REAL-TIME EMOTION DETECTION USING AI

A Mini Project Report Submitted in Partial fulfilment of the Requirement for the Award of the Degree of

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING

Submitted by

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K.S.R.M. COLLEGE OF ENGINEERING

(UGC - AUTONOMOUS)

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CERTIFICATE

This is to certified that the Mini Project report entitled "**REAL-TIME EMOTION DETECTION USING AI"** is being submitted by SHAIK MUJAMMIL (249Y5A0516) to K.S.R.M. College of Engineering (UGC - AUTONOMOUS), Kadapa. This Mini-Project work has been carried out by him under our supervision during the period 2025-2026.

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Table of Contents

ABSTRACT

In this digital age, understanding human emotions has become a crucial part of enhancing **human-computer interaction (HCI)**. Emotion detection aims to automatically recognize human emotional states such as happiness, sadness, anger, fear, disgust, surprise, and neutrality through facial expressions.

The main objective of this project is to build a **real-time emotion detection system** that uses **computer vision and deep learning** techniques to interpret human facial expressions. The system captures video input from a webcam, detects faces using **OpenCV's Haar Cascade Classifier**, and analyzes emotional states using the **DeepFace library** built on top of **TensorFlow** and **Keras**.

This project demonstrates the power of AI in interpreting non-verbal cues and can be applied in multiple areas such as **education (student engagement analysis)**, **healthcare (mental health monitoring)**, **marketing (customer satisfaction tracking)**, and **security (behavioral analysis)**.

Keywords: Emotion Detection, DeepFace, OpenCV, Artificial Intelligence, Facial Expressions.

LIST OF ABBREVIATIONS

ABBREVIATION	FULL FORM
AI	Artificial Intelligence
CV	Computer Vision
FPS	Frames Per Second
CNN	Convolutional Neural Network
HCI	Human-Computer Interaction
ROI	Region of Interest
GUI	Graphical User Interface
GPU	Graphics Processing Unit
IDE	Integrated Development Environment
OS	Operating System
XML	Extensible Markup Language
API	Application Programming Interface
VS Code	Visual Studio Code
RGB	Red Green Blue (Color Model)

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Overview

Facial expressions are one of the most powerful and universal means of non-verbal communication among humans. They serve as a window into one's emotional state, enabling people to express feelings such as happiness, sadness, anger, fear, surprise, and disgust without uttering a word. The ability to automatically detect and interpret these expressions forms a critical component of Affective Computing, a subfield of Artificial Intelligence (AI) that focuses on enhancing human–computer interaction (HCI) through emotional awareness.

This project aims to develop a **REAL-TIME EMOTION DETECTION USING AI** and Deep Learning techniques to recognize human emotions from live webcam feeds. By leveraging **OpenCV** for face detection and **DeepFace** for emotion recognition, the system can identify and classify emotions dynamically. The integration of computer vision with AI provides a foundation for machines to understand human feelings, thus paving the way for more intuitive and empathetic technology.

1.2 Objectives

The primary objectives of this project are:

- To detect human faces from live video streams using OpenCV's Haar Cascade Classifier.
- To analyze detected facial regions using pre-trained deep learning models.
- To classify emotions into seven basic categories: Happy, Sad, Angry, Fearful, Surprised, Disgusted, and Neutral.
- To display the predicted emotion on the live video output in real time.
- To explore the potential applications of emotion detection in various domains such as education, healthcare, marketing, and security.

1.3 Scope

This emotion detection system can be effectively applied in multiple real-world environments, including:

- **Online Education:** Measuring student engagement and attention during virtual classes.
- **Healthcare:** Monitoring patient emotions to detect stress, depression, or anxiety levels.
- **Marketing:** Evaluating customer satisfaction and emotional responses to products.
- **Security Systems:** Identifying suspicious or abnormal behavior in surveillance feeds.
- **Customer Interaction:** Improving chatbot empathy and AI assistant communication

CHAPTER 2

SYSTEM ANALYSIS

2.1 Problem Definition

In today's era of intelligent systems, most computers and machines lack the ability to understand or respond to human emotions. Traditional computing systems can process data and execute commands but fail to interpret the emotional states of users. This limitation reduces the effectiveness of **Human–Computer Interaction (HCI)**, as systems cannot adapt their responses based on the user's mood or behavior.

Manual emotion recognition from facial images or videos is both **time-consuming** and **subjective**, often leading to inaccurate results. Moreover, the absence of emotional awareness in automated systems creates a communication gap between humans and computers, especially in areas such as **education**, **healthcare**, **customer service**, and **security surveillance**.

Hence, there is a strong need for a **real-time automated emotion detection system** that can accurately recognize and classify human emotions from facial expressions using **Artificial Intelligence (AI)** and **Computer Vision (CV)** techniques. Such a system can enhance interaction, improve user experience, and enable emotion-aware applications in diverse domains.

2.2 Proposed Solution

To overcome the limitations of traditional systems that lack emotional awareness, the proposed solution is a **real-time emotion detection system** that automatically recognizes human emotions through facial expressions using **Artificial Intelligence (AI)** and **Deep Learning** techniques.

The system captures live video input through a **webcam** and detects faces using **OpenCV's Haar Cascade Classifier**. Once the face is identified, it is analyzed using the **DeepFace library**, which employs pre-trained **Convolutional Neural Network (CNN)** models such as **VGG-Face**, **ResNet**, and **Facenet** to classify the emotion into one of seven categories — **Happy, Sad, Angry, Fearful, Disgusted, Surprised,** and **Neutral**.

2.3 Features

The proposed *REAL-TIME EMOTION DETECTION USING AI* system includes several important features that make it efficient, accurate, and user-friendly. These features ensure smooth real-time performance and practical usability across multiple domains.

