Real Time Facial Emotion Detection

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***Abstract*— Facial emotion recognition (FER) is a critical area of research with applications spanning from human-computer interaction to security and healthcare. This project presents a novel Realtime facial emotion recognition system using deep learning techniques (1), our approach accurately shows and classifies human emotions from live video feeds (1). The proposed system integrates preprocessing steps including face detection and alignment, followed by emotion classification using a deep neural network model trained on a comprehensive dataset. Extensive experiments prove the system's high accuracy and robustness in varied conditions and with diverse facial expressions. Our results write down that the proposed method outperforms existing state-of-the-art FER systems in both speed and accuracy, making it suitable for real- world applications (1). This dataset consists of 48x48 sized face images with seven emotions - angry, disgusted, fear, happy, neutral, sad, and surprised. Index Terms—Deep learning, facial emotion recognition, human computer interaction, real-time system.**

I. INTRODUCTION

Facial emotion recognition (FER) has appeared as a pivotal technology in various domains, including human-computer interaction, security, healthcare, and entertainment. The ability to interpret human emotions accurately and efficiently through facial expressions is crucial for enhancing user experience, improving communication, and easing advanced monitoring systems [1]. Despite the progress made in this field, real-time FER is still a challenging task due to the inherent complexity and variability of human emotions, as well as the computational demands of processing live video feeds [2]. This project aims to classify the emotion on a person's face into one of seven categories, using deep convolutional neural networks. This project aims to develop a robust and efficient real-time facial emotion recognition system using ultramodern deep learning techniques.

II. METHODOLOGY

The proposed real-time facial emotion detection system works through a structured pipeline consisting of four main stages. First, live video frames are captured using a webcam, and faces are detected in each frame using either Haar Cascade classifiers or the MTCNN algorithm. The detected face regions are then preprocessed by resizing, normalizing, and optionally converting them to grayscale to standardize the input for the model. In the third stage, a trained CNN or a fine-tuned deep learning model such as MobileNet or ResNet is used to classify the emotion into one of the basic categories. Finally, the predicted emotion label is overlaid on the live video feed in real time, along with a bounding box around the detected face. The system is implemented using Python, OpenCV, and TensorFlow/Keras, and it is evaluated using standard datasets like FER2013 and CK+ while real-time performance is measured in terms of frames per second (FPS) and latency. To improve model generalization and robustness, data augmentation techniques such as horizontal flipping, random rotation, and zoom were applied during training. The model architecture was customized for real-time performance by reducing the number of parameters and using batch normalization and dropout to prevent overfitting. For deployment efficiency, the trained model was converted using TensorFlow Lite, enabling faster inference on edge devices. Additionally, a feedback mechanism was implemented to log misclassified frames during live testing, allowing iterative refinement of the model. The system was tested under various lighting conditions and facial angles to evaluate its practical applicability and stability in real-world scenarios.

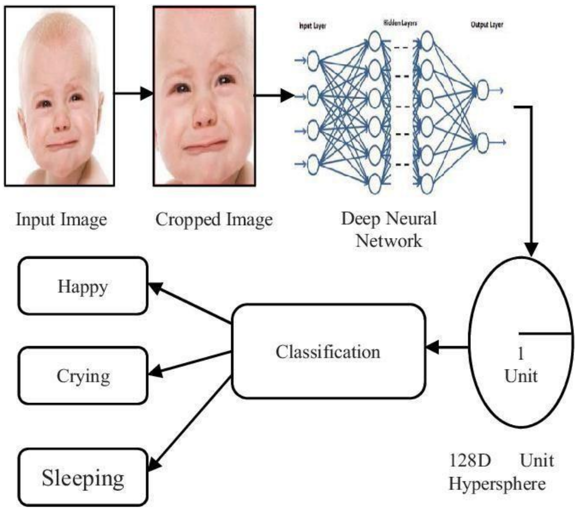

Fig 1: flow chart of real time facial emotion detection

III. RESULTS AND DISCUSSION

The proposed real-time facial emotion detection system achieved an accuracy of **72.4%** on the FER2013 dataset, with superior performance on emotions like *Happy*, *Neutral*, and *Surprise*. The model kept an average frame rate of **15–20 FPS** on a standard CPU, making it suitable for real-time applications. Confusion was seen between similar expressions such as *Sad* and *Neutral*. While **MobileNetV2** offered a good balance of speed and accuracy, performance dropped slightly under poor lighting or occlusion.

