WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Multimodal Approaches for Depression Detection: A Comprehensive Review

Harini S[1], Bhuvana R[2]

[1]Information Science and Engineering, BMS College of Engineering, Bangalore, India harinis.ise@bmsce.ac.in
[2]Information Science and Engineering, BMS College Of Engineering. Bangalore, India. bhuvana.r98@gmail.com

ABSTRACT—

Depression is a major worldwide health concern that requires creative approaches to successful early detection and treatment. This paper examines the relationship between psychiatry and technology, with a particular emphasis on developments in techniques for diagnosing depression. The psychiatric landscape is changing in the direction of individualized, easily available, and effective mental health care with the advent of wearable technology, artificial intelligence, and smartphone applications. The literature review covers novel technologies, conventional diagnostic techniques, and artificial intelligence integration for predictive modeling. The potential of wearable technology for ongoing patient monitoring is being explored, and the use of social media data opens up new possibilities for mental health evaluation. The possibility of smartphone applications with emotion recognition and neuro-linguistic programming to offer precise and individualised depression therapy is investigated. This review provides insights into the effects of technology-driven approaches on the psychiatric landscape by critically analyzing the benefits and drawbacks of these approaches. The goal of the synthesis of existing information is to serve as a roadmap for future research attempts and cooperative efforts to improve mental health treatment, assisting clinicians, researchers, and policymakers. In order to improve patient outcomes, the review ends with a forward-looking outlook, predicting the ongoing incorporation of technology into depression detection and treatment.

Keywords— *Depression, Psychiatry, Technology, Wearable technology, Artificial intelligence, Machine Learning, Smartphone applications, Mental health care, Diagnosis.*

Introduction

A prevalent and crippling mental illness that affects millions of people globally is depression. The prevalence of depression throughout the world and its profound effects on social functioning and individual well-being highlight the urgent need for novel methods of diagnosing, tracking, and treating the condition. Technological developments in the mental health profession have created new opportunities in recent years, with promising paths for early intervention and better patient outcomes.

An estimated 3.8% of people suffer from depression, including 5.7% of individuals over 60 and 5% of adults (4% of males and 6% of women). Depression affects about 280 million people worldwide. Women are around 50% more likely than men to experience depression. Over 10% of women who are pregnant or recently gave birth experience depression globally. An estimated 700,000 people lose their lives to suicide each year. The fourth most common cause of mortality for people aged 15 to 29 is suicide.

Despite the fact that there are proven, efficient treatments for mental illnesses, over 75% of people in low- and middle-income nations do not obtain care. The societal stigma attached to mental illnesses, a shortage of skilled healthcare professionals, and a lack of funding for mental health services are all obstacles to providing effective therapy.

This review article seeks to offer a thorough examination of the rapidly changing field of technologically aided depression detection, with particular attention to advancements in wearable technology, artificial intelligence, and smartphone apps. The interaction of technology and psychiatry has made it possible to develop innovative techniques that go beyond conventional clinical methods, allowing for quick interventions, ongoing monitoring, and individualized therapy. This review aims to provide insights into the possible advantages and difficulties of technology-driven solutions for depression identification by conducting a thorough literature review and critical analysis.

This review's main points of emphasis include the development of cutting-edge technology in mental health care, the application of artificial intelligence to predictive modeling, and an analysis of conventional approaches to the diagnosis and treatment of depression. The potential of wearable technologies to transform the psychiatric environment is discussed, along with their function in continuous patient monitoring and the use of social media data for mental health assessment. Additionally, the paper explores the usage of smartphone applications that make use of advanced capabilities like emotion detection and neuro-linguistic programming in order to give depression sufferers precise and individualized therapies.

It is critical for academics, clinicians, and policymakers to comprehend the current status of the field as we negotiate the intricate interactions between technology and mental health. In addition to summarizing the body of research, this review attempts to provide an outlook on the direction that depression detection and treatment will go in the future. Through a critical analysis of the advantages and disadvantages of different approaches and technology, our goal is to lay the groundwork for future research projects and cooperative efforts aimed at improving mental health services.

