

Analysis of Human Body Signals for Prediction of Depression Disorder

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ABSTRACT

In today's competitive world, an individual needs to act smartly and take rapid steps to make his place in the competition. The ratio of the youngsters to that of the elder people is comparatively more and also they contribute towards the development of the society. The survey shows that to survive in the competitive world seven amongst ten individuals face mental disorder called Depression. In this world which runs with a lightning speed, it is time consuming for a person to visit a psychiatrist and take traditional treatment. This proposed system will analyze the various human body signals such as blood pressure, EEG signals, vocal prosody etc to predict the level of depression so that suitable therapy can be suggested. This eventually will put a stop to traditional way of taking consultation from doctors thereby reducing the valuable time of an individual.

Keywords: Depression, predict, human body, analysis, therapy, Heart rate, Blood pressure, decision fusion, optimal weighting, prediction of depression, risk for depression, speech classification, EEG signals.

1. INTRODUCTION

Depression is a major disorder, it's like being caged without a key, one never knows when the end is going to be. Depression is one of the deadliest illnesses hitting about a major population around the globe. While everybody feels sad, moody or low from time to time, some people experience these feelings intensely, for long periods of time (weeks, months or even years) and sometimes without any apparent reason. Depression is more than just a low mood – it's a serious condition that affects your physical and mental health. Feelings associated with depression: Overwhelmed, guilty, irritable, frustrated, lacking in confidence, unhappy, indecisive, disappointed, miserable, sad. The literature shows that several factors, including speech patterns, voice prosody, eye movement, blood pressure, heart rate, Electroencephalogram (EEG) signals, and facial expressions can be taken into consideration for detecting the severity of depression. Various questionnaires can be found on the Internet which can give the severity of depression and also can suggest suitable remedies to fight it out. A better way is a user- friendly system which can serve as a first-aid at crucial times when going to the psychiatrist is not feasible. This project aims at giving on the spot relaxation to the patients to be at ease by suggesting them therapies like music, meditation, an interface to communicate to friends and in the worst of scenarios consultation of a psychiatrist. According to WHO report, Indians are the world's most depressed people with nearly 36 per cent suffering from Major Depressive Episode (MDE). The average age of depression in India is 31.9 years compared to 18.8 years in China, and 22.7 years in the US. WHO ranks depression as the

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fourth leading cause of disability worldwide and projects that by 2020, it will be the second leading cause. Women are twice as likely to suffer depression as men and the loss of a partner, whether from death or divorce, was a main factor, the study reveals. Major Depressive Episode (MDE) is characterized by sadness, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep or appetite, low energy and poor concentration, besides feeling depressed. Depression affects over 120 million people worldwide. It can interfere with a person's ability to work, make relationships difficult, and destroy quality of life. In severe cases it leads to suicide, causing 850,000 deaths a year. Extreme weep-ness and severe melancholy are not the only calling cards of depression, a serious mental disorder that roughly affects. High-income countries tend to have higher rates of depression than lower income countries.

2. LITERATURE SURVEY

Self-executing depression examination has recently gained attention in the affective computing research community. In recent work, Jyoti Joshi Abhinav Dhall Roland Goecke Jeffrey F. Cohn modeled a paper named.

“Relative Body Parts Movement for Automatic Depression Analysis” [1]. In this paper, human body part movement is analyzed to relate it with depression analysis. Relative orientation and radius are computed for the body parts detected using the pictorial structures framework. A histogram of relative parts motion is drawn. To analyze the motion on a holistic level, space-time interest points are plotted and a bag of words framework is studied. These two histograms are fused and a support vector machine classifier is trained. This method has effective results on clinical database.

“Content Based Clinical Depression Detection in Adolescents” was a research work conducted by Lu-Shih Alex Low, Namunu C. Maddage, Margaret Lech, Lisa Sheeber, Nicholas Allen[2]. This paper elaborates on the speech content of adolescents to detect clinical depression. The paper reveals performance evaluation of acoustic features such as Mel Frequency Cepstral Coefficients (MFCC), Short Time Energy (Energy), Zero Crossing Rate (ZCR) and Teager Energy Operator (TEO) using Gaussian mixture models for depression detection. A clinical database of speech from 139 adolescents, which included 68 diagnosed as clinically depressed, was used in the experiments. Each subject participated in three brief interactions. The classification was first performed using the whole data and a smaller sub- set of data selected based on behavioral constructs defined by trained human observers (data with constructs). In the experiments, it was found that the MFCC + Energy feature outperformed the TEO feature. The results indicated that the use of construct based speech contents in the problem solving interactions (PSI) session improved the detection accuracy. Accuracy was further improved by 4% when the gender dependent depression modeling technique was adopted.

