# Automatic Depression Detection Based on Merged Convolutional Neural Networks Using Facial Features

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**Abstract**

**Mental health is a vital component of overall well-being, significantly influencing personal and professional success. Common issues such as stress, anxiety, and depression can impede daily functioning, strain relationships, and reduce productivity. As the global prevalence of mental health challenges increases, early identification and intervention are crucial. This project proposes the development of an automated system for detecting signs of depression through the analysis of facial features captured in frontal face videos. By leveraging advanced image processing and machine learning techniques, the system aims to accurately assess emotional states, enabling timely support for individuals who may be unaware of their condition or reluctant to disclose their struggles. Ultimately, this innovative approach seeks to enhance mental health awareness and promote proactive interventions in diverse populations.**

## INTRODUCTION

Mental health is increasingly recognized as a fundamental aspect of overall well-being, influencing various facets of life, including emotional, social, and occupational functioning. The World Health Organization (WHO) emphasizes that mental health is more than just the absence of mental disorders; it encompasses a state of emotional and psychological stability that enables individuals to cope with the stresses of life, work productively, and contribute meaningfully to their communities. However, the prevalence of mental health issues, particularly stress, anxiety, and depression, has risen dramatically in recent years, presenting a significant public health challenge globally.

Depression, in particular, is one of the leading causes of disability worldwide and often goes undetected due to various factors. Many individuals may not recognize the symptoms of their condition or may feel reluctant to seek help due to stigma or a lack of awareness. This creates a critical need for innovative methods to identify and address mental health issues early. Traditional diagnostic methods, such as self-report questionnaires and clinical interviews, can be limited by their reliance on individuals' self-awareness and willingness to disclose their struggles.

In this context, the integration of technology into mental health assessment presents a promising avenue for enhancing early detection. Recent advancements in image processing and machine learning have opened up new possibilities for analyzing human emotions through facial expressions. The proposed automated system aims to detect signs of depression by analysing facial features captured in frontal face videos. By employing sophisticated algorithms to interpret emotional indicators, this system seeks to provide an objective and scalable approach to identifying individuals at risk of depression, thereby facilitating timely interventions

and support. Ultimately, this project aspires to contribute to the growing field of mental health technology, enhancing awareness and promoting better mental health outcomes in diverse populations**.**

## LITERATURE SURVEY

[1].In this research, the authors explain the technology behind automatic depression assessment based on visual cues, highlighting the rapid growth in this domain. Pampouchidou et al., ”Automatic Assessment of Depression Based on Visual Cues: A Systematic Review,” The present exhaustive review of existing approaches as reported in over sixty publications during the last ten years focuses on image processing and machine learning algorithms. Visual manifestations of depression, various procedures used for data collection, and existing datasets are summarized. The review outlines methods and algorithms for visual feature extraction, dimensionality reduction, decision methods for classification and regression approaches, as well as different fusion strategies. A quantitative meta-analysis of reported results, relying on performance metrics robust to chance, is included, identifying general trends and key unresolved issues to be considered in future studies of automatic depression assessment utilizing visual cues alone or in combination with vocal or verbal cues.

[2].In this research, the authors explain the role of technology in identifying nonverbal behavior indicators for the automatic assessment of psychological conditions such as depression and PTSD, particularly focusing on gender differences. G. Stratou, S. Scherer, J. Gratch and L. -P. Morency, ”Automatic Nonverbal Behavior Indicators of Depression and PTSD They identify a directly interpretable and intuitive set of predictive indicators, selected from three general categories of nonverbal behaviors: affect, expression variability, and motor variability. For the analysis, they introduce a semi-structured virtual human interview dataset that includes 53 video-recorded interactions. Their experiments on automatic classification of psychological conditions show that a gender-dependent approach significantly improves performance over a gender-agnostic one.

[3].In this research, the authors explain the technology used in sentiment analysis (SA), which involves labeling people's opinions as different categories, such as positive and negative, from a given piece of text. Z. Madhoushi, A. R. Hamdan and S. Zainudin, ”Sentiment analysis techniques in recent works,” 2023 Science and Information Con5 ference (SAI), London, UK, 2015, pp. 288-291,The paper categorizes SA techniques in general, without focusing on specific levels or tasks, and reviews the main research problems in recent articles presented in this field. The study **found that machine learning-based techniques, including supervised, unsupervised, and semi-supervised learning techniques, Lexicon-based techniques, and hybrid** techniques, are the most frequent techniques used. The open problems include the inability of recent techniques to work well in different domains, the challenge of sentiment classification based on insufficient labeled data, a lack of SA research in languages other than English, and the difficulty of dealing with complex sentences that require more than sentiment words and simple parsing..

