



A

Report on

“Affective Computing”

Submitted To

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In Fulfillment of the

Requirement

For the Degree Of

Final Year of B. Tech.

(COMPUTER SCIENCE AND ENGINEERING)

Submitted by

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Year 2022-2023



CERTIFICATE

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We express our sincere thanks to all the teaching and non-teaching staff and all those who have directly or indirectly helped in making the project a success.

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1. ABSTARCT

Over the past few years, the term AI gained huge popularity defining a new era of machines carrying intelligence which will simulate human intelligence. The AI today is in its extremely basic stage i.e., Artificial Narrow Intelligence. The later stage of AI is considered as more advanced and called Artificial General Intelligence where machines will have strong capabilities of complex problem solving and reasoning. The third stage of AI is an immensely powerful stage where machines will have the ability to make decisions and it will surpass human intelligence and be called as a state of intelligence explosion which can be considered as the critical and unsafe stage for humans even AI can give solution to some critical problems.

Understanding this scenario machines today rather than being simply Artificial Intelligence they need to be more Emotionally Intelligent machines which will understand, simulate, and react to human emotions, making the human-machine interaction and hence relation stronger and more cooperative. The research aims to simulate the human emotional intelligence in the machines and make it more precise by applying certain physical and psychological behavior patterns in human-to-human interaction.

2. INTRODUCTION

With the introduction of Machine Learning and Artificial intelligence the machines today are striving hard to become intelligent rather than only becoming accurate. The term Artificial Intelligence defines simulation of human intelligence by machines. This intelligence can be improved automatically over time as machines go on learning. As far as AI is concerned, we have various robotic systems, software's like stock market predictions systems, even personal digital assistants like Siri, Google Assistant and Alexa which help people make human life easier.

Considering an example of personal digital assistants like Siri, Alexa they are most intelligent as long as answering the questions and doing online tasks are concerned but can be considered as dumbest when we consider them from the perspective of emotional intelligence. Rosalind Piccard, Director of Affective Computing Research at MIT once said, "Even your dog can understand when you are feeling frustrated of it then why the personal digital assistants can't?". Yet developing that kind of intelligence in particular, the ability to recognize human emotions and then respond appropriately is essential to the true success of digital assistants and the many other artificial intelligences (AIs) we interact with every day. So, this research will aim for finding out some ways so that machines can be made more emotionally intelligent and connected to humans rather than just being intelligent.

The affective system refers to the set of cognitive, physiological, and behavioral processes involved in human emotions and feelings. It is a complex network that recognizes our emotional experiences, expressions, and responses. The affective system plays a crucial role in our daily lives, shaping our perceptions, decision-making, social interactions, and overall well-being.

Key components of the affective system include:

- 1. Emotion Generation:** This involves the processes by which emotions are elicited or generated in response to various stimuli. It encompasses the appraisal of events, memories, thoughts, and sensory inputs.
- 2. Emotional Experience:** Once emotions are generated, they are subjectively experienced. This involves the conscious awareness of emotional states, such as joy, sadness, anger, fear, or love. Emotional experiences can vary in intensity, duration, and complexity.
- 3. Physiological Response:** Emotions trigger physiological changes in the body, including alterations in heart rate, blood pressure, respiration, hormonal levels, and neural activity.

These bodily responses are closely linked to emotional experiences and can provide valuable information about an individual's emotional state.

4. **Emotional Expression:** Emotions are expressed through facial expressions, vocal intonations, body language, and other non-verbal cues. These outward manifestations allow others to perceive and interpret our emotional states, facilitating social communication and understanding.
5. **Regulation and Adaptation:** The affective system also involves processes aimed at regulating and modulating emotions.

Affective systems are essential in fields such as human-computer interaction and artificial intelligence.

3. LITERATURE REVIEW

Artificial (Emotional) Intelligence by Rosalind Picard, et al., (2018) the word artificial emotional intelligence defined as a part of affective computing where it represents machines that can understand and identify human emotions. The literature focused on the drawbacks and limitations of artificial intelligence by giving examples of smart assistants like Google assistant, Siri, and Alexa. These assistants are intelligent enough to provide accurate answers to asked questions but not smart enough to identify the emotions of the human who is asking the questions. Identifies key to improve the result of any smart assistant is to identify the emotion behind every question rather than just answering the question by regular NLP.

Understanding Citizens' Emotional Pulse in a Smart City using Artificial Intelligence, by Achini Adikari et al., (2020) introduces an innovative approach of smart city where the emotions of people living in a particular smart city can be identified based on the social media conversation done between them over the internet. The approach used simple method of NLP to identify positive and negative words used by the people while talking with each other on social media conversation and tries to predict the mood of citizens resulting to identify how much happy or sad the people of that city are which can be adopted by industry leaders and government officials for smart observation of citizen opinions to improve security, communication, and policymaking.

The literature review reveals that very few research studies have been conducted till date in the domain of affective computing and emotional intelligence. The identification of human expressions based on facial recognition is the most common part of artificial intelligence but even very few or no attempts are made at national level to contribute to the effective computing domain. Emotional intelligence now rather than recognizing the emotions of the human it needs to understand various moods and the behaviors of humans on which very little or no attempt is made at the national level.

4. SYSTEM ANALYSIS

4.1. Existing System

Earlier, systems could answer given questions but were unable to predict the emotion of the human who has asked a question. Some systems can find emotions based on only a few parameters, such as some assistants play songs only based on facial expressions which is not sufficient.

Sometimes, even if someone is happy, they may have tears in their eyes. So, considering other factors like what they speak, and their tone of voice is a must to better understand their emotions, which is not implemented in existing systems.

Considering most of the parameters and then deciding the final emotion results in better throughput.

- ***Pros and Cons of Existing Methods***

Methods	Pros	Cons
Method 1	This method is intelligent enough to provide the accurate answers to asked questions.	Not smart enough to identify the emotions of the human who is asking the questions.
Method 2	An innovative approach to smart city where the emotions of people living in a particular smart city can be identified based on the social media conversation done between them over the internet.	The emotional intelligence now rather than recognizing the emotions of the human it needs to understand various moods and the behaviors of humans on which very less or no attempt is made at the national level.

4.2. Requirements

4.2.1. Functional Requirements

1. *Detecting inputs*

- First of all, the system should detect input parameters such as face/s from live video frames and text from speech, tone etc.

2. *Emotion Recognition*

- The system should be able to recognize and classify human emotions accurately based on facial expressions, speech patterns, and tone.
- It should support recognition of a wide range of emotions, including happiness, sadness, anger, surprise, fear, and disgust.
- The recognition system should be robust and adaptable to different individuals and contexts.

3. *Emotional Understanding*

- The system should be capable of understanding the emotional context of an interaction.
- It should be able to interpret not only explicit emotional expressions but also subtle cues, such as tone of voice, to infer the user's emotional state accurately.

4. *Personalization*

- The system should have the ability to learn individual users' emotional preference based on expressions as well as gender and age group.

5. *Ethical Considerations*

- The system should adhere to ethical guidelines and prioritize user privacy, confidentiality, and consent.
- It should ensure that emotional data collected from users is handled securely and used only for the intended purposes.