A paper presented by Marwa Mahmoud and Peter Robinson titled *“Towards automatic analysis of gestures and body expressions in depression”* proposes the investigate assessment of depression using automatic detection non-verbal body signals and other body gestures[3]. The system makes use of multimodal fusion of features to include body, face and head for better results in predicting depression level. This automatic detection of body cues is of great help to the psychologists.

“Analysis of Prosodic Speech Variation in Clinical Depression” by Elliot Moore II, Mark Clements, John Peifert and Lydia Weissert shows how someone is speaking can be equally important to what they are saying when analysis psychological disorders such as depression[4]. Acoustic speech signals are used to analyze the variations in prosodic feature statistics for those suffering from depression. From the collected data set, pitch, energy and speaking rate feature statistics are generated at a sentence level and grouped into series of observations for analysis. We investigate the merit of a series of statistical measures as a means of quantifying a subset of feature statistics to capture emotional variations from sentence to sentence within a single observation.

Survey done by Yashika Katyal, Suhas V Alur, Shipra Dwivede, Menaka R lead to *“EEG Signal and Video Analysis Based Depression Indication”*[5]. One of the ways to monitor the brain activity is the

electroencephalogram EEG signals, which help us detect the parameter in the brain. It combines EEG signals along with the facial emotion through video analysis to categorize the depression into respective level. Here, we studied about depression detection and combining various results to obtain accurate and efficient results, which is a methodology we are going to adopt to land to our results.

“Eye Movement Analysis for Depression Detection” by Sharifa Alghowinem, Roland Goecke, Michael Wagner, Gordon Parker, Michael Breakspear says that Eyes speak what heart wants to say. Eyes are the direct medium as far as emotions detection is concerned. Eye movement can be recorded to detect the level of depression. The eye movement patterns are analyzed based on the video using Active appearance models. The system also studies the blinking rate between depressed and healthy people. It was found that the average duration of blinks are longer in depressed people which are a result of eye contact avoidance and fatigue.

Researcher Kuryati Kipli, Abbas Z. Kouzani, Matthew loordens published paper *“Computer-aided detection of depression from magnetic resonance images”*[7]. Magnetic resonance imaging (MRI) of the brain is used to detect depression disorder. However, a large number of MRI scans needs to be analyzed for such detection. Manual segmentation of the biomarkers in MRI scans by clinical experts can become time consuming and sometimes erroneous. This paper presents a study on computer-aided detection of depression from MRI scans. These systems have not yet been identified, categorized and compared in the literature. The paper covers fully automated to semi-automated detection systems. It also presents performance comparison for the considered systems.

“Multichannel Weighted Speech Classification System for Prediction of Major Depression in Adolescents” introduced by Kuan Ee Brian Ooi, Margaret Lech, and Nicholas B. Allen shows that acoustic speech analysis and classification can be used to determine early signs of major depression in adolescents, up to two years before they meet clinical diagnostic criteria for full-blown disorder. Individual contributions of four different types of acoustic parameters [prosodic, glottal, Teager’s Energy Operator (TEO), and spectral] to depression related changes of speech characteristics were examined. The novel aspect of this methodology is in the introduction of multichannel classification with a weighted decision procedure. It was observed that single channel classification was effective in predicting depression with a desirable specificity-to-sensitivity ratio and accuracy higher than chance level only when using glottal or prosodic features. The best prediction performance was achieved with the new multichannel method, which used four features (prosodic, glottal, TEO, and spectral).

