Study of Mental Disorder Prediction Model approaches its issues and Challenges

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Abstract— Mental disorder is becoming one of the major health issues in society today. (WHO) depression will be the leading mental disorder all over the world by 2030.The timely prediction of such disorders is very essential for maintaining the health of human beings. These mental disorders are associated with different symptoms, some of these symptoms are visible in the form of facial expressions, gestures, change in voice modulation etc. and some of them even cannot be noticed by naked eyes. Therefore, it is highly important to collect appropriate verbal and non-verbal symptom details about any individual along with using best suited algorithms for accurate prediction using information technology. This paper explores different types of such symptoms associated with different types of mental disorders, its causes and existing prediction based solutions. The paper further presents the critical analysis of these aspects and proposes usages of biometrics based traits for building better prediction systems for mental disorders.

Keywords— *Mental Disorder, Questionnaires, Depression Scale, Depression Symptoms, Machine Learning, Biometric trait, Performance Parameters*

1. INTRODUCTION

Congratulations! As per the report by the world health organisation WHO [1] more than 300 million people are currently suffering from major depressive disorder worldwide and with more than 264 million people are affected from mental health disorder i.e., depression [1]. Depression is also called a mental disorder. Close to 800000 people commit suicide every single year and it is the subsequent utmost cause of death in the range between 15 to 29 years of age [1]. There are multiple reasons for mental disorders like financial stress, family problems, fear of losing a job, unhealthy lifestyle, sleeping patterns, physical health and many more. Amongst so many causes COVID-19 [2] also one of the reasons for mental illness.

Every disease is associated with symptoms but in case of depression identifying the symptoms is the biggest challenge, the people suffering from mental disorders are having different symptoms related to appetite, sleep, weight loss or gain, tiredness, weakened immune system etc. These symptoms are not visible hence 76% to 85% of the population are not receiving proper treatment for mental disorders. [3]. To overcome this problem these symptoms, need to be identified at the early stage so that treatment can be given at the right time.

Other than these symptoms there are some behavioral symptoms and they may cause based on current events e.g. facial expressions which can be vary like seeing happiness, anger etc. These expressions consist of various features like eyes, forehead, eyebrows etc. Along with these facial expressions, gestures of the patients and voice modulation can also be considered as behavioral symptoms which can be called as Biometric traits. As per the literature survey youngsters between the ages 15-29 are maximum suffering from mental disorder and suicide ratio is more in male as compared to female. Hence the classification of gender and age is must to identify the behavioral symptoms. The author [4] and [5] has proposed novel approaches to classify the age and gender from the biometric trait. These behavioral symptoms can be used to predict the depression level.

Adding further traditional ways to diagnose depression by a psychiatrist which uses depression scale PHQ-9 [10] to interview the patient. Based on the generated score, depression level is determined. There is a need to develop instinctive techniques for the recognition of the existence and seriousness of depression. Prediction of such disease is important; many research findings have claimed that applications of Machine Learning and Deep Learning have provided better results in the area of diagnosis. The immense research is going on in the medical field for prediction based outcome using Machine Learning

approach, along with Machine Learning, Deep learning algorithms are wisely used to analyse medical images. Firstly, it is very important to understand different types of mental disorders, symptoms associated with these disorders, the impact of mental disorders and the causes of mental disorders.

2. MENTAL DISORDERS

Depression is a common mental disorder and one of the main causes of disability worldwide. An estimated 264 million universally and 57 million people in India affected by depression. This section is focused on types of mental disorders, symptoms that result in depression, various reasons / factors responsible for mental disorders, impact of depression.

2.1 Types of Mental Disorders

The mental disorders have various forms which come with different symptoms, seasons, situations and diseases. In this section different mental disorders have been discussed with respect to definition, no of cases and treatment. Different mental disorders are listed below:

1. Major / Clinical Depression: This depression is characterised by a miserable mood or loss of concentration in activities. It is very common in India and no of cases are more than 10 million per year in India. Treatments include therapy, medication.

