AN EVALUATION OF MACHINE LEARNING TECHNIQUES IN PREDICTING DEPRESSION USING MOTION AND FACIAL EXPRESSIONS

[1]Tanvi Sharma, [2]Kakoli Banerjee, [3]Sonali Mathur

[1]M. Tech Student, [2]Associate Professor, [3]Assistant Professor,
[1]Department of Computer Science and Engineering,
[1]JSS Academy of Technical Education, Noida, India.

Abstract: Depression or depressive disorder is a mental disorder that is prevalent in current times. Some of the time people feel down or low in their lives. However, when this inclination perseveres for longer time, it influences general intellectual capacity of the mind. It may prompt some genuine cerebrum working handicaps, for example, alarm assaults, tension, dread and so on. Wretchedness is not quite the same as misery/pain. It is regularly accepted that downturn is a consequence of substance awkwardness however that doesn't catch the unpredictability of the illness. Moreover, misery contributes significantly to the worldwide weight of malady and impacts individuals in each and every society around the globe. While the worldwide weight of misery presents a significant challenge to general wellbeing, at the clinical level, at the financial level, and at the social level, there are several evidence-based and distinct approaches that can efficiently tackle or reduce this burden. Understanding mechanisms that contribute to chronic impairment induced by significant depressive disorder is still not known. Therefore, in recent years, Machine Learning (ML) methods have appeared as interesting techniques to address such complicated issues. This study describes the current functionality procedures of distinct methods, including some models with distinct parameters, benefits, and drawbacks. The primary focus of this paper is to underscore a relative examination of methods that can be used for overall identification and assessment of depression. The purpose of this study is to present a better and more effective assessment of different methods to propose the best procedure from all current methods. Moreover, this research work presents comparison of the features and techniques that are used in prediction of depression. Also, the point of this paper is to explore to accomplish better customized treatment for the indications of melancholy.

Keywords: Depression, Machine Learning, Vocal, Motion and Facial Expressions, Depression Detection.

I. INTRODUCTION

Now a days the lifestyle of people has been enormously changed and the quantity of hysteria patients, especially the people who are in melancholy, has been on the ascent with the high evolution of social and intelligent advancement [6]. As indicated by The World Health Organization (WHO), a solid individual ought to have a sound personality alongside physical wellness. Changes in emotional well-being and manners of thinking are of the most significant age-related changes among the individuals throughout the world. Tension and melancholy are the two significant emotional wellness issues related to it [9]. Today, misery is evaluated to influence 350 million individuals. It was found that out of 20 people reported at least one individual reported having a scene of demoralization in 17 countries by The World Mental Health Survey [6]. The WHO predicts that the downturn will turn into the main source of sickness within years. Melancholy is widely recognized, impairing psychological issues, and have solid antagonistic impacts on individual and societal working. This issue can occur at any age [11]. Depression is defined as an ordinary psychological problem which presents with disheartened perspective, loss of interest or delight, poor concentration, estimations of fault or low confidence, Hunger, or diminished vitality [25]. Additionally, depression regularly accompanies manifestations of uneasiness. These issues can end up incessant or repetitive and lead to generous weaknesses in a person's capacity to deal with their ordinary obligations. Worst case scenario, wretchedness can prompt suicide. As each individual commit suicide, at least 20 may endeavor to end their life (WHO, 2012) [28].

While despondency is the principle source of incapacity for the both females and guys, the weight of misery is half higher for females than males (WHO, 2008). Truth be told, melancholy is the main source of illness trouble for ladies in both high-pay and low center salary nations (WHO, 2008) [15]. Ongoing examination [18] demonstrates that having a low pay demonstrates an expanded possibility of having a significant burdensome issue. The greater part of the individuals that get treatment for melancholy doesn't recover from it. The sickness still stays with the individual. This might be as a sleeping disorder, over the top resting, weakness, loss of vitality or stomach related problems [5]. Research in creating nations recommends that maternal discouragement might be a hazard factor for poor development of small kids. The factor can imply the motherly psychological well-being in cheap salary nations might impact development during youth, with the impacts of melancholy influencing this age as well as the next [28]. Artificial insight and scientific displaying procedures continuously acquainted in emotional well-being research with an attempt and explain this issue. The emotional well-being zone can benefit from these strategies, as they comprehend the significance of getting detailed data to describe the diverse mental issues [5]. There are different techniques utilized for forecast of depression, for example, facial pictures, discourse tones and so on. Be that as it may, a large portion of the progressing enquires depend in use of a specific particular technique. An examination for various techniques needed to come up with the precise forecast technique [3].