Key Features:

1. **Real-Time Emotion Detection:**
   The system captures live video input from a webcam and detects human emotions instantly without any delay.
2. **Automatic Face Detection:**
   Utilizes **OpenCV's Haar Cascade Classifier** to automatically locate and extract faces from video frames for further analysis.
3. **Deep Learning-Based Emotion Recognition:**
   Employs **DeepFace** with pre-trained **Convolutional Neural Network (CNN)** models such as **VGG-Face**, **ResNet**, and **Facenet** to classify emotions accurately.
4. **Multi-Emotion Classification:**
   Capable of recognizing seven basic emotions — **Happy, Sad, Angry, Fearful, Disgusted, Surprised,** and **Neutral**.
5. **User-Friendly Interface:**
   Displays the detected emotion label directly on the live video feed, making it easy for users to interpret the results visually.
6. **High Accuracy and Performance:**
   Integrates AI and Deep Learning models to ensure precise emotion recognition even under varying lighting or facial orientation conditions.
7. **Cross-Platform Compatibility:**
   Can run on multiple operating systems such as **Windows**, **Linux**, and **macOS**, using Python-based libraries.

2.4 Applications

The *Real-Time Emotion Detection Using AI* system can be applied in a wide range of real-world scenarios where understanding human emotions enhances efficiency, safety, and interactivity. By recognizing emotional expressions accurately, this technology improves human–computer communication and supports intelligent decision-making in various fields.

1. Human–Computer Interaction (HCI):

Enhances user experience by enabling computers and AI systems to understand and respond according to human emotions, creating more natural and adaptive interactions.

2. Education:

Used in online learning platforms to monitor students' attentiveness, engagement, and emotions during virtual classes, helping teachers adjust their teaching approach effectively.

3. Healthcare:

Assists medical professionals and psychologists in analyzing patient emotions for stress, anxiety, or depression detection. It can also be integrated into telemedicine for remote emotional monitoring.

4. Marketing and Customer Feedback:

Helps organizations study customer reactions to advertisements, products, or services by analyzing facial expressions to measure satisfaction or disinterest levels.

5. Security and Surveillance:

Detects suspicious, aggressive, or stressed behavior in public or restricted areas through emotion analysis, enhancing safety and crime prevention systems.

6. Entertainment and Gaming:

Used to develop emotion-aware games and applications that adapt to the player's mood, creating more engaging and personalized entertainment experiences.

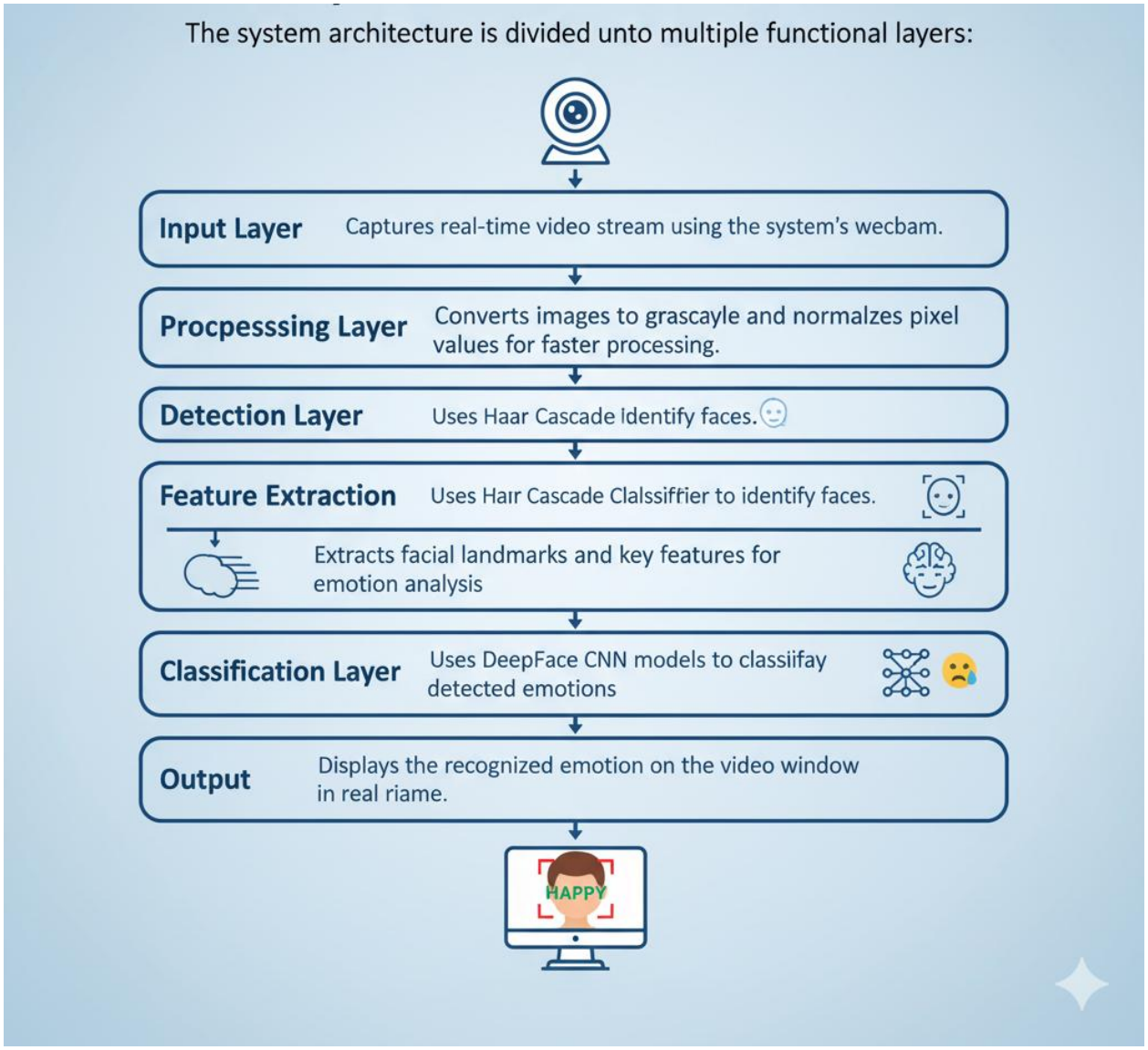
7. Customer Service:

Improves chatbot and virtual assistant performance by allowing them to sense user emotions and respond empathetically to ensure better customer satisfaction.