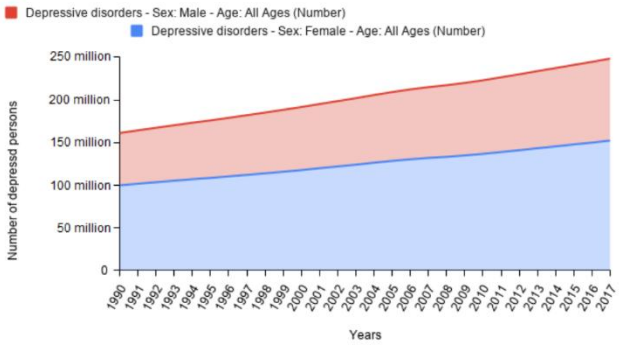

Fig 1. No. of people suffering from Depression from 1990-2017

Literature Review

Faming Yin [1] presents a unique deep learning model for automated depression identification through speech analysis in an effort to address the widespread threat that depression poses to people's health and quality of life. In order to capture temporal sequential information, the model combines a transformer module with a parallel convolutional neural network (parallel-CNN) module that emphasizes local knowledge. In contrast to previous research that focuses mostly on stacking deep networks, our method seeks to get over any potential drawbacks in voice representation of depression. The suggested model outperforms state-of-the-art techniques in experimental evaluations on the DAIC-WOZ and MODMA datasets, demonstrating its effectiveness in enhancing audio-based depression identification.

The increasing incidence of depression, which is expected to rank as the second most common cause of disability by 2030, highlights the need for easily accessible screening techniques. In this paper, Bhanusree Yalamanchili [2] presents an automated method for training a classification model to discriminate between people with and without depression based on acoustic characteristics. Prosodic, spectral, and voice control features are retrieved and combined using the DIAC-WOZ database. The Synthetic Minority Over-sampling Technique (SMOTE) is used to address class imbalance, while the Depression Classification Model (DCM) uses the SVM algorithm to achieve 93% accuracy. A qualified psychiatrist oversees 50 individuals in real-time testing of the cureD android application, which is designed for self-assessment utilizing DCM and the PHQ-8 questionnaire. The application has demonstrated 90% accuracy in testing. This strategy has potential for accurate and approachable depression

These days, anxiety and mental health problems are becoming more and more common. This affects people's capacity to perform daily tasks and can have serious repercussions, including eating disorders, personality disorders, eating disorders, trauma-related conditions, and suicide. A approach to identify depression based on speech analysis is proposed by Dimple Muskan Shukla [3], who recognizes the vital necessity for timely intervention. The research uses a feedforward neural network, a deep supervised learning technique, to extract statistical and energetic data from speech signals in order to distinguish between persons who are depressed and those who are not. This strategy may enable quick and early diagnosis, providing a route to treatment that can lessen mental trauma, stop suicides, and lower the risk of serious illnesses linked to extended

A closer look into artificial intelligence's (AI) possible effects on psychological and mental health has been warranted by the technology's growing importance in a number of industries, most notably healthcare. Several research show how AI-powered tools and therapies help people overcome significant psychological issues including stress, anxiety, and depression, upending traditional therapy techniques. Comprehensive study is necessary despite the transformative potential of AI in mental health due to ethical and accessibility problems. With a sample size of 197 patients dealing with various psychological and mental health conditions, this study [4] investigates elements such chatbots and other AI-driven conversational tools, remote patient monitoring, AI-based individualized counseling, and rapid and simple diagnosis. This study attempts to address ethical issues and provide nuanced viewpoints on using AI to improve mental health care.

