $y_1$  Output

$f_3 =$  Take  $x_2$  input

$f_4 =$  Give  $y_2$  output

$f_5 =$  Take  $x_3$  Input

$f_6 =$  Give  $y_3$  Output

**C. Result Generation**

At the end, all the results calculated earlier are analysed all together and the final result/output is generated. It is basically in the form of a scale, scale of depression.

On the basis of this final result, the user is provided with a proper suggestion. A suggestion can be given to the user in the form of consultancy, prescriptions, meditation details, etc.

#### D. System Features

##### 1) Easy to Use

The easy to understand use user interface helps provide a user-friendly environment to the user (person taking test).

##### 2) Reliable

As we are using a wide and revised datasets, this system is reliable.

##### 3) User suggestions

The According to the level of depression of the user, the required and useful suggestions are provided.

### VII. CONCLUSION

Depression may lead to disasters. A person on the verge should be detected and helped accordingly. This system will help in doing that. If the user is feeling sad, the signals will indicate the respective expressions. Sentiment analysis is done based on BDI which includes set of questions, speech recognition and finally the facial expressions to determine the face of a person. Nearby doctors/suggestions/ notifications can also help in the detection process. These tests will determine whether the person is happy or depressed.

### VIII. FUTURE SCOPE

Implementing this project in android to use it in mobiles so that we can conduct the tests anytime. Adding sensor devices so that we can detect depression in real time or alert the person to take the test.

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