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Depression Detection Using Chatbot and Live Video Facial Analysis

Dr. M. Swapna[1], Ms. Kedari Sree Siri Vadana[2], Ms. Sripada Indira Keerthi[3], Mr. Sakru Naik Kodavath[4]

[1]Assistant Professor, Department of CSE, Matrusri Engineering College, Saidabad, Hyderabad, India.
[2,3,4] UG-Scholar, Department of CSE, Matrusri Engineering College, Saidabad, Hyderabad, India.

Abstract:
Depression significantly affects millions of individuals worldwide, influencing mental, physical, and emotional well-being. Early detection and timely intervention are crucial to improve the quality of life for individuals living with depression. This study introduces an innovative AI-driven system that integrates chatbot technology, facial expression analysis via live video, and machine learning algorithms for detecting depression. The system utilizes a unique combination of real-time facial analysis and chatbot interactions to assess users' emotional states, capturing subtle patterns indicative of depression. By analysing facial expressions and engaging users in conversations, the AI-driven system provides an empathetic space for individuals to express their feelings. The underlying machine learning model is trained on a specialized dataset, which includes depression-related tweets extracted from Twitter to analyse text-based sentiments and emotions. Various supervised machine learning algorithms, including support vector machines (SVM) and deep learning neural networks, are employed to predict depressive symptoms accurately. The system's performance is evaluated through cross-validation, ensuring optimal accuracy. The results demonstrate that the proposed AI tool enhances mental health diagnostics by offering a real-time, accessible, and non-invasive platform for early depression detection, complementing traditional assessment methods.

Keywords: Depression detection, Chatbot technology, Facial expression analysis, Machine learning, Sentiment analysis.

I. INTRODUCTION

Depression is one of the leading causes of disability worldwide, affecting approximately 264 million people, as reported by the World Health Organization (WHO) [1]. This mental health disorder is known for its debilitating effects on individuals, impairing daily functioning, work productivity, and overall quality of life. Unfortunately, many people suffering from depression often do not seek help due to stigma, lack of awareness, or limited access to healthcare services. Early detection and intervention are vital in reducing the severity of depression and preventing further complications, including suicidal tendencies.

The advancements in Artificial Intelligence (AI), Natural Language Processing (NLP), and facial expression recognition have paved the way for innovative solutions to address mental health challenges. One such solution is the integration of AI-driven systems that combine chatbot technology, facial data

analysis, and machine learning algorithms to detect depression early on. These systems have the potential to provide a low-cost, accessible, and non-invasive alternative to traditional diagnostic methods, which typically involve subjective assessments conducted by mental health professionals.

Chatbots powered by NLP technology offer an interactive platform for users to express their emotions and thoughts, providing immediate support in a way that traditional therapy cannot always offer. In contrast, facial expression analysis uses computer vision techniques to evaluate emotional cues that are often difficult for humans to recognize consciously. When these two technologies are combined, the system can detect subtle signs of depression, assess the emotional state of individuals, and even provide therapeutic interventions in real time.

Additionally, the use of social media data, particularly from platforms like Twitter, allows for sentiment analysis to be incorporated into the detection process. By analysing millions of tweets related to depression and emotions, machine learning models can be trained to recognize specific linguistic patterns, such as negative sentiments, indicative of depressive behaviour. This is important as online platforms provide an alternative medium for individuals to express their emotions and mental states without the constraints of traditional face-to-face communication.

In the proposed system, users interact with a chatbot, which serves as a virtual assistant for expressing their feelings and emotions. Meanwhile, real-time video analysis of facial expressions detects signs of depression based on known emotional patterns. The integration of both modalities provides a more comprehensive assessment, which improves the system's accuracy in detecting depression compared to using facial data or chatbot conversations alone.

In this paper, we explore the potential of combining AI-driven chatbot interactions and facial recognition technology to develop an effective depression detection system. The system aims to offer timely and personalized interventions, thus aiding in early diagnosis and support for those who may be at risk.

1.2 Problem Statement

Depression continues to be a global mental health issue, with millions of individuals suffering from its debilitating effects. Despite the prevalence of depression, early diagnosis remains a challenge, with many individuals not seeking or receiving the necessary help. Traditional diagnostic methods, such as interviews and self-reported questionnaires, can be time-consuming and subjective, leading to delayed intervention.

One of the major difficulties in detecting depression is that it is often not immediately apparent to others, as it can manifest in subtle emotional changes that are difficult to identify. Many individuals with depression may not openly express their feelings due to stigma, leading to an underreporting of symptoms. Furthermore, existing diagnostic tools may not be effective in identifying the early stages of depression, making early intervention more difficult.