6. *Integration and Compatibility*

- The system should be compatible with various platforms. It should integrate seamlessly with existing digital assistant technologies and services.

These functional requirements aim to guide the development of an affective computing system that can understand human emotions, creating more emotionally intelligent and connected machines.

4.2.2. Non-Functional Requirements

1. Performance

- The system should have low latency in recognizing user emotions.
- The system's emotion recognition accuracy should meet reliable and consistent results.

2. Reliability and Robustness

- The system should be highly reliable and resilient, minimizing the occurrence of errors or failures during emotion recognition.
- It should be able to handle unexpected or noisy input data and still provide accurate emotional interpretations.
- The system should have built-in error handling mechanisms and graceful degradation strategies to recover from failures or exceptions gracefully.

3. Security and Privacy

- The system should adhere to ethical guidelines and prioritize user privacy, confidentiality, and consent.
- It should ensure that emotional data collected from users is handled securely and used only for the intended purposes.

4. Scalability

- The system should be scalable to accommodate increasing user demands and growing datasets.
- It should have the capability to handle expanding computational and storage requirements.

5. Usability and User Experience:

- The system should be user-friendly and enable easy and intuitive interaction with the emotional intelligence features.

6. Compatibility and Integration

- The system should be compatible with a variety of platforms, operating systems, ensuring broad accessibility.

These non-functional requirements aim to ensure that the affective computing system is not only technically capable but also reliable, secure, scalable, and user-friendly. It

emphasizes the ethical considerations and responsible use of emotional intelligence technologies, while providing a seamless and satisfying user experience.

4.2.3. Usability Requirements

1. Ease of Use

- The affective system should be designed with simplicity in mind, allowing users to interact with it effortlessly.
- It should minimize the need for complex user inputs or configurations, promoting a seamless user experience.
- The system should have a shallow learning curve, enabling users to quickly understand and utilize its emotional intelligence capabilities.

2. Customizability

- The affective system should allow users to personalize and customize their emotional experiences.

3. Error Handling

- The system should effectively handle errors and provide clear error messages or alerts to users when necessary.
- Error messages should be informative.
- The system should minimize the occurrence of errors.

4. Accessibility

- The affective system should be accessible to users with diverse abilities, including those with visual, auditory.
- The system should provide alternative modes of interaction to accommodate different user accessibility needs.

These usability requirements aim to ensure that the affective system is user-friendly, intuitive, and provides satisfying emotional recognition for users. By focusing on usability, the system can enhance user engagement, adoption, and overall satisfaction with its emotional intelligence features.

4.2.4. Implementation Requirements

1. Emotion Recognition Algorithms

- The affective system should have robust and accurate emotion recognition algorithms capable of processing various data inputs such as facial expressions, speech or textual analysis.
- The algorithms should be capable of handling real-time processing to enable timely emotion detection and interpretation.
- Libraries like deepface for facial emotion recognition, transformers, torch, TensorFlow, speechrecognition, librosa, pyaudio for emotion recognition based on speech and tone.

2. Data Collection and Training

- The affective system should have mechanisms for collecting and curating diverse and representative emotion datasets for training and validation purposes.
- The system should have appropriate data collection methods, considering user concern.
- Adequate preprocessing techniques should be applied to the collected data to ensure quality and reliability for training the emotion recognition models.

3. Pretrained Models

- The system should utilize pretrained models to process and analyze emotional data and generate appropriate responses.
- The models should be trained and fine-tuned using the collected emotion datasets to improve accuracy and adaptability to different users and contexts.

4. Real-time Processing

- The system should be optimized for real-time processing of emotional data.
- It should have low latency in analyzing emotional cues.

5. Testing and Validation

- The system should undergo rigorous testing and validation to ensure the accuracy and reliability of emotion recognition.
- Functional and non-functional testing should cover different use cases, scenarios, and user profiles to validate the system's performance and adherence to requirements.

- Continuous testing and quality assurance processes should be in place to address potential issues or errors and ensure consistent performance.

4.3. Problem Definition

To identify the human emotions based on the various attributes Facial expression & NLP & (tone) modulations.

