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Detection of Clinical Depression in Humans using Sentiment Analysis

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Abstract - *Depression, though a common mental disorder, is not one that is easily diagnosed. Though millions are affected by it, depression still remains a taboo in the society. Due to this reason millions are afraid to speak up about this, leading them to fall deeper into the pit of depression. One way to help these people is to diagnose them by merely interacting over the phone and taking their choice of words and voice modulation into consideration. The aim is to give these as an input to a sentiment Analysis algorithm, which then decides the tone of the speaker whether positive, negative, or neutral. The level of negativity in the choice of words and also the frequency modulations of his voice helps decide his level of depression. This analysis is done using Naïve Bayesian algorithm. This algorithm is chosen because it works with key-value pairs. This helps in distinguishing between the words that are to be considered and words that need not be. The major issue solved is that the diagnosis rate can be improved as the patients can communicate much more freely. Also, some hints that may not be observed by the doctors can be noticed by a device like this. This benefits both the doctors and the patients.*

Keywords: *Depression, Sentiment Analysis, Voice Modulation*

I. INTRODUCTION

Depression or Clinical Depression is a common but serious mood disorder. It causes severe symptoms that affect how you feel, think and handle daily activities, such as sleeping, eating, or working. According to the world Health Organization (WHO) over 4.5% of India's population is affected by it. Depression affects human beings right from age of three though it may not always manifest itself in the same way as in adults. Depression not just affects human beings but also animals causing them to behave erratically and also commit suicide.

Though a huge population is affected by depression, many hesitate to get themselves diagnosed from the fear of getting judged by the society. Since the diagnosis of the illness is critical at an early stage and also keeping in mind the privacy of the person this project has been proposed. Just the voice of a person is enough to detect if an individual is depressed or not.

According to a recent study, "depressed patients often display negative tone, reduced speech variability and monotonicity in loudness and pitch, reduced speech, reduced articulation rate, increased pause duration, and varied switching pause duration". These features can be extracted even from voice sample of the patient provided over the phone or in person. This in a way helps protect the privacy of the patient when he doesn't need to visit the doctor in person and also paves way to remote diagnosis.

This system aims to achieve this with the help of machine learning algorithms. Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it learn for themselves.

The process of learning begins with observations or data, such as examples, direct experience, or instruction, in order to look for patterns in data and make better decisions in the future based on the examples that we provide. The primary aim is to allow the computers learn automatically without human intervention or assistance and adjust actions accordingly.

Machine learning algorithms are often categorized as supervised or unsupervised. Supervised machine learning algorithms can apply what has been learned in the past to new data using labelled examples to predict future events. Starting from the analysis of a known training dataset, the learning algorithm produces an inferred function to make predictions about the output values. The system is able to provide targets for any new input after sufficient training. The learning algorithm can also compare its output with the correct, intended output and find errors in order to modify the model accordingly. In contrast, unsupervised machine learning algorithms are used when the information used to train is neither classified nor labelled. Unsupervised learning studies how systems can infer a function to describe a hidden structure from unlabelled data. The system doesn't figure out the right output, but it explores the data and can draw inferences from datasets to describe hidden structures from unlabelled data.

This system follows the supervised learning approach and uses Naïve Bayesian algorithm. Naive Bayes classifiers are a collection of classification algorithms based on Bayes' Theorem. It is not a single algorithm but a family of algorithms where all of them share a common principle, i.e. every pair of features being classified is independent of each other. It predicts membership probabilities for each class such as the probability that given record or data point belongs to a particular class. The class with the highest probability is considered as the most likely class. This is also known as Maximum a Posteriori (MAP).The MAP for a hypothesis is:

MAP(H)

= max(P(H|E))
= max((P(E|H)*P(H))/P(E))
= max(P(E|H)*P(H))

In this system, the audio input received from the patients is given to the classifier and it in turn classifies the patient as depressed or normal. It includes various parameters like choice of words, positivity or negativity in the statement, tone and frequency. A combination of these factors, with the help of pre-determined facts about depressed people's behaviour, can give out diagnosis results for patients.

II. EXISTING SYSTEM

The existing systems perform sentiment analysis for any case scenario using mostly text data rather than voice data. This is capable of identifying the tone of the speaker but its drawback is that it wouldn't be very informative in the case of detection of depression. This is because in the case of depression the number of words spoken by the patient is important and also his tone which can be identified only from his voice is necessary.

