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Hybrid Approach Involving Deep Learning Techniques for Recognition Facial Emotions Efficiently

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ABSTRACT

Facial emotion recognition holds paramount importance in various human-centric applications, particularly in human-computer interaction (HCI) systems. This paper delves into the realm of machine vision and artificial intelligence (AI) to explore the methodologies and advancements in facial emotion identification. Leveraging computer vision technologies, coupled with AI algorithms, the research focuses on the recognition of human emotions through facial expressions. In human communication, facial expressions serve as a vital channel for conveying emotional states, playing a significant role in interpersonal understanding. Understanding emotions expressed through facial cues aids in effective decision-making and tailored interactions in human-machine interfaces. Emphasizing the relevance of non-verbal communication, this study investigates the significance of facial expressions in conveying emotional nuances.

Deep learning techniques, particularly convolutional neural networks (CNNs), have revolutionized facial emotion recognition by enabling end-to-end learning from raw image data. By minimizing reliance on handcrafted features and pre-processing techniques, CNN-based approaches demonstrate superior performance in emotion detection and classification. Researchers have made substantial strides in developing intricate neural network architectures to enhance the accuracy and efficiency of facial emotion recognition systems.

Through a comprehensive review of existing literature and methodologies, this research contributes to the ongoing discourse surrounding facial emotion recognition. Insights gleaned from this study pave the way for the continued advancement of HCI systems, facilitating more nuanced and responsive human-machine interactions.

Keywords: *Deep Learning, CNN, FERC, AI and SSD.*

1. INTRODUCTION

In the perspective of machine vision, image recognition is defined as the capability of software to recognize people, objects, places, writing and action in an image. Image recognition is possible with the usage of machine vision technologies with an

association of artificial intelligence (AI) software and camera device [1]. The methods of collecting, processing, and analyzing data from the real world is included in the computer vision technology [2]. Collected data is in the high dimensional structure in which it generates symbolic or numerical information in the form of decisions. In addition to the image recognition, it also includes learning, image reconstruction, video tracking, event detection and object detection. Various fields like image recognition, character recognition, finger print recognition, iris recognition, numerals recognition and facial emotion recognition are also covered in the area of recognition. In this research, facial emotion identification is considered [3-4].

In human-computer interaction (HCI) field, human emotion recognition is considered as a critical issue for machines while making decisions, providing suitable feedback and customized interactions with human. Facial expression is identified as one of the basic methods used to recognize the emotions in humans [6]. In everyday life, facial emotion plays an important role as it is a technique of non-verbal communication. The emotions of the human can be expressed by non-verbally or verbally. The machine must recognize the human emotions from both types while communicating with human in which non-verbal communication is known as emotional behavior of human [7]. In human communication, facial emotions are considered as a significant factor that help us to understand the intentions of others. People normally understand the emotional states of other people like happiness, sorrow, and wrath, using facial expressions and vocal tone. According to various studies [8-9], non-verbal components express two-thirds of communication while verbal components express one-third communication. Facial expression means carrying emotional meaning is considered as one of the main information cannels in interpersonal communication between various nonverbal components. In computer animations and in perceptual as well as cognitive science field, the research of facial emotion recognition (FERC) has gains lot of attention over the last few years [10].

Object detection and classification is enhanced with the deep learning algorithms in which it has been proven to be excellent for computer vision tasks [11]. Dependence on face-physics-based models and other pre-processing techniques are highly minimized by the deep-learning-based FERC approaches by enabling end-to-end learning to follow in the pipeline directly from the input images [12]. A particular type of deep learning named as the convolutional neural network (CNN) is the most popular network model among the different kind of deep-learning models. To produce a feature map, the input image is convolved over a filter collection in the convolution layers of the CNN [13]. The fully connected network is implemented by the combination of feature map and the softmax algorithm is utilized to recognize the facial expression which is belongs to a specific class. Due to the development of automatic extraction and classification, deep learning methods are considered as very successful and efficient approach. So that, researchers start to utilize these techniques to identify the facial emotions in humans. Researchers make several efforts on the development of deep neural network architectures due to its very satisfactory results in this area [14-15].

2. LITERATURE REVIEW

When compared to humans, the facial expression detection is always a challenging task to the computer system with some algorithms. In this paper [16], Ninad Mehendale developed a CNN technique to recognize the facial emotions on human face. CNN was executed based on two different part in which first stage removes background from the picture and second part was utilized to extract the facial feature vectors from the images. Five different type of regular facial expression was discovered with the help of expressional vector (EV). Based on the EV value, this paper correctly predicts the emotion with 96% accuracy. Datasets like Cohn-Kanade (CK+) expression, Caltech faces, etc were utilized to perform the recognition process.

Ivan Gogic *et al.,* [17] developed a shallow neural network architecture to find the fast facial expression using binary features. This research combines neural networks and gentle boost decision trees to perform the recognition process. Highly discriminative feature vectors were extracted with the help of gentle boost decision tree method. Binary features were grouped to optimize the facial expression identification over a shallow neural network structure. Difficult expressions like sadness and fear were easily recognized with this joint optimization procedure. CK+, MMI, JAFFE and SFEW 2.0 datasets were utilized to perform the emotion identification simulation.