Feeling analysis has appeared to be a viable study perspective to display burdensome issue. Late false displaying techniques for programmed feeling examination for sadness related issues are broad [8]. The face can viably convey feelings to other individuals using outward appearances. It contains the mix of face features for every appearance [12], utilized as apparatus to identify the passionate condition of an individual by the facial features. Another way to deal with group feeling through outward appearances

is utilizing neighborhood and comprehensive component descriptors [11]. Not at all like FACS, these systems manage the entire look the equivalent, search for examples completely, and not only for specific features. Still, melancholy issue isn't obliged to be imparted by the face, passionate body developments and motions has indicated to be seen by progression of examinations utilizing patients [13].

The majority of this exploration is proved by the arrangement of global Audio/Visual Emotion Recognition Challenges (AVEC2014 and AVEC2016). The issue gives a data file that has ample video substance holding contents which experience the ill effects of sorrow. Tests comprise of visible and spoken information, the outward appearances or feelings through the voice is caught cautiously by intellectual point of view. The goal is to impart and decipher feelings through articulations utilizing different modalities [4]. Effective AI ways to deal with despondency identification are depended on feature engineering, for example, theme displaying dependent regarding the subject's reactions to explicit kinds of inquiries, or on simply information-driven start to finish prepared profound neural system models which endeavor to misuse worldwide and additionally time-fluctuating statistics [2], melancholy recognition disappointment could be because of absence of assets & prepared consideration suppliers. In spite of the logical examinations that have just been led, surprisingly little development has happened for the burdensome issue. The board analytic strategy depends on the indicative and factual manual of mental issue (DSM) criteria.

II.   LITERATURE SURVEY

Artificial intelligence (ML)- based insightful models are continuously progressively for merging colossal proportion of data into one model and are improved for evaluating the model's farsighted cause for effectively obscure individuals. AI methodologies have been successfully used to anticipate MDD, chronicity, and reality, similarly as treatment response, suicide endeavors and first and fresh start of MDD scenes. These investigations saw the most significant factors as extreme as outrageous dysphoria, design Quick Inventory of Depressive Symptomatology (QIDS) full-scale reality score, male sex, lifetime hopelessness screen, and family heritage. Desire models in these examinations relied upon clinical and measurement factors and excluded natural measures. Common measures, for instance, blood and spit decided natural measures, may be related to the covered-up pathophysiology of wretchedness and along these lines may have prognostic motivation for disease course. Regardless, starting at now they are not being routinely used and their sufficiency for the gauge is yet to be set up. In the present examination, we expanded past assessments anticipated perceiving markers of the naturalistic course of discouragement by including extra mental and natural pointers and by using a novel quality assurance approach that is expected to pick the perfect game plan of basic judicious elements from a multivariate ML model.

The Prescient examination is the way toward gaining from authentic information to make predictions (or any obscure). For the forecast of wretchedness, the prescient examination will empower the best choices to be made, taking into consideration care to be taken for every person [8]. This section shows a review on different techniques for predicting and identifying melancholy in the individuals.

[7] constructed model of speech features related to gloom utilizing classifier from a mental point of view.

[23] gave a one of a kind component to the video, feature vector progressions are applied by proposed FDHH. [8] separated and characterized user feeling features dependent on the LSTM system paradigm and applied them to prenatal misery put out situations. explored the ampleness of ACT on misery decrease and further investigate the association between different follow-up periods, unmistakable degree of misery, and various time of patients through subgroup examination.

[2], 2019 proposed a novel strategy that joins an information expansion method dependent on subject displaying utilizing mechanism and profound 1D CNN system for audial component demonstrating.

