Facial Emotion Recognition Using Conventional Machine Learning and Deep Learning Methods

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ABSTRACT

Facial Emotion Recognition (FER) is a rapidly evolving field in computer vision and artificial intelligence that aims to accurately detect and classify human emotions based on facial expressions. This technology has numerous applications, including human-computer interaction, security, healthcare, and marketing. The growing interest in FER has led to the development of various approaches, primarily categorized into conventional machine learning methods and deep learning techniques.

Conventional machine learning methods typically involve handcrafted feature extraction, followed by classification using algorithms such as Support Vector Machines (SVM), Random Forests, and k-Nearest Neighbours (k-NN). Feature extraction techniques such as Local Binary Patterns (LBP), Histogram of Oriented Gradients (HOG), and Principal Component Analysis (PCA) help capture essential facial features for emotion classification.

1. INTRODUCTION

Facial Emotion Recognition (FER) is a pivotal area of research within the broader fields of computer vision and artificial intelligence. By analyzing facial expressions, machines can interpret emotions. It has gained substantial attention due to its applications in human computer interaction, healthcare, security, affective computing and entertainment. The ability to accurately interpret emotions from facial expressions enables machines to interact with humans in a more intuitive and human-like manner, making FER an essential component of affective computing.

With advancements in technology, there has been an increasing demand for systems that can recognize emotions with high accuracy and efficiency. Conventional machine learning methods depend on handcrafted feature extraction techniques followed by classification models, whereas deep learning approaches, particularly Convolutional Neural Networks (CNNs), automate feature learning and have achieved superior results.

Despite these advancements, facial emotion recognition remains a challenging task due to variations in facial expressions, occlusions, lighting conditions, and individual differences in expressing emotions. Therefore, researchers continue to explore and improve both conventional machine learning and deep learning

approaches to enhance the accuracy and robustness of FER systems.

Fig 1: Paul Ekman's Basic Emotions

1.1 **Importance of Facial Emotion Recognition**

Facial expressions are one of the most natural and effective means of communication. They provide insight into an individual's emotional state, which is essential in understanding human behavior. Image segmentation can play an important role in facial emotion recognition (FER) by isolating relevant regions of the face—such as the eyes, eyebrows, [6]mouth, and cheeks to improve the accuracy of emotion detection algorithms.

2. LITERATURE REVIEW

In recent years, facial emotion recognition has become a hot focus of research. To identify emotion from faces, most people utilize computer vision, machine learning, or deep learning technologies. This study [1] gives a brief overview of FER research done over the last few decades. The traditional FER techniques are presented first, followed by a description of the typical FER system types and their major algorithms. The authors next describe deep-learning-based FER methods that use deep networks to enable "end-to-end" learning. This paper also looks at new hybrid deep-learning technique that employs a convolutional neural network (CNN) for spatial characteristics of a single frame and a long short-term memory (LSTM) for temporal data of several frames.

2.1 Existing Systems

Facial emotion recognition is a rapidly evolving field with a wide range of applications in human-computer interaction, healthcare, security, and education. Over the years, various techniques have been developed to detect and classify human emotions based on facial expressions. The existing systems primarily use conventional machine learning techniques and deep learning models to process facial images and predict the corresponding emotions. While these methods have achieved significant progress, they still face challenges such as accuracy, robustness, real-time performance, and generalization across diverse populations.

This section provides an in-depth review of the existing facial emotion recognition systems, including their

methodologies, strengths, and limitations. The discussion covers conventional machine learning techniques, deep learning approaches, dataset usage, and practical challenges encountered in real-world applications.

3. PROPOSED SYSTEM

The proposed facial emotion recognition system aims to provide a reliable and efficient method for detecting and classifying human emotions using both conventional machine learning and deep learning techniques. It aims to enhance accuracy and robustness over traditional methods that rely solely on handcrafted features and shallow models. The system supports both real-time and offline image processing, making it suitable for applications such as human-computer interaction, mental health monitoring, security, and entertainment.

4. RESULTS

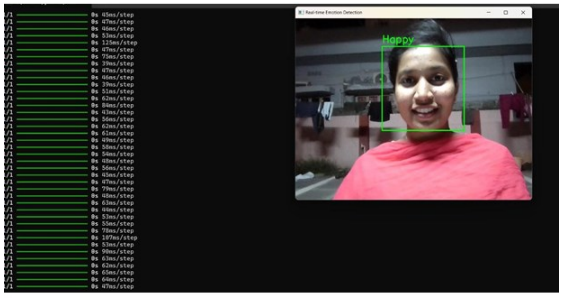

Fig 2: Happy emotion

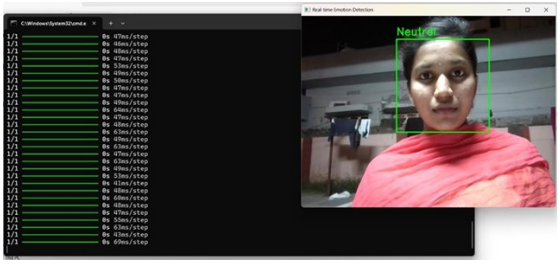

Fig 3: Neutral

True\ pred	Angry	Disgust	Fear	Happy	Sad	Surprise	Neutral
Angry	45	0	1	1	1	1	1
Disgust	1	45	0	1	1	1	1
Fear	1	1	45	1	1	1	0
Happy	0	0	0	49	0	0	1
Sad	0	1	1	0	47	0	1
Surprise	1	0	1	1	1	45	1
Neutral	0	0	0	1	1	1	48

Fig 4: Matrix

CONCLUSION

In this paper, a detailed analysis and comparison are presented on FER approaches. We categorized these approaches into two major groups conventional ML-based approaches and DL-based approaches. The convention ML approach consists of face detection, feature extraction from detected faces and emotion classification based on extracted features. Several classification schemes are used in conventional ML for FER, consisting of random forest, SVM. FER performance has increased due to the combination of DL approaches.

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