8. Social Robotics:

Enables robots to recognize human emotions and react appropriately, making interactions with humans more natural and socially intelligent.

2.5 System Architecture Overview



CHAPTER 3

SYSTEM REQUITEMENTS

3.1 Hardware Requirements

- Processor : Intel i3 or Higher
- Ram : Minimum 4 GB
- Hard Disk : 500 MB Free Space
- Webcam : Integrated or USB Webcam (640x480)
- Graphics : NVIDIA GPU for faster model inference
- Display : 14-inch / 15-inch Monitor.

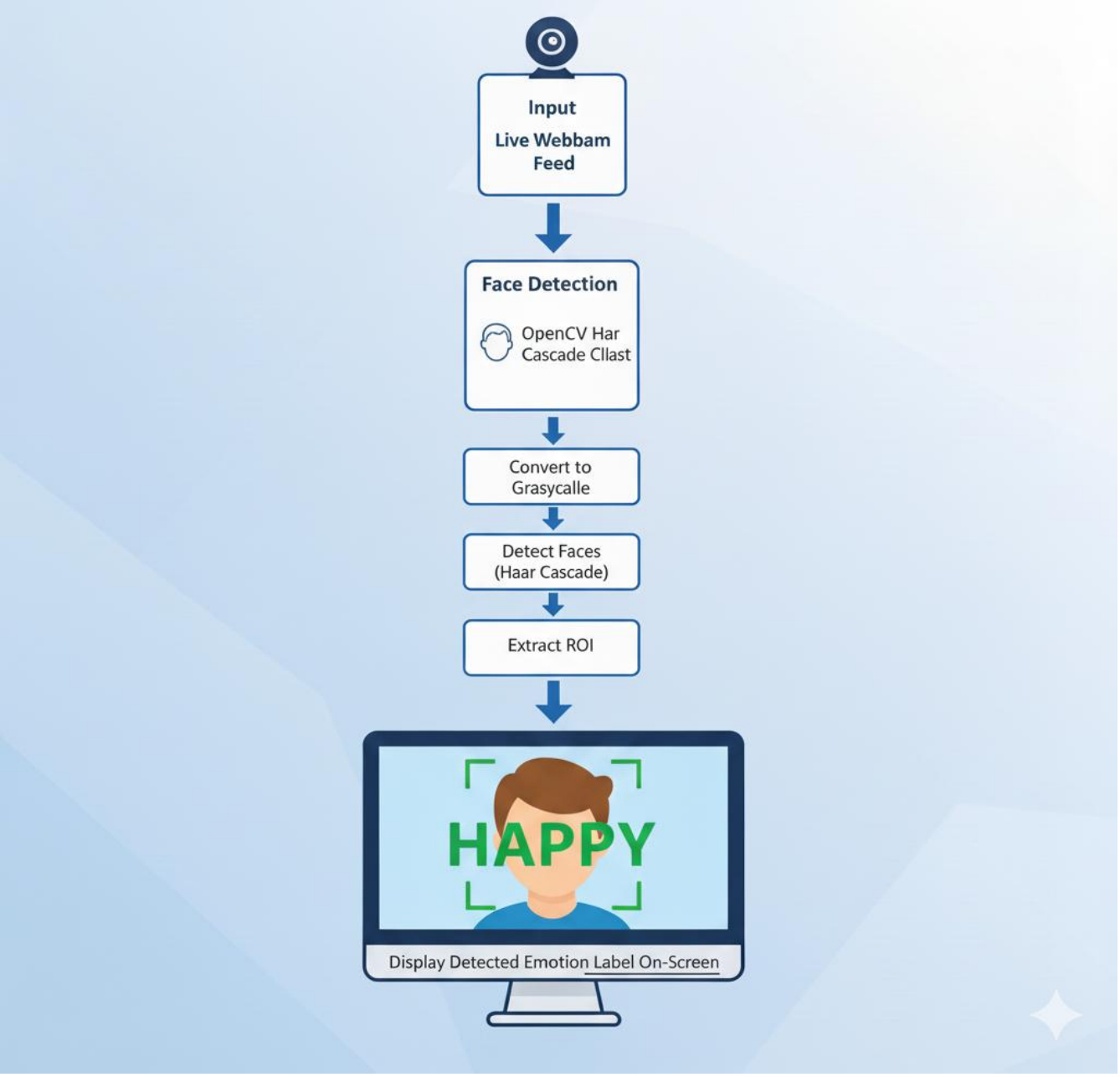
3.2 Software Requirements

- Operating system : Windows 10 / 11, Linux , MacOS
- Coding Language : Python 3.8 or higher
- IDE / EDITOR : PyCharm or VS Code
- Libraries / Packages : OpenCV (cv2) , DeepFace, NumPy, TensorFlow / Keras.

