

Real-Time Emotion Recognition: Project Report

1. Approach & Implementation

This project is a Python application that uses a webcam to recognize emotions in real time. Video frames are captured by the script using OpenCV and processed continuously. A face detection model initially finds any faces in each frame. An emotion detection model then analyzes the trimmed face region and categorizes the expression. The user is shown the outcome in real-time on the video feed, which includes the predicted emotion and a bounding box.

2. Machine Learning Models Used

The application relies on the **deepface** library to access pre-trained models for its two-stage pipeline:

- **Face Detection:** I selected the **OpenCV Haar Cascade classifier** (detector_backend='opencv'). This classic model was chosen for its exceptional speed, which ensures smooth, real-time video processing on a standard CPU.
- **Emotion Recognition:** A deep **Convolutional Neural Network (CNN)**, provided by **deepface**, performs the classification. It is trained to recognize seven universal emotions: **happy, sad, angry, fear, disgust, surprise, and neutral**.

3. Limitations & Challenges Encountered

The primary challenge was balancing the trade-off between detection accuracy and real-time performance.

- **Model Performance Trade-off:** The fast **OpenCV** detector was chosen for its speed but proved less accurate with subtle emotions like 'surprise'. More advanced deep learning detectors like **MTCNN** were tested and found to be far more accurate, but their high computational cost caused severe video lag, making them unsuitable for this real-time application without further optimization.
- **Limited Emotion Set:** The pre-trained model is unable to recognize emotions outside its training data, such as "**contempt**."
- **Environmental Sensitivity:** The system's accuracy is highly dependent on environmental factors. Performance degrades significantly with poor lighting, non-frontal camera angles, or facial occlusions (e.g., glasses, hair).