In this paper, *“Detecting Depression Severity from Vocal Prosody”* by Ying Yang, Catherine Fairbairn, and Jeffrey F. Cohn, Associate Member, IEEE[9] are investigating the relation between vocal prosody and change in depression severity over time, 57 participants from a clinical trial for treatment of depression were evaluated at seven-week intervals using a semi-structured clinical interview for depression severity (Hamilton Rating Scale for Depression (HRSD)). All participants met criteria for major depressive disorder (MDD) at week one. Using both perceptual judgments by naive listeners and quantitative analyses of vocal timing and fundamental frequency, three hypotheses were tested: 1) Naive listeners can perceive the severity of depression from vocal recordings of depressed participants and interviewers. 2) Quantitative features of vocal prosody in depressed participants reveal change in symptom severity over the course of depression. 3) Interpersonal effects occur as well; such that vocal prosody in interviewers shows corresponding effects. These hypotheses were strongly supported. Together, participants’ and interviewers’ vocal prosody accounted for about 60 percent of variation in depression scores, and detected ordinal range of depression severity (low, mild, and moderate-to-severe) in 69 percent of cases.

Working over , Beiming Sun and Vincent TY Ng tells that social network can also be useful for detecting depression in a person. Lots of effort has been conducted to analyze information of social networks, such as sentiment trend analysis of social network users. Our aim is to analyze the sentimental influence of posts and compare the result on various topics and different social media platforms. Large amounts of posts are

generated on social networks every day. People are curious in finding the influence among them. Most researchers measured. The influence of a post through the number of replies it received. However, we are not sure if the influence is made positively or negatively on other posts if their sentimental information is not considered. In this paper, three research questions are raised and methodologies are proposed for the measure of sentimental influence of posts. Finally, a preliminary experiment is designed and carried out with some interesting results found.

3. PROPOSED SYSTEM

This proposed system consists of a versatile measuring device which possesses the capability to measure all the body signals like voice prosody, blood pressure, EEG signals. This device has a wireless connectivity,

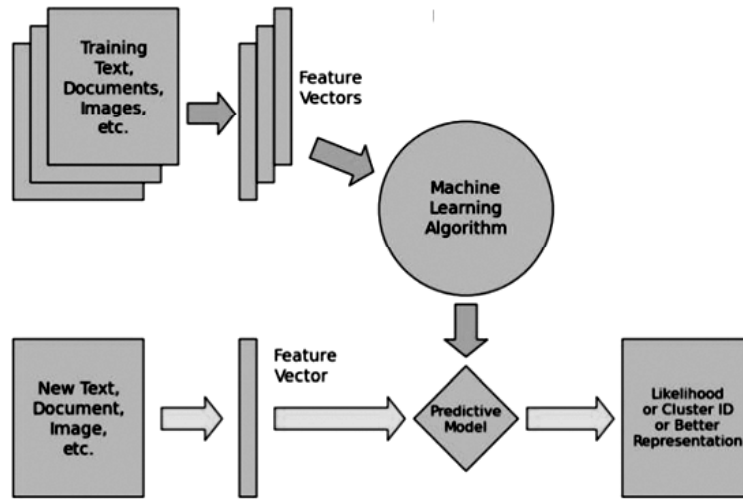
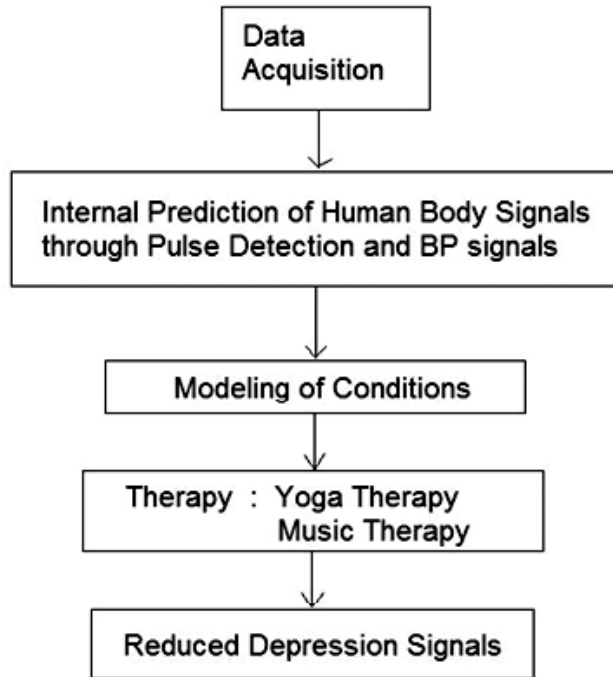


Figure 1: Proposed System



Flow diagram

Figure 2:

which will be used for transferring the measured values onto the system. This will prevent users from entering the values and hence inducing errors. For processing these values, a self-designed prediction algorithm will be used for better accuracy and precision. Apart from musical therapy, other remedies such as yoga, consultation to the doctor, immediate contact to a near one, are included in this system.