2. Persistent depressive disorder: This type of depression is long-term depression. It is very common in India and no of cases are more than 10 million per year in India. Treatments include self-care, therapy, medication

3. Bipolar disorder / Manic depression: This disorder is associated with mood swings ranging from depressive lows to manic highs. The exact reason for bipolar disorder isn't known. It is very common in India and no of cases are more than 10 million per year in India. Treatments include supportive care, therapy, medication.

4. Postnatal / Perinatal depression: This type of depression is experienced during pregnancy or after delivery. It is very common in India and no of cases are more than 10 million per year in India.

5. Seasonal Affective Disorder (SAD): This type of depression arises and goes with the season when the sunlight is less. It is very common in India and no of cases are more than 10 million per year in India. Treatments include therapy, selfcare, medication

6. Schizophrenia: A disorder that affects a person's ability to think, feel and behave clearly. It is very common in India and no of cases are more than 1 million per year in India. Treatments include therapy, medication.

7. Anxiety disorder: A mental health disorder characterised by feelings of worry, anxiety or fear that are strong enough to inhibit daily activities. It is very common in India and no of cases are more than 10 million per year in India. Treatments include therapy, self-care , medication.

8. Attention deficit hyperactivity disorder (ADHD):This includes attention difficulty, hyperactivity and impulsiveness. It is very common in India and no of cases are more than 10 million per year in India. Treatments include therapy, medication.

9. Autism spectrum disorder: A serious developmental disorder that weakens the ability to communicate and interact. It is very common in India and no of cases are more than 1 million per year in India. Treatment includes therapy

10. Other Mental Disorders

2.2 Causes of Mental Disorders

Spread of certain types of other diseases can also be a reason for depression. There are many reasons for depression. There are so many factors which lead to depression are sociological, clinical [6] and psychological factors. Lots of things can raise the chance of depression like family problems, diseases or clinical problems (family history), employment, financial problems, drug addiction etc. Along with those factors there are four main reasons which cause depression are listed below: 1. Situational Depression: Based on the situation this type of depression occurs. Specifically when the pandemic-like situation gets developed all around. Latest example of causing the depression is COVID-19, after the first case detected in Wuhan China, numbers keep on increasing thereafter. COVID-19 was also one of the boosters for mental disorders. To analyse the pandemic situation [7] has conducted an online survey and 10000 plus responses have been collected. The questions were framed on stress level, depression, sleeping patterns, and eating habits. Due to COVID-19 43% of Indians are currently suffering from depression. The response from the survey has been discussed as below [7]:

1.1 Respondents who felt stress during COVID-19 pandemic India 2020 by intensity: Mild=11%, Moderate= 4% and Moderately Severe= 2%.

1.2. Respondents who felt down, depressed, or hopeless during COVID-19 pandemic in India in July 2020, by frequency: Few days=34%, More than half day= 6% and nearly every day= 4%.

1.3. Respondents who had trouble sleeping or slept too much during COVID-19 pandemic in India in 2020, by frequency: Few days=33%, More than half day= 9% and nearly every day=7%

2. Biological Depression: Biological depression's depressive symptoms start with an imbalance in any of the neurotransmitters or hormones that affect mood and physical health which leads to depression.

3. Psychological Depression: This type of depression is related to psychological factors, like losing something, negative talk, and non-viable expectations.

4. Existential Depression: Existential depression is caused by fear, or uncertainty about the existential issues of human experience.

2.3 Symptoms of Mental Disorders

Symptoms are the key for the diseases, from the symptom's illnesses can be identified. In this section the different symptoms associated with mental disorders have been discussed. Not all the symptoms are expressive and may differ with respect to age groups with minor differences. The symptoms of children are they may lose their interest in going to school, to participate in extra activities, weight loss, minor pains and discomforts, typically in the muscles etc. In teens anger, poor performance or less attendance in school, less interactive socially, consuming drugs or alcohol, sleeping pattern, eating habit, self-harm etc. Adults often want to stay at home, rather than going out to socialize or doing new things, physical aches or pain, memory loss problem, suicidal thinking or feeling, loss of appetite, excessive sleep or less sleep etc.