Min gave reported structure of Big Black Dog, a cellphone-based framework for get-together information about social and rest practices. Similarly expounded on the results of a pilot evaluation to grasp the common sense of social event and using data from phones for interpreting the start of the downturn.

Pantic reported on the advancement of building a framework that empowers completely robotized quick and powerful outward appearance identification from visual video. Investigated unpretentious variation in visual appearance, perceiving face feature activity parts & breaking down their performance. Recognizing parts from visual video, we empower the examination of different visual gestures inclusive of outward appearances of mood, feeling, and thoughts.

Table 1: Related Work on Comparison of Various Approaches of Predicting Depression

S. N o.	Paper	Techniques	Features	Methodology	Advantages	Disadvantages
1.	A Novel Method Design Using Speech Analysis for Diagnosis of Depression Psychological Symptoms [23].	AI techniques and discourse speech signal strategies for discouraging speech.	Depressed Speech Features.	Constructed model of speech features related to gloom utilizing classifier from a mental point of view.	Gives innovation and technique for analysis and early screening in misery.	The exactness of Speech-based feeling acknowledgment has been addressed and it is hard to make an obsessive judgment.
2.	Automatic Depression Analysis for Relative Body Parts	Training the Support Vector Machine.	Facial elements like shoulder and head movement and	Proposed a framework which combines the comprehensive body movement-based	Maintained the spatial information and solve the	Manual note of the points is needed to train an AAM, whenever an issue

	Movement [16].		vocal highlights like pitch.	group of words approach with the body parts movement designs.	vagueness in polar histograms.	is put into the database.
3.	Automatic Depression Level Analysis for AI System through Vocal and Visual Expressions [14].	Deep learning techniques for visual highlights, for vocal articulations and Feature Dynamic History Histogram to catch transient movement.	Vocal highlights as sound fragments, visual highlights as gestures and facial.	To give a one of a kind of component to the video, feature vector progressions is applied by proposed FDHH.	The application has achieved an exceptional performance.	The size of misery is restricted to the questions asked which affected the system performance.
4.	A Machine Learning Application: Collation and Study of Prediction Algorithms for Depression Identification [12].	Using machine learning methods and classifiers, using WEKA and by imaging and risk factors.	Features like age sex, education, physical and mental health, country etc.	A product created called WEKA, is utilized in AI classifiers, techniques and hazard factors. It is utilized for characterization and to anticipate misery among individuals.	Linear method used to avoid complexity in machine learning methods.	Cross-Validation technique is exceptionally temperamental and variant. Feature reduction technique demonstrates a high variation.
5.	Multi-Modal Depression Detection for Context-Aware Deep Learning [7].	AI methodologies such as context-aware analysis through deep neural systems.	Sound and content modalities.	Proposed a novel strategy that joins an information expansion method dependent on subject displaying utilizing mechanism and profound 1D CNN system for audial component demonstrating.	A data acquisition framework dependent on topic modeling made a bigger, increasingly adjusted dataset and expands the vigor of prepared models.	Constrained accessibility and high-class variability of information.
6.	Prediction of Family History of Depression using Machine Learning [21].	Executed logistic regression-based regularization, support vector machine, and convolutional neural system.	Family ancestry of misery.	Proposed an information-driven, fair, and thorough AI approach utilizing multimodal cerebrum highlights to catch the perplexing portrayals of mind structure.	It can be used for hypothesis-generating tool, rigorous exploratory and to overcome a biased analytic method.	Small sample size.
7.	Predicting Depression and Anxiety Using Machine Learning Technology in Older Patients [23].	Machine learning technique such as random forest classifier.	Extract features like residence, age, sex, employment status, history of depression, insomnia, etc.	Ten classifiers were assessed with an informational index of 510 geriatric patients and tried with ten times cross-approval strategy.	Highest predictive precision.	Random forest classifier is difficult and complex to construct.
8.	Automatic Depression Analysis using Machine Learning Techniques [26].	Support vector classifier.	Appearance-based low-level highlights.	Built-up a robotized structure for straight out discouragement assessment dependent on low-level highlights.	Accomplished an F1 score of 81.93%.	Less tests and less extracted features reduced the performance of the system.
9.	Deep Learning-Based Sentiment Analysis and Perinatal Depression Screening Applications [36].	LSTM network and deep learning model.	User emotion features classified.	We separated and characterized user feeling features dependent on the LSTM system paradigm and applied them to prenatal misery put out situations.	It abbreviates the screening time and diminishes the specialist persistent correspondence costs.	Slope vanishing, detonating issues etc.