Evaluation Parameters for Depression Prediction

1. Blood Pressure
2. Vocal Prosody
3. EEG signals

System takes Blood Pressure as input and predicts whether the person is depressed or not. We make prediction based on the real time dataset provided to system. The severity of the depression is measured by the range of the Blood Pressure acquired. The Blood Pressure (Systolic/Diastolic) above/below the normal range is considered to be the symptom of depression. The digitized Blood Pressure level of an individual is further mapped with the clusters that informs us whether the same is depressed or not. If it falls under the depressed category then system provides with suitable depression relieving therapy.

Taking the speech analysis into consideration it was demonstrated that the acoustic speech analysis are classified into two classes (AR and NAR). The first step consists of individual contributions of four different types of acoustic parameters that are (G, P, TEO, and S). The observation tells us that the prosodic (P) and glottal (G) parameters are strongly correlated with the AR speech characteristics, whereas the TEO and glottal (G) parameters showcase the highest correlation with the NAR characteristics. It was also observed that only the glottal and prosodic features were effective on their own in prediction of depression with a

Patient Id	Age	Blood Pressure		BP Level
		SBP	DBP	
1	20	110	80	mid
2	25	115	90	mid
3	65	165	110	high
4	42	157	95	high
5	60	80	55	low
6	80	120	80	mid
7	30	133	100	high
8	55	152	120	high
9	18	120	80	mid
10	47	127	85	mid

Figure 3: Sample Dataset of BP

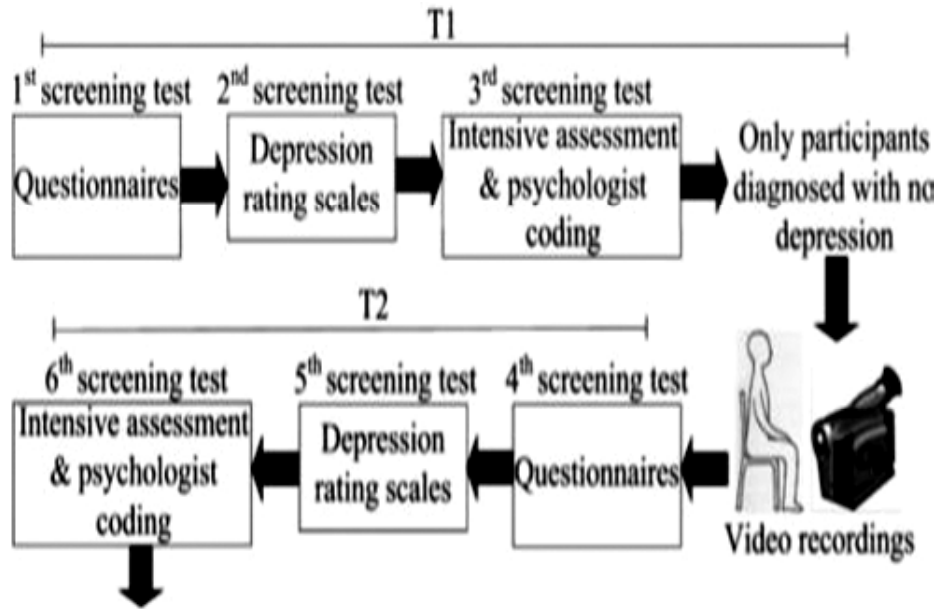


Figure 4: Longitudinal data collection procedure

desirable specificity/sensitivity ratio and specificity, sensitivity, and accuracy higher than the chance level. The second step includes, the individual contribution of the four types of features were used to develop and test a new computational methodology for the early prediction of depression in adolescents. The primary aspect of this methodology is the introduction of a multichannel classification approach and a weighted classification decision procedure.