Other than this there are many symptoms which are expressive like change in facial expressions like worry, sadness, anxiety can be noticeable in the forehead, nose lines with anger & sadness, raised eyebrows, under eyes with stress & loss, voice modulation, movements of hands and legs etc. Below figure shows the different expressions of the same person which shows different emotions through which nonverbal communication can happen. Different emotions can be extracted from the face features like eyes, eyebrows, mouth, nose, forehead etc.

Figure. 1 Universal Human Expressions [8]

To study these symptoms are very essential, since many of the symptoms are not visible due to which the patient remains untreated for a longer time. and when diagnosed then treatment will take place. Because of such negligence the impact of mental disorders increased and suicide rate is also increasing.

2.4 Impact of Mental Disorders

According to WHO more women are affected by depression than men. Due to which suicide rate is also increased, per populate of 100000 according to WHO is male 14.44% and female is 11.11%. Close to 800 000 people lost their life due to suicide every year. The below graph shows the suicide rate for Male Vs Female in India from 2014 to 2018.
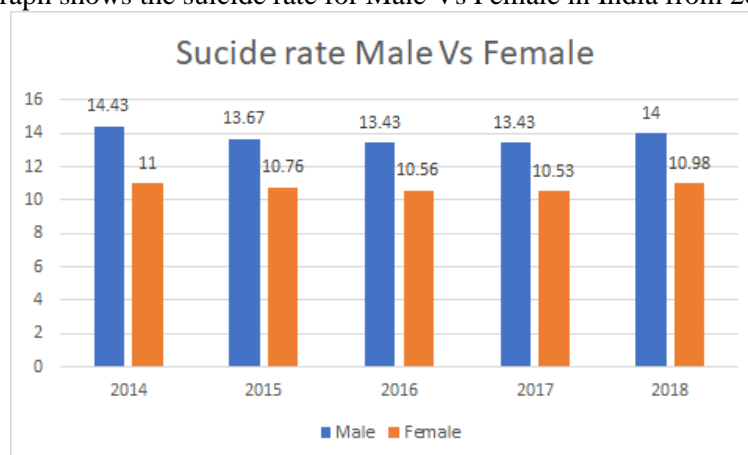

Figure. 2 Year wise Suicide rate in India

As we can see in the above graph in Fig.2 the suicide rate is increase after 2017, According to one study youngsters between the age 15-29 are maximum suffering from depression. To understand the burden of these Mental disorders, risk factors associated with these mental disorders and reason for occurrence of mental disorders need to be known. As discussed, earlier depression types, symptoms, treatments can be used to identify the type of depression or mental disorder. To analyse the current situation WHO stated [1], years lived with disability (YLDs) and disability-adjusted life-years (DALYs) can be used, with the help of YLDs and DALYs the listed mental disorder numbers can be generated. The method proposed by [9] for evaluating the occurrence of mental disorder is, years lived with disability (YLDs), and disability-adjusted life-years (DALYs) in India below (1) and (2) can be used

$$YLD = I \times DW \times L \qquad (1)$$

where N = number of deaths due to condition, L = standard life expectancy at age of death

and

DALY = YLL + YLD $\qquad$ (2)

YLL is calculated as the number of deaths (n) x the standard life expectancy at age of death (L1). These equations (1) and (2) can be used for the analysis purpose to generate the total number cases of mental disorders country wise or world-wide.

3. EXISTING PREDICTION SYSTEM

Mental disorders are a serious cause in society, according to [9] analysis Autism Spectrum Disorder, Anxiety Disorder are affected the most to all the age group even less than 5-year children also got affected. The need for a prediction system is because the traditional methods are a time-consuming process for the mental disorders patients. The clinical practitioners use the clinical tools (questionnaire / scale) for interviewing the patient which has some questions and while interviewing the patient score will be noted down. Based on the final total score (points) depression level will be predicted. PHQ-9 [10] uses following prediction level:

1. 0 to 4 points: No depression

2. 5 to 9 points: Mild depression

3. 10 to 14 points: Moderate depression

4. 15 to 19 points: Moderately severe depression

5. 20 to 27 points: Severe depression.