R. Jeen Ratna Kumar *et al.,* [18] established a Fuzzy Support Vector Machine (SVM) for facial emotion identification with sub-band selective multi-level stationary wavelet gradient transform. The features were extracted from the images using wavelet transform method in which this method extract both spectral and spatial domain information. For the quality amelioration of sub-bands, the gradient transform find the gradient of sub-band avails to calculate the edges in images. Pearson-kernel-principal method was performed to reduce the dimensions of the extracted features. Finally, fuzzy SVM classifier was proposed to classify the emotion using selected features. FG Net, CK+ and JAFEE databases were utilized to perform the simulation.

FERC becomes a popular research area in image processing thanks to the development and application of HCI systems. In this paper [19], Kuan Li *et al.,* developed a novel face cropping and rotation method using CNN to identify the facial expressions from the humans. JAFEE and CK+ datasets were utilized to perform the simulation process. Moreover, the images from these datasets were in different kind of postures and this variation affects the performance of system. So, Dlib toolkit was utilized to

perform the face alignment process. OpenCV toolkit was used to perform the image cropping process. This method removes unwanted background from the image. Then, Histogram equalization was performed to reduce the variation in the image. Random horizontal flipping and random rotation was performed to ensure the abundancy and adaptability of the data. Finally, CNN was applied to perform the feature extraction process.

Adish Rao *et el.,* [20] uses Deep Neural Network (DNN) architecture for recognizing emotions from facial expressions in adults and children. This paper combines DNN with geometric-based approach named as facial landmark technique to perform FER in both children and adults. The most expressive feature was selected to perform FER on human face so that, unnecessary selection of features were omitted. CK+ and Child Affective Facial Expression (CAFÉ) datasets were utilized by this research to perform recognition process.

3. PROBLEM IDENTIFICATION AND MOTIVATION

Due to the importance of academic and commercial prospect, facial emotion recognition (FERC) is considered as a vital topic in the fields of Artificial Intelligence (AI) and computer vision. Moreover, different domains like education, software engineering and gaming applications gain more attentions in the field of emotion recognition. But, emotion recognition and face detection are considered as a very challenging problem in the above fields. Because, human behavior understanding, synthetic human expressions and mental disorder detection of humans are not easily identified by the automatic facial expression recognition system. Plenty of the researchers utilize two popular automatic FERC named as appearance and geometry based detection methods. The research is still going on for the development of new techniques like machine learning and deep learning methods. When compared to previous methods, deep learning algorithms achieve better results with less memory usage. Even though they accomplish better recognition results, problems with over-fitting and slow run-time is still a challenging issue. Also, it needs an effective and fast FERC method. This motivate us to develop an efficient FERC system with the help of optimization algorithm which is hybridized with deep learning method to accomplish better recognition.

4. OBJECTIVES

Aim of this research is to develop a system that can automatically recognize the emotions from the group of peoples as happy, sad, angry, fear, disgust, neutral, and surprise. Major contributions of this research is defined as follows:

- To remove the noise of the image by performing the adaptive filtering based pre-processing method.
- To extract the different kind of features by using different feature extraction techniques.
- To reduce the computational complexity of this entire system by identifying the optimal features using optimization algorithm.
- To design a hybrid deep learning technique with optimization algorithm that can effectively recognize the facial emotion with highest accuracy and less error value.
- To improve the accuracy with less error.

5. PROPOSED METHODOLOGY

The emotion changes in human being is can't understand by the machines accurately so, facial expression recognition (FERC) is considered as an important challenge for the same. In this research, Deep Neural Network (DNN) technique is hybridized with Manta Ray Foraging Optimization (MRFO) algorithm to efficiently recognize the emotions of human beings. To perform this process, most commonly used publically available datasets like CK+, JAFEE, and MMI are utilized. In initial stage, the image is pre-processed with the help of Adaptive Weiner Filter (AWF) technique which remove the speckle noise from the whole dataset. Then, the face from pre-processed image is detected with the help of Viola Jones Classifier. This method easily identify the human face from the image. Features from this detected face are extracted for recognition purpose. The horizontal-vertical neighborhood Local Binary Pattern (hvnLBP) method and Gabor filter methods are utilized to extract the features. After feature extraction, certain features are selected using Social Sky-Driver (SSD) Optimization algorithm. Finally, the facial emotions are recognized with the help of proposed hybrid DNN-MRFO algorithm. This hybrid algorithm can perform better emotion recognition results than any other conventional techniques. The proposed methodology can be efficiently used in the fields of education, medical care, transportation and communication. In education field, FERC can be applied to assist teachers in teaching and measuring student learning levels as well as monitoring the test room environment. In medical field, this method has been utilized to assist doctors in the treatment of psychiatric and mental diseases. This may be possible to identify the mental and emotional state of children with depression and autism so that, doctors can make timely treatment policies. In communication side, the mobile manufacturing companies utilize this kind of FERC system. Based on the user's expression, face shape and environmental conditions, it can

accurately identify the users face and unlock the mobile using this system. Also, it helps designers to understand the psychological needs of users more scientifically and quantify the psychological needs of consumers.

6. EXPECTED OUTCOME

The proposed work is implemented in the Python simulation platform. The parametric evaluations are taken in terms of average accuracy, Precision, Recall and F1-Score and this will be compared with the recent existing methodology.

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