CHAPTER 4

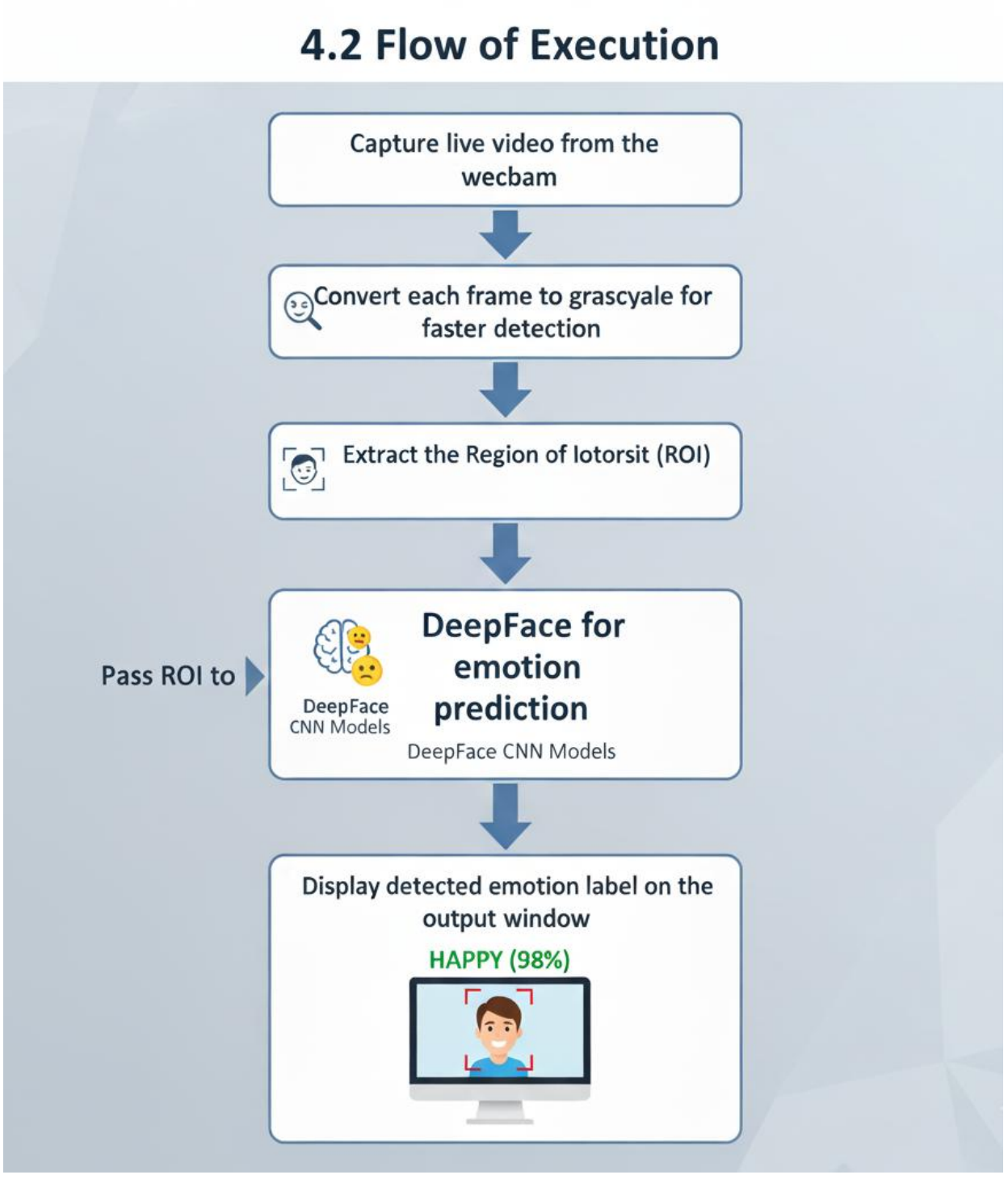
SYSTEM DESIGN

4.1 Architecture Diagram



This diagram shows the high-level architecture of the real-time emotion recognition system. The webcam captures a live video feed, which passes through the **Face Detection** module (using OpenCV's Haar Cascade) to identify faces. The detected faces are then analyzed by **DeepFace** for emotion prediction, and the **Output Display** shows the recognized emotions in real time.

