



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 5, May 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

 9940 572 462

 6381 907 438

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Computer Vision Based Adaptive Sentiment Analysis Through Intelligent Chatbot

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ABSTRACT: Sentiment analysis is one of the recent technologies under NLP (an application of AI and ML). Opinion examination is utilized in numerous applications for suggestion and input examination. This paper delves into various aspects, starting with face detection and identification, extending to defining sentiment analysis, exploring algorithms for sentiment analysis, and progressing through the initial stages of sentiment analysis to assessing the efficacy of sentiment classifiers. In sentiment analysis process machine learning is used to analyze sentiments, emotions and produce a summarized result for decision making [1]. Algorithms such as Haar Cascade to recognize facial expressions associated with specific emotions are used having an accuracy of 85-90%. Also, LLM (Large Language Model) a type of artificial intelligence model designed to understand and generate human-like language is used for sentiment analysis which gives an accuracy of 65-70%. This Research paper has been divided into different sections, each section concerning the stepwise process of sentiment analysis.

KEYWORDS: Face detection, Emotion Classification, Sentiment analysis, Haar Cascade, LLM

I. INTRODUCTION

In today's fast-paced digital landscape, chat-bots have emerged as valuable tools for businesses and individual alike, facilitating efficient and personalized interactions. However, to take chat-bots to the next level of engagement and functionality, the integration of face detection technology adds a profound dimension. We can create intelligent, context-aware systems capable of recognizing and responding to users based on their facial expressions and identity.

An Open CV based sentiment analysis chat-bot is a type of chat-bot that uses Open CV, a computer vision library, to analyze the user's facial expressions and sentiment in order to generate more relevant and engaging responses. The goal is to automate the process of determining emotions in real-time, by analysing the various features of a face.

Sentiment analysis, also known as opinion mining, involves a natural language processing (NLP) technique aimed at discerning the emotional essence conveyed within a text corpus.

Open CV is a powerful library that can be used for a variety of computer vision tasks, including face detection, tracking, and recognition. It can also be used to extract features from faces, such as the position of the eyes, mouth, and nose. These features can then be used to train a sentiment analysis model to predict the user's emotions. Once the sentiment analysis model is trained, it can be integrated with a chat-bot to generate more relevant and engaging responses. These chat-bots have the potential to be used in a variety of applications, including customer service, education, and healthcare.

In customer service, they can be used to provide more personalized support to customers. In education, they can be used to help students learn more effectively. And in healthcare, they can be used to monitor patients' emotional state and provide them with the support they need.

The primary aim of this proposed system is to comprehensively detect, analyze and showcase the development and implementation of Computer Vision-based Adaptive Sentiment Analysis system integrated into an intelligent Chatbot.

Objectives are as follows:

- i. Automate the process of determining emotions.
- ii. Discerns the emotional undertones within a text body.
- iii. Recognizing and responding to users based on their facial expressions.

II. METHODOLOGY

Data Extraction: Sentiment analysis process begins with data collection task and then processing it for the further operations. Many datasets are available online for academic and research purposes.

Face detection: Face detection is a computer vision technique that focuses on locating and identifying human faces within images or video frames.

Feature extraction: Feature extraction is an important task in aspect-based sentiment analysis. Selection of appropriate features is important because it affects the learning task which results in poor accuracy of the system.

Face Recognition: Face Recognition is the process of identifying or verifying the person by matching the detected face with a database of known faces.

Sentiment detection: In sentiment detection phase each tokenized sentence of the review is analysed for subjective information. That means Subjectivity classification is performed at this phase. The sentence that expresses any opinion is known as subjective sentence else it is called objective.

Sentiment Analysis: In this phase each opinionated sentence is classified as positive, negative or neutral category. In many sentiment-analysis application this task is performed as a two-class classification, that is only positive and negative category is considered.

Sentiment summarization: Summarized result of large data makes the task of decision making easy. Generally, decision makers make use of number of reviews, before to come across certain decision.

