Classification of Facial Expression Recognition using Machine Learning Algorithms

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Abstract. Face is the reflection of brain facial expressions are the discernible consequences of moving a facial muscle. In the perception of human articulations, the facial expression like Sad, Happy, Anger, Disgust, Fear is assumes a fundamental part. The objective of this research focuses on facial expression recognition which related to machine learning and optimization algorithms. Here, we proposed Hybrid Adaptive Kernel based Extreme Learning Machine (HAKELM) algorithm to identify the human facial expression based on certain image processing technique. Thus, the obtained results shown the proposed HAKELM scheme achieved 10% more accuracy, sensitivity and specificity than existing algorithms like Principal Component Analysis (PCA) and Support Vector Machine (SVM).

Keywords: Facial Emotion Recognition, Hybrid Adaptive Kernel based Extreme Learning Machine, Principal Component Analysis, and Support Vector Machine.

1. Introduction
Over recent years, omnipresent computers and digital processing came out to be an extremely vital part of everyday life. It also pushes advances in the creation of agent-controlled interfaces. As an essential element in human life, our feelings and influences also made us communicate and understand our intentions, emotions, and feelings affecting unconsciously our day-to-day activities like thinking, decision making, and interpersonal relations. Therefore, in the current technological era where life is so complicated, the detection of emotions automatically has become a current centre of the AI field, since the importance of impacts in human life and daily functioning are well known.
Facial Expression Recognition (FER) System is the invasive and recent successful technology in biometric technology. It can be denoted as verification of individual identifier about the human face. FER is considered as a computer application for automatically identifying or verifying a person in the form of digital image. The Facial Expression Recognition system was introduced during 1978. The importance for evolving FER system was face detection, image normalization, feature extraction, feature analysis and classification (Ming-Hsuan Yang et al. 2002). Every individual has a fairly unique face that can be captured without user co-operation. In face recognition, image processing
techniques are used to enhance raw images which are captured from cameras/sensors located on satellites, space probes and aircrafts or pictures from photographs. Over a decade, a FER had gained a significant attention in several applications of pattern recognition, image analysis, commercial identification, marketing tool security systems and biometrics such as fingerprint or eye iris recognition systems (Gosavi & Khot 2013). The facial expression recognition has gained awareness in the growing security concerns to avoid forgery and untreatable activities. In this paper, we proposed the Hybrid Adaptive Kernel based Extreme Learning Machine (HAKELM) algorithm to identify the human facial expression based on certain image processing technique. Thus, the performance results are acquired in terms of accuracy, sensitivity and specificity.

Further, the section 2 organises the related works of facial emotional states. Section 3, explains the proposed methodology. Section 4, gives results and discussion. Section 5, concluded the entire work of facial expression recognition.

2. Related Works
This chapter includes a detailed literature review for the FER system. All the pre-processing, Feature extraction and classification techniques mentioned in the literature are discussed in this section. The machine learning techniques for the Facial Expression Recognition (FER) approach has been proposed (Harihara Santosh Dadi & Gopala Krishna Mohan 2016). In which, pre-processing is employed to diminish the noise. Feature extraction has been performed through the Histogram of Oriented Gradients (HOG) which basically stores the edges of the face and the directionality of those edges. Supervised Support Vector Machine is employed to classify the face patterns. The performances’ results are tested on two sets of databases such as AT&T database and the YALE B to examine the results which demonstrates that the proposed methods accomplish 90% accuracy. Automatic Facial Expression Recognition (FER) system (Lajevardi & Hussain 2012) has been developed based on the feature extraction, feature selection and classification. AdaBoost algorithm is employed for face detection and feature extraction with the help of Gabor filter. The performance results carried out on Cohn-Kanade and JAFFE database shows greater improvement in the classification accuracy, compared with some traditional methods. Facial expression Recognition system (Mavani et al. 2017) has been proposed using convolutional neural network trained on the visual recognition images. In which, the result of the edited faces and their visual saliency maps are processed utilizing the Deep Multi-Layer Network for saliency prediction and forwarded to the facial expression recognition CNN. The performance results demonstrate the generalization of deep learning network with the visual saliency achieves 65.39% when compared to the other techniques. Bougrhara et al. (2016) has presented a training algorithm for Multi-Layer Perceptron (MLP) to distinguish the facial expression recognition. The skin features are extracted by certain texture features depending on the biological vision based facial description, Perceived Facial Images (PFI). The experimental results are carried out on GEMEP- FERA and Cohn-Kanade. The recognition rate has been achieved using constructive training algorithm. Biometric analysis system for the face