1. Similar way, prediction of depression level can also be evaluated by using depression scale. The Geriatric Depression Scale (GDS) [8] is one of the depression scales having following prediction level:

2. A score > 5 points is suggestive of depression.

3. A score $\geqslant$ 10 points is almost always indicative of depression.

4. A score > 5 points should warrant a follow-up comprehensive assessment

The different questionnaires and scales which can be used for prediction of depression level are Beck Depression Inventory (BDI-II) [8],Hamilton Depression Rating Scale [8] ,The Geriatric Depression Scale (GDS) [8], Personal Health Questionnaire Depression Scale (PHQ-8) [8], Personal Health Questionnaire Depression Scale (PHQ-9) [10], Generalized Anxiety Disorder Assessment (GAD-7) [10], Minnesota Multiple Personality Scale (MMPI) [11] and Composite international diagnostic interview (CIDI) [12]. This entire process is time consuming and most of the patients are not benefited as detection of depression is at a later stage after evaluation. When the patient is diagnosed with depression using those questionnaires or a scale, based on the results medicines will be prescribed to the patients but such treatments will affect only 50% of the population [13]. Solution to this problem is to propose a prediction-based system which may predict the diseases at the early stage so the treatment can take place at the right time. The prediction system consists of different stages.
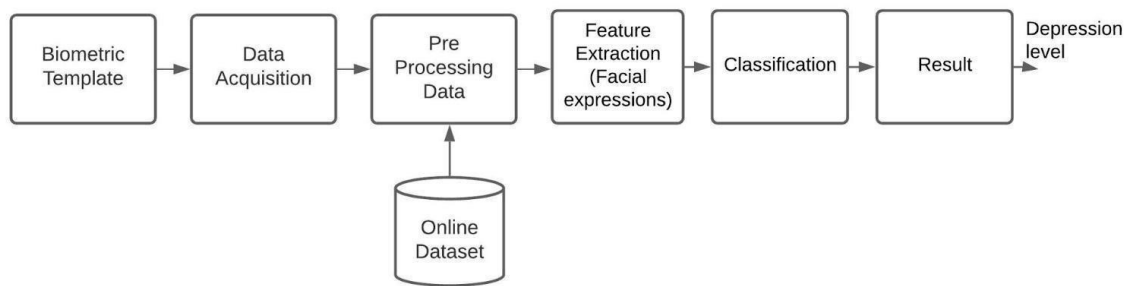
Figure. 3 Block diagram of Prediction System

So, the existing prediction system takes the input sample from either in the form of online available datasets as discussed in the next section or data that needs to be captured through the device. The author's [10], [14],[15] and [16] proposed the technique where online datasets need to be loaded in the system whereas [6],[17],[18] and [19] used the data which were generated through the capturing device at stage one for the prediction based approach. The author's [6],[17],[18] and [19] uses the concept where the certain types of questions - answers, showing movies / videos /audios and the regular activities recorded through the camera then the frames were extracted. After extracting the data these data need to be process hence it is given to the preprocessing block where data cleaning, data integration, data reduction, and data transformation will take place. After cleaning those data feature extraction block will extract the required features from the data. Different Machine Learning classifiers will classify and label the data based on similarities & dissimilarities. Lastly, based on the data received from the classification block, prediction of depression level can take place.

3.1 Current dataset generation process and limitations

As discussed, data collection is a very essential step. Dataset plays an important role for any research. Specifically, if research is in the medical field, then the richness of the data should be good so as to get better results. Source for the data in the medical field is the clinic or hospital where the clinical interview as discussed using questionnaire or depression scale is done by a physiatrist, medical records, patient surveys and administrative databases. So to collect the data from the clinic, researchers need to follow protocols and mutual agreement so the data can be made available to the researcher.

Apart from this procedure there are some depression datasets which are available online are: AVEC 2013-2014 [8], Emo-DB [8], DAIC-WOZ [8], Karolinska Directed Emotional Faces (KDEF) database [8], fMRI dataset [10], AVEC 2017 [16]. The limitations of these datasets are:
1. The data could be incomplete and can have missing values.
2. As discussed if the depression data has been generated from the survey, interviews possibly don't provide accurate information as it involves different point of views.
3. Collected data may vary in the format as well as in terms of quality because they are collected from different sources.