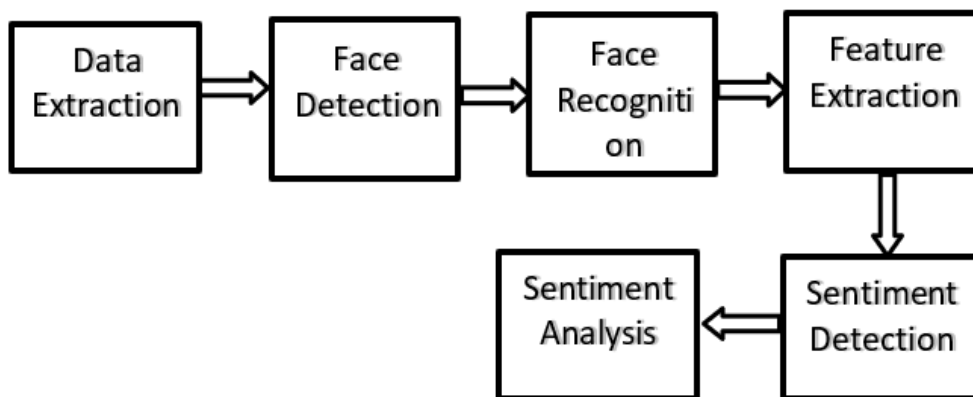


Fig. 1. Sentiment Analysis Process

III. FACE DETECTION

Face detection is a computer vision technique that focuses on locating and identifying human faces within images or video frames. There are multiple methods available for face detection. We used Haar cascades algorithm. Alternatives include Viola-Jones, Histogram of Oriented Gradients (HOG), and deep learning-based methods like Convolutional Neural Networks (CNNs).

Haar Cascades: Haar cascades are a machine learning approach that uses a set of simple Haar-like features and a classifier to detect faces. Haar-like features, also known as Haar features, are simple, rectangular pattern descriptors used in computer vision and image processing for various tasks, including object detection and facial recognition. These features are named after their developer, Paul Viola, who, along with Michael Jones, introduced them as a key component in the Viola-Jones object detection framework.

Key capabilities:

- i. Recognition and localization of facial features: Obtaining the coordinates of facial components such as eyes, ears, cheeks, nose, and mouth for each detected face.
- ii. Extraction of facial feature contours: Obtaining the outlines of identified faces along with their eyes, eyebrows, lips, and nose.
- iii. Identification of facial expressions: Determining expressions such as smiles or closed eyes exhibited by individuals.
- iv. Facial tracking across video frames: Assigning a unique identifier to each detected face, facilitating consistent tracking across different frames in a video stream for tasks like image manipulation.

IV. FACE RECOGNITION

Face Recognition is the process of identifying or verifying the person by matching the detected face with a database of known faces. Face recognition systems employ computer algorithms to identify unique and discernible features of an individual's face. These features, such as the spacing between the eyes or the contour of the chin, are translated into a mathematical format and cross-referenced with information stored in a face recognition database. This data pertaining to a specific face is commonly referred to as a face template, distinct from a typical photograph as it focuses solely on specific details essential for distinguishing one face from another. In face recognition, there are two primary tasks. Verification (one-to-one) determines whether an individual's face matches a specific reference face. Identification (one-to-many) involves searching a database to find the identity of an individual based on their face.

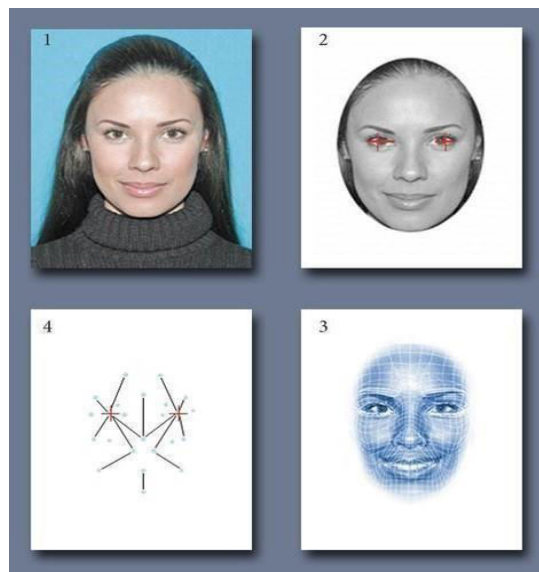


Fig 2. Face Recognition

Live Detection: To enhance security, some face recognition systems include liveness detection to ensure that the face being presented is from a live individual, not a photograph or video.