III. LITERATURE REVIEW

A. AUTOMATIC SENTIMENT DETECTION IN NATURALISTIC AUDIO

Sentiment Analysis of Audio data is done from a variety of naturalistic audio sources such as YouTube. Due to the use of Naturalistic Audio i.e. Audio that is not transcribed into text for analysis, a second corpus called UT-Opinion is made use off. The technique used in this paper is Key Word Spotting (KWS) which helps in increasing the accuracy as it looks for only the Key Words while parsing through the audio. The issue in this system is that it makes use of naturalistic audio meaning that there can a lot of unwanted noise, multiple speakers can be talking at the same time and since the number audio databases for opinion mining is very limited creation of a new audio corpus becomes a compulsion.

B. SENTIMENT ANALYSIS BY IDENTIFYING THE SPEAKER'S POLARITY IN TWITTER DATA

The twitter data is examined by removing redundant words, URLs etc. Also, parts of the text like Emojis etc. are converted to text that describes that emoji using emoji dictionary. Stop words such as "is", "the" etc. are ignored. This analysis is done using Kernel tree which classifies the words individually into stop words, exclamations, positives, negatives etc. This tree is used in determining the sentiment of the examined piece of data. The issue is that the words have been examined individually. A collection of the same set of words may or may not result in the same sentiment.

C. ANALYZING ADVERBS IMPACT FOR SENTIMENT ANALYSIS USING HADOOP

In this paper, the research focuses on the different types of adverbs in detail so as to improve the accuracy of the sentiment analysis. The basic feature extraction is done by Hadoop and the scores of the sentiments are calculated. After this, the polarity feature extraction is done using the calculated scores. Hadoop results in a lower execution time due to parallel processing. But on the other hand, some types of adverbs fail to be classified accurately. Also, when a larger group of adverbs are considered together, the accuracy ratio goes down because it is uncommon for many adverbs to occur together.

D. SENTIMENT ANALYSIS OF SOCIAL NETWORKING SITES (SNS) DATA USING MACHINE LEARNING APPROACH FOR THE MEASUREMENT OF DEPRESSION

This paper makes a comparison among SVM, NB and ME classifiers regarding sentence level sentiment analysis for depression measurement. The experiment indicates that SVM shows superior result as compare to Nave Bayes and Maximum Entropy classifiers. It was observed that the accuracy of SVM is 91 %, the accuracy of Nave base is 83 % and the accuracy of Maximum Entropy is 80 %. These values may have errors because the same kind of text can be spoken by normal and depressed people in different ways. Such differences cannot be pointed out with these basic methodologies.

E. SENTIMENT ANALYSIS IN TRIPADVISOR

Sentiment Analysis is done on the comments from TripAdvisor, a travel Website. The Analysis is done on three popular monuments using SentiStrength, Bing, Syuzhet, and Core NLP methods and extract the overall polarity on each opinion. The result obtained from these methods are then compared with the five star rating given to each of these monuments to check for the accuracy. The issue here is that if the speaker uses a sarcastic or an ironic tone it is difficult to identify using just the words because of which the accuracy of the result reduces.

IV.PROPOSED MODEL

A. AUDIO TO TEXT CONVERSION

This module converts the audio input to text transcripts with the help of Google Speech API. Here, the features are extracted from the audio. That is, all other unnecessary noises are removed and the necessary (all) words are extracted as features. These are decoded with the help of an acoustic model, language model and pronunciation dictionary. These components help the decoder to determine details such as language, slang, strength of the audio etc. These words are then stored as text files for further analysis. This is illustrated in fig.1.