To overcome these limitations an alternative approach is to capture the facial expressions through the capturing device and process it further for the feature extraction process to get better datasets. According to the researcher face, voice, and gestures can act as biometric traits and these traits are known for their uniqueness and richness. While capturing these traits light, makeup, expressions, makeup, hair, beard and Moustache factors need to be considered. Different emotions like sadness, happiness, anger, annoyed, surprise and fear can be captured during the capturing phase and help us to understand the depression level. The involvement of Biometric will lead research to its uniqueness and robustness. Adding further different image processing algorithms can also be apply for the

feature extraction process and lastly Machine Learning classifier to classify the data. But this process may be a time consuming process as every face needs to be extracted individually and the quality of the capturing devices should be good to produce the better result.

3.2 Analysis of Prediction algorithms

According to the research major / clinical, Bipolar, Anxiety disorder are very common in India. More than 10 million cases per year (India) have suffered from these disorders. Such depressive disorder should be treated on time. The medical diagnosis system may predict the diseases. As per the literature prediction of diseases the Machine Learning approaches and Deep learning concept can be used. These concepts also have been in use for segmentation, object detection, image classification etc. This section has stated different approaches of predicting mental disorders with the available online datasets and along with the use of capturing devices which were generated by conducting the interviews / observing the activities etc. The dataset has been approved by Emory University Institutional Review Board which has been generated by authors [17] and proposed the novel approach for predicting the depression by evaluating 365 videos from a group of 12 depressed patients with before and after deep brain stimulation (DBS) treatment. Using the Convolution Neural Network, seven different emotions were extracted from the video frame and segmentation, classification was performed. Vector Machine, Logistic Regression classifier and Decision Tree have been used for video classification. Classification using the LR classifier with average happiness alone resulted in an average Area Under Curve (AUC) of 0.721 and an average test accuracy of 0.706 in 10 trials, which is better than the other seven emotions.

According to the author [6] depression is strongly associated with type 2 diabetes. They have proposed a system which predicts type-II diabetic from depression. Different factors like Sociodemographic Factors, Clinical factors and psychosocial factors have been considered and based on these factors' interviews were conducted. According to research, prediction of depression helps the specialists to detect type-II diabetic as early as possible. The SVM classifier gives accuracy of 98.67% as compared to Kmean, Fmean and PNN.

The aim of this research paper [14] is to combine Facial expression geometry with speech analysis of male and female dataset from AVEC 2013-14 and different fusion methods have been applied to test depression level. Since the window size is only for 2 seconds therefore detected data regarding depression are very low so to overcome this problem the author may require larger window size to evaluate the depression. The performance of this research with symptomatology depressive is 94.8%.

The author [16] has proposed a system in which depression has been detected from facial expression which has been captured through video. The author has applied a deep learning concept to implement the proposed system. 150 videos from AVEC 2013 and AVEC 2014 dataset have been used and experimentation has been carried out. The process of detection depression method requires a large amount of high-quality labelled training data. For depression detection, labelling data is expensive and normally, only limited labelled data is available for training deep models. Along with face body movements, audio and head movements can also be considered for input. The author [19] has stated an approach that uses these traits as input. The sample has been collected from 60 different subjects out of which 30 healthy subjects were also included. After receiving the input different techniques like LPQ and PHOG have been used to evaluate these traits and to extract the features PCA, LDA, Kernel PCA algorithm has been used. According to [20] the correlation study between head pose, smile and gaze for depression and they found the difference between lowest and highest depressed patients with the help of these three behaviours. Suicide rate in the young population is a major concern, the author [15] proposed the approach for the undergraduate students. The aim of the research is to identify depression at early stages to prevent sucide. This approach is based on survey questionnaires in the first section basic information of students need to be collected and in

the second section 16 questions relating to the reasons for depression along with this Beck Depression Inventory-II (BDI-II) scaling method and Depression Anxiety Stress Scales have been used. The accuracy of SVM and Random Forest algorithms are 73% and 75% respectively and the F-measure is 57% and 60%.