10.	A Systematic Review and Meta-Analysis to Reduce Depression using Acceptance and Commitment Therapy (ACT) [4].	Depression reduced by using Acceptance and Commitment Therapy.	Behavior change methodologies, to increment mental adaptability.	Two reviewers screened for qualified examinations, extricated information, and evaluated the risk of bias of the included examinations. Review Manager 5.3 Software was used for the meta investigation.	Decreased burdensome side effects.	A large portion of the particular strategies for random sequence generation and designation covering were not clear.

Table 1 incorporates the different research work in the field of depression detection and their principle target is included with the objectives involved.

III.   DISCUSSION

Machine learning technology is another promise for the improvement of a robotized sickness indicative framework. Analysts from medicinal and engineering fields are attempting to address this issue together. The past investigations that utilized three significant strategies for the forecast of depression have various results while utilizing AI classifiers and WEKA, the steadiest technique is Bayes Net categorizer. Bolster vector machines being widely recognized machine learning technique, it is the most well-known because of its insensitivity toward high dimensional information. Be that as it may, there is still fluctuation for whether a direct or nonlinear learning strategy was utilized. As a result, the direct learning technique ought to be utilized to avoid complexity [15]. While utilizing Feature reduction strategy, it demonstrates a big variety in choice of quality limiting techniques. Low test sizes are utilized in the previous investigations while execution of quality limiting strategy increments accompanied by increment to a test sample. Thus, needs additional validation. Cross-Validation strategy used for little test sizes and when given huge scale information, is exceptionally problematic and variated. Speech-based feeling acknowledgment experiences a ton of troubles and it is progressively hard to make an obsessive judgment. Subsequently, it is essential to open up new research thoughts based on past examinations. [7]

In this paper, it is concluded that different characteristics of misery were used to predict depression. There are multiple features that are used, extracted and processed to predict the level of depression. So, different features of depression are compared to find out which features can predict depression better. Therefore, the various features that are utilized in this paper are voice, pitch, facial expressions like emotions, body gestures, head or shoulder movement, family ancestral history, hormonal changes like pregnancy, insomnia, age, sex, income, sleep hours etc. [7] used depressed speech in their work, [3] used features like age, sex, education, physical and mental health, country etc., Liu et al. used family ancestry of misery as the feature, [10] classified user emotion feature etc. Figure 1 shows that family ancestry depression proved better in predicting depression in comparison to other features. However, combination of the features can prove to be more coherent in prediction of depression.
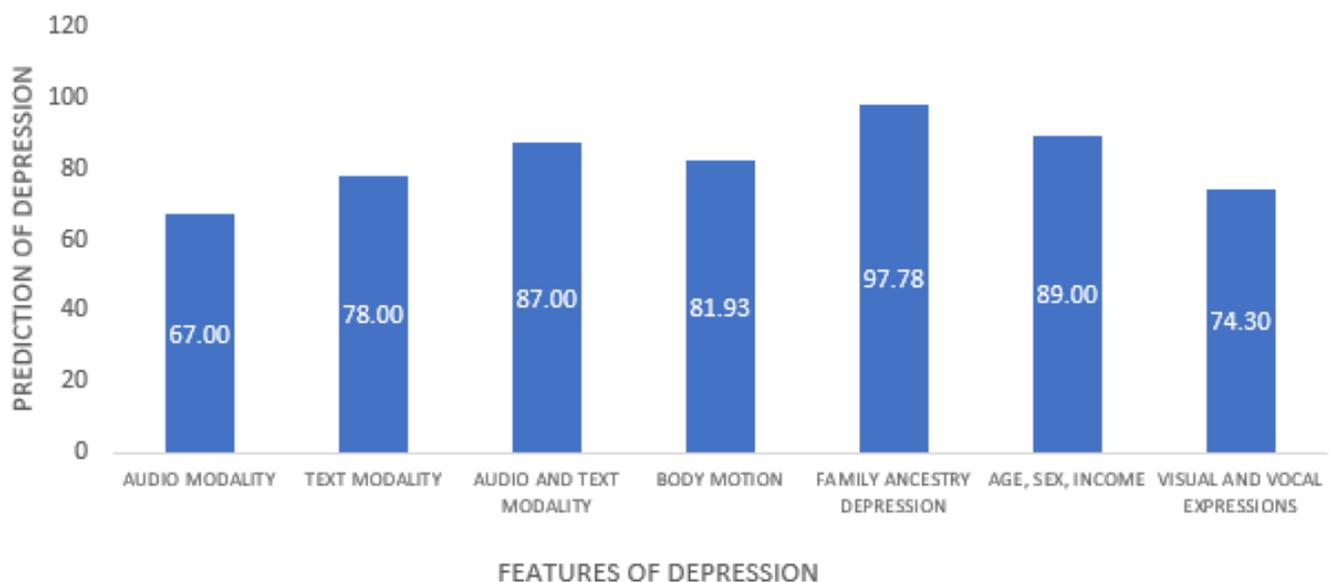

