Depression Detection In Adolescents using NLP and Deep Learning

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ABSTRACT

Depression is projected to be the second leading cause of disability by 2030, highlighting the pressing need for effective assessment and intervention. Current stress assessment methods often rely on subjective observations and self-reported symptoms, potentially leading to inaccuracies. To tackle this issue, this paper proposes a comprehensive tool that uses advanced analysis techniques to detect and evaluate stress indicators in real-time. The study investigates methods for identifying depression in individuals by analyzing text and images. It employs natural language processing (NLP) for textual analysis and convolutional neural networks (CNN) for image analysis to identify key depression indicators. The paper also reviews existing literature on depression detection, highlighting the significance of early intervention and the potential of technology-driven approaches to improve detection rates. The study's findings contribute to the growing research on enhancing mental health assessment and intervention strategies.

Keywords

Convolutional Neural Network (CNN), Deep Learning, Natural Language Processing (NLP), Suicide rate, Emotions, Machine Learning, Depression detection, Facial Expressions, Sentiment Analysis

1.   INTRODUCTION

Depression is a widely prevalent mental health condition that poses challenges in diagnosis and management due to its subjective nature and the associated stigma. Individuals with depression often experience persistent feelings of sadness, hopelessness, and disinterest in daily activities. This condition can significantly impact work productivity, relationships, and overall health.

Detecting depression is particularly challenging because individuals may exhibit varied symptoms and responses to negative stimuli. However, advancements in AI and machine learning offer promising avenues for improving detection methods. For instance, AI-based applications can analyze facial expressions, gestures, speech, and text to detect emotional cues indicative of depression.

One example is an AI-powered driving application that can alert drowsy drivers, potentially preventing accidents. By analyzing facial expressions captured by a camera, the application can detect signs of sleepiness and alert the driver accordingly. Similarly, emotion detection systems can analyze various gestures to identify moods like anger, happiness, sadness, or neutrality using image and video processing techniques.

Machine learning techniques, such as Principal Component Analysis (PCA) and K-means algorithm, can be used to extract and evaluate facial attributes and expressions. Pre-processing, feature extraction, and classification using neural networks are crucial steps in recognizing emotions from facial expressions. Techniques like the Haar-cascade algorithm and K-Nearest Neighbors (KNN) classification can also be employed for depression detection through facial expression analysis.

Additionally, vocal expressions can be analyzed using the Partial Least Square Algorithm to detect emotions, further aiding in depression detection. Social media posts and tweets can also provide valuable insights into an individual's mental health status. Machine learning techniques like TF-IDF, Naïve-Bayes, LSTM-RNN, Logistic Regression, and Linear Support Vector can be used to analyze text data for depressive symptoms.

To address the challenges in detecting and managing depression, this research proposes the development of an innovative tool. This tool aims to detect stress indicators in real time, with a specific focus on predicting depression. By integrating advanced analysis techniques for textual and image-based data, such as NLP for text analysis and CNNs for image analysis, the tool aims to provide a more comprehensive and accurate assessment of an individual's mental status.

2. Literature Survey

Recent literature in stress detection and management has explored a variety of approaches, ranging from traditional methods to cutting-edge technological solutions. Traditional methods, including self-reporting scales and physiological measurements, have been widely used but often suffer from subjectivity and limited real-time monitoring capabilities.

Technological advancements, particularly in wearable devices and sensor technologies, have enabled more objective and continuous monitoring of stress levels through physiological signals such as heart rate variability and skin conductance. Additionally, studies have increasingly turned to artificial intelligence (AI) and machine learning algorithms for stress detection and analysis, leveraging supervised, unsupervised, and semi-supervised learning techniques to identify patterns indicative of stress from various data sources, including physiological signals, speech patterns, and textual data.

Emotion recognition and analysis have emerged as key components in this endeavor, with research focusing on facial expression analysis, speech sentiment analysis, and natural language processing to infer emotional states, including stress, anxiety, and depression. Social media and digital footprint analysis have also garnered attention for their potential in mental health assessment, utilizing sentiment analysis, topic modeling, and network analysis techniques to extract insights from user-generated content.