As discussed in the literature, face, head movements, voice can also be considered as biometric trait. In the literature we have seen the author has proposed a method in which these traits have been used to detect depression. For Face detection [18],[22],[23] has proposed different approaches and the accuracy of these approaches [24] are Local Binary Pattern (LBP) with 96.7%, Local Phase Quantisation (LPQ) with 95.3%, Phase-Only Correlation (POC), Local binary Patterns & Nearest Feature Space (LBP & NFS) with 72.5%, Local binary Pattern & Local Phase Quantisation (LBP & LPQ) with 98.3%. For Face identification: Eigenfaces and Fisherfaces approach can be used.

3.3 Performance Parameters

Performance parameters are used to measure the performance of the system. To detect the depression level, robustness is important. There are two variables that define the performance measure are accuracy and power of the classifier. The accuracy can be defined as the percentage of correctly = (True Positive + True Negative) / (True Positive + True Negative + False Positive + False Negative) is also called as TP, FN, FP and TN respectively. The authors [6],[10],[18],[21] have proposed depression detection approaches and discussed the accuracy, sensitivity and specificity for their proposed work. The author [24],[25] has suggested different performance parameters for prediction based systems and Biometric systems which are FAR or FMR, FRR or F NMR, EER or CER, Precision, recall, F1, Sensitivity, specificity, Mean absolute error,Root mean square error ,cross validation and accuracy as defined earlier. The accuracy, sensitivity & specificity are most likely to be considered performance parameters for the depression prediction system has been evaluated from the research paper and are listed below:

Table 1 Performance parameters of Prediction based system

Dataset	Modality /Biometric Trait	Classifier	Sensitivity	Specificity	Accuracy
667 participants (186 depressed patients and 481 normal) [11]	Image + Face	SVM	88%	84%	86%
Black Lion General Specialized Hospital Considering 39 attributes for Type-II Diabetes Patients [18]	1.Sociodemographic Factors 2. Clinical factors 3. Psychosocial factors	SVM	-	-	96.7%
		Fmean	-	-	95.45%
		PNN	-	-	93.75%
		Kmean	-	-	87.87%
Taiwanese Facial Expression Image Database [26]	Image + Face	Reaction Time Feature,	80%	80%	80%
Chinese Facial Affective Picture System (CFAPS) [27]	Face	Eye Movement Feature,	81%	-	81%
Negative and positive background images from IAPS and Google are chosen based on the Minnesota Multiphasic Personality Inventory (MMPI) [28]	Image + Face	Fusion Features (Using Machine Learning Classifiers)	76%	91.67%	83.67%
AVEC 2013 [29]	Face	LTrP	-	-	91.00%

4. CURRENT CHALLENGES AND ISSUES

The rate of depression is increasing day by day, as discussed earlier there are many factors that cause depression. The real challenge and issues in this research are listed below:

1. The medical field is the largest field to collect data in the initial stage as discussed earlier, mutual agreement needs to be made between the research institute and hospital / clinic.

2. The authenticity of the data is the primary requirement.

3. Since the hospital / clinic follows the interview (from questionnaires / scales) based procedure so possible the collected data may be present in the form of paper. Hence it is a time consuming procedure to convert that data online.

4. If the data is made available online then as discussed earlier then need to check for the missing values, authenticity etc.

5. Since depression comes in many forms with a variety of symptoms, possibly according to symptoms it is very difficult to categories the depression type.

6. To conduct the research in the medical field required statistics to get a closer view of diseases.

7. Lastly based on the statistics which group and which gender should be followed.

5. CONCLUSION

Mental disorders affecting the young generation according to numbers between 15 years to 49 years affected the most with Autism Spectrum Disorder and Depressive/Clinical Disorder. These numbers are increasing due to avail treatment for the correct time. These mental disorders are not easy to detect as they are associated with non visible symptoms as discussed in the literature. The visibility of symptoms has been discussed with the possible way of capturing those symptoms like features of face, gesture of body, voice & gait of a person etc. This paper has also reviewed various mental disorders along with treatment, the number of cases in India and correlated symptoms. The dataset in this research acts as an asset, as discussed two types of datasets can be used, the one readily available and the other one considered to be Biometric traits which can be captured face features, audio/ speech, gait etc. through the device. This paper assesses various Machine Learning techniques used to predict depression. We have reviewed models that use the datasets, questionnaires / scales to process the depressed patients using Image processing concepts and classify the depression level with the use of Machine Learning classifiers. The performance parameters of Biometrics and prediction systems have been disclosed.