The third parameter i.e, EEG data for patients will also be useful to train the system for accurate prediction of disorder. Downloaded data from the website arises from a large study to examine EEG signals. This dataset is used to train the system . Further the versatile hardware devices are used to take the real time input from the patients (for testing purpose).

4. METHOD USED

This paper propose an self prediction algorithm for covering a high level of accuracy for our depression detection system. We induce to take input parameters like BP from an individual to map it with the real time dataset that has been provided to our system. This mapping will result into prediction an will provide us with suitable therapy. This also includes machine learning strategies by our algorithm. We have referred clustering and classification algorithm k-means and Naive-Bayes.

K-means clustering algorithm:

K means is clustering algorithm where the input data samples get clustered which have more inter-cluster similarity and less intra-cluster similarity. In K means “K” stands for the number of clusters to be formed. The clusters are formed by assumption of the mean values from the initial given points. The points are then categorized by calculating the Euclidean distance. For the next iteration, new mean is calculated and the procedure for differentiating the points repeat. The algorithm stops when the new value of mean is similar to the mean in the previous iteration.

Input:

k: the number of clusters,

D: a data set containing n objects.

Output:

A set of k clusters.

Method:

- (1) arbitrarily choose k objects from D as the initial cluster centers;
- (2) repeat
- (3) (re)assign each object to the cluster to which the object is the most similar, based on the mean value of the objects in the cluster;
- (4) update the cluster means, i.e., calculate the mean value of the objects for each cluster;
- (5) until no change;

Naive bayes:

Working:

1. Let D be a training set of tuples and their associated class labels. As usual, each tuple is represented by an n-dimensional attribute vector, $X = (x_1, x_2, \dots, x_n)$, depicting n measurements made on the tuple from n attributes, respectively, A_1, A_2, \dots, A_n .
2. Suppose that there are m classes, C_1, C_2, \dots, C_m . Given a tuple, X, the classifier will predict that X belongs to the class having the highest posterior probability, conditioned on X. That is, the naive Bayesian classifier predicts that tuple X belongs to the class C_i if and only if

$$P(C_i|X) > P(C_j|X) \text{ for } 1 \leq j \leq m; j \neq i$$

Thus we maximize $P(C_i|X)$. The class C_i for which $P(C_i|X)$ is maximized is called the Maximum posteriori hypothesis.

By Bayes theorem :

$$P(C_i|X) = P(X|C_i)P(C_i)/P(X)$$

3. As $P(X)$ is constant for all classes, only $P(X|C_i) P(C_i)$ need be maximized. If the class prior probabilities are not known, then it is commonly assumed that the classes are equally likely, that is, $P(C_1) = P(C_2) = \dots = P(C_m)$, and we would therefore maximize $P(X|C_i)$. Otherwise, we maximize $P(X|C_i)P(C_i)$. Note that the class prior probabilities may be estimated by $P(C_i) = |C_i, D|/|D|$, where $|C_i, D|$ is the number of training tuples of class C_i in D.
4. Given data sets with many attributes, it would be extremely computationally expensive to compute $P(X|C_i)$. In order to reduce computation in evaluating $P(X|C_i)$, the naive assumption of class conditional independence is made. This presumes that the values of the attributes are conditionally independent of one another, given the class label of the tuple (i.e., that there are no dependence relationships among the attributes).

4. CONCLUSION

Thus, we have conducted an extensive research on depression and also on the psychological condition of the mass affected by this psychological disorder. We have also studied the existing system for depression level detection. We have made a sincere attempt to consider all the loop holes in this existing system and improvise them in our proposed system. We propose a design, which will give a better user experience and user interface. We realized that k-means prediction algorithm wouldn't suffice our needs of this medical domain. Hence, we propose a self-designed prediction algorithm which will be used for a sensitive issue such as depression. The proposed system will be more accurate, error-free, and precise with complete

expertise. This system will then accurately detect the level of depression and justify the remedy for the cure of given affected with expert inter domain. We thus make a sincere attempt to serve the cause of this psychological disorder and make world a better, healthier and happier place to live in.

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