4.4. Analysis Diagrams

4.4.1. Architecture Diagram

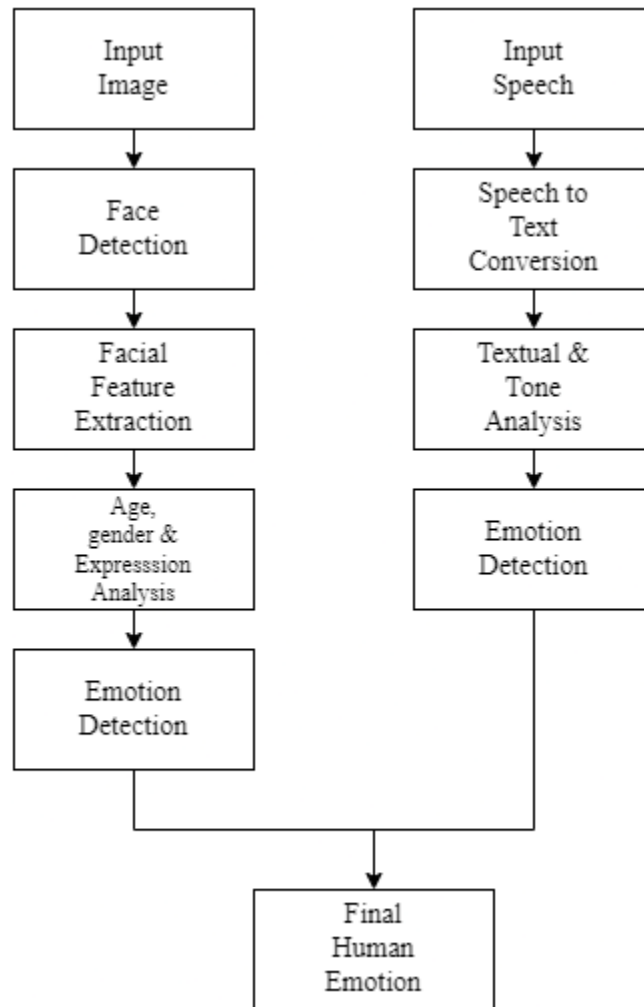


Fig. 4.4.1.1. Architecture Diagram

4.4.2. Use Case Diagram

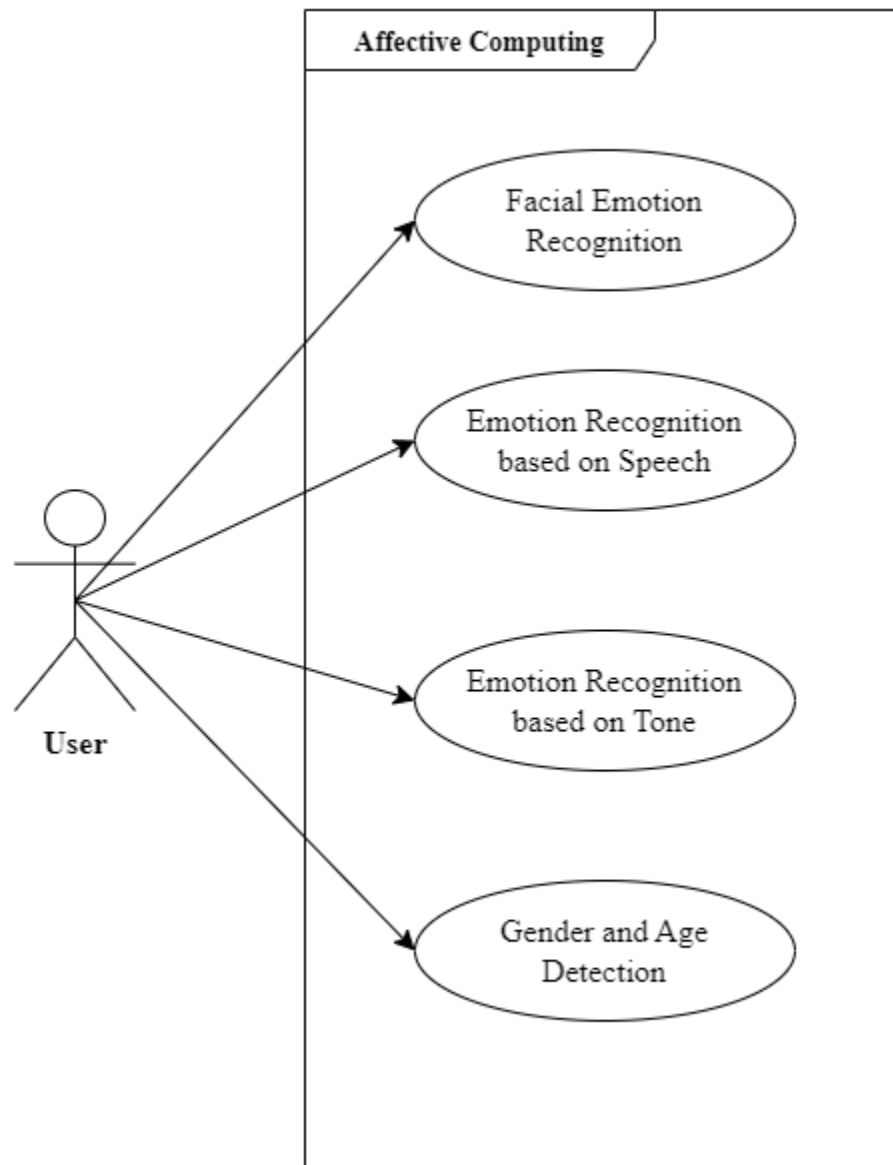


Fig. 4.4.2.1. Use Case Diagram

Use Case: Affective Computing

Primary actor 1:	User
Goal in context:	To provide facial expressions and voice.
Precondition:	System started and ready to take inputs.
Trigger:	User provides facial expression through connected camera and voice through connected microphone.
Scenario:	<ol style="list-style-type: none">1. User: Start the system.2. User: Provide facial expressions and voice.
Exception:	If facial expressions not found or voice is not recorded.
Priority:	Essential, must be implemented.
Frequency of use:	Always (For each execution)
Channel to actor:	Control via system.

5. PROPOSED SYSTEM

The proposed system for our project is designed to understand and recognize human emotions in a more accurate and comprehensive way. We will create a system that combines three important elements: analyzing facial expressions, understanding tone of voice, and interpreting the words people use.

In the first module, we will use special software to detect faces in live video. This will help us understand the expressions on people's faces. However, we know that facial expressions alone may not always tell us the whole story. Sometimes, even if someone is happy, they may have tears in their eyes. So, we will also consider other factors like how they speak and their tone of voice to better understand their emotions.

The second module focuses on analyzing the tone of voice. We will develop algorithms that can understand how someone says something, not just the words they use. For example, even if someone says, "I am okay," their tone might indicate if they are actually feeling negative or positive. By analyzing the variations in tone, we can get a better understanding of their emotions.

The third module is about understanding emotions through the words people use. Certain words can give us clues about how someone is feeling. For instance, if someone says, "Today I got an offer letter, so I am extremely happy," the words "offer" and "happy" indicate a positive emotion. By using special techniques called natural language processing, we can analyze the words people use to gain insights into their emotions.

By combining these three modules, our proposed system will have a better understanding of human emotions. We will look at facial expressions, tone of voice, and the words people use to communicate to accurately recognize and understand their emotions. This will provide a more comprehensive picture of how people feel and help us improve our understanding of human emotions.

5.1. Purpose

The purpose of this project is to create a system that can understand and recognize human emotions in a more comprehensive and accurate way. We will achieve this by considering different aspects of a person's communication, like facial expressions, tone of voice, and words used in communication.

5.2. Scope

The scope of this project is to develop a system that can understand and recognize emotions by analyzing facial expressions, tone of voice, and the words people use. By considering these different aspects, we aim to create a more accurate and comprehensive understanding of human emotions.

5.3. System Design

The system design of our Affective computing-based project involves three key models that work together to recognize and understand emotions: facial expression analysis, tone recognition, and Natural Language Processing (NLP).

- **Emotion recognition using facial Expression**

In this module, we will utilize the OpenCV library to detect faces in real-time video streams. Once a face is detected, we will employ the DEEP FACE library to analyze the facial expressions exhibited by the person.

- **Emotion recognition using Tone**

The second module focuses on the importance of analyzing the tone of voice in understanding emotions. We will develop algorithms to assess the variations in tone during speech. Even if the words used in a sentence may appear neutral, the tone can provide insights into whether the sentiment is positive, negative, or neutral.

- **Emotion recognition using NLP**

In this module, we will leverage NLP techniques to recognize emotions based on the words people use in their communication. Words play a vital role in conveying emotions. By applying NLP algorithms, we can extract and analyze emotional cues from textual data, enabling us to gain a better understanding of the underlying emotions.

6. REQUIREMENTS

6.1. Hardware Requirements

Sr. No.	Components	Specifications
1	Processor	Intel Core i5, AMD, GPU (2 GB Minimum)
2	RAM	Recommended 8 GB
3	Webcam	Any working Webcam with better resolution
4	Microphone	Any working Microphone

6.2. Software Requirements

Sr. No.	Components	Specifications
1	Operating System	Windows, Linux, Mac
2	Libraries	FER, OpenCV, Deep face, TensorFlow, Deep Speech, Speech Recognition, Librosa etc.
3	IDE	PyCharm, VS Code

7. IMPLEMENTATION

7.1. Module implementation

The creation of an environment for implementation of the project involves setting up the necessary tools and components to develop and execute Pyretic programs. This typically includes the following steps:

- **Installation:** Install Python 3.10.10 and PyCharm Studio on your computer.