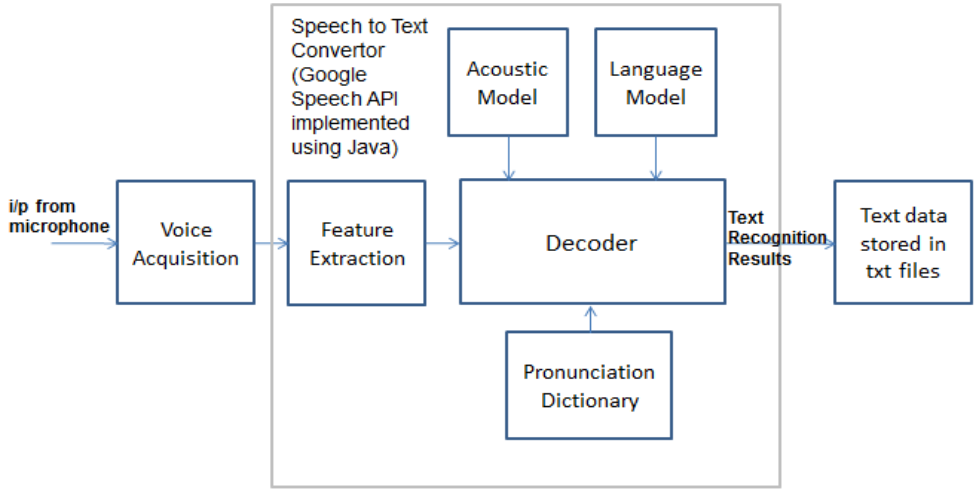

Fig. 1 Audio to text conversion module

B. CLASSIFICATION OF TEXT USING NAÏVE BAYESIAN ALGORITHM

This module classifies the text snippets as positive or negative by using naïve Bayesian algorithm. The test subjects are split into training and test data, preferably in the ratio 0.75:0.25. Necessary features such as pronouns, sentimental words etc. are extracted and are used to train the model. The test data is classified based on these results.

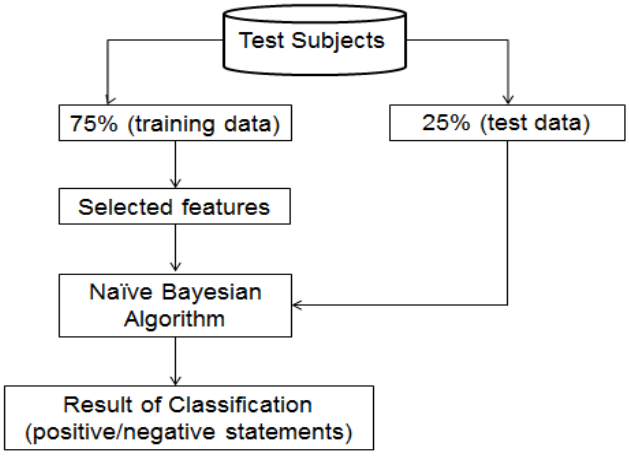

Fig. 2 Text Classification

C. INTEGRATION WITH FREQUENCY FROM AUDIO INPUT

Additionally, the frequency of the words is calculated by taking the text transcript from the first module. This transcript is examined for the number of words and the given time frame. These parameters help in deciding the average sepeed in which the patient speaks. This speed is an important factor which will help in determining the anxiety level of the patient. Fig 3. Illustrates the same

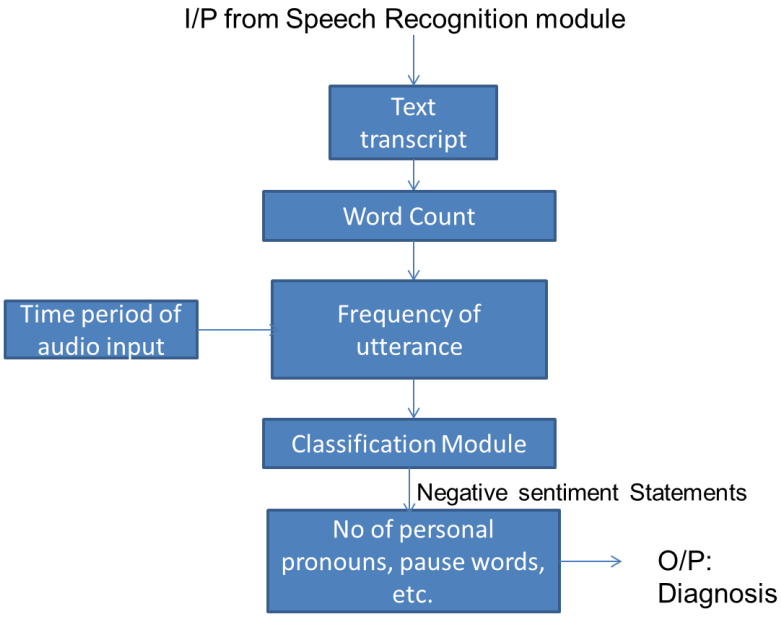

Fig. 3 Frequency calculation

D. FUNCTIONAL ARCHITECTURE

On the whole, the audio is sent as an input to the Google Speech API, where it is decoded into text transcripts with the help of speech to text module. These are then used to extract sentimental features which in turn help in the classification of statements into positive or negative ones. Additionally, the pitch and frequency are calculated from the audio data and integrated with the final results so as to get accurate results. Fig.4 illustrates this.