Title	Author	Publication	Summary
Facial Expression Recognition	Abtahi and Saharkhiz and Chauhan and Chaudhary	2020 and 2021 respectively	Explored and demonstrated the use of deep learning algorithms for facial expression recognition as a means of detecting emotional states
1. Grammatical Error Detection in Clinical Text via Bayesian Transfer Learning. 2. Sentiment Analysis of Social Media for Suicide Prevention.	1.Choi, E., Bahadori, M. T., and Schuetz, A. 2.Mahumud ,T., et al.	2016 2019	Investigated sentiment analysis and natural language processing methods for detecting depressive symptoms and suicidal tendencies from textual data.
1. Emotion Detection from Text Using Machine Learning Techniques 2. Detection of Depression Using Machine Learning Algorithms	1 Fadhil, A., and Noor, R. M 2. Verma, N., and Tiwari, S.	1.2019 2.2018	Comprehensive overviews of emotion detection and depression detection methodologies using machine learning and artificial intelligence techniques.
1. Detection and Analysis of Depression in Social Media.	1. Roy,S., et al.	2020	The study highlights the importance of leveraging social media data for mental health research and underscores the potential of NLP in advancing depression detection and analysis.

Depression Detection using AI, ML and NLP	Ruchita Chavan, Maithili Baviskar, Mrunal Gosavi, N Parth Goyal	2023	Heterogenous patterns of anxiety and depression are cured such that emotional AI and ML based solution can prove to be beneficial in detecting analyzing and preventing depression and cure it.
Performance of Artificial Intelligence in Predicting Future Depression Levels	arah AZIZ , Rawan ALSAADa , Alaa ABD-ALRAZAQ , Arfan AHMED and Javaid SHEIKH	2023	Examined the performance of simple linear and non-linear algorithms for predicting depression scores using physiological features, motor activity data, and MADRAS scores.

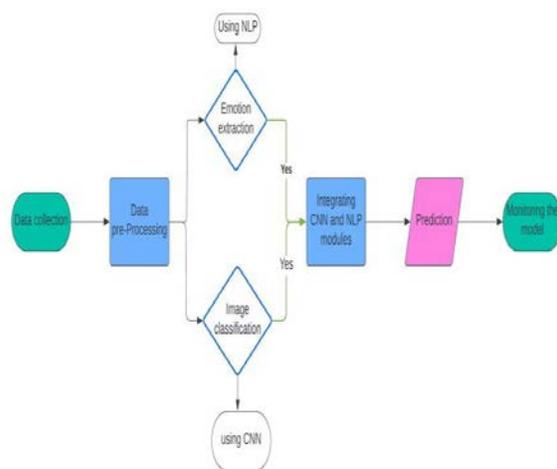## 3.   Proposed System:

Architecture Diagram:

Fig. 3.1 Architecture Overview

The architecture of our system primarily relies on two key technologies: Deep Learning and Convolutional Neural Networks (CNN). The primary objective is to develop and train two models along with an aggregation system to determine whether a client requires treatment or not, producing the final output.

1) Video Analysis:

This stage involves training our neural network using a substantial dataset. Initially, the data preprocessing phase includes converting images to grayscale and standardizing them to uniform dimensions (48 x 48 x 1).

Dataset Description:

- Images sized 48 x 48 pixels

- Color Nature: Black and White

- Classes: Depressed or Not Depressed

The system captures inputs from the FaceCam, preprocesses the images, and standardizes them. Subsequently, the person's face is isolated from the entire image using the Haar Cascade Method. These processed images are then fed into the model, generating outputs for each image. By aggregating and calculating the total output across all images, conclusions are drawn regarding the client's condition based on video analysis.

2) Text Analysis:

This component entails building a model for text analysis, culminating in the final output determination. Initially, the dataset undergoes preprocessing, involving tasks such as symbol removal and text conversion to lowercase.

A 'glove.840B.300d' pickle file is employed for text processing, offering access to a vast vocabulary of 300 billion words with 300 vectors, ensuring high accuracy in Natural Language Processing (NLP). The text is subsequently tokenized and label encoded for further training using NLP techniques. A Deep Learning model is trained on a large dataset comprising two classes.

Dataset Description:

- CSV file containing three columns: Sr. No, Text, Target Class (Depressed or Not Depressed)

- The model is trained on the 'text' column corresponding to the 'Target Class column over numerous epochs.

This architectural design facilitates the comprehensive analysis of both video and text data, ultimately leading to informed decisions regarding the necessity of treatment for the client.