Key capabilities:

- i. Image is captured
- ii. Eye location is determined
- iii. Image is converted into greyscale and cropped
- iv. Image is converted to a template used by the search engine for facial comparison results
- v. Image is searched and matched using sophisticated algorithm to compare the template to other templates

V. SENTIMENT DETECTION

Sentiment detection analyzes the emotional tone associated with each individual detected face. This involves interpreting facial expressions, features, or contextual cues to determine whether the expressed sentiment is positive, negative, or neutral. The goal is to capture the underlying emotional state conveyed by facial expressions to aid the overall sentiment analysis process further classifying into range of human sentiments such as happiness, sadness or anger, etc. The Sentiment Detection process plays a pivotal role in understanding and categorizing the emotional aspect of the data, providing valuable insights for applications such as adaptive sentiment analysis through intelligent systems like chat-bots.

Haar Cascade algorithm for Sentiment Detection: The use of the Haar Cascade algorithm for sentiment detection involves training a classifier to recognize facial expressions associated with specific emotions. The process includes labeling training data with sentiments, extracting features through the intensity patterns, training the Haar Cascade classifier, and integrating the classifier's output into a broader sentiment analysis framework. It enables the algorithm to detect facial features in new images or video frames and contribute to the overall sentiment analysis of individual faces or groups of faces based on recognized emotional expressions.

VI. SENTIMENT ANALYSIS

Sentiment analysis is a natural language processing (NLP) technique that involves determining the sentiment or emotion expressed by the user. The primary goal of sentiment analysis is to understand and classify the sentiments expressed in the text as positive, negative, or neutral. We used LLM (Large Language Model) a type of artificial intelligence model designed to understand and generate human-like language. This is a valuable tool for understanding and interpreting the emotions expressed by user, enabling businesses to make informed decisions based on public or customer sentiment.

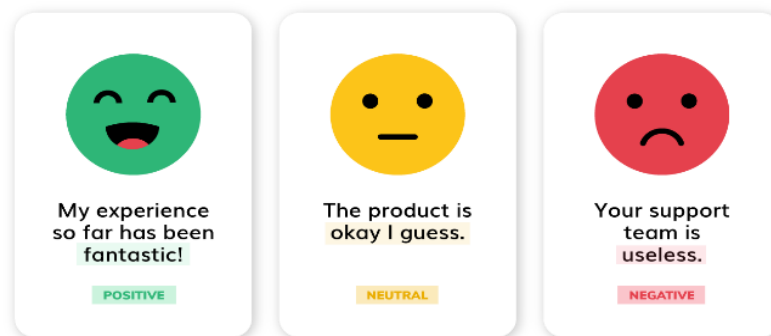
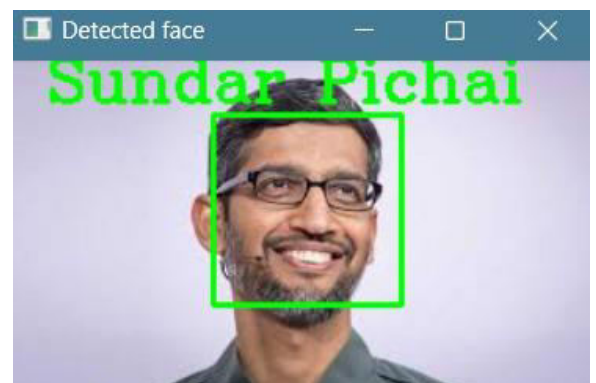


Fig 3. Sentiment Analysis

VII. TEST RESULTS

Figures shows the results of Face Detection, Face recognition and Sentiment Detection.