REFERENCES

[1]. "WHO|Mental health", Who.int,2019,Accessed on:APRIL.3,2021,[Online] Available: https://www.who.int/health-topics/mental-health#tab=tab_1

[2] "Mental health in India - statistics & facts ",Published by Statista Research Department, Sep 16, 2020,Accessed on: APRIL. 3, 2021[online] Available: https://www.statista.com/topics/6944/mental-health-in-india

[3] Wang et al. Use of mental health services for anxiety, mood, and substance disorders in 17 countries in the WHO world mental health surveys. The Lancet. 2007; 370(9590):841-50.

[4] Nitesh Kumar, Vivek Jaglan and Akshat Agrawal, "A Review of various Face Prediction Models using Image Processing", International Journal of Computer Applications (0975 – 8887), Volume 142 – No.3, May 2016.

[5] Juan E. Tapia and Kevin W. Bowyer, "Gender Classification from the Same Iris Code Used for Recognition", IEEE Transaction, Vol. 11, No. 8, Aug 2016.

[6] Raid M. Khalil, Adel Al-Jumaily, "Machine Learning Based Prediction of Depression among Type 2 Diabetic Patients", 12th International Conference on Intelligent Systems and Knowledge Engineering (ISKE), 978-1-5386-1829-5/17/$31.00 , IEEE, 2017.

[7] "Mental health in India - statistics & facts ",Published by Statista Research Department, Sep 16, 2020,Accessed on: APRIL. 3, 2021[online] Available: https://www.statista.com/topics/6944/mental-health-in-india

[8] Swathy Krishna, Anju. J, "Different Approaches in Depression Analysis :A Review", 2020 International Conference on Computational Performance Evaluation (ComPE) North-Eastern Hill University, Shillong, Meghalaya, 978-1-7281-6644-5/20/IEEE, India. Jul 2-4, 2020

[9] "GDB Compare Viz Hub",Published by IHME Measuring what matters, Access on 7 May 2021[Online] Available: https://vizhub.healthdata.org/gbd-compare/vizhub.healthdata.org.

[10] Prajwal Kharel, Kalpana Sharma, Sunil Dhimal, Sital Sharma "Early Detection of Depression and Treatment Response Prediction using Machine Learning: A Review", Second International Conference on Advanced Computational and Communication Paradigms (ICACCP), IEEE Transaction, 2019

[11] Zeyu Pan, Huimin Ma, Lin Zhang ,Yahui Wang, "Depression Detection Based on Reaction Time and Eye Movement", 978-1-5386-6249-6/19/$31.00, ICIP ,IEEE, 2019.

[12] Madhurima Hooda, Aashie Roy Saxena, Dr. Madhulika, Babita Yadav, "A Study and Comparison of Prediction Algorithms for Depression Detection among Millennials: A Machine Learning Approach", International Conference on Current Trends in Computer, Electrical, Electronics and Communication (ICCTCEEC), 978-1-5386-3243-7/17, IEEE, 2017.

[13] I. Papakostas, "Managing partial response or nonresponse: switching, augmentation, and combination strategies for major depressive disorder." The Journal of clinical psychiatry, vol. 70, pp. 16–25, 2009.

[14] A. Pampouchidou et al., "Facial geometry and speech analysis for depression detection," 2017 39th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2017, pp. 1433-1436, doi: 10.1109/EMBC.2017.8037103.

[15] Ahnaf Atef Choudhury, Md. Rezwan Hassan Khan, Nabuat Zaman Nahim, Sadid Rafsun Tulon, Samiul Islam, Amitabha Chakrabarty,"Predicting Depression in Bangladeshi Undergraduates using Machine Learning", IEEE Procedings ,978-1-7281-0297-9,2019.