Figure 1: Prediction of depression with the help of various features

This research work also tried to find out which technique for depression detection is better. So, Machine Learning and Artificial Neural Network techniques have been compared. Both the techniques are compared on the basis of their accuracies and F1 scores. Accuracy is the proportion of all the accurately recognized cases whereas F1 score is the symphonious mean of precision and recall and gives better result for incorrect classified cases.

$$Accuracy = \frac{True\ Positive + True\ Negative}{(True\ Positive + False\ Positive + True\ Negative + False\ Negative)} \qquad (1)$$

Equation 1. calculates the accuracy with true positive and true negative divided by all the outcomes. True Positive is the result in which the model forecasts the positive samples while True Negative is the result in which the model forecasts only the negative samples. False positive is the result in which the model incorrectly forecasts the positive samples whereas False Negative is the result where model incorrectly predicts the negative samples.

$$F1\text{-score} = \frac{(Recall^{-1} + Precision^{-1})^{-1}}{2} = 2 * \frac{(Precision * Recall)}{(Precision + Recall)} \qquad (2)$$

Equation 2. calculates the F1- score which is obtained by multiplying 2 with precision and recall.

$$Precision = \frac{True\ Positive}{(True\ Positive + False\ Negative)} \qquad (3)$$

$$Recall = \frac{True\ Positive}{(True\ Positive + False\ Positive)} \qquad (4)$$

Equation 3. gives true positive divided by true positive and false negative which is precision. Whereas, Equation 4. Gives true positive divided by true positive and false positive which is recall.

While using machine learning techniques, [8] used SVM classifier with the help of facial motions to detect depression. It used MHI and GMHI methods for facial motion extraction. The advantage of this classifier is that it accomplished 81.93 F1 score but less extracted features reduced the performance of the system. [1] used Random Forest classifier which extracts features like age, sex, employment status, history of depression, insomnia etc. In this classifier, ten classifiers were assessed with an informational index of 510 geriatric patients and tried with ten times cross-approval strategy. Random forest classifier (RF) obtained the highest prediction accuracy of 89.00%. But it is complex to construct. [6] used logistic regression-based regularization, support vector machine, and convolutional neural system and got accuracy 97.20%, 93.67% and 89.58% respectively. It can be used to overcome a biased analytic method but it has small sample size.