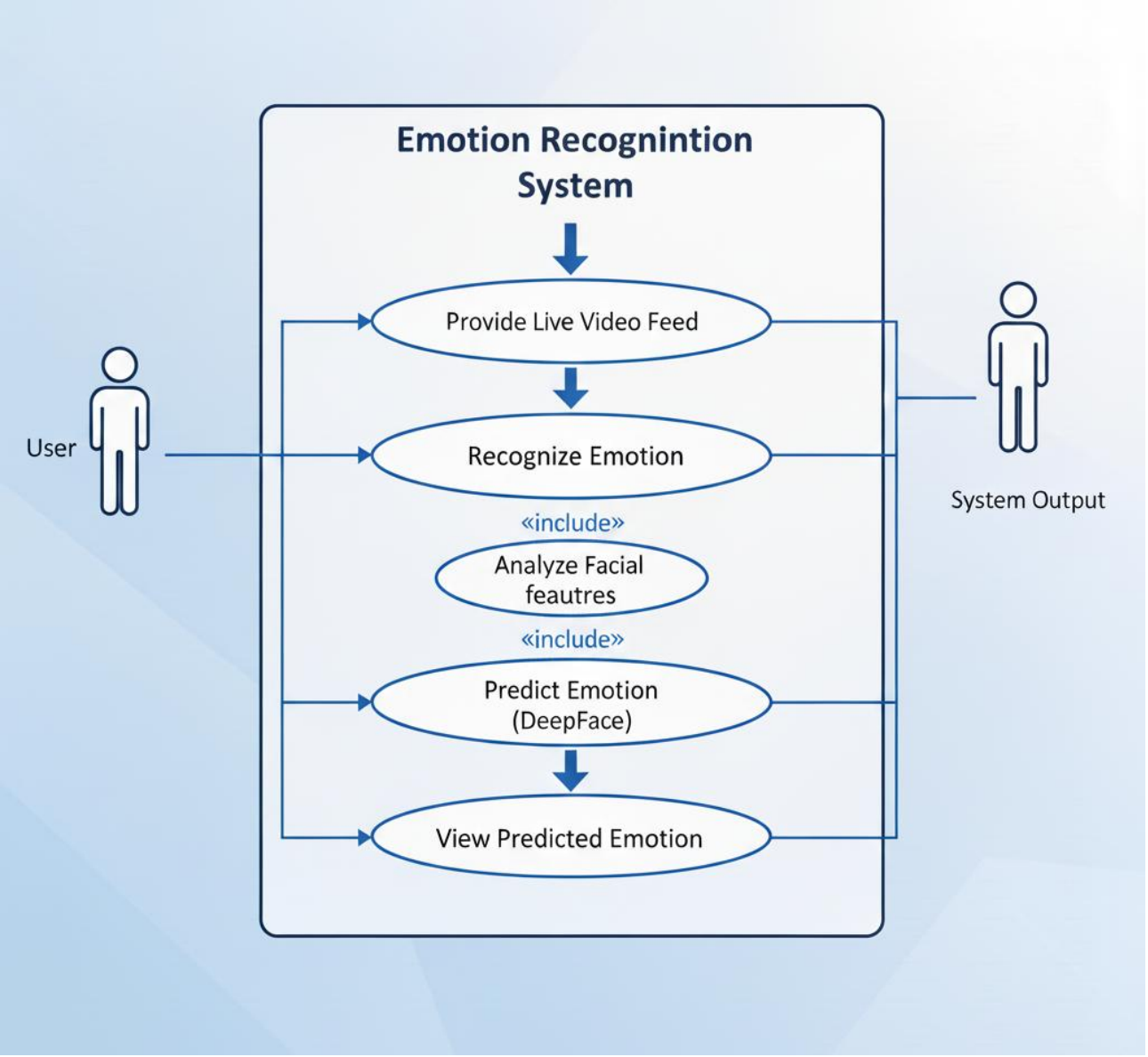
4.2 Flow of Execution



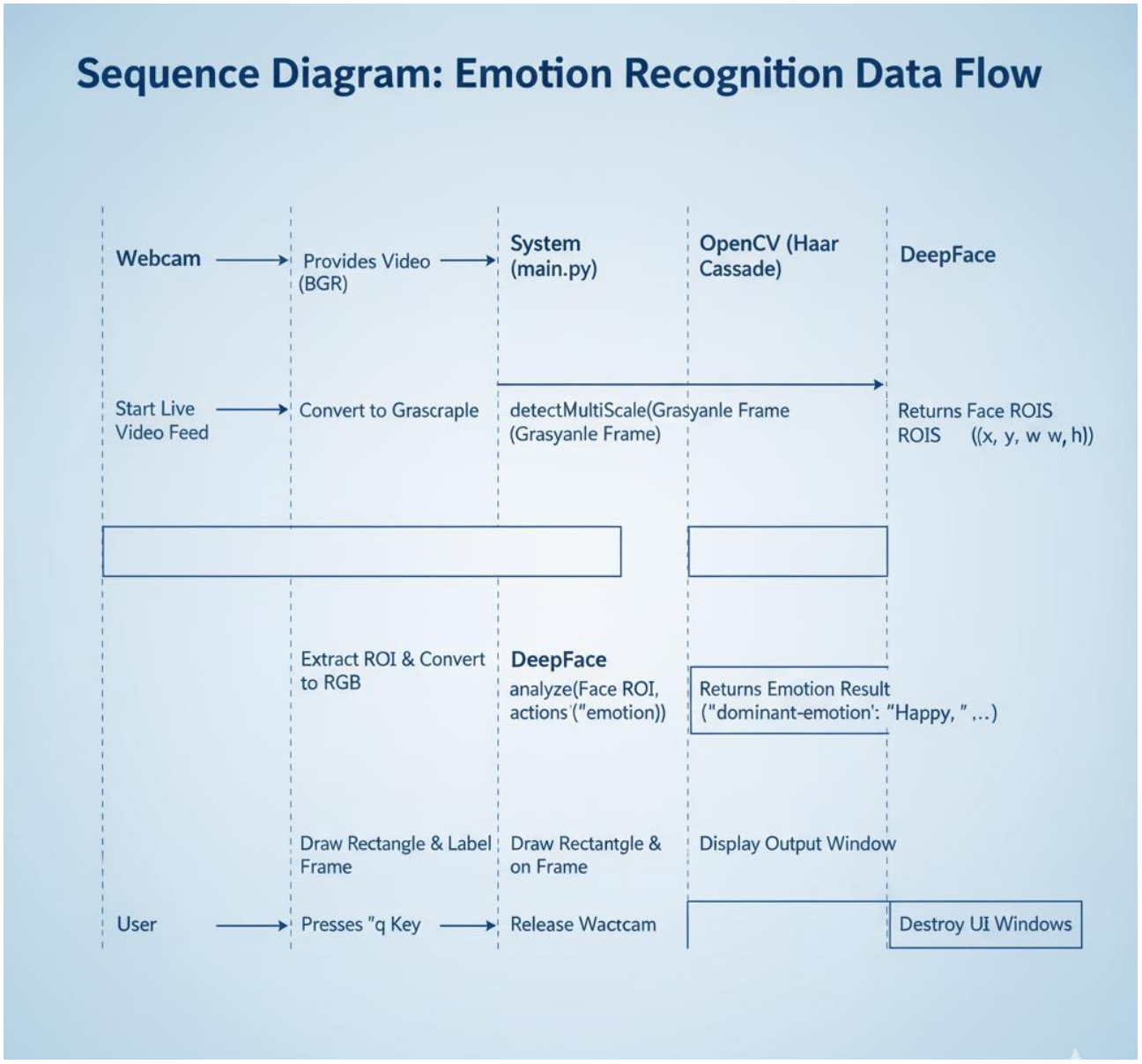
This diagram outlines the sequential steps for real-time emotion recognition. The system first **captures live video** from the webcam. Each frame is then **converted to grayscale** for efficient processing. A **Haar Cascade Classifier detects faces**, from which the **Region of Interest (ROI) is extracted**. This ROI is then fed to **DeepFace for emotion prediction**. Finally, the **detected emotion label is displayed** on the output video window in real time..