- **Dependencies**

- ***For Facial Emotion Detection:***

1. OpenCV-python
2. pyinstaller
3. TensorFlow
4. NumPy
5. matplotlib

- ***For Natural Language Processing:***

1. transformers
2. speech_recognition
3. Pyaudio
4. torch
5. TensorFlow

- ***For Sound Intensity Analysis:***

1. speech_recognition
2. librosa
3. Pyaudio
4. scikit-learn

- **Development Environment and Code Editor**

Development is done with the help of PyCharm Studio IDE. PyCharm is an integrated development environment (IDE) used for programming in Python. It provides code analysis, a graphical debugger, an integrated unit tester, integration with version control systems, and supports web development with Django. PyCharm is developed by the Czech company JetBrains.

- **Program Execution**

Once your environment is set up, you can use PyCharm studio to execute programs using the appropriate syntax and semantics.

7.2. Product Functions

- **Emotion recognition using Facial Expression**

In this module, we will utilize the OpenCV library to detect faces in real-time video streams. Once a face is detected, we will employ the DEEP FACE library to analyze the facial expressions exhibited by the person.

- **Emotion recognition using Tone**

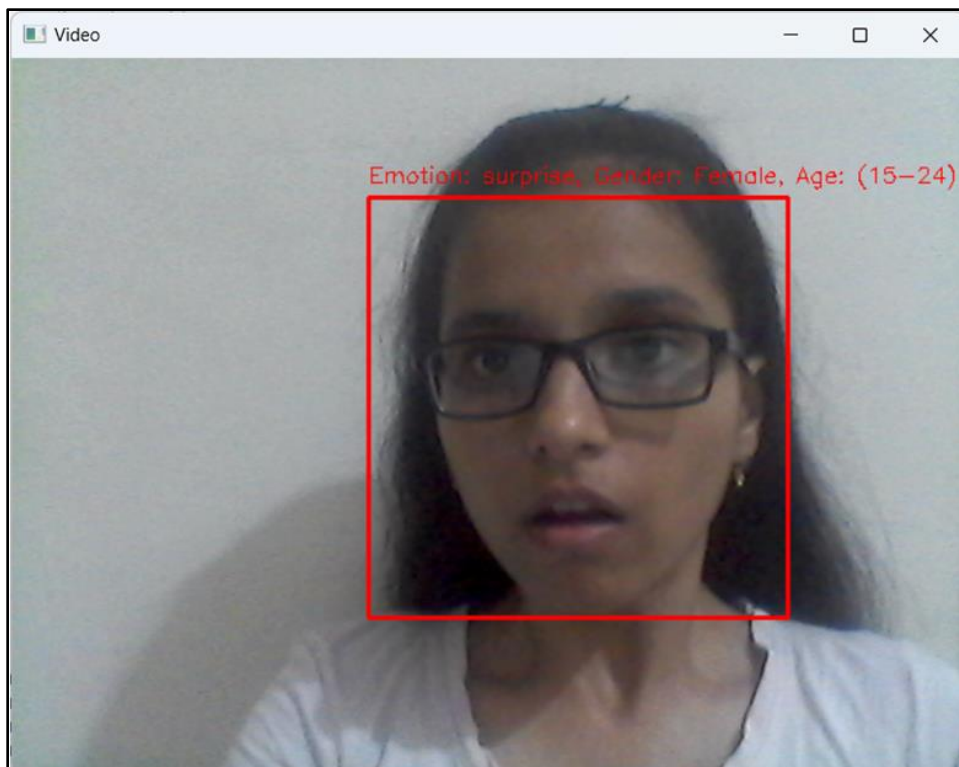
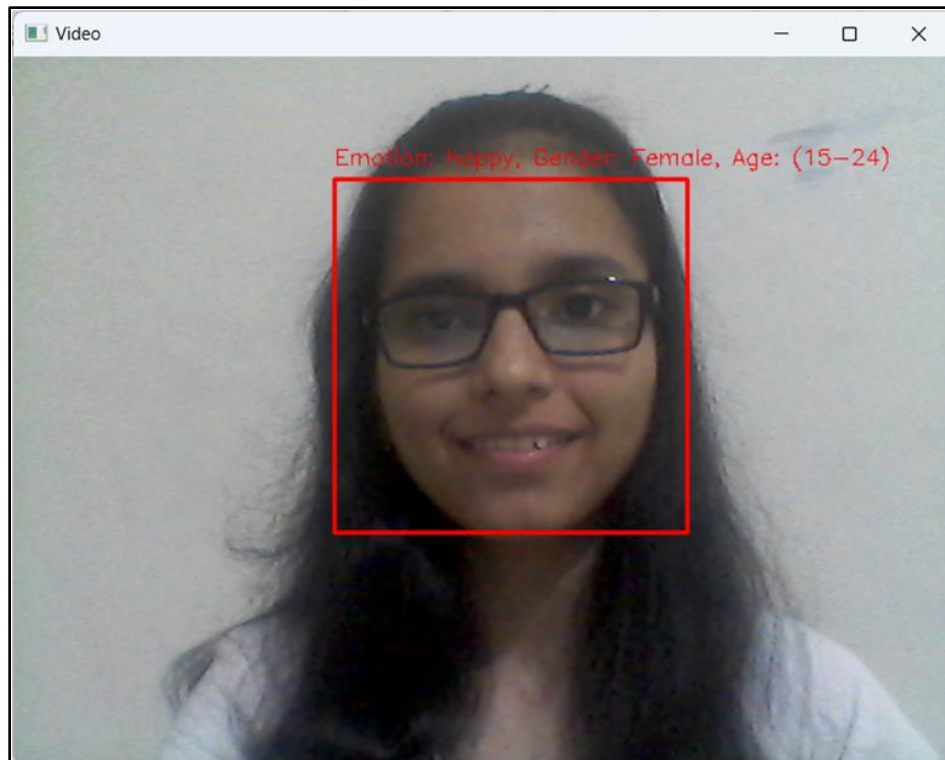
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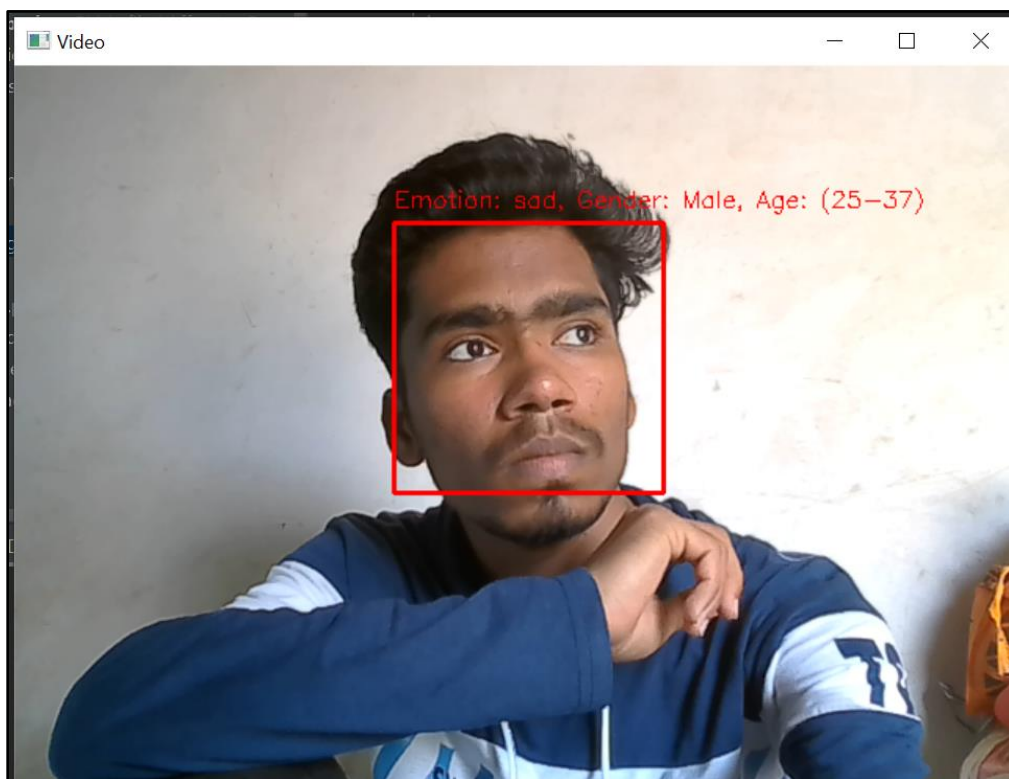
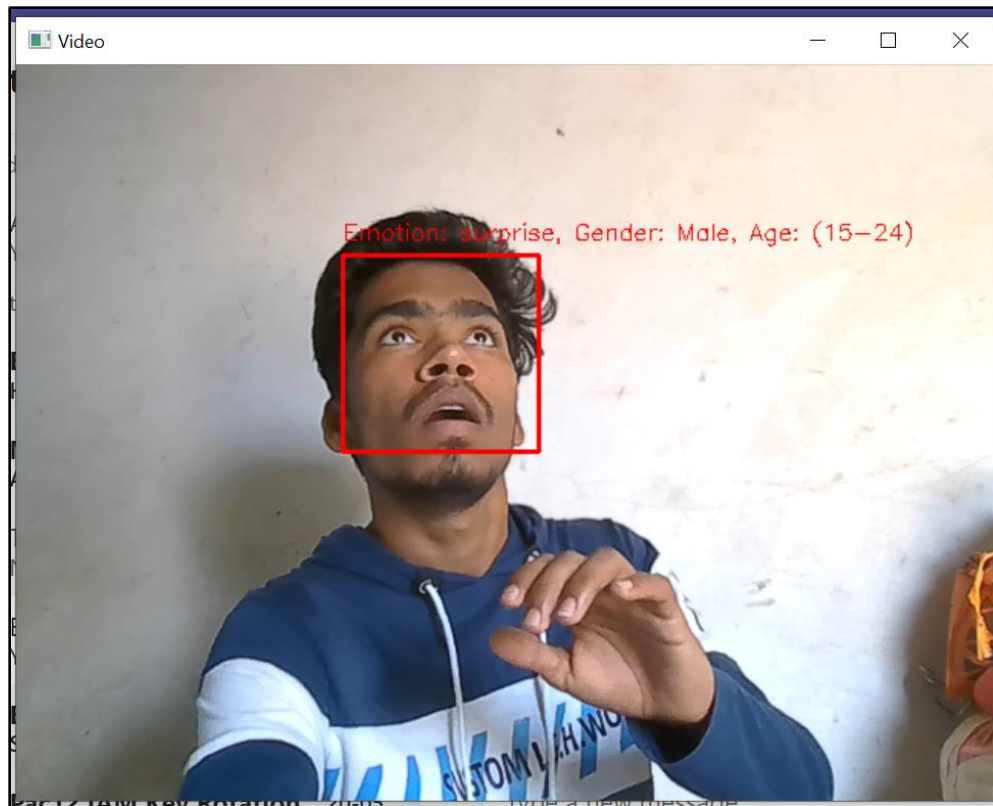
- **Emotion recognition using NLP**