However, while using artificial neural network techniques, [2] used AI methodologies such as context-aware analysis through deep neural systems and extracted sound and content modalities. For the sound just methodology, the CNN accomplished a F1 score of 67.00 for the text-only modality. Transformer model accomplished a F1 score of 78.00 and for the varied-modular situation, feedforward network accomplished a F1 score of 87.00 but has high-class variability of information.
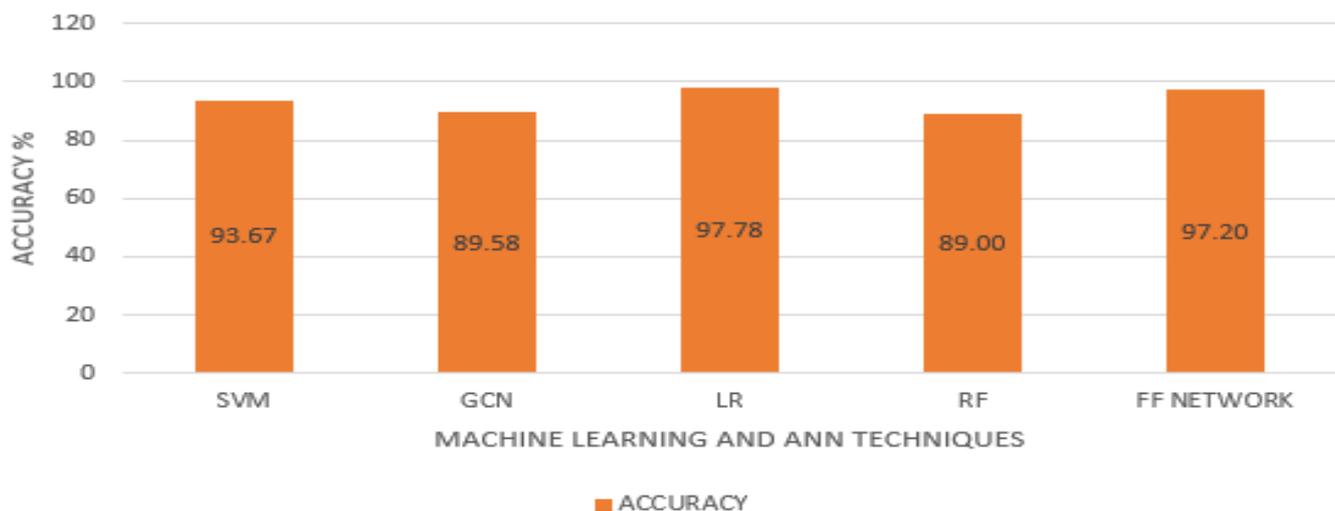

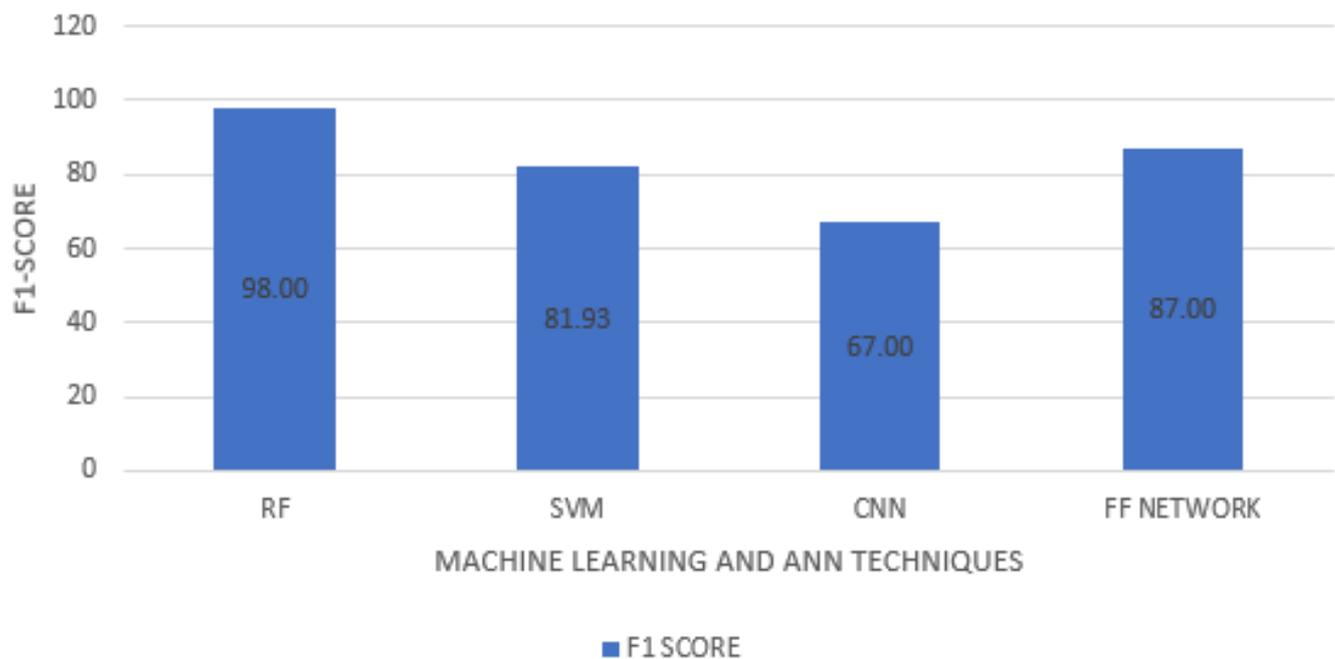Figure 2: Depicts the accuracy of machine learning and ANN techniques

