iJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/

FACIAL EMOTION RECOGNITION & DETECTION IN PYTHON USING DEEP LEARNING

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ABSTRACT
The paper introduces a real-time facial emotion detection system based on Convolutional Neural Networks (CNNs) and OpenCV. The system detects the faces and identifies emotions from facial expressions by processing video frames in real time. The model of CNN is trained on a big facial image dataset and emotions, and the performance shows accurate and speedy emotion detection. Integration of OpenCV with CNN model facilitates real-time processing of video frames, and thus the system is applicable in practical purposes. Application of machine learning includes the recognition of facial emotions of emotion.
Those that were abstracted from an image on the basis of features,it classifies a face emotion image into one of the facial emotion categories. Among the classification methods, convolutional neural network (cnn) also extracts patterns from an image. Here, we employed the CNN model for facial expression recognition.In order to enhance the accuracy of facial emotion detection, the wavelet transform is utilized afterward. There are seven various face emotions contained in the facial emotion image dataset, which were collected from Kaggle. Experimental facial emotion recognition using the CNN and wavelet transform enhances the accuracy.

Keywords:
Convolutional Neural Network, Emotion Recognition, Facial Expression, Perceptron, Support Vector Machine.

INTRODUCTION

Facial expression recognition has emerged as a crucial research area due to its diverse applications in security, healthcare, retail, and human-computer interaction. Accurately identifying emotions from facial expressions can enhance communication, improve user experiences, and strengthen security monitoring. In today's world, where security and behavioral analysis are increasingly important, automated facial expression recognition systems offer significant advantages.In countries like Nepal, where crime rates are rising, there are currently no automated systems for tracking individuals based on facial expressions. Real-time analysis of facial expressions could enable authorities to identify individuals and monitor emotional responses, aiding in crime prevention and surveillance. This research aims to design, implement, and evaluate a novel facial expression recognition system using various statistical learning techniques.The system will consist of multiple components, each responsible for a specific task. The initial phase involves reviewing existing literature and defining the system architecture, including its modules, their functions, and interactions. Different techniques will then be tested for each module, and the most effective combination will be selected based on accuracy, speed, and robustness. At the core of the system lies the classifier, which plays a critical role in recognition accuracy. The research seeks to develop improved algorithms that outperform existing models. Facial expression recognition is fundamental to understanding human emotions and intentions. Traditional systems typically recognize six basic emotions—joy, sadness, anger, disgust, fear, and surprise—but this categorization often fails to capture the complexity of human expressions. Subtle muscle movements convey a wealth of emotional information, and accurately recognizing these expressions enables various applications, including customer interest analysis in retail, emotional assessment in healthcare, audience

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engagement tracking in entertainment, and real-time emotion monitoring in security systems. While humans are naturally adept at interpreting emotions—research shows that infants as young as 14 months can distinguish between happy and sad expressions—the question remains: Can computers surpass human capabilities in emotion recognition? To explore this, we propose a deep learning-based facial expression recognition system that provides accurate and real-time emotion detection. This research is motivated by the need to develop a reliable and efficient system that enhances human-computer interaction and improves security and monitoring applications.

OBJECTIVES

The goal of this project is to create a real-time facial recognition system that correctly classifies facial signs based on deep learning. By utilizing OpenCV to capture images and the SSD MobileNet v2 model to classify, the system will translate hand gestures into written or verbal text. This shall bridge the deaf-hearing communications gap to allow accessibility, inclusion, and efficacious interactions within everyday life. The project additionally aims at checking the practicability of exploiting common webcams for the recognition of sign languages, in such a manner as to enable pragmatic and popular uses of the technology.

METHODOLOGY

The research methodology of the current project includes the following most significant steps towards executing proper and effective identification of sign language. First, webcam records images of ASL alphabet signs and processes them with OpenCV. Image quality is enhanced using preprocessing techniques such as resizing, normalization, and noise removal, and labelling is executed to prepare a structured dataset. The SSD MobileNet v2 pre-trained model is trained using this dataset for classifying hand gestures correctly. The dataset is separated into training and testing sets to study model performance. For real-time recognition, the system captures hand gestures through a webcam, processes the frames, and sends them to the trained model for classification. The recognized gestures are converted into corresponding text or speech output, enabling successful communication. Evaluation of the model is done with precision, recall, and F1-score metrics, with further optimization through hyperparameter adjustments and other image improvement techniques. The system is finally tested for robustness with real-life test cases. Future extension possibilities would be incorporation of real-time speech output, multilingual compatibility, and use of more efficient deep neural networks like Faster R-CNN to gain higher precision and accuracy. This is a systematic research approach that guarantees developing an efficient and accessible sign language recognition system.