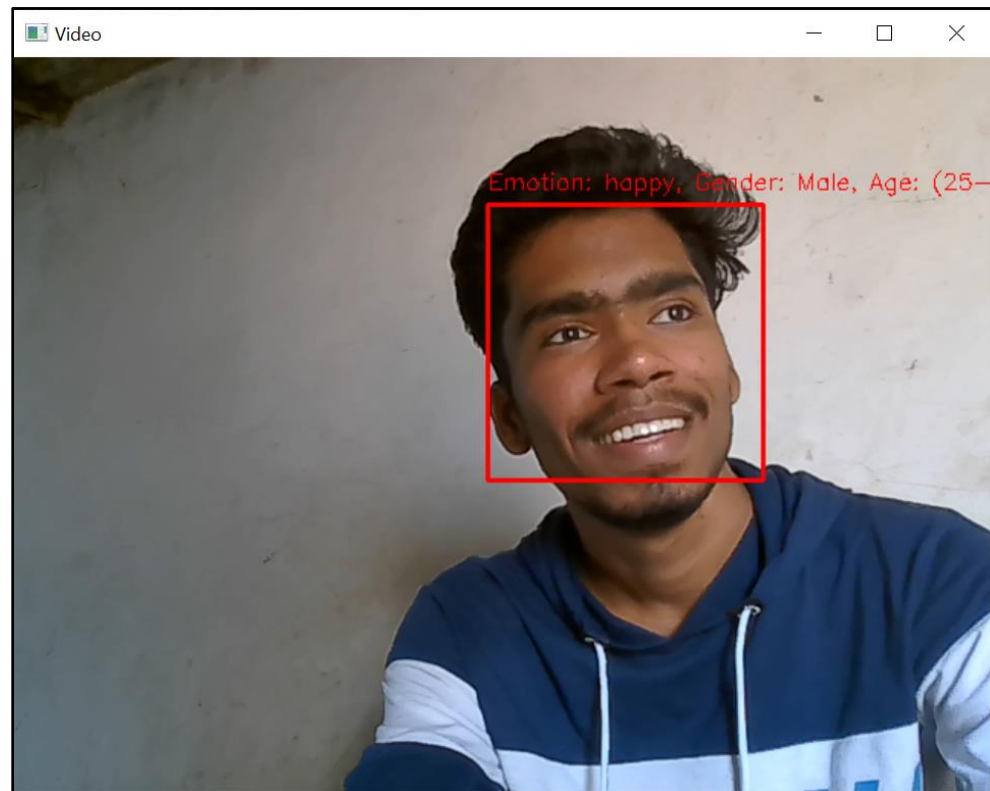
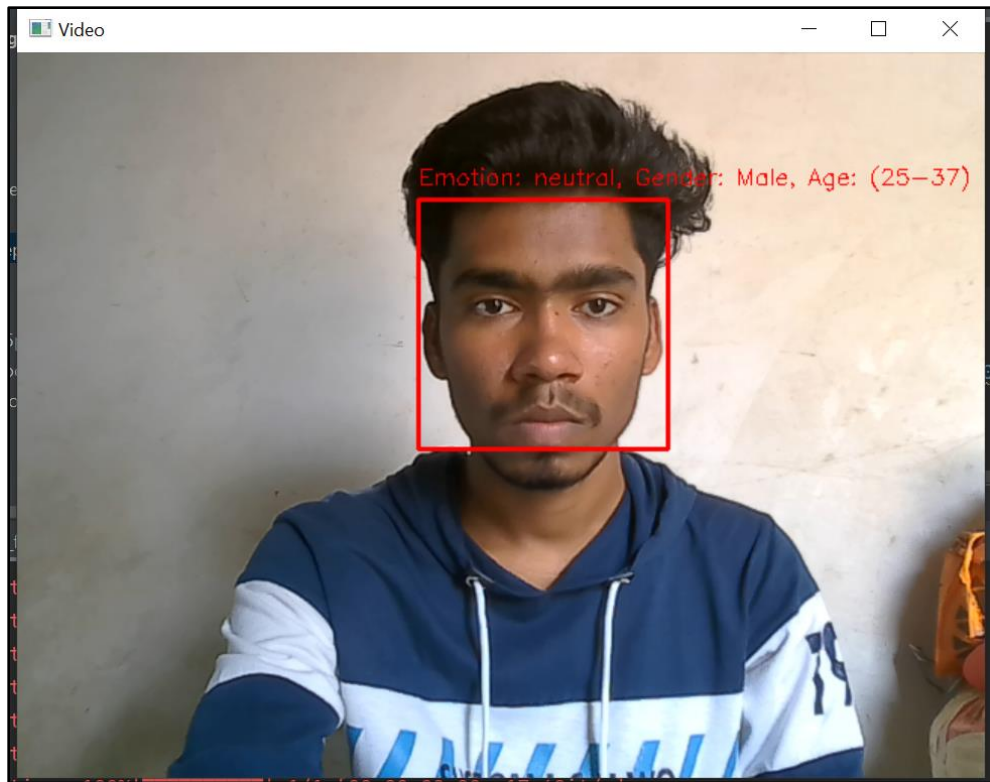
In this module, we will leverage NLP techniques to recognize emotions based on the words people use in their communication. Words play a vital role in conveying emotions. By applying NLP algorithms, we can extract and analyze emotional cues from textual data, enabling us to gain a better understanding of the underlying emotions.