4.3 UML Diagrams

4.3.1 Use Case Diagram: Depicts user–system interaction during emotion recognition.



4.3.2 Sequence Diagram: Illustrates the data flow from video capture to emotion output.



CHAPTER-5

SOURCE CODE

```
# Import required libraries
import cv2
from deepface import DeepFace

# Load the Haar Cascade Classifier for face detection
face_cascade = cv2.CascadeClassifier(cv2.data.haarcascades + 'haarcascade_frontalface_default.xml')

# Start webcam capture
cap = cv2.VideoCapture(0)

while True:
    # Read frame from webcam
    ret, frame = cap.read()
    if not ret:
        break

    # Convert frame to grayscale (for detection)
    gray_frame = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
    # Convert grayscale to RGB (for DeepFace analysis)
    rgb_frame = cv2.cvtColor(gray_frame, cv2.COLOR_GRAY2RGB)

    # Detect faces in the frame
    faces = face_cascade.detectMultiScale(gray_frame, scaleFactor=1.1, minNeighbors=5, minSize=(30,
30))

    for (x, y, w, h) in faces:
        # Extract the face region
        face_roi = rgb_frame[y:y + h, x:x + w]

        # Perform emotion analysis using DeepFace
        result = DeepFace.analyze(face_roi, actions=['emotion'], enforce_detection=False)

        # Extract dominant emotion and confidence score
        dominant_emotion = result[0]['dominant_emotion']
        emotion_confidence = result[0]['emotion'][dominant_emotion]

        # Prepare label with emotion and confidence
        label = f"{dominant_emotion.capitalize()} ({emotion_confidence:.2f}%)"

        # Draw rectangle around the face
        cv2.rectangle(frame, (x, y), (x + w, y + h), (0, 0, 255), 2)

        # Display emotion label above the rectangle
        cv2.putText(frame, label, (x, y - 10),
```

```
            cv2.FONT_HERSHEY_SIMPLEX, 0.8, (0, 0, 255), 2)

    # Show the frame with emotion labels
    cv2.imshow('Real-Time Emotion Detection', frame)

    # Exit the program when 'q' key is pressed
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break

# Release webcam and close all windows
cap.release()
cv2.destroyAllWindows()
```

5.1 Explanation:

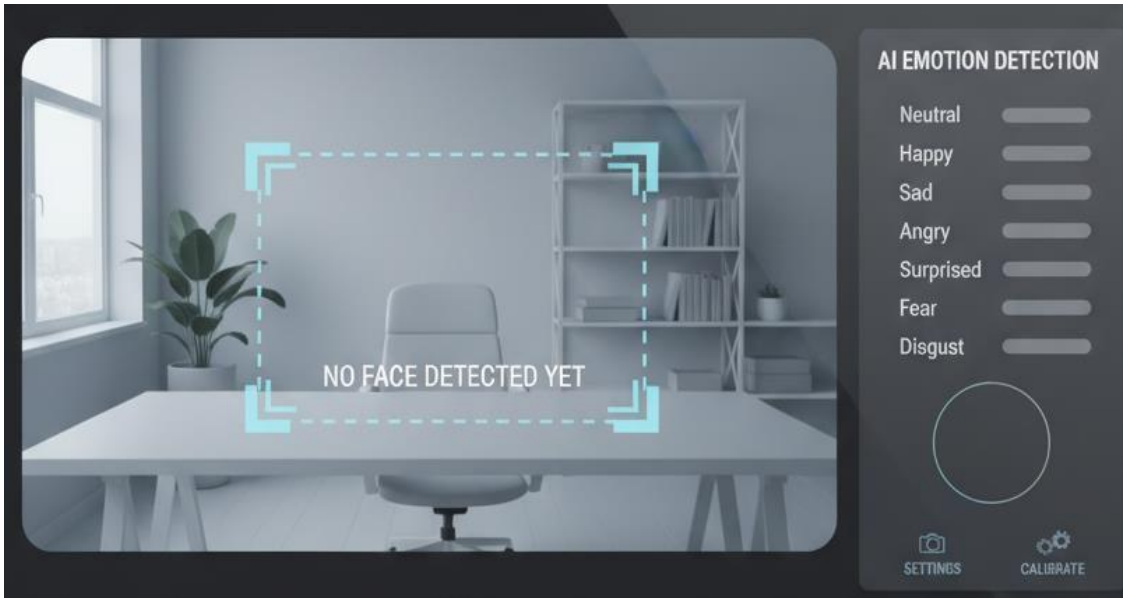
1. **Libraries Used:**
   - cv2 → Used for video capture and face detection using OpenCV.
   - DeepFace → Used for emotion recognition through pre-trained CNN models.
2. **Steps Performed:**
   - Captures live video input from the webcam.
   - Detects faces using Haar Cascade Classifier.
   - Analyzes each detected face using DeepFace.
   - Displays real-time emotion label (like *Happy, Sad, Angry, Neutral, etc.*) with confidence percentage.
   - Closes when the user presses **'q'**.
3. **Output:**
   - The system opens a webcam window titled **"Real-Time Emotion Detection"**.
   - Each detected face is outlined with a red rectangle, and the identified emotion appears above it in real time.

CHAPTER-6

OUTPUT -SCREENS

This section demonstrates the visual results of the project *"Real-Time Emotion Detection Using AI"*. Each screen represents a specific stage in the emotion detection process, showing how the system captures, analyzes, and displays emotions in real time.