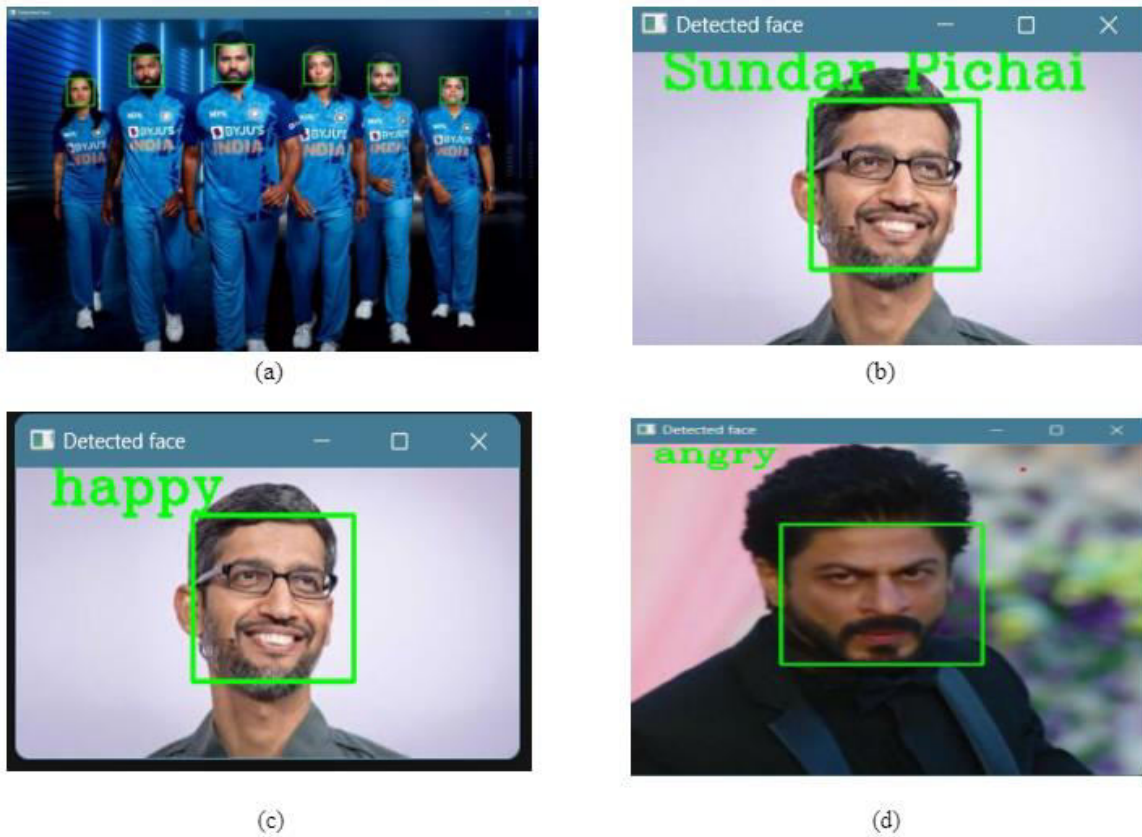


Fig 4. Tests Results

Fig 4. (a) shows the face detection of 6 faces enclosed in square each, (b) is the face recognized from the present database, (c) sentiment detected as happy and (d) sentiment detected as angry

VIII. CONCLUSION

This proposed system represents a comprehensive exploration at the intersection of computer vision, sentiment analysis, and conversational AI. By integrating advanced computer vision techniques, we have enabled our intelligent chatbot to dynamically adapt its responses based on the emotional content extracted from visual cues. The adaptive nature of our sentiment analysis, coupled with the responsiveness of the intelligent chatbot, ensures a dynamic and versatile system capable of catering to a wide range of user emotions and expressions.

As technology continues to evolve, our proposed system exemplifies the potential for creating emotionally intelligent interfaces that can better connect with users in diverse scenarios. Through facial expression recognition and sentiment classification, our system demonstrates a nuanced understanding of user emotions, allowing for personalized and context-aware interactions.

The integration of computer vision not only enhances the chatbot's ability to interpret user sentiments accurately but also provides a more immersive and empathetic user experience. In the realm of human-computer interaction, the fusion of computer vision and chatbot capabilities holds promise for applications in customer service, mental health support, and various domains where understanding and responding to user emotions are pivotal.

As we move forward, ongoing research and development in this field will likely uncover new avenues for refinement and innovation, ultimately contributing to the evolution of more empathetic and adaptive AI systems.

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