IJARSCT

International Journal of Advanced Research in Science, Communication and Technology

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

ISSN: 2581-9429

Volume 5, Issue 13, April 2025

Impact Factor: 7.67

Emotion Recognition using Deep Autoencoder

Kaushal Rankhambe[1], Rushikesh Vishe[2], Piyush Doke[3]

Students, Department of Computer Engineering[1-3]

Yadavrao Tasgaonkar Institute of Engineering and Technology Bhivpuri

rankhambekauhsal@gmai.com, visherushikesh80@gmail.com, dokepiyush295@gmail.com

Abstract: *A key requirement for developing any innovative system in a computing environment is to integrate a sufficiently friendly interface with the average end user. Accurate design of such a user-centered interface, however, means more than just the ergonomics of the panels and displays. It also requires that designers precisely define what information to use and how, where, and when to use it. Facial expression as a natural, non-intrusive and efficient way of communication has been considered as one of the potential inputs of such interfaces. The work of this thesis aims at designing a robust Facial Expression Recognition (FER) system by combining various techniques from computer vision and pattern recognition. Expression recognition is closely related to face recognition where a lot of research has been done and a vast array of algorithms has been introduced. FER can also be considered as a special case of a pattern recognition problem and many techniques are available. In the designing of an FER system, we can take advantage of these resources and use existing algorithms as building blocks of our system. So a major part of this work is to determine the optimal combination of algorithms. To do this, we first divide the system into 3 modules, i.e. Preprocessing, Feature Extraction and Classification, then for each of them some candidate methods are implemented, and eventually the optimal configuration is found by comparing the performance of different combinations. Another issue that is of great interest to facial expression recognition systems designers is the classifier which is the core of the system. Conventional classification algorithms assume the image is a single variable function of a underlying class label. However this is not true in face recognition area where the appearance of the face is influenced by multiple factors: identity, expression, illumination and so on.*

Keywords: Facial Expression Recognition (FER), Computer Vision, Pattern Recognition, Feature Extraction, Classification, Emotion Detection, Human-Computer Interaction

I. INTRODUCTION

Emotion recognition plays a crucial role in AI-driven applications, including human-computer interaction, healthcare, and customer service. This project aims to develop an emotion recognition system using deep autoencoders to classify emotions from facial expressions. Autoencoders are unsupervised neural networks that learn to compress and reconstruct input data, making them well-suited for extracting meaningful features from images. These features are then used to identify emotions in facial expressions. For this project, we use the FER-2013 dataset, which contains labelled facial images depicting various emotions. The dataset is pre- processed to enhance generalization, and a deep autoencoder model is designed to extract features from the images. The model's output is passed through a classification head to predict the emotion being expressed. The goal is to demonstrate the potential of deep autoencoders for emotion recognition and to lay the groundwork for real-world applications such as virtual assistants and interactive systems.

II. LITRATURE REVIEW

Lee et al. (2015): This paper explored the use of deep autoencoders for facial emotion recognition, demonstrating their effectiveness in learning discriminative features.

Liu et al. (2016): This study investigated the application of deep autoencoders for emotion recognition from EEG signals, highlighting their potential for non-invasive emotion sensing.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 13, April 2025
Impact Factor: 7.67

Denoising Autoencoders: These autoencoders are trained to reconstruct input data corrupted with noise, making them more robust to variations in data.

Variational Autoencoders (VAEs): VAEs introduce latent variables to model the probability distribution of the input data, providing a probabilistic framework for emotion recognition.

Sparse Autoencoders: Sparse autoencoders encourage the learned representations to be sparse, promoting feature selection and reducing overfitting.

Fusion of Visual and Audio Modalities: Studies have explored the combination of deep autoencoders for facial expressions and speech features to improve emotion recognition accuracy.

Integration of Physiological Signals: Incorporating physiological signals (e.g., heart rate, skin conductance) with deep autoencoders can provide a more comprehensive understanding of emotional states.