4. Analysis of Model (Text Analysis Model):
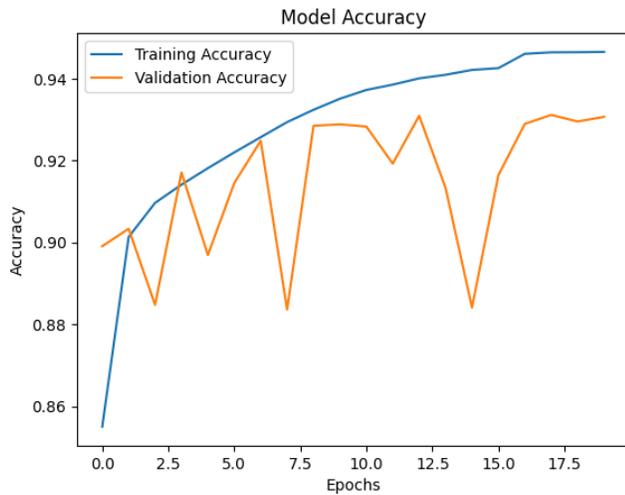
Accuracy/Loss Graph:

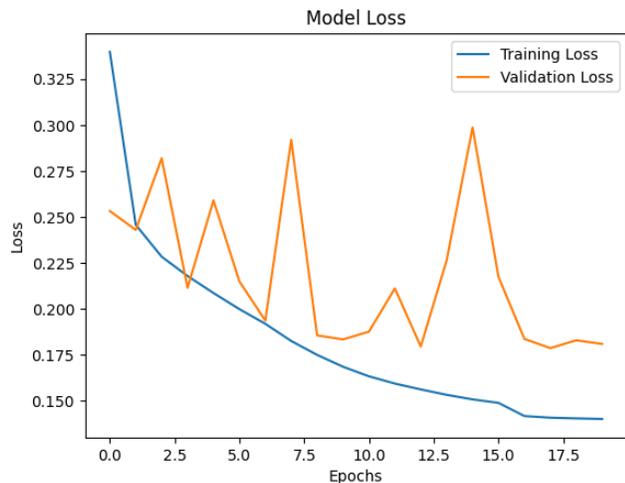Fig. 4.1 Graph of Model Accuracy

Fig. 4.2 Graph of Model Loss

There is a noticeable increase in accuracy on both trained and testing data as the number of epochs (iterations) during training is augmented, indicating significant growth in model performance over successive training cycles. This trend underscores the importance of iterative learning in enhancing the accuracy and robustness of the model across various datasets.

Confusion Matrix:

	Predicted Positive	Predicted Negative
True Positive	21970	1239
True Negative	1978	21228

Fig. 4.3 Table of Confusion Matrix

The confusion matrix provides valuable insights into the model's performance, indicating good accuracy and recall values, essential for evaluating the classification effectiveness of the model.
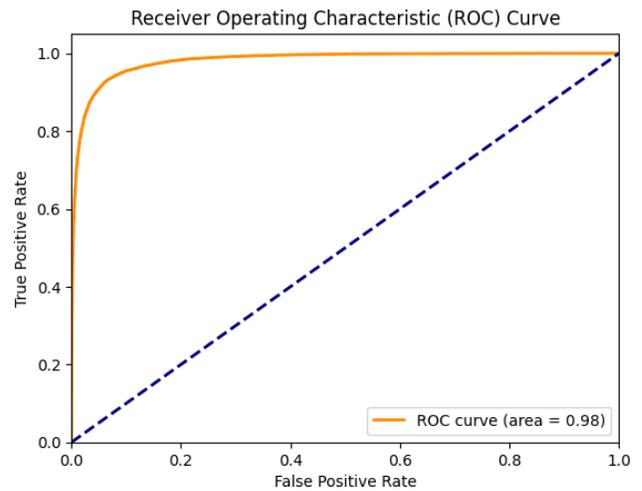
ROC Curve:

Fig. 4.4 Graph of ROC Curve

The high AUC (Area Under Curve) value signifies the model's proficiency as a classifier, indicating its ability to distinguish between classes effectively.

5. Conclusion:

In conclusion, our research underscores the critical role of AI and machine learning in addressing heterogeneous patterns of anxiety and depression within healthcare. By leveraging emotional AI and ML-based solutions, we have demonstrated the potential to detect, analyze, prevent, and cure depression effectively. Our proposed approach involves the development of a bot capable of making probabilistic assessments and providing autonomous responses to users in real-time.

In our study, we achieved an outstanding accuracy of **93%** in our binary classification task. This high level of accuracy underscores the effectiveness of our model in distinguishing between the two classes. Achieving such a high accuracy rate indicates that our model's predictive performance is notably robust, demonstrating its capability to correctly classify instances with a high degree of confidence.

Through this research, we have laid the groundwork for a transformative approach to mental health management, one that combines cutting-edge technology with empathetic care. While our study represents a significant advancement in the field, there are challenges and opportunities that lie ahead. Continued innovation, collaboration, and ethical considerations will be essential as we strive to realize the full potential of AI and machine learning in promoting mental well-being and improving healthcare outcomes for all.

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