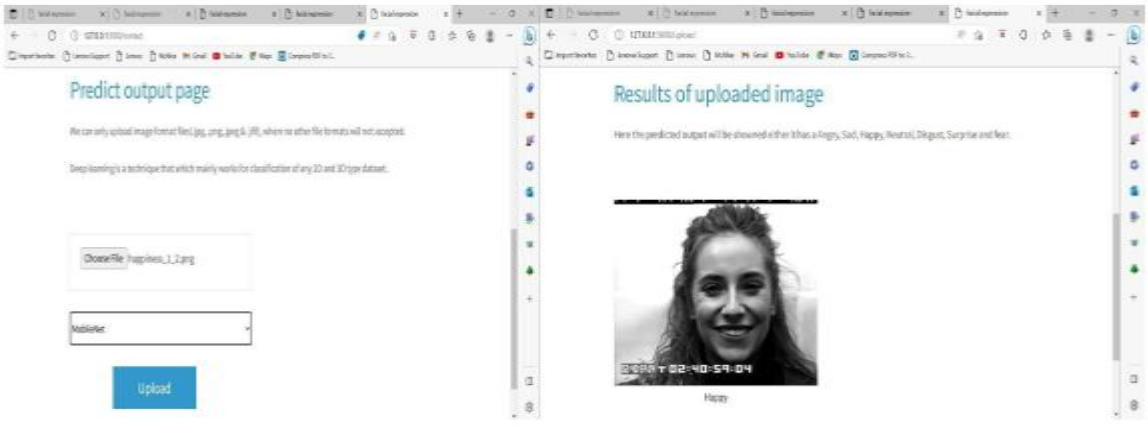

Fig.25: Results of Image

RESULTS AND DISCUSSION

Experiment Description Real-time testing was also performed on eight volunteers (three males, five females) with a mean age of 22.75 ± 4.62 years. Written consent was obtained from all the participants prior to inclusion in the study. Testing was done in a light room under daylight and also supplemented with more light to provide uniform illumination. A Nikon D5100 camera was employed, set 50 cm from the subjects. To facilitate a balanced comparison of various emotion recognition methods, all algorithms should ideally have been tested in synchrony

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on real-time input data. Due to the challenge of real-time synchronization, we decided to videotape the volunteers and played them back as standardized inputs for all models. This arrangement guaranteed that the same input data was made available to each algorithm, simulating real-time scenarios. The facial expressions of each volunteer were captured at 24 frames per second (fps) for 160 seconds. The participants expressed four successive emotions—happiness, sadness, anger, and fear—five times, in a cycle, over this period. The selected 24 fps frame rate was informed by pre-testing, which established that all algorithms were able to process frames online in real-time without lag (i.e., their offline processing rate was ≥ 24 fps). To guide the participants, a screen pointer presented the emotion to be felt for five seconds, after which a pause of three seconds was allowed before moving to the next emotion. For each period of displaying an emotion, five frames (one per second) were captured. Five predictions per emotion were given by each algorithm, which were then averaged to achieve a single final prediction per emotion for every algorithm. Two separate observers manually checked the recorded facial pictures to ensure test validity. For analysis, only frames that truly matched the reference emotion being shown on the screen were used.

CONCLUSION

This pilot study explored the real-time performance of conventional and deep learning approaches in facial emotion recognition. Our preliminary results indicate that fine-tuned AlexNet CNN and Affdex CNN demonstrate better generalization and real-time performance compared to SVM and MLP methods.Among all tested models, the commercial Affdex CNN achieved the highest overall accuracy. However, AlexNet CNN and SVM outperformed Affdex in recognizing "anger", achieving an accuracy of 96.77% compared to Affdex's 70.97%. Meanwhile, FER-CNN, despite having the lowest overall accuracy, performed notably well in recognizing "sadness," achieving 81.82% accuracy, which is comparable to Affdex CNN's 84.85%. For future research, we aim to expand the study by including a larger group of volunteers and extending the classification beyond the four basic emotions to explore the model's robustness in recognizing a broader range of facial expressions.

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