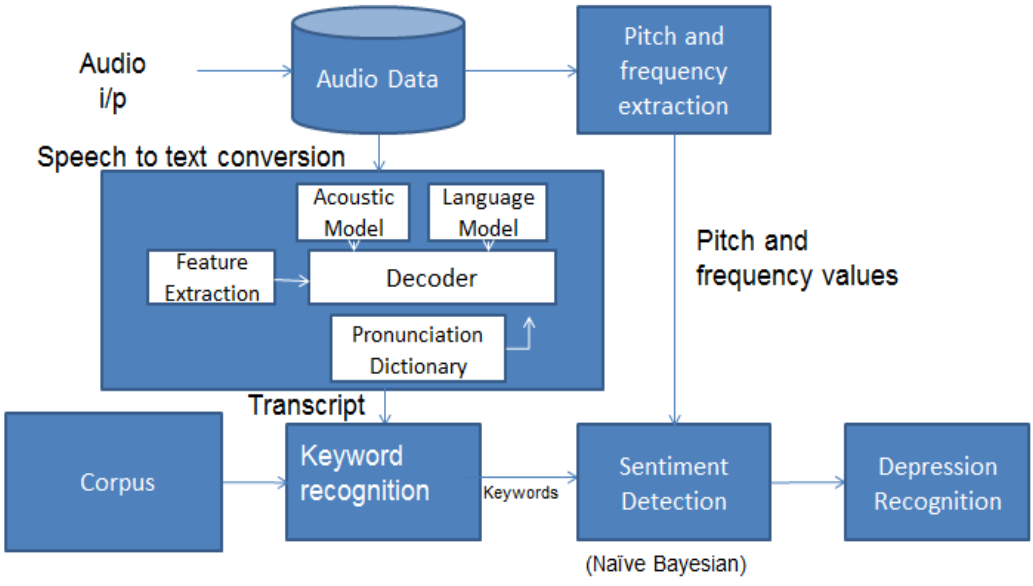

Fig. 4 Functional architecture

E. CODE SNIPPETS

```
def create_word_features(words):
useful_words = [word for word in words if word not in stopwords.words("english")]
my_dict = dict([(word, True) for word in useful_words])
return my_dict
create_word_features(all_neg_words)
create_word_features(all_pos_words)

classifier = NaiveBayesClassifier.train(train_set)
test_neg_words = word_tokenize(test1)
create_word_features(test_neg_words)
test_pos_words = word_tokenize(test2)
create_word_features(test_pos_words)
test_neg_senti = []
test_neg_senti.append((create_word_features(test_neg_words), "negative"))
test_pos_senti = []
test_pos_senti.append((create_word_features(test_pos_words), "postitve"))
test_set = test_neg_senti + test_pos_senti
print test_set
statement = "this is sad"
words = word_tokenize(statement)
words = create_word_features(words)
classifier.classify(words)
```

V. ACHIEVED RESULTS

The system effectively differentiates between a depressed and a not depressed person. With the use of google speech API there is almost an 83% of accuracy in identifying the sentence spoken by the patient. The accuracy of the Naïve Bayesian algorithm is greater than 90% for detecting whether the given statements are of the positive or negative sentiment. Since the project takes into account features such as the pauses, frequency of utterance of words, use of personal pronouns which helps boost the efficiency of the system and helps the physician perform a better diagnosis.

VI. CONCLUSION

This chapter concludes all the ideas that were discussed till now in the proposed system. The proposed idea of the system detecting depression with the use of sentiment analysis would be beneficial to the hundreds suffering from clinical depression to get diagnosed easily. The main outcome of this project is firstly the use of a speech recognition system which will help analyse the patients in real time. Secondly the use of voice ensures higher accuracy of detection of depression because of the use of parameters such as frequency of utterance of words, use of filler words, etc. Finally the user interface is simple and straightforward making it easy for anyone to operate it with ease. This work ensures that anyone suffering from depression can ensure their privacy and at the same time get the best care possible.

VII. FUTURE WORKS

This is only a tiny step towards improving the lives of those suffering from depression. There are some scope for this project firstly this can be developed in multiple languages. Secondly this can be implemented using a number of additional voice features. In addition to this, this technology can be used to treat multiple mental illnesses such as PTSD, multiple personality disorder. Finally some more improvement can be added to the user interface. This will provide the physicians with a better way to diagnose and cure patients with depression.

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