Screen 1 : System Initialization



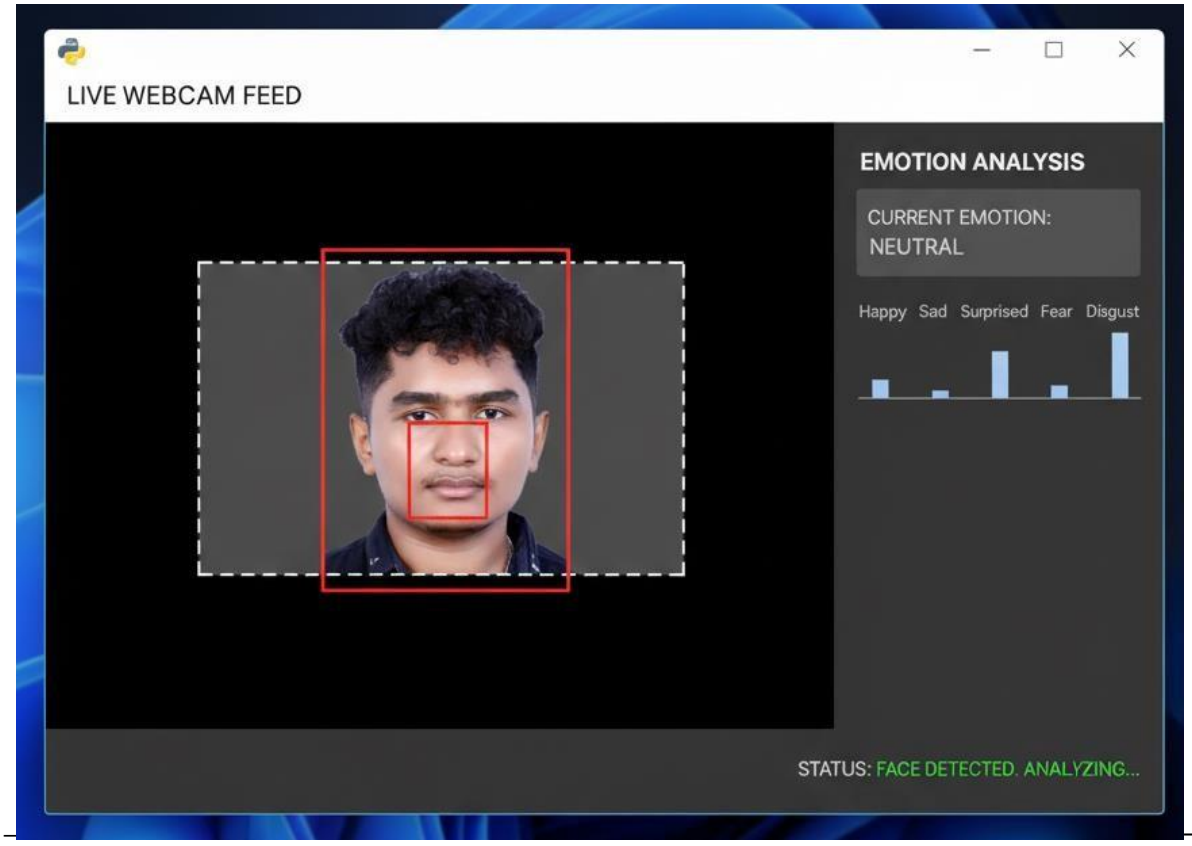
- **Description:**

This screen displays the initial interface when the program is executed. The webcam starts capturing live video input, and the OpenCV window titled "Real-Time Emotion Detection" appears.

- **Purpose:**

To confirm that the webcam is properly connected and the program is ready to process video frames in real time.

Screen 2: Face Detection



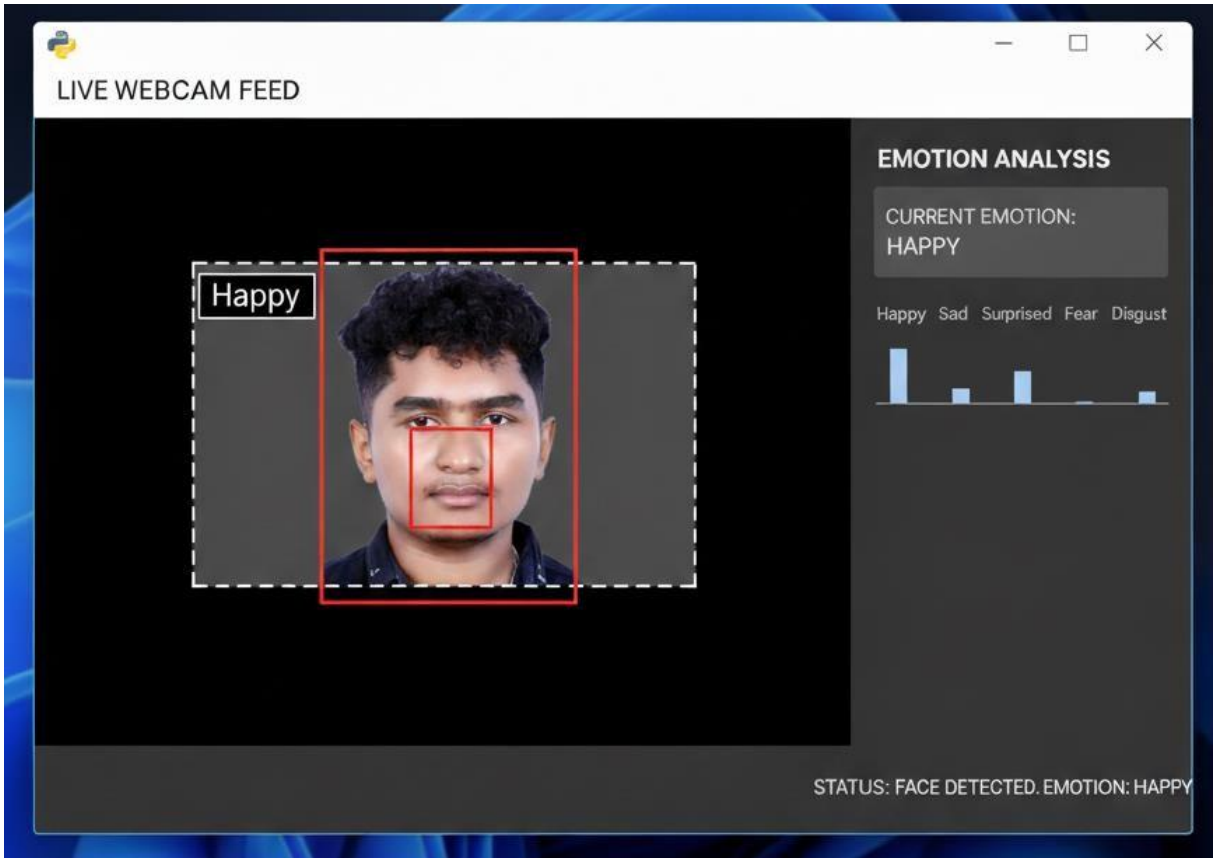
- **Description:**

  The system detects one or more faces in the live video feed using OpenCV's Haar Cascade Classifier. A rectangular boundary appears around each detected face.

- **Purpose:**

  To identify and isolate the Region of Interest (ROI) from which the emotional analysis will be performed.