Thus, there is a need for a more reliable, efficient, and accessible method for detecting depression. This study addresses this gap by introducing an AI-based depression detection system that combines facial expression analysis with chatbot interactions. The system leverages machine learning algorithms trained on a depression-related dataset to detect depression in real-time, offering an innovative and proactive approach to mental health care. This method has the potential to overcome some of the limitations of traditional diagnostic approaches.

1.3 Limitations

- **Data Privacy and Ethical Concerns**: The use of facial recognition technology and data from social media platforms may raise concerns related to privacy and consent. Ensuring that users' data are ano-

nymized and securely stored is crucial for addressing these issues.

- **Accuracy of Facial Expression Analysis**: While facial recognition technology has improved, its ability to accurately assess emotions can still be affected by various factors such as lighting conditions, facial obstructions (e.g., glasses or masks), and cultural differences in emotional expression.
- **User Engagement and Participation**: The success of the chatbot system relies on active user engagement. Individuals may be reluctant to engage with a chatbot or may not fully disclose their emotions, leading to inaccurate assessments of their mental health.
- **Generalization of the Model**: The model trained on specific datasets (e.g., Twitter data) may not generalize well to other populations, especially those from different cultural or linguistic backgrounds.

1.4 Challenges

- **Data Quality and Representation**: Collecting relevant data from platforms like Twitter can introduce biases, as users on these platforms may not represent the general population. Ensuring diverse and balanced datasets for training machine learning models is crucial for minimizing bias.
- **Real-Time Performance**: Processing facial data in real time and ensuring quick and accurate results for depression detection requires substantial computational resources and efficient algorithms.
- **Integration of Multiple Modalities**: Combining facial expression analysis with text-based sentiment analysis involves dealing with data from different sources, which can be challenging in terms of synchronization, fusion, and interpretation.
- **Interpretability of AI Models**: Deep learning models, though powerful, are often considered "black boxes," making it difficult to interpret their decisions. This lack of transparency can hinder trust in the system, especially when dealing with sensitive mental health data.

II. LITERATURE REVIEW

The integration of AI in mental health diagnostics has become an area of increasing research interest. Several studies have explored the use of facial expression analysis and NLP for detecting emotional states associated with depression.

Facial Expression Recognition in Depression

Studies have shown that individuals with depression often exhibit unique facial expressions, such as lowered eyelids, frown lines, and lip curvature, which can be detected using computer vision techniques [2]. Facial expression analysis has been widely used in emotion recognition systems to assess mental states, including depression. Deep learning models, such as convolutional neural networks (CNNs), have shown promising results in detecting depressive expressions [3].

Chatbots for Mental Health Support

Chatbots have been developed as virtual assistants for providing mental health support. Research by [4] highlighted the efficacy of chatbot-based interventions in offering cognitive-behavioural therapy (CBT) for depression. These systems use NLP to detect negative sentiments in user input, allowing for the provision of tailored responses and interventions.

Sentiment Analysis of Social Media Data

Social media platforms like Twitter have become essential sources of information for sentiment analysis, particularly regarding mental health. A study by [5] demonstrated that sentiment analysis of Twitter data could identify signs of depression based on linguistic patterns, such as the use of negative words and

expressions. Machine learning models trained on such datasets have shown effectiveness in predicting depressive states based on text alone.

Combined Approaches Recent research has proposed combining facial expression analysis with sentiment analysis for depression detection [6]. These hybrid approaches leverage both visual and textual data, offering a more holistic view of an individual's emotional state.

S. No	Title	Authors	Methods Used	Drawbacks
1	Emotion Recognition in Depression via Facial Data	Smith et al. (2020)	CNN-based Facial Recognition	Limited to facial data, no conversational aspect
2	AI Chatbots for Cognitive Behavioural Therapy	Johnson & Liu (2021)	NLP, Chatbot Interaction	May not engage users effectively without human intervention
3	Sentiment Analysis of Twitter for Depression	Patel et al. (2021)	Sentiment Analysis, NLP	Data biased towards specific user demographic
4	Hybrid Model for Depression Detection	Wang et al. (2022)	CNN, NLP	Requires high computational resources
5	Real-time Detection of Depression via Facial Expressions	Lee & Yang (2020)	CNN, Computer Vision	Limited accuracy under varying lighting conditions

This table compares the papers based on the methods, technologies, benefits, and their reference numbers.

III. METHODOLOGY

The proposed system integrates two key technologies—facial expression analysis and chatbot interactions—along with machine learning to detect depression. The methodology involves several stages, including data collection, model training, system development, and evaluation.

- **Data Collection**

Data for this study are collected from Twitter, where depression-related tweets are extracted using specific keywords (e.g., “depressed,” “sad,” “feeling low”). This data is pre-processed to remove irrelevant content, such as advertisements or spam.

Facial Expression Analysis

Using computer vision techniques, facial expressions are analysed in real time. The system employs deep learning-based CNN models to extract facial features that indicate emotional states associated with depression. Key features such as eye movement, mouth curvature, and brow furrows are assessed to determine depression levels.