Cross-Domain Emotion Recognition: Research has focused on adapting deep
autoencoder models to recognize emotions across different domains (e.g., in-the-wild vs. controlled environments).

Domain-Invariant Features: Exploring techniques to extract domain-invariant features can improve the generalizability of emotion recognition models.

Interpretability of Deep Autoencoders: Understanding the learned representations and decision-making processes of deep autoencoders can enhance trust and transparency in emotion recognition systems.

Ethical Implications: Addressing ethical concerns related to privacy, bias, and fairness in emotion recognition is crucial for responsible deployment.

III. METHODOLOGY

Proposed Algorithm for Emotion Recognition Using Deep Autoencoders Input:

- Raw data (e Fig 4 – User Interface.g., facial images, speech audio, physiological signals)
- Labels for emotional expressions (if available)

Process:

Data Preprocessing:

- Clean and normalize the data.
- Handle missing values or outliers.
- If necessary, augment the data to increase diversity.

Feature Extraction Using Deep Autoencoder:

- Construct a deep autoencoder architecture with appropriate layers and activation functions.
- Train the autoencoder in an unsupervised manner to learn latent representations of the input data.
- Extract the learned features from the latent space.

Feature Selection:

- Select the most informative features from the extracted latent representations.
- Techniques like feature importance or principal component analysis can be used.

Emotion Classification:

- Train a classifier model (e.g., support vector machine, random forest, neural network) on the selected features and corresponding labels.
- Use cross-validation to evaluate the model's performance and tune hyperparameters.

Model Evaluation:

- Evaluate the model's performance using appropriate metrics (e.g., accuracy, precision, recall, F1-score, confusion matrix).
- Analyze the results to identify areas for improvement.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 13, April 2025
Impact Factor: 7.67

Output:
- Predicted emotions for new input data.
- Evaluation metrics to assess the model's performance.

Example Output:
Predicted Emotions:
- Happy: 0.7
- Sad: 0.2
- Angry: 0.1

Evaluation Metrics:
- Accuracy: 85%
- Precision: 0.8
- Recall: 0.9
- F1-score: 0.85

This output indicates that the model predicted "Happy" with the highest probability (0.7), followed by "Sad" and "Angry". The evaluation metrics show that the model achieved an overall accuracy of 85% and performed well in terms of precision and recall

IV. SYSTEM ARCHITECTURE

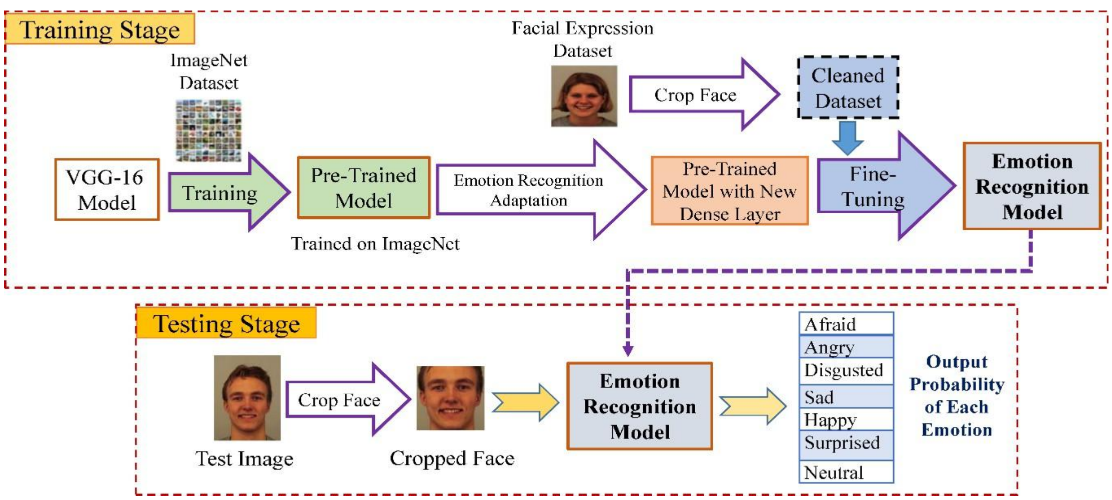

Fig-1 Architecture

This diagram represents the functional workflow of a emotion recognition model. Below is a detailed explanation of each component:

Training Stage
- Use EEG model pre-trained on ImageNet dataset.
- Train model on ImageNet to learn general image features.
- Collect facial expression dataset.
- Crop faces from the dataset to focus on relevant regions.
- Clean the dataset by removing poor-quality or irrelevant data.
- Add new dense layer to pre-trained model for emotion recognition.
- Perform fine-tuning on cleaned dataset to adapt model to FER.
- Output: Trained Emotion Recognition Model

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 5, Issue 13, April 2025 Impact Factor: 7.67

Testing Stage

- Input a test image.
- Crop the face from the test image.
- Pass cropped face through the trained Emotion Recognition Model.
- Model outputs probability scores for each emotion:
  - Afraid
  - Angry
  - Disgusted
  - Sad
  - Happy
  - Surprised
  - Neutral

V. RESULT

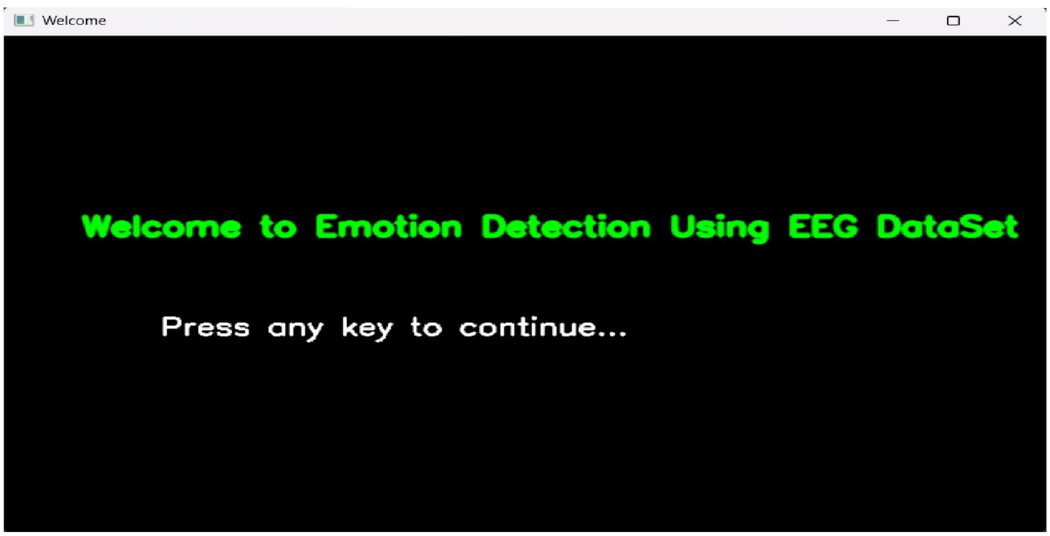

Fig 2 - User Interface

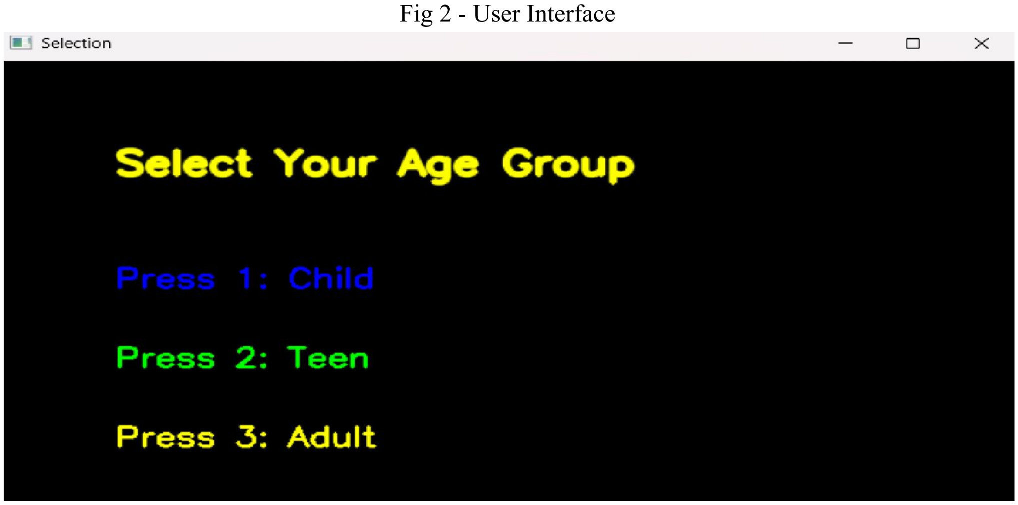

Fig 3 – User Interface

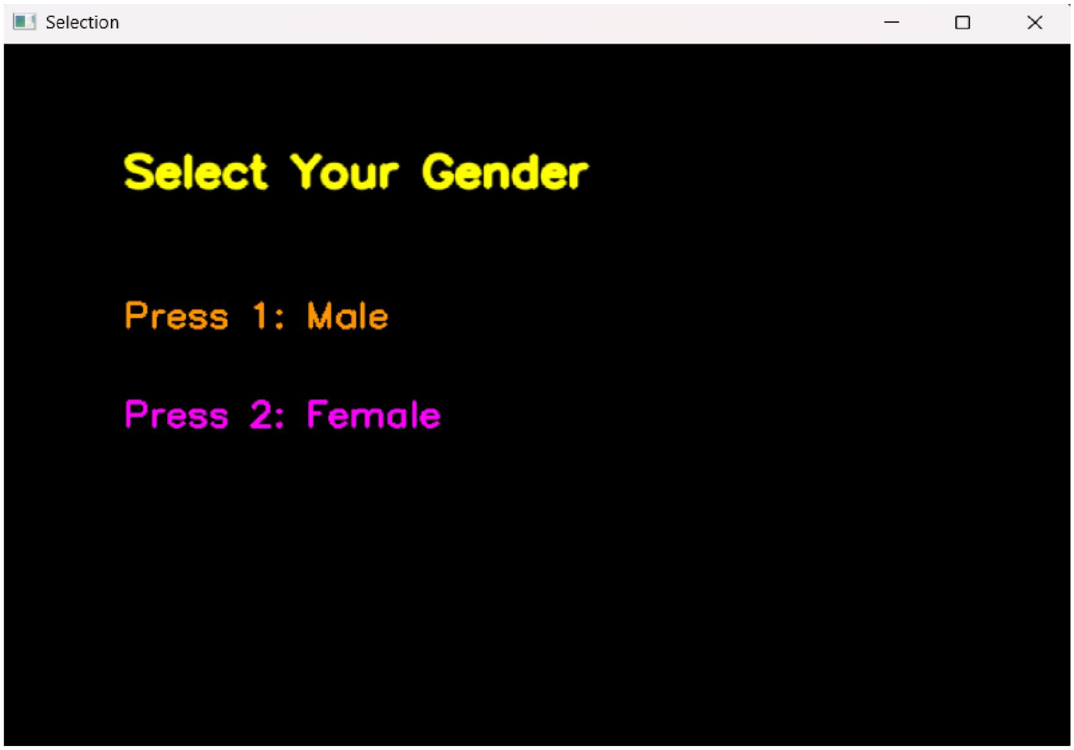

Fig 4 – User Interface