[16] W. C. de Melo, E. Granger and A. Hadid, "Depression Detection Based on Deep Distribution Learning," 2019 IEEE International Conference on Image Processing (ICIP), 2019, pp. 4544-4548, doi: 10.1109/ICIP.2019.8803467.

[17] Z. Jiang, S. Harati, A. Crowell, H. S. Mayberg, S. Nemati and G. D. Clifford, "Classifying Major Depressive Disorder and Response to Deep Brain Stimulation Over Time by Analyzing Facial Expressions," in IEEE Transactions on Biomedical Engineering, vol. 68, no. 2, pp. 664-672, Feb. 2021, doi: 10.1109/TBME.2020.3010472.

[18] Sakshi Goel, Akhil Kaushik and Kirtika Goel, "A Review Paper on Biometrics: Facial Recognition", International Journal of Scientific Research Engineering & Technology (IJSRET), Volume 1 Issue 5 pp 012-017 August 2012.

[19]Joshi, J., An automated framework for depression analysis. In Affective Computing and Intelligent Interaction (ACII), 2013 Humaine Association Conference on (pp. 630-635). IEEE,2013, September.

[20] S. Scherer ,"Automatic behavior descriptors for psychological disorder analysis," in Proc. IEEE Int. Conf. Autom. Face Gesture Recognit., Shanghai, China, pp. 1–8,2013.

[21] Ishita Bhakta,Arkaprabha Sau ,"Prediction of Depression among Senior Citizens using Machine Learning Classifiers",International Journal of Computer Applications 144(7):11-16,DOI: 10.5120/ijca2016910429, June 2016.

[22] Rajeshwar Dass, Ritu Rani and Dharmender Kumar, "Face Recognition Techniques: A Review", International Journal of Engineering Research and Development,vol. 4, Issue no. 7, pp. 70-78, 2012.

[23] Sheikh Ahmed Saleh and Kheng Cher Yeo, "An improved face recognition method using local binary pattern method" , 11 th International Conference on Intelligent Systems and Control (ISCO), 978-1-5090-2717-0/171$31 .00 ©2017 IEEE

[24] Shah A., Mishra D. (2018) A Review of Biometrics Modalities and Data Mining Algorithms. In: Perez G., Tiwari S., Trivedi M., Mishra K. (eds) Ambient Communications and Computer Systems. Advances in Intelligent Systems and Computing, vol 696.Springer,Singapore https://doi.org/10.1007/978-981-10-7386-1_51

[25] S. A. Rajesh, V. A. Bharadi and P. Jangid, "Performance improvement of complex plane based feature vector for online signature recognition using soft biometric features," 2015 International Conference on Communication, Information & Computing Technology (ICCICT), 2015, pp. 1-7, doi: 10.1109/ICCICT.2015.7045719.

[26] Wenyu Li, Huimin Ma, Xiang Wang, Dazhao Shi, "Features derived from behavioral experiments to distinguish mental healthy people from depressed people," ,DOI: 10.2316/P.2014.818-021,(818) Biomedical Engineering / 817: Robotics Applications - 2014

[27] X. Li, T. Cao, S. Sun, B. Hu and M. Ratcliffe, "Classification study on eye movement data: Towards a new approach in depression detection," 2016 IEEE Congress on Evolutionary Computation (CEC), 2016, pp. 1227-1232, doi: 10.1109/CEC.2016.7743927.

[28] Le C., Ma H., Wang Y. (2017) A Method for Extracting Eye Movement and Response Characteristics to Distinguish Depressed People. In: Zhao Y., Kong X., Taubman D. (eds) Image and Graphics. vol 10666. Springer, Cham. https://doi.org/10.1007/978-3-319-71607-7_43,ICIG 2017

[29] P. B. Kulkarni and M. M. Patil, "Clinical Depression Detection in Adolescent by Face," 2018 International Conference on Smart City and Emerging Technology (ICSCET), 2018, pp. 1-4, doi: 10.1109/ICSCET.2018.8537268.