7.3. Screenshots

7.3.1. Emotion Recognition by Facial Expression







7.3.2. Emotion Recognition by NLP and SER

```
Voice Recording...
Please talk
Voice Recorded Successfully!

Prediciting Emotion...
Speech to Text : with great power comes great responsibility

Sentiment by NLP : Admiration
Sentiment by SER : Happy
Emotion Predicted Successfully!
```

```
Voice Recording...
Please talk
Voice Recorded Successfully!

Prediciting Emotion...
Speech to Text : don't mess with me

Sentiment by NLP : Anger
Sentiment by SER : Angry
Emotion Predicted Successfully!
```

```
Voice Recording...
Please talk
Voice Recorded Successfully!

Prediciting Emotion...
Speech to Text : i am very hungry

Sentiment by NLP : Neutral
Sentiment by SER : Neutral
Emotion Predicted Successfully!
```

```
Voice Recording...
Please talk
Voice Recorded Successfully!

Prediciting Emotion...
Speech to Text : i am going to do suicide

Sentiment by NLP : Sadness
Sentiment by SER : Neutral
Emotion Predicted Successfully!
```

```
Please talk
Voice Recorded Successfully!

Prediciting Emotion...
Speech to Text : today is my birthday

Sentiment by NLP : Excitement
Sentiment by SER : Neutral
Emotion Predicted Successfully!
```

7.4. Constraints

It is necessary to install the required version of python and dependencies. Also, it is necessary to have a good working microphone and camera before starting the project implementation.

7.5. Assumptions and Dependencies

The camera and microphone are at a distance from which the face and voice of the person who is going to execute the system are captured without any problem.

7.6. External Interface Requirements

Windows command line interface or Linux Terminal is used for interaction with the system. It will display the result of the module executed.

7.7. Implementation Architecture

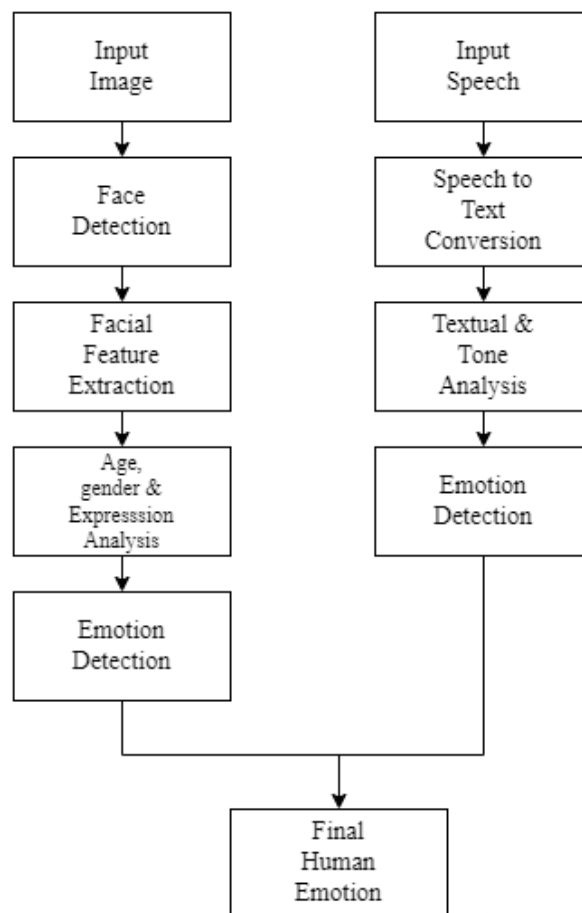


Fig. 7.7.1. Implementation Architecture Diagram

8. PROJECT MANAGEMENT

8.1. Process model

The process model means the various methodologies that are being selected for the development of the project, depending on project goals. There are many development models that have been developed in order to achieve different required goals. The selected model defines in which stage which process will be carried out.

For “**Affective Computing**” “**Extreme Programming (XP)**” model is chosen. Extreme Programming (XP) is an agile software development framework that aims to produce higher quality software and follows engineering practices for development. The methodology has a name like this from the idea that it follows software engineering practices to an “Extreme” level. XP is based on the iterations through which the developers implement user stories. User story means the statement provided by the user that describes features of the required system. The activities conducted for development using XP are coding, testing, listening, designing and feedback. XP is mostly applicable for small projects or projects involving modern technology or research projects.

This model is selected because this is much more amenable to change within their iterations. If the team has not started work on a particular feature, a new feature can be added into XP's iteration. XP works in strict priority order. Features to be developed are prioritized by the product owner and the team is required to work on them in that order. XP adopts strict engineering methods like pair programming, uncomplicated design, refactoring etc. So, this is a suitable model as this ensures progress or quality in the process of software implementation.