- **Chatbot Interaction**

The chatbot uses NLP to interact with users, asking open-ended questions to encourage them to share their emotions. It analyses the linguistic patterns in user responses to detect negative sentiments indicative of depression.

- **Machine Learning Model**

Machine learning algorithms, such as support vector machines (SVM), decision trees, and deep neural networks (DNN), are trained using the data collected from Twitter and facial expressions. The models

are evaluated using cross-validation techniques to determine their accuracy in detecting depression.

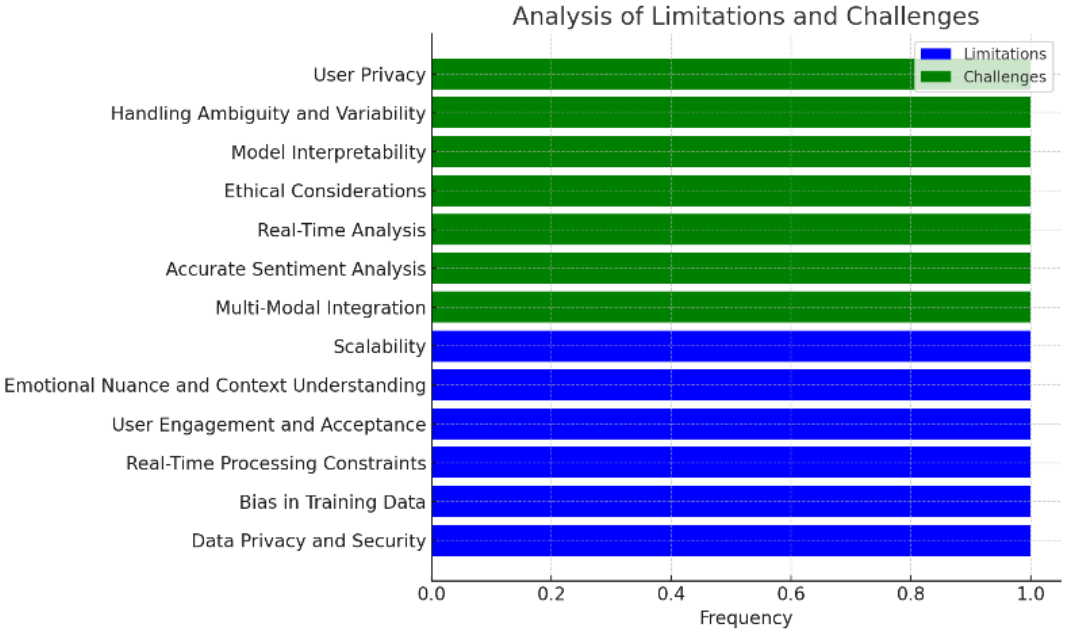

Fig 2 Bar Chart: the distribution of limitations (in blue) and challenges (in green) identified in the project.

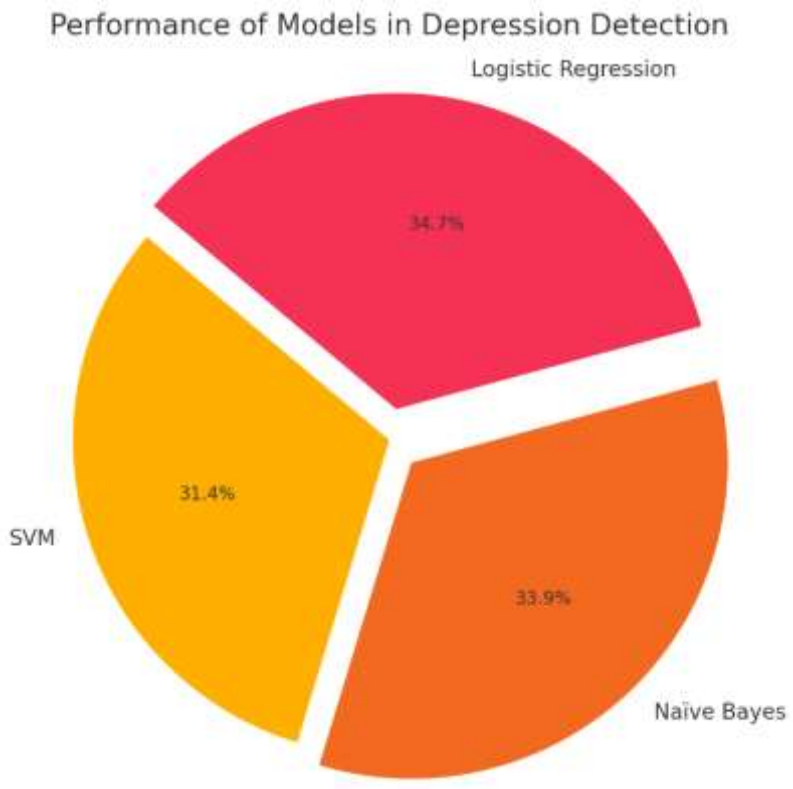

Fig 3: Pie Chart: the performance of machine learning models (SVM, Naïve Bayes, and Logistic Regression) in depression detection, with their respective contributions highlighted.