[4].In this research, the authors explain the technology behind NLP-based machine learning approaches for text summarization, presenting various methods used so far for summarizing large texts. Rahul, S. Adhikari and Monika,”NLP based Machine Learning Approaches for Text Summarization,” The paper discusses different approaches to generate Abstractive (ABS) or Extractive (EXT) summaries of text documents. Query-based summarization techniques are also discussed. The paper primarily focuses on structured-based and semantic-based approaches for summarization. Various datasets, such as the CNN corpus, DUC2000, and single and multiple text documents, were used to test the summaries produced by these models. The study reviews the tendencies, achievements, past work, and future scope of these methods in text summarization and other related fields.

[5]. Depression Detection Using an Automatic Sleep Staging Method With an Interpretable Channel-Temporal Attention Mechanism

Despite previous efforts in depression detection studies, there is a scarcity of research on automatic depression detection using sleep structure, and several challenges remain: 1) how to apply sleep staging to detect depression and distinguish easily misjudged classes; and 2) how to adaptively capture attentive channel-dimensional information to enhance the interpretability of sleep staging methods. To address these challenges, an automatic sleep staging method based on a channel-temporal attention mechanism and a depression detection method based on sleep structure features are proposed.

[6]. Cost-Sensitive Boosting Pruning Trees for Depression Detection on Twitter, Qian Li; Xiaoyan Chen

Depression is one of the most common mental health disorders, and a large number of depressed people commit suicide each year. Potential depression sufferers usually do not consult psychological doctors because they feel ashamed or are unaware of any depression, which may result in severe delay of diagnosis and treatment.

[7]. Task-State Heart Rate Variability Parameter- Based Depression Detection Model and Effect of Therapy on the Parameters, Yaowen Xing; Nini Rao; Mengmeng Miao; Quanchi Li,

Depression is a common psychiatric disease. At present, psychometric scales are the main methods for detecting depression in patients and evaluating the clinical treatment effect of depression. However, the accuracy of the scales is influenced by the subjective factors of patients and doctors. This paper explored the construction of a depression detection model based on task-state heart rate variability (HRV) parameters and the effect of therapy on the related HRV parameters.

**METHODOLOGY**

The proposed system for detecting signs of depression through facial analysis employs a systematic approach that integrates data collection, preprocessing, feature extraction, model training, and evaluation. Initially, a dataset comprising frontal face videos will be curated, including diverse demographic groups to ensure a comprehensive representation of the population. Ethical considerations will be prioritized, ensuring that informed consent is obtained from participants and that their privacy is respected.

Once the dataset is established, preprocessing steps will be implemented to enhance video quality and standardize the data. This will involve techniques such as normalization, resizing, and noise reduction to improve the accuracy of subsequent analyses. The next phase focuses on feature extraction, where key facial landmarks will be identified using computer vision techniques. This includes utilizing algorithms like Facial Landmark Detection (e.g., Dlib or OpenCV) to pinpoint areas of interest, such as the eyes, mouth, and eyebrows, which are critical in conveying emotional states.

Subsequently, the extracted features will be analyzed using machine learning algorithms to classify emotional states indicative of depression. A Convolutional Neural Network (CNN) will be employed due to its efficacy in image analysis tasks. The CNN architecture will be designed to process the extracted facial features, training the model on labeled data that includes various emotional expressions associated with depression. The model's performance will be evaluated using metrics such as accuracy, precision, recall, and F1-score, with a separate validation set to prevent overfitting.

To further refine the system, techniques such as data augmentation will be applied to enhance the model's robustness by simulating variations in facial expressions and lighting conditions. Additionally, real-time

processing capabilities will be incorporated to enable immediate feedback during video capture, allowing for timely assessments of emotional states. Finally, user interfaces will be developed to present results and recommendations clearly, ensuring that mentalhealth professionals can effectively interpret the findings and provide appropriate support.

**OBJECTIVE**

The primary objective of this project is to develop an automated system capable of analyzing facial features from frontal face videos to identify signs of depression, thereby facilitating early detection and intervention. To achieve this, the project will establish a comprehensive dataset of frontal face videos that represent diverse demographics, ensuring inclusivity and reliability in the detection process. Advanced image processing techniques will be implemented to preprocess the videos, including normalization, resizing, and noise reduction, enhancing the accuracy of facial feature extraction. Key emotional features will be extracted by utilizing facial landmark detection algorithms that focus on critical areas for assessing depression-related expressions. A Convolutional Neural Network (CNN) will be designed and trained on labeled data representing various emotional states, enabling effective classification and interpretation of facial expressions indicative of depression. The model's performance will be rigorously evaluated using metrics such as accuracy, precision, recall, and F1-score to ensure its reliability in real-world applications. Additionally, the system will incorporate real-time processing capabilities, allowing for immediate feedback during video capture, which enables prompt assessments of individuals' emotional states. Finally, a user-friendly interface will be developed to present the analysis results and recommendations clearly, empowering mental health professionals to interpret findings effectively and provide necessary support.

**FUCTIONAL REQUIREMENTS**

a) Data Collection: The system shall allow the collection of frontal face video data from participants with their informed consent. The system shall support the upload and storage of video files securely.

b) Preprocessing: The system shall pre process videos by normalizing, resizing, and reducing noise to enhance video quality. The system shall extract facial landmarks from each frame of the video for further analysis.

c) Feature Extraction: The system shall identify and extract key emotional features from the detected facial landmarks, focusing on expressions associated with depression.

d) Model Training: The system shall utilize a Convolutional Neural Network (CNN) for training on labeled datasets representing various emotional states. The system shall allow for continuous training and refinement of the model based on new data.

e) Emotion Classification: The system shall classify emotional states as indicative of depression or non-depression based on the extracted features. The system shall provide confidence scores for the classification results to indicate the level of certainty.

f) Real-Time Processing: The system shall enable real-time analysis of facial features during video capture, providing immediate feedback on emotional states.

g) User Interface: The system shall present analysis results and recommendations clearly through an intuitive user interface. The system shall provide functionality for mental health professionals to access detailed reports and insights based on the analysis.

h) Reporting: The system shall generate and export comprehensive reports summarizing analysis results, including emotional state classifications and recommendations for further action.

**NON FUCTIONAL REQUIREMENTS**

a) Performance: The system shall process video data and provide analysis results within a maximum response time of 2 seconds to ensure timely feedback. The system shall be capable of handling multiple simultaneous users without significant degradation in performance.

b) Scalability: The system shall be designed to scale easily, accommodating increased data volumes and user loads as needed.

c) Usability: The user interface shall be user-friendly, ensuring ease of navigation for both mental health professionals and individuals using the system. The system shall include user guidance and tutorials for first-time users.

d) Security: The system shall implement robust security measures to protect user data, including encryption and secure access protocols. The system shall comply with relevant data protection regulations, such as GDPR or HIPAA, to ensure user privacy.

e) Reliability: The system shall be reliable and maintain high availability, with an uptime of at least 99.5%.The system shall include backup and recovery procedures to prevent data loss.

f) Maintainability: The system shall be designed for easy maintenance and updates, allowing for quick integration of new features or improvements. The system documentation shall be comprehensive, enabling efficient troubleshooting and support.

g) Compatibility: The system shall be compatible with various devices (e.g., smartphones, tablets, and desktops) and operating systems (e.g., Windows, macOS, Android, iOS).

h) Ethical Considerations: The system shall ensure that all data collection methods adhere to ethical standards, prioritizing informed consent and user autonomy.

**CONCLUSION**

In conclusion, the development of an automated system for detecting signs of depression through facial analysis represents a significant advancement in the field of mental health assessment. By harnessing the power of image processing and machine learning, this project addresses the critical challenge of early detection in a scalable and objective manner. The system's ability to analyze facial features from frontal face videos not only enhances the accuracy of identifying individuals at risk of depression but also alleviates the reliance on subjective self-reporting methods.

As mental health challenges continue to rise globally, implementing such innovative technologies could play a pivotal role in promoting awareness, providing timely interventions, and ultimately improving the overall well-being of individuals. Future work will focus on refining the model, expanding the dataset, and ensuring that the system is accessible to a wide range of users, including mental health professionals and individuals seeking support. By integrating this automated approach into existing mental health frameworks, we can pave the way for a more proactive and effective response to the growing mental health crisis.

**REFERENCES**

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