Screen 3: Emotion Analysis



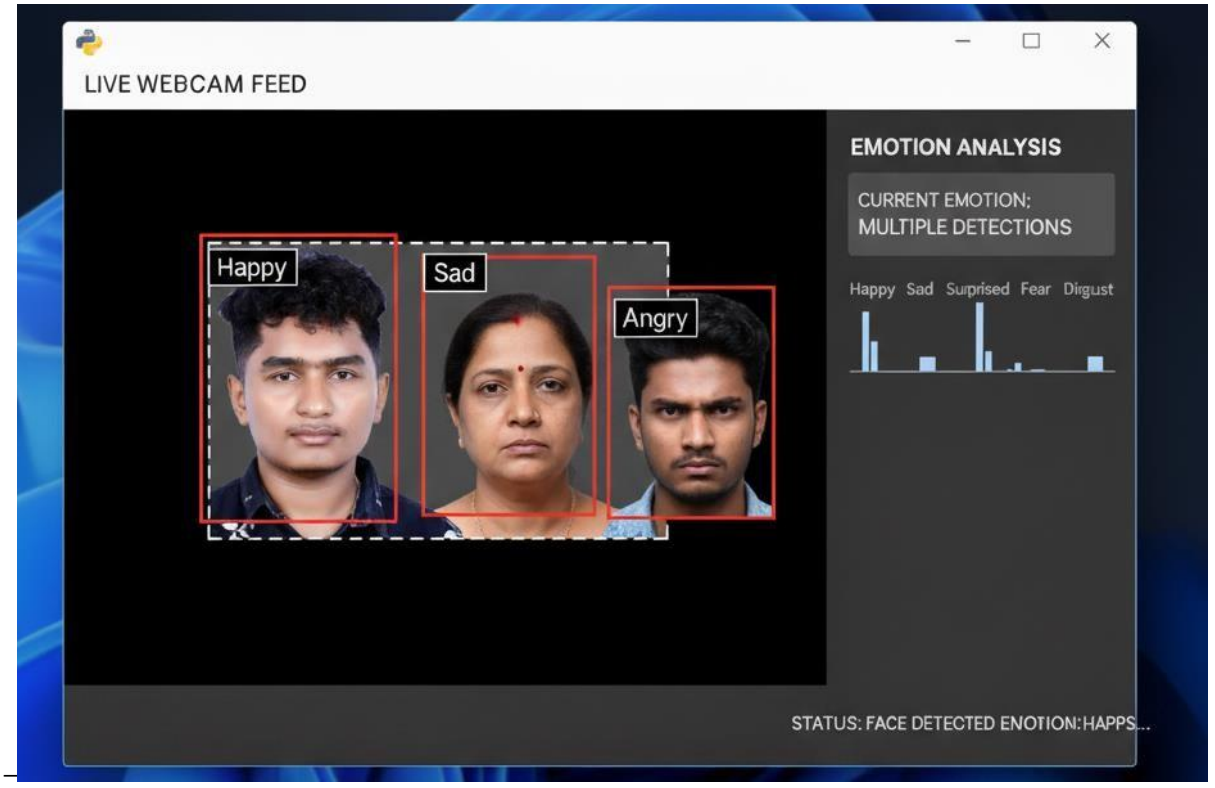
- **Description:**

  Once the face is detected, the region is passed to the DeepFace library for emotion prediction. The system analyzes facial features such as eyes, mouth, and eyebrows to determine emotional state.

- **Purpose:**

  To apply the Deep Learning model (CNN) and predict the dominant emotion for the detected face.

Screen 4 : Multiple Faces Detection (Group Scenario)



Description:

When more than one person appears in front of the webcam, the system simultaneously detects multiple faces and predicts each individual's emotion independently. Each detected face is labeled with the corresponding emotion.

Purpose:

To demonstrate multi-face emotion detection capability, ensuring scalability and robustness of the model.

Screen 5: Program Termination

- **Description:**

  When the user presses the ‘q’ key, the program stops capturing video, releases the webcam, and closes all OpenCV windows.

- **Purpose:**

  To safely exit the emotion detection system and free all resources.

CHAPTER-7

CONCLUSION & FUTURE SCOPE

7.1 Conclusion of Emotion Detection System:

The *Real-Time Emotion Detection Using AI* project successfully demonstrates the integration of **Artificial Intelligence (AI)** and **Computer Vision (CV)** technologies to recognize and analyze human emotions in real time. By utilizing **OpenCV's Haar Cascade Classifier** for face detection and the **DeepFace library** for emotion classification, the system can efficiently identify emotions such as **Happy, Sad, Angry, Fearful, Disgusted, Surprised,** and **Neutral** with high accuracy.

This project highlights how machines can interpret non-verbal human cues and respond intelligently, thereby improving **Human–Computer Interaction (HCI)**. It showcases the potential of AI-driven emotion recognition in transforming various sectors — including **education**, **healthcare**, **security**, **marketing**, and **entertainment** — where understanding human emotions plays a vital role.

Through this system, we have achieved a foundation for developing emotionally intelligent applications that can make technology more adaptive, personalized, and empathetic toward users. The results validate that real-time emotion recognition is not only feasible but also an essential step toward building **next-generation intelligent systems** capable of human-like perception and interaction.

7.2 Future Scope:

The *Real-Time Emotion Detection Using AI* system lays the groundwork for emotionally intelligent computing. Although the current system effectively recognizes basic human emotions using facial expressions, there is vast potential to enhance and expand this project in the future.

1. Integration with IoT Devices:

The system can be connected with **IoT-based smart environments** such as homes, offices, or hospitals to trigger automated responses — for example, adjusting lighting, music, or temperature according to the user's mood.

2. Mobile and Web-Based Applications:

A lightweight mobile or web application can be developed to make emotion detection accessible anytime and anywhere using smartphone cameras or browsers.

3. Multi-Modal Emotion Recognition:

Future systems can incorporate additional inputs such as **speech tone, body posture, and physiological signals** to detect complex or mixed emotions more accurately.

4. Improved Dataset and Model Training:

Training on **larger, diverse, and real-world datasets** will improve emotion recognition accuracy across various lighting conditions, face angles, and cultural differences.

5. Mental Health and Counseling Applications:

The system can be adapted to monitor users' emotional states over time, helping psychologists and doctors identify signs of **depression, stress, or anxiety** early.

6. Emotion Analytics Dashboard:

An advanced analytical dashboard can be added to visualize and log detected emotions for use in research, marketing, or education analysis.

7. Edge AI Implementation:

The emotion detection model can be optimized for **Edge AI devices** (like Raspberry Pi or NVIDIA Jetson Nano) to perform real-time detection even without an internet connection.

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