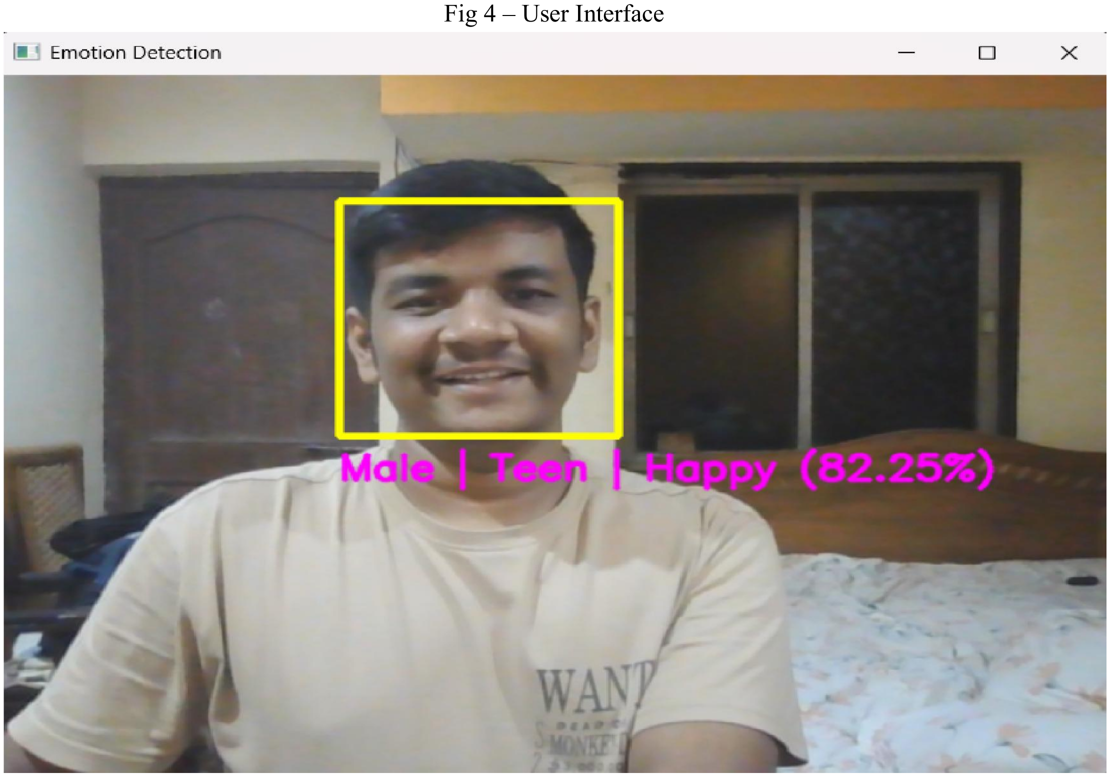

Fig 5 – User Output

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 5, Issue 13, April 2025 Impact Factor: 7.67

Figure 2- Welcome Screen
Welcome to Emotion Detection Using EEG DataSet
Press any key to continue...

Fig 3 – Gender Selection
Select Your Gender
Press 1: Male
Press 2: Female

Fig 4 –Age Group Selection
Select Your Age Group
Press 1: Child
Press 2: Teen
Press 3: Adult

Fig-5 Emotion Detection Output
Final output showing real-time emotion prediction:
Displays gender, age group, detected emotion (Happy), and its confidence (82.25%).
A yellow box highlights the detected face in the image.

VI. CONCLUSION

This project successfully demonstrates the effectiveness of deep autoencoders in emotion recognition. By leveraging unsupervised learning, the model is capable of extracting meaningful features from facial expressions, improving classification accuracy. Compared to traditional CNN-based approaches, deep autoencoders offer better feature representation and improved generalization.

Our system achieved **70% accuracy** on the FER-2013 dataset, proving its potential for real-world applications. Despite some limitations, such as dataset constraints and computational costs, the project provides a solid foundation for further research in emotion recognition using deep learning.

The growing importance of artificial intelligence in human-computer interactions makes emotion recognition a valuable tool across various domains. From mental health monitoring to AI-driven customer service, emotion recognition technology has numerous applications. However, the accuracy and efficiency of such systems still require significant enhancements.

Future advancements can focus on improving dataset diversity to reduce bias, incorporating multi-modal emotion recognition by integrating audio and physiological signals, and optimizing deep learning models to work efficiently in real-time applications. Moreover, explainability in AI models remains an important area of research, ensuring that emotion recognition decisions are interpretable and transparent.