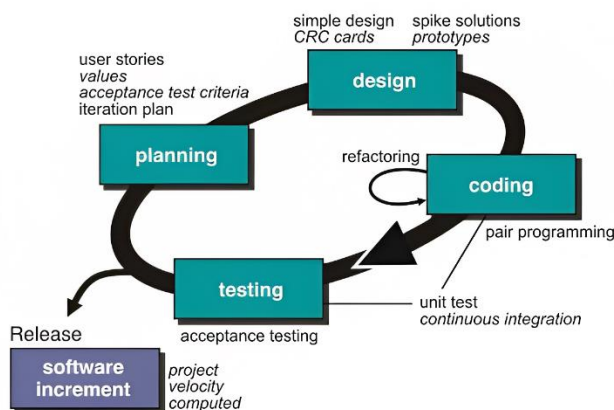


Fig. 8.1.1. Extreme Programming (XP)

8.2. Project Timeline

Sr. No.	Task Name	Start Date	Finish Date
1	Idea presentation	Tuesday, 20 September, 2022	Tuesday, 20 September, 2022
2	Brainstorming	Wednesday, 21 September, 2022	Monday, 3 October, 2022
3	Topic selection	Tuesday, 4 October, 2022	Saturday, 8 October, 2022
4	Research on topic	Monday, 10 October, 2022	Saturday, 5 November, 2022
5	Synopsis creation	Sunday, 20 November, 2022	Wednesday, 23 November, 2022
6	PPT creation	Friday, 2 December, 2022	Monday, 5 December, 2022
7	Synopsis and PPT presentation	Friday, 9 December, 2022	Friday, 9 December, 2022
8	Implementation of Text based emotion detection with the help of NLP using NLTK library.	Saturday, 4 February, 2023	Sunday, 5 March, 2023
9	Implementation of Speech Emotion Recognition using voice intensity using Librosa library.	Saturday, 4 February, 2023	Sunday, 12 March, 2023
10	Implementation of Emotion Recognition based on facial expressions using FER and Tensorflow library	Saturday, 11 February, 2023	Sunday, 19 March, 2023
11	Tried to implement the module that can detect heartbeat for emotion recognition.	Saturday, 11 February, 2023	Sunday, 12 March, 2023
12	Implementation of Gender and age detection using CV2 library.	Sunday, 19 March, 2023	Saturday, 22 April, 2023
13	Implementation of Text based emotion detection with the help of NLP using hugging face.	Sunday, 19 March, 2023	Sunday, 16 April, 2023
14	Implementation of Emotion Recognition based on Facial Expressions using Deep Face Library	Sunday, 19 March, 2023	Sunday, 9 April, 2023
15	Implementation of Speech Emotion Recognition using voice intensity with Librosa with sklearn library.	Sunday, 19 March, 2023	Saturday, 15 April, 2023
16	Testing and finalization of Facial Expression Recognition modules (FER vs Deep Face)	Sunday, 16 April, 2023	Saturday, 29 April, 2023
17	Testing and finalization of Speech Emotion Recognition and NLP modules.	Sunday, 16 April, 2023	Saturday, 29 April, 2023

18	Integration of NLP and SER finalized modules	Saturday, 6 May, 2023	Saturday, 13 May, 2023
19	Integration of Gender and Age Detection module and Facial Expression Recognition modules.	Saturday, 6 May, 2023	Saturday, 13 May, 2023
20	Started working on Final Report	Sunday, 14 May, 2023	Sunday, 21 May, 2023

8.3. Feasibility Study

1. Introduction

To evaluate the practicality and viability of our project, we have conducted a comprehensive feasibility study. This study examines various aspects including technical feasibility, economic feasibility, operational feasibility, and schedule feasibility. By analyzing these factors, we aim to determine the likelihood of successfully implementing the proposed emotion recognition system, which combines facial expression analysis, tone recognition, and natural language processing techniques.

2. Technical Feasibility

The technical feasibility assessment focuses on evaluating the availability and suitability of the required technologies and tools for our project. This includes the OpenCV library for face detection, the DEEP FACE library for facial expression analysis, and NLP techniques for emotion recognition. We have verified that these technologies are widely used, accessible, and can be integrated to create a cohesive system.

3. Economic Feasibility

The economic feasibility analysis examines the financial viability of our project. It considers the costs associated with acquiring the necessary hardware, software licenses, and resources required for development. Additionally, it assesses the potential benefits and returns that can be gained from implementing the system. Our analysis indicates that the benefits of developing an accurate emotion recognition system outweigh the costs involved, making the project economically feasible.

4. Operational Feasibility

Operational feasibility evaluates whether the proposed system aligns with the operational processes and requirements of the target users. We have considered the practicality of integrating the emotion recognition system into existing workflows and how users would interact with it.

5. Schedule Feasibility

The schedule feasibility assessment considers the time required for development, testing, and deployment of the proposed system. We have evaluated the complexity of the tasks involved and the availability of resources. Based on our analysis, we are confident

that the project can be completed within the defined schedule, allowing us to deliver the system on time.

Based on our comprehensive feasibility study, we have determined that our project is technically feasible, economically viable, operationally practical, and can be completed within the allocated time frame. We are confident that the proposed system, which combines facial expression analysis, tone recognition, and NLP techniques, will effectively recognize and understand human emotions.

9. TESTING

9.1. Unit Testing

9.1.1. Module Name: Speech Emotion Recognition

Sr. No.	Test Case No.	Test Case Objective	Prerequisites	Steps	Input Data	Expected Output	Actual Output	Status
1	TC_01	To check whether program starts executing or not.	All required libraries must be installed.	1. Execute the program.	NA	Program should be start executing.	Program sated executing successfully.	Pass
2	TC_02	To check whether model builds or not.	Datasets consist of multiple audio files.	1. Execute the program.	Dataset	Model should be built.	Model built successfully.	Pass
3	TC_03	To check whether audio gets recorded or not with the help of microphone.	1. System must have microphone connected to it. 2. Model must be built. 3. Required libraries and packages must be installed.	1. Execute the program.	Microphone Connection	Audio recording should be started.	Audio recording done successfully.	Pass
4	TC_04	To check whether recorded audio gets saved or not.	1. System must have microphone connected to it. 2. Model must be built. 3. Required libraries and packages must be installed.	1. Execute the program. 2. Record the audio.	Audio	Audio files should be recorded and saved into .wav file.	Audio recorded and saved in .wav file.	Pass

5	TC_05	To check whether emotion is detected or not based on audio.	1. Model must be built. 2. Recorded audio file must be available.	1. Execute the program. 2. Record the audio.	Audio	Approximate emotion should be recognized.	Approximate emotion recognized.	Pass
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9.1.2. Module Name: Natural Language Processing