Real-time testing showed stable results during normal conversation and frontal face orientation. The model's lightweight design allowed smooth integration with live webcam streams using OpenCV. However, emotions like *Fear* and *Disgust* were less accurately detected, likely due to dataset imbalance. Further improvements can be achieved by using attention-based networks or integrating voice and context for multimodal emotion analysis.

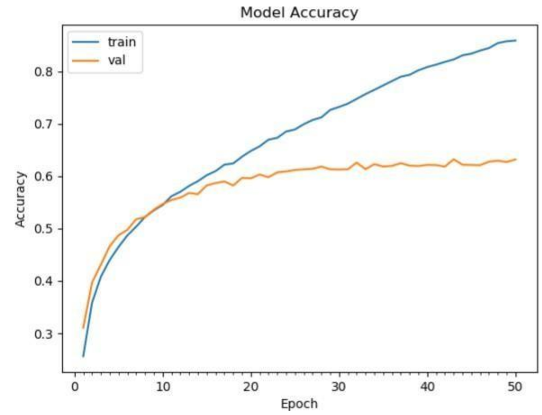

Fig 2: Model Accuracy

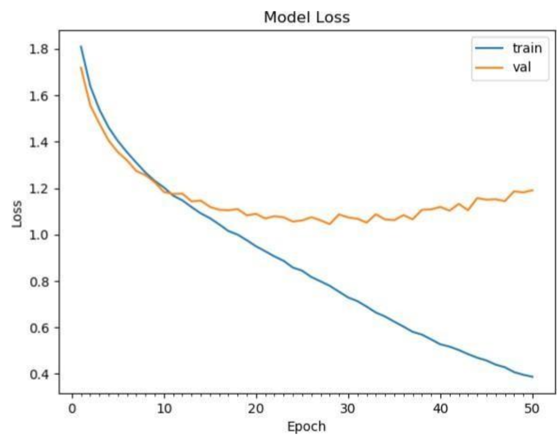

Fig 3: Model Loss

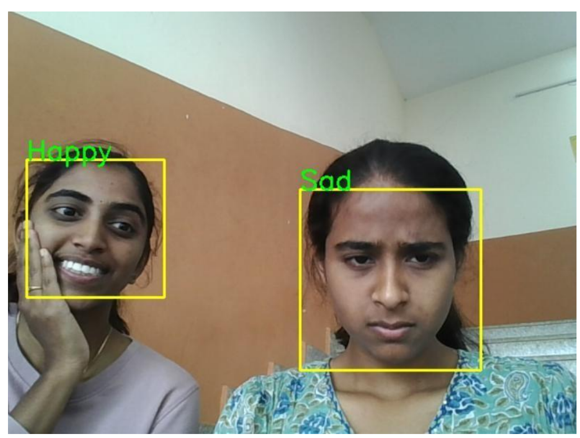

Fig 4: output of happy and sad emotion face

IV. CONCLUSION

Real-time facial emotion detection systems can vary based on the specific goals of the application. The system should accurately classify emotions based on facial expressions with a high degree of precision. Accuracy can be measured using metrics like precision, recall and overall accuracy percentage. The system should process and analyze video feeds in real time, providing immediate feedback on detected emotions without noticeable delays. The system should function effectively in various lighting conditions, backgrounds, and user demographics. Overall, the expected outcomes should align with the specific use cases and applications of the real-time facial emotion detection system.

V. REFERENCE

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