By refining these aspects, the proposed system can contribute significantly to the development of intelligent and empathetic AI applications, further bridging the gap between machines and human emotions.

VII. ACKNOWLEDGMENT

We would like to express our sincere gratitude to all those who have contributed to the successful completion of this project.

First and foremost, we extend our heartfelt appreciation to our guide, **Dr. Nilesh Pawar**, for his invaluable guidance, continuous support, and constructive feedback throughout the research and implementation phases. His insights and expertise have been instrumental in shaping our work.

We are also grateful to **Yadavrao Tasgaonkar Institute of Engineering and Technology** for providing us with the necessary resources, infrastructure, and a conducive learning environment to carry out our research effectively.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 13, April 2025
Impact Factor: 7.67

Our sincere thanks go to our Head of Department**, Dr. Harish Barapatre**, and all the faculty members of the Department of Computer Engineering for their encouragement and academic support.

We would like to acknowledge the efforts of our peers and classmates who provided valuable suggestions and motivated us during this journey.

Lastly, we express our profound gratitude to our families and friends for their unwavering support, patience, and encouragement throughout this project. Their belief in us has been a source of motivation and inspiration.

This project is a testament to the collaborative efforts of all those who have contributed directly or indirectly, and we deeply appreciate their support.

REFERENCES

[1]. Koujan, M. R., Alharbawee, L., Giannakakis, G., Pugeault, N., & Roussos, A.(2020, November). Real-time facial expression recognition “in the wild” by disentangling 3d expression from identity. In 2020 15th IEEE International Conference on Automatic Face and Gesture Recognition (FG 2020) (pp. 24-31). IEEE.

[2]. Haghpanah, M. A., Saeedizade, E., Masouleh, M. T., & Kalhor, A. (2022, February). Real-time facial expression recognition using facial landmarks and neural networks. In 2022 International Conference on Machine Vision and Image Processing (MVIP) (pp. 1-7). IEEE.

[3]. Bisogni, C., Castiglione, A., Hossain, S., Narducci, F., & Umer, S. (2022). Impact of deep learning approaches on facial expression recognition in healthcare industries. IEEE Transactions on Industrial Informatics, 18(8), 5619-5627.

[4]. Modi, S., & Bohara, M. H. (2021, May). Facial emotion recognition using convolution neural network. In 2021 5th international conference on intelligent computing and control systems (ICICCS) (pp. 1339-1344). IEEE.

[5]. Pham, L., Vu, T. H., & Tran, T. A. (2021, January). Facial expression recognition using residual masking network. In 2020 25Th international conference on pattern recognition (ICPR) (pp. 4513-4519). IEEE.

[6]. Zhang, K., Li, Y., Wang, J., Cambria, E., & Li, X. (2021). Real-time video emotion recognition based on reinforcement learning and domain knowledge. IEEE Transactions on Circuits and Systems for Video Technology, 32(3), 1034-1047.

[7]. Gilderlane Ribeiro Alexandre, José Marques Soares, George André Pereira [2020],Systematic review of 3D facial expression recognition methods , Thé Pattern Recognition 100, 107108, 2020.

[8]. Emmanuel Dufourq [2020],A survey on factors affecting facial expression recognition based on convolutional neural networks , Conference of the South African Institute of Computer Scientists and Information Technologists 2020, 168-179, 2020.

[9]. H Dino, Maiwan Bahjat Abdulrazzaq, SR Zeebaree, Amira B Sallow, Rizgar R Zebari, Hanan M Shukur,Lailan M Haji [2020],Facial Expression Recognition based on Hybrid Feature Extraction Techniques with Different Classifiers , TEST Engineering & Management 83, 22319-22329, 2020.

[10]. Liu Sijia, Chen Zhikun, Wang Fubin, et al. Multi-angle face recognition based on convolutional neural network [J]. Journal of North China University of Technology (Natural Science Edition), 2019, 41 (4): 103-108.