Sr. No.	Test Case No.	Test Case Objective	Prerequisites	Steps	Input Data	Expected Output	Actual Output	Status
1	TC_01	To check whether program starts executing or not.	All required libraries must be installed.	1. Execute the program.	NA	Program should be start executing.	Program sated executing successfully.	Pass
2	TC_02	To check whether model builds or not.	Datasets consist of multiple audio files.	1. Execute the program.	Dataset	Model should be built.	Model built successfully.	Pass
3	TC_03	To check whether already available NLP model gets download or not.	All required libraries must be installed.	1. Execute the program.	NA	Available model should be downloaded.	Available model downloaded successfully.	Pass
4	TC_04	To check whether audio gets recorded or not with the help of microphone.	1. System must have microphone connected to it. 2. Model must be built. 3. Required libraries and packages must be installed.	1. Execute the program.	Microphone Connection	Audio recording should be started.	Audio recording done successfully.	Pass
5	TC_05	To check whether recorded audio gets converted to text and saved or not.	1. System must have microphone connected to it. 2. Model must be built. 3. Required libraries and	1. Execute the program. 2. Record the audio.	Audio	Audio should be recorded and converted to text and saved into .txt file.	Audio recorded and converted to text and saved into .txt file.	Pass

			packages must be installed.					
6	TC_06	To check whether emotion is detected or not based on text converted from audio.	1. Model must be built. 2. Recorded audio's text file must be available.	1. Execute the program. 2. Record the audio.	Audio's text file.	Approximate emotion should be recognized.	Approximate emotion recognized based on available keywords.	Pass

9.1.3. Module Name: Facial Emotion Recognition

Sr. No.	Test Case No.	Test Case Objective	Prerequisites	Steps	Input Data	Expected Output	Actual Output	Status
1	TC_01	To check whether program starts executing or not.	All required libraries must be installed.	1. Execute the program.	NA	Program should be start executing.	Program sated executing successfully.	Pass
2	TC_02	To check whether model builds or not.	Datasets consist of multiple audio files.	1. Execute the program.	Dataset	Model should be built.	Model built successfully.	Pass
3	TC_03	To check whether already available FER Deep Face model gets download or not.	All required libraries must be installed.	1. Execute the program.	NA	Available model should be downloaded.	Available model downloaded successfully.	Pass
4	TC_04	To check whether pre-trained model gets loaded or not.	1. All required libraries must be installed. 2. Model must be present.	1. Execute the program.	NA	Pre-trained model should be loaded for further execution.	Pre-trained model loaded successfully.	Pass
5	TC_05	To check whether camera is accessible or not.	VideoCapture class object must be initialized	1. Execute the program.	Camera Connection	The system should be able to display error message and exit if camera is not accessed otherwise start processing live video.	The system can display error message and exit when camera is not accessed otherwise started processing live video.	Pass

6	TC_06	To check whether system captures the frame or not.	Webcam must be accessed.	1. Capture frame	Camera Connection	The system should capture the frame.	The system captured the frame.	Pass
7	TC_07	To check whether system detects face/s in the frame or not.	The frame must be loaded.	1. Provide frame	Frame	The system should be able to detect the face/s if it is present.	The system can detect the face/s if it is present.	Pass
8	TC_08	To check whether Region of Interest extracts or not.	The frame must be loaded.	1. Capture frame 2. Provide frame	X, Y coordinates	The Region of Interest should be extracted for further execution.	The Region of Interest is extracted.	Pass
9	TC_09	To check whether emotion is detected or not based on facial expressions.	1. Model must be built. 2. Camera must be available and video capturing must on.	1. Execute the program. 2. Start capturing.	Video/Image with face present	Approximate emotion should be recognized.	Approximate emotion recognized.	Pass
10	TC_10	To check whether rectangle gets drawn around the face or not after emotion recognition.	1. Emotion must be recognized.	1. Execute the program. 2. Start capturing.	X, Y coordinates	Rectangle should be drawn around the face.	Rectangle gets drawn around the face.	Pass
11	TC_11	To check whether emotion is displayed or not after emotion recognition.	1. Emotion must be recognized.	1. Execute the program. 2. Start capturing.	X, Y coordinates and Emotion	Recognized emotion should be displayed.	Recognized emotion displayed successfully.	Pass

12	TC_12	To check whether system terminated or not.	1. Emotion must be recognized. 2. Rectangle must be drawn around the face. 3. Emotion must be displayed.	1. Press Q or q key.	Key Pressed	The system should be terminated.	The system is terminated.	Pass
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9.2. Integration Testing

9.2.1. Module Name: Speech Emotion Recognition and Natural Language Processing

Sr. No.	Test Case No.	Test Case Objective	Prerequisites	Steps	Input Data	Expected Output	Actual Output	Status
1	TC_01	To check whether program starts executing or not.	All required libraries must be installed.	1. Execute the program.	NA	Program should be start executing.	Program sated executing successfully.	Pass
2	TC_02	To check whether model builds or not.	Datasets consist of multiple audio files.	1. Execute the program.	Dataset	Model should be built.	Model built successfully.	Pass
3	TC_03	To check whether already available NLP model gets download or not.	All required libraries must be installed.	1. Execute the program.	NA	Available model should be downloaded.	Available model downloaded successfully.	Pass
4	TC_04	To check whether audio gets recorded or not with the help of microphone.	1. System must have microphone connected to it. 2. Model must be built. 3. Required libraries and packages must be installed.	1. Execute the program.	Microphone Connection	Audio recording should be started.	Audio recording done successfully.	Pass
5	TC_05	To check whether recorded audio gets converted to text and	1. System must have microphone connected to it. 2. Model must be built.	1. Execute the program. 2. Record	Audio	Audio should be recorded and converted to text and saved into .txt file.	Audio recorded and converted to text and saved into .txt file.	Pass

		saved or not.	3. Required libraries and packages must be installed.	the audio.				
6	TC_06	To check whether recorded audio gets saved or not.	1. System must have microphone connected to it. 2. Model must be built. 3. Required libraries and packages must be installed.	1. Execute the program. 2. Record the audio.	Audio	Audio files should be recorded and saved into .wav file.	Audio recorded and saved in .wav file.	Pass
7	TC_07	To check whether emotion is detected or not based on text converted from audio.	1. Model must be built. 2. Recorded audio's text file must be available.	1. Execute the program. 2. Record the audio.	Audio's text file.	Approximate emotion should be recognized.	Approximate emotion recognized based on available keywords.	Pass
8	TC_08	To check whether emotion is detected or not based on audio.	1. Model must be built. 2. Recorded audio file must be available.	1. Execute the program. 2. Record the audio.	Audio	Approximate emotion should be recognized.	Approximate emotion recognized.	Pass

10. CONCLUSION

By identifying human emotions, the “**Affective Computing**” project has successfully accomplished its goals. We have created a comprehensive system that can successfully identify human emotions by combining different inputs, including speech patterns, facial expressions, and textual data.

We used models from the computer vision, audio processing, and natural language processing areas throughout the project. We created a facial recognition system using computer vision techniques that can extract facial features and recognize emotional expressions on the face. We used speech analysis techniques to capture pitch variations and recognize emotion. And last, by employing natural language processing methods, we may assess textual content and recognize emotions. This project's multi-modal technique has proven to be quite effective in attaining approximate emotion recognition. Human emotions can be detected by merging data from many modules. The technology can be employed in real-world settings such as mental health monitoring, various personal assistants, and so on.

There are some areas, nevertheless, where improvements and additional research can be made. For example, improving the integration and synchronization of several modalities to achieve seamless information fusion could boost system performance. The system could be strengthened and made more culturally sensitive by increasing the dataset and considering various cultural situations.

11. REFERENCES

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