Figure 3 Depicts the F1 score of machine learning and ANN techniques

Table 2. Comparison of approaches with their accuracies

Approach	Accuracy %
Support Vector Machine	93.67
Random Forest	89.00
Logistic Regression	97.78
Graph Convolutional Network	89.58
Feed Forward Network	97.20

Table 3. Comparison of approaches with their F1 scores

Approach	F1 Score
Support Vector Machine	81.93
Random Forest	98.00
Feed Forward Network	87.00
Convolutional Neural Network	67.00

Therefore, from the above observations, it can be concluded that machine learning methods give better performance for depression detection as compared to deep learning methods. However, the above-mentioned models and methods focus on how to increase the exactness rate. But the accuracy rate fluctuates with change in parameters and other ecological conditions. Moreover, the utilization of various parameters (Vocal highlights as sound, visual highlights as gestures and facial etc.) together with artificial intelligence can give better prediction outcomes in depression detection.

IV. Conclusion

In contrast to enormous scale worldwide issues, an answer for misery is within reach. Useful and financially savvy medicines are accessible to improve the wellbeing and the lives of a large number of individuals around the globe experiencing melancholy. On a personal, network level, the opportunity has come to instruct individually regarding melancholy, also bolster the individuals who are experiencing this psychological issue. Older people are less inclined to contact psychological well-being experts for potential depression manifestations compared with moderately aged people. Specifically, old people in the most minimal income group were more averse to utilize psychological mental health services contrasted with the highest salary group. Few strategies in the wake of examining AI categorizer, the steady, exact strategy is Bayes net Classifier for testing. Different methods have some advantages and limitations like high accuracy, exceptional performance, small sample size etc. So, Machine learning methods demonstrate to accomplish competitively.

Machine Learning techniques have been applied to examine affective display differences exhibited during emotion states, such as facial expression and vocal prosody, through audio and video-based analysis. These advances have generated a new field of research which has successfully used ML techniques, such as support vector machines and neural networks, for automatic recognition of emotion using audio visual data from conventional databases and recently more naturalistic environments. Moreover, ML has also been extended to investigate verbal and nonverbal affective abnormalities associated with psychiatric disorders and has gone on to successfully classify those presenting with and without a given diagnosis. Also, ML methods have reliably demonstrated an increase in prediction accuracy when compared with older, more conventional statistical techniques or physician-based expert systems. Moreover, machine learning methods gave good accuracy in comparison with deep learning techniques.

However, the majority of current algorithms still require some level of human intervention such as labor-intensive manual labelling or hand classification of data in order to extract useful features prior to analysis. These steps render current algorithms-based analysis time-consuming as well, ultimately hampering feasible application of current ML techniques in clinical settings. Furthermore, this paper will help to build a system that can predict real-time depression in individuals and could predict depression before the person actually gets into depression. Also, this research work presented comparison between the features and techniques and found out on the basis of the comparison that feature like family history of depression and machine learning techniques helped better to predict depression. In addition to it, this study can be helpful for those researchers who want to predict depression among people with this comparative study of the techniques used in detecting misery.

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