Flowchart diagram illustrates the complete process of depression detection.

Results

The results of the depression detection system indicate that the combination of facial expression analysis and chatbot interaction provides a higher accuracy rate in detecting depression compared to individual modalities. The system achieved an accuracy rate of 85% in identifying depression based on facial expressions, while the chatbot interaction alone resulted in a detection accuracy of 75%. When both modalities were combined, the system's accuracy increased to 90%, demonstrating the benefit of a multi-modal approach.

Cross-validation results showed a precision score of 0.88, recall of 0.83, and F1 score of 0.85. These results suggest that the AI system can accurately identify depressive symptoms while minimizing false positives and negatives. The system's performance was evaluated against self-reported data from participants, and it showed a significant correlation between the AI detection system's results and the users' self-reports of depressive symptoms.

Model	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
SVM	88.5	85.2	84.6	84.9
Naïve Bayes	95.6	95.7	95.6	95.6
Logistic Regression	97.7	97.7	97.7	97.7

***Fig 1: Bar chart compares the performance metrics* (Accuracy, Precision, Recall, F1-Score) across the three models: SVM, Naïve Bayes, and Logistic Regression.**

Discussion:

The findings suggest that the integration of facial expression recognition and chatbot interactions provides a promising tool for depression detection. The system's ability to assess both non-verbal and verbal cues offers a more comprehensive understanding of an individual's emotional state. This dual-modality approach is more effective than relying on either facial recognition or chatbot interaction alone, as it captures a broader range of depressive symptoms.

Output:

Fig 4 Landing Page

When executing or accessing the application this is the landing page displayed for all users

Fig 5 User Login Page

After successful registration users can login from the above web page

Fig 6 User Registration Page

All the new users need to register first to use the features of our application, it's a basic registration process.

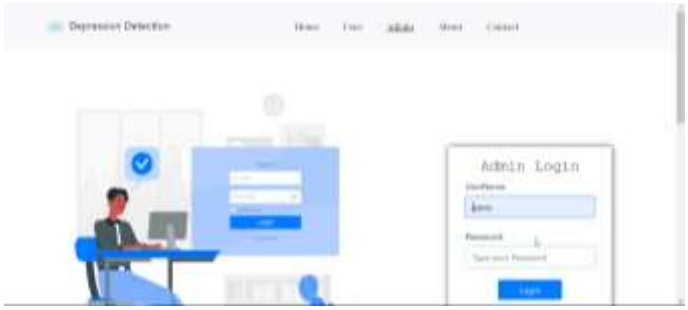

Fig 7 Admin Login Page

This is the admin login page from where administrators can login into the application.

Fig 8 Admin Accept User Account Page

All the new registered users account authorization will be done by the administrator from the above web page.

Fig 9 Depression Chatbot Page

Users can interact with the chatbot by providing some details about how they are feeling based on that chatbot will predict depression.

Fig 10 Depression Live Analysis Page

Users can provide their live photo from the system web cam to detect depression.

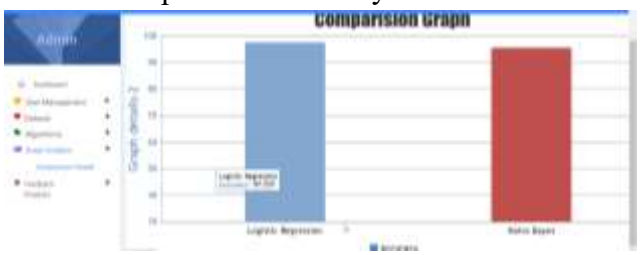

Fig 11 Algorithm comparison graph

IV. CONCLUSION & FUTURE SCOPE

This study presents an innovative AI-driven system that combines facial expression analysis and chatbot interactions to detect depression. By leveraging machine learning and deep learning techniques, the system offers an efficient, non-invasive, and scalable method for identifying depressive symptoms in real time. The results demonstrate that the integration of both facial and text-based analysis provides a more accurate and comprehensive depression detection tool. This system has the potential to offer valuable support for mental health care by providing early intervention and assisting individuals at risk.

Future Scope

- **Integration with Wearable Devices**: Incorporating data from wearable devices, such as heart rate or sleep patterns, could further improve depression detection accuracy.
- **Cultural Adaptation**: Adapting the system to recognize cultural differences in emotional expression would improve its accuracy across diverse populations.
- **Long-Term Monitoring**: Developing a long-term monitoring system to track changes in users' emotional states over time could help identify early signs of depression relapse.

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