The present research on the use of conversational agents, or chatbots, in psychiatry is examined in this literature review, with particular attention to how these tools are used for mental health screening, diagnosis, and therapy. A thorough literature search spanning PubMed, EmBase, PsycINFO, Cochrane, Web of Science, and IEEE Xplore was conducted in June 2018 by Aditya Nrusimha Vaidyam [5]. The search produced 1466 records, with 8 papers matching inclusion criteria. A total of 10 research were included after an additional 2 studies were found through reference list filtering. Consistently, the results show how very promising conversational agents are for use in psychiatric settings, especially for self-adherence and psychoeducation. Furthermore, the research' satisfaction scores show that chatbots are useful and pleasurable tools for mental health treatment. Nonetheless, additional research with standardized outcomes reporting is necessary for a thorough evaluation of the efficacy of conversational agents in mental health,

considering the variability of the examined studies. However, with the right strategy and ongoing study, this survey highlights the bright future for using chatbots in mental treatment.

The World Health Organization has identified depression as the world's most disabling disease, and this article [6] discusses the important problem of depression and the related social concerns. In order to address the increasing nursing demands of patients suffering from depression, the study draws attention to the current scarcity of medical and nursing personnel in the field of psychiatry. The survey offers a remedy in the form of the MEMO box system, a health management assistant that concentrates on the emotional side of depression. This technology gathers multi-mode patient data through an electronic medicine box and mobile applications, laying the groundwork for health support. The MEMO box system provides patient health services quickly by utilizing algorithms for emotion identification and exercise advice that are deployed in the edge cloud. It promotes timely medication adherence by the integration of hardware and software, which is essential for the efficient control of persistent depression. This novel strategy aims to close the gap between the increasing needs of depressed patients and the availability of healthcare resources by highlighting the importance of emotional well-being in health monitoring.

The important role that machine learning will play in transforming healthcare is examined in this study by T Piyush Kumare [7], especially when combined with the Internet of Things (IoT). While machine learning has shown impressive outcomes across a range of scientific and technological fields, treatment and prediction issues persist in the field of mental illness. Psychologists provide assessments and therapy, however there is uncertainty around treatment, and antidepressant medicines are not always effective in treating mental diseases. In order to close this gap, our research applies machine learning algorithms—Logistic Regression, Support Vector Machine (SVM), Decision Tree, K-Nearest Neighbor, and Naïve-Bayes—to a Kaggle dataset consisting of 334 samples and 31 fields pertaining to mental health and unemployment. In addition to highlighting the promise of IoT in healthcare, this study advances our understanding of how machine learning may be applied to forecast mental diseases. It also provides insightful information for future research and applications in the field of mental health prediction and treatment.

The complicated nature of depression—a mental illness influenced by a variety of elements like daily stress, physical activity, and diseases—is examined in this research by JI-WON BAEK and KYUNGYONG CHUNG [8]. Depression is a mental illness that manifests in symptoms like persistent depression, sleep difficulties, and suicidal thoughts. Using multiple-regression analysis, this work suggests a novel method to predict depression risk: the context-DNN model. Accurate prediction and management are crucial in mental healthcare. The context-DNN model attempts to anticipate circumstances and settings impacting depression, in contrast to previous research that mostly concentrates on predicting depression based on voice, word choice, and conversation length. The DNN receives all context data associated with predictor variables as input, and its output is a depression prediction. Regression analysis is used by the model for the DNN connection, which provides better results for both regression and comparison assessments. This novel method advances our knowledge of depression and its prognosis in the larger framework of mental health treatment.

A lack of knowledge, a shortage of medical specialists, and social stigmas are some of the obstacles that frequently prevent depression, a common and recurrent illness with major consequences, from receiving the appropriate treatment. Healthcare systems have resorted to technological solutions as a result of their recognition of the growing influence of technology in numerous industries. Many research, including this one [9], show that smartphones may be used to predict and cure depression by proposing activities. EmoCure, our suggested remedy, is a smartphone application that uses wearable sensor data, patient history, social media data, and usage habits to forecast, track, and treat depression through emotion-regulating activities. The program makes use of ensemble learning to forecast depression and machine learning models to assess attitudes in social media posts. EmoCure then illustrates the prospective integration of technology in mental health care by suggesting customized emotion-regulating exercises depending on user preferences.

Depression is defined by mood disorders that affect how people think. It can worsen negative thinking and excessive reflection on life's hardships, which can eventually lead to suicide thoughts. Depression is a treatable illness, despite its severity. Even when they work, traditional conventional medicines take a long time to show benefits. In response, Syed M. Nabeel Mustafa's Anti Depression and Anti Suicidal application [10] offers a cutting-edge substitute for conventional therapies by utilizing neuro-linguistic programming. With the help of Microsoft cognitive services, the application's strong emotion detection features have been improved. Its goal is to help users fight depression by offering precise therapy. This creative method highlights how technology can provide more effective and easily accessible mental health treatments.

This project aims to prevent suicidal attempts by identifying depression symptoms, a critical issue as suicide is frequently associated with untreated depression. Kulasinghe S. A. S. A. [11], acknowledging the therapeutic benefits of discussing emotions, the system integrates a chatbot to facilitate user engagement. The chatbot uses speech and text analysis to learn about users' feelings. To better comprehend the user's mental state, the application also examines recent browser history and Facebook status updates. By combining data from all the components, the back-end processing enables the Chat-bot to respond as the system sees fit. This all-encompassing strategy pays off, as evidenced by the product's over 75% accuracy in every component and its potential influence on early intervention and mental health support.

Artificial intelligence (AI) is being included into behavioral health interventions to address major issues in identifying individuals who require psychological assistance. This is especially true for early depression diagnosis. Many people are left unrecognized and at danger because to obstacles like expense, distance, stigma, and a lack of health workers. The purpose of this project [12] is to evaluate the viability and effectiveness of using chatbots powered by AI to identify depression in its early stages. The Hamilton Depression Scale and the inventory of depressive symptomatology serve as inspiration for the structured interview guide used by the Dialogflow-developed DEPRA chatbot. Ten participants in a focus group, comprising academics and HDR candidates, help train Dialogflow to provide more accurate and varied responses. Fifty people are involved in the non-clinical

research, which integrates DEPRA with a social media platform for accessibility. With a high overall satisfaction rate of 79%, the data demonstrate promising outcomes for early depression identification using scientific scoring systems ,QIDS-SR and IDS-SR.

In order to reduce the danger of suicide, this paper [13] offers an extensive overview of the techniques used to forecast depression in people. It emphasizes the vital significance of early identification. Since depression affects a large number of people worldwide, this study looks at several approaches, strategies, and algorithms used to predict depression. The study explores the many forms of depression and the corresponding methods for prediction. Three main parts make up the developed system: sentiment analysis, EEG signal processing and diagnosis, and a question-and-answer section. The system provides a comprehensive method for predicting depression by utilizing machine learning methods like Naïve Bayes and Neural Network for data classification. This can help with prompt intervention and perhaps save lives.

With over 300 million individuals affected globally and 7.5% of Indians suffering from a mental illness, the prevalence of depression is a major worry. 2015 had the greatest number of cases of depressive disorder in India, underscoring the seriousness of the illness and its link to suicide. Social stigma, ignorance, and a lack of medical specialists are obstacles in the treatment of depression. Particularly for mental health concerns, mobile phone technology presents a potential path for easily accessible and reasonably priced healthcare. This document promotes the use of this domain's best practices to enhance patient outcomes. Furthermore, the widespread usage of social media in today's world—especially in India, where millions of people have access to the internet and use a variety of platforms—offers the chance to analyze social media data to comprehend and forecast people's mental states. In addition to reviewing current depression prediction systems, Yash Kesarwani's work [14] suggests a comprehensive strategy that not only predicts depression but also keeps track of patients and suggests activities to help with therapy.

Ava Podrazhansky and Hao Zhang's work [15] presents a new mobile chatbot application that is intended to evaluate people's mental health. The application makes recommendations for preventive actions and uses machine learning algorithms to identify mental illnesses. This software uses natural methods including text, audio, and video interactions to engage users, unlike other mental counseling apps that focus on questionnaires. For a more sophisticated and user-friendly mental health evaluation process, the system combines natural language processing (NLP) with continuous emotion conversation analysis, phrase and audio production, and other features.

Methodologies and Techniques used

Using a variety of techniques, machine learning for depression identification examines pertinent features and trends in datasets. Algorithms that can be used for this include Feedforward Neural Networks, Convolutional Neural Networks (CNN), Decision Trees, Logistic Regression, Naive Bayes, and Support Vector Machine (SVM) which have been reviewed in the 15 papers.Support Vector Machine (SVM): For binary classification tasks, SVM works well. When it comes to depression identification, it evaluates the characteristics taken from several sources, such speech, text, or physiological data, and use the patterns it has learnt to divide people into groups according to whether they are depressed or not.Decision Trees: Decision trees are interpretable models that help determine the boundaries of decisions made when diagnosing depression. Decision trees are able to capture intricate correlations between input factors and depressive state by recursively dividing the data based on pertinent aspects.Naive Bayes: This algorithm works especially well with text-based data, including sentiment analysis of written material. To determine the possibility of depression, it evaluates textual elements such as social media posts or clinical notes.For binary classification jobs, the simple approach known as logistic regression is employed. It models the relationship between input features and an individual's probability of being depressed in the context of depression detection, yielding a probability score for each case.Convolutional Neural Networks: CNNs are particularly good at problems involving images. CNNs are capable of learning hierarchical features from visual input and capturing subtle patterns linked to emotional states, which is used for depression identification through image processing or facial expressions.Feedforward Neural Network: Deep neural networks in particular are capable of processing intricate correlations seen in multidimensional data. It is used to detect depression in a variety of data formats, such as text, physiological signals, and structured clinical data.

By utilizing cutting-edge algorithms to examine emotional cues and patterns, Emotion Artificial Intelligence (Emotion AI) can diagnose depression and offer insights into a person's mental health. AI that can identify, decipher, and react to human emotions is referred to as emotion AI. Regarding the identification of depression, the following are some essential elements and methods:Emotion Recognition from Facial Expressions: Emotion AI can identify depressive symptoms by analyzing facial expressions using image or video processing techniques. Certain facial expressions, such as melancholy or a lack of facial engagement, might be linked to depressive moods.Voice and Speech Analysis: An individual's voice and speech patterns' acoustic characteristics can be examined by Emotion AI. Pitch, tone, and speech rate variations can be signs of emotional discomfort and help identify depression through audio processing.Sentiment mining and textual analysis: feelings Artificial intelligence (AI) may analyze textual material, including communications, social media posts, and medical notes, to detect emotions linked to depression. Textual data's emotional tone and context can be understood with the aid of Natural Language Processing (NLP) tools.Physiological Signals: To give a complete picture of emotional states, emotion AI can incorporate physiological signals like skin conductance, heart rate variability, or EEG data. Signals from the body can be useful predictors of stress and emotional health.

Real-time and continuous monitoring of emotional states is made possible by emotion AI. For those at risk of depression, this ongoing assessment can offer timely treatments and individualized assistance.Image and Video Processing Techniques for Facial Expression Analysis: Facial expressions are powerful markers of emotional states, and by analyzing facial features, one might identify depressive symptoms. In photos or video feeds, algorithms can identify patterns linked to depression, sluggishness, or other emotional indicators.Sentiment analysis on Twitter: Sentiment analysis can be performed using the abundance of data available on social media sites like Twitter. Natural language processing (NLP) and machine learning

techniques for tweet analysis can reveal information about users' emotional states and can help detect those who may be depressed or in emotional discomfort.Multimodal Approaches: Chatbots can communicate with users via text, audio, or video, resulting in a tailored and dynamic exchange. Through the analysis of language, tone, and attitudes conveyed throughout these exchanges, chatbots can enhance our comprehensive understanding of a person's mental health.Text-Based Detection Methods: By using natural language processing (NLP) techniques to the analysis of written material, such as messages, social media posts, or clinical notes, it is possible to identify linguistic markers linked to depression. Depressive states can be identified by alterations in language patterns, displays of hopelessness, or enduring bad feelings.Image-Based Detection Methods: In addition to examining facial expressions, examining photographs for visual cues associated with depression, like themes of melancholy or images of self-harm, can help provide a more thorough evaluation.Audio-Based Detection Methods: Additional information about emotional well-being can be gained by analyzing audio data, such as speech rate, intonation, and voice patterns. Modifications to these auditory characteristics could be a sign of depression.Video-Based identification Methods: The richness of the data utilized for depression identification is improved by integrating information from voice, body language, and facial expressions in video data. Video-based methods offer a more comprehensive picture of a person's emotional condition.Multimodal Fusion: Using multimodal fusion approaches, depression detection models become more accurate and robust by combining data from many modalities, such as text, images, audio, and video. Multimodal datasets can be used to train machine learning models for in-depth analysis, such as deep learning architectures (convolutional and recurrent neural networks).

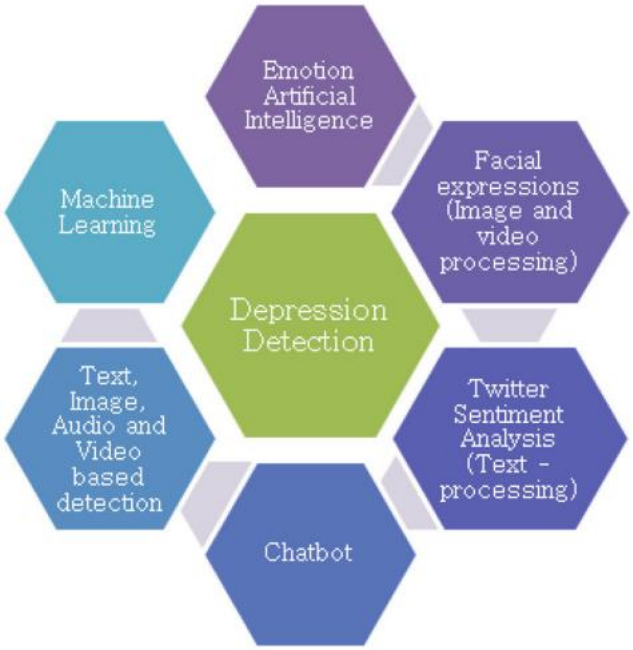

Fig 2. Different sources of depression detection

After reviewing 15 research papers focused on depression detection, the average accuracies of various machine learning algorithms were assessed. The results are summarized in the table below.

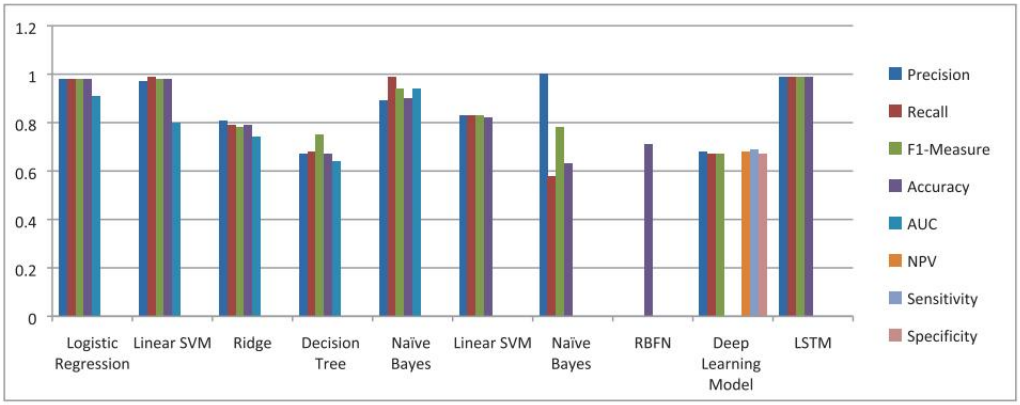

Fig 3. Accuracy comparison of ml algorithms

Results

It is difficult to categorically name one approach as the best overall after analyzing the data from numerous papers on the detection of depression using machine learning, emotional artificial intelligence, facial expressions (image and video processing), Twitter sentiment analysis, chatbot interactions, and multimodal approaches (text, image, audio, and video-based detection). A method's efficacy is contingent upon various aspects, including the nature of the dataset, the way features are represented, and the particular research question.Nevertheless, taking into account the overall patterns noted in the papers:

Machine Learning Algorithms: Throughout the research, Support Vector Machine (SVM) and Convolutional Neural Network (CNN) demonstrated competitive accuracy and exhibited strong performance.

Emotional Artificial Intelligence: Deep learning approaches in particular have shown promise in enabling models of emotional artificial intelligence to capture complex emotional states associated with depression.

Face Expressions (Image and Video Processing): Deep learning techniques coupled with facial expression analysis have shown promise in identifying emotional cues that can be used to diagnose depression.

Twitter Sentiment Analysis: This technique has shown promise in gleaning information from social media posts and providing a possible means of comprehending and forecasting depression episodes.

Text-Based and Chatbot Detection: These methods proved beneficial for natural language processing, helping to identify user attitudes and possible signs of depression.

Multimodal Approaches: Integrating text, image, audio, and video with other modalities showed promise, highlighting the significance of comprehensive data integration.

In summary, the best course of action might combine several techniques, utilizing each one's advantages in a multimodal system. Scholars are urged to customize their methods according to the particular situation, data at hand, and the intended results of their depression screening systems.

Conclusion and future scope

A dynamic landscape with promising advancements in machine learning, emotional artificial intelligence, facial expressions (image and video processing), Twitter sentiment analysis, chatbot interactions, and multimodal approaches is revealed by the review of 15 papers on depression detection using various methodologies. Robust machine learning approaches that have gained popularity include Support Vector Machine (SVM) and Convolutional Neural Network (CNN). Additionally, emotional artificial intelligence has shown promise in identifying complex emotional states linked to depression. Facial expression analysis has shown promise in identifying emotional indicators, especially when combined with deep learning. The usefulness of social media data in comprehending and forecasting depressive states was demonstrated using Twitter sentiment analysis. Natural language processing relied heavily on text-based methods and chatbot interactions to gain insights into user sentiment. Integrating text, image, audio, and video, multimodal techniques highlighted the significance of comprehensive data fusion.

In order to increase the precision and resilience of depression detection systems, future research should concentrate on developing and enhancing multimodal approaches by utilizing developments in data fusion techniques.Creating real-time monitoring systems that make use of continuous data streams from multiple modalities can improve early detection and offer timely insights into people's mental states.Research on the moral issues pertaining to the use of private information to identify depression is required. It is essential to guarantee permission, privacy, and appropriate technology use in mental health applications. The generalizability and reliability of depression detection models will be improved by carrying out extensive validation tests with a variety of population types, increasing their applicability to a wider range of demographics. User acceptability and engagement can be increased by incorporating user preferences and feedback into the design of depression detection systems, such as through personalized recommendations and user-friendly interfaces.Studies that follow participants over long periods of time can shed light on the dynamic nature of depressive disorders and aid in the creation of specialized intervention plans.In conclusion, the developing field of depression detection offers chances for ethical deliberation, interdisciplinary cooperation, and user-centric design, which promotes the creation of more precise, dependable, and approachable systems for mental health monitoring and assistance.

References

Yin, F.; Du, J.; Xu, X.; Zhao, L. Depression Detection in Speech Using Transformer and Parallel Convolutional Neural Networks. Electronics 2023, 12, 328.

B. Yalamanchili, N. S. Kota, M. S. Abbaraju, V. S. S. Nadella and S. V. Alluri, "Real-time Acoustic based Depression Detection using Machine Learning Techniques," 2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE), Vellore, India, 2020, pp. 1-6,

D. M. Shukla, K. Sharma and S. Gupta, "Identifying Depression in a Person Using Speech Signals by Extracting Energy and Statistical Features," 2020 IEEE International Students' Conference on Electrical,Electronics and Computer Science (SCEECS), Bhopal, India, 2020.

Raino, Rinkey, Neelam Kumari, Kashinath Chandelkar, Kanchan Chetiwal. (2023). Role of Artificial Intelligence in Psychological and Mental Well Being: A Quantitative Investigation. Journal for ReAttach Therapy and Developmental Diversities, 6(9s(2), 149–156.

Vaidyam AN, Wisniewski H, Halamka JD, Kashavan MS, Torous JB. Chatbots and Conversational Agents in Mental Health: A Review of the Psychiatric Landscape. Can J Psychiatry. 2019 Jul;64(7):456-464.

L. Luan, W. Xiao, K. Hwang, M. S. Hossain, G. Muhammad and A. Ghoneim, "MEMO Box: Health Assistant for Depression With Medicine Carrier and Exercise Adjustment Driven by Edge Computing," in IEEE Access, vol. 8, pp. 195568-195577, 2020.

P. Kumar, R. Chauhan, T. Stephan, A. Shankar and S. Thakur, "A Machine Learning Implementation for Mental Health Care. Application: Smart Watch for Depression Detection," 2021 11th International Conference on Cloud Computing, Data Science & Engineering (Confluence), Noida, India, 2021, pp. 568-574.

J. -W. Baek and K. Chung, "Context Deep Neural Network Model for Predicting Depression Risk Using Multiple Regression," in IEEE Access, vol. 8, pp. 18171-18181, 2020.

Basantani Ashish,Kesarwani Yash,Bhatia Srishti,Jain Sarika 2021/03/01,012010,EmoCure: Utilising Social Media Data and Smartphones to Predict and Cure Depression,IOP Conference Series: Materials Science and Engineering

S. M. N. Mustafa, H. Zaki, S. Alam, M. S. Khan and H. Zafar, "Anti Depression And Anti Suicidal Application," 2020 International Conference on Information Science and Communication Technology (ICISCT), Karachi, Pakistan, 2020.

S. A. S. A. Kulasinghe, A. Jayasinghe, R. M. A. Rathnayaka, P. B. M. M. D. Karunarathne, P. D. Suranjini Silva and J. A. D. C. Anuradha Jayakodi, "AI Based Depression and Suicide Prevention System," 2019 International Conference on Advancements in Computing (ICAC), Malabe, Sri Lanka, 2019

Kaywan P, Ahmed K, Ibaida A, Miao Y, Gu B (2023) Early detection of depression using a conversational AI bot: A non-clinical trial. PLoS ONE 18(2): e0279743.

Narkbunnum, W.; Wisaeng, K. Prediction of Depression for Undergraduate Students Based on Imbalanced Data by Using Data Mining Techniques. Appl. Syst. Innov. 2022, 5, 120.

CHAP,Bhatia, Srishti,Kesarwani, Yash,Basantani, Ashish,Jain, Sarika,2021/02/01, Engaging Smartphones and Social Data for Curing Depressive Disorders: An Overview and Survey

Ava Podrazhansky, Hao Zhang,Meng Han,Selena He A Chatbot-based Mobile Application to Predict and Early-prevent Human Mental Illness/ACM Southeast Conference – ACMSE 2020 – Session 3: Abstracts – ISBN: 978-1-4503-7105-6