



AI-Based Facial Expression Analysis for Depression Detection

Shashanka Das, Vishant Verma, Vaasu Goyal, Gollapathi Allen Jacinth, Uddipan Bhattacharjee

Chandigarh University, Mohali, Punjab, India

Abstract

Depression remains one of the most prevalent yet underdiagnosed mental health disorders globally. Traditional diagnostic methods often suffer from subjectivity and stigma barriers. This paper reviews an AI-powered, non-invasive facial expression analysis system utilizing deep learning, specifically Convolutional Neural Networks (CNNs), to detect depressive symptoms based on micro-expressions. The system exhibits strong classification performance, positioning it as a promising complement to conventional mental health screening, particularly in telemedicine and mobile health applications.

Keywords

Depression Detection · Facial Expression Analysis · Deep Learning · Convolutional Neural Networks · Mental Health Monitoring · Computer Vision · Telehealth · Multimodal Emotion Recognition

1 Introduction

Depression affects over 300 million individuals worldwide, often remaining undiagnosed due to social stigma and subjective assessments. Recognizing the limitations of current diagnostic practices, AI and computer vision technologies offer new opportunities. By analyzing subtle facial expressions often overlooked in clinical interactions, AI systems can objectively flag emotional deviations associated with depression.

The reviewed paper outlines a system that captures real-time facial expressions and utilizes deep learning to infer emotional states indicative of depression. This application highlights the potential for broader, scalable, and cost-effective early intervention tools.

2 Literature Review

The study builds upon an extensive foundation of prior research including works by Chen et al., Mu et al., Joshi and Kanoongo, Patil and Khedkar, and Tsai et al. These studies explore various methods for detecting depression through passive tasks, facial expressions, multimodal input, and emotional AI. Gaps such as dataset diversity and standardization are noted.

3 Methodology

The system development involved dataset selection (FER2013, AffectNet, DAIC-WOZ), preprocessing (face detection, grayscale conversion, data augmentation), and model development using CNNs and transfer learning (VGG16, ResNet50, MobileNetV2). A real-time prototype was created using OpenCV for facial expression capture and analysis.

4 Results and Evaluation

The CNN achieved an overall classification accuracy of 87.2%, with 91.5% accuracy for 'sad' and 88.4% for 'neutral'. Real-time implementation showed an inference time of approximately 0.07 seconds per frame. A pilot study involving 30 volunteers showed 80% correct identification of depressive tendencies.

5 Challenges and Limitations

Challenges include emotional variability across demographics, limited depression-specific datasets, ethical concerns regarding facial data privacy, and limitations in context capture without multimodal inputs.

6 Future Outcomes

Future work aims at integrating multimodal emotion recognition (voice, text, physiological signals) and building personalized models via federated learning, ensuring improved accuracy and user privacy. Telemedicine integration and real-time monitoring enhancements are envisioned.

7 Conclusion

AI-based facial expression analysis demonstrates a strong potential as an auxiliary tool for early depression detection. Despite challenges, this technology could significantly enhance mental health screening accessibility and reliability. Ethical deployment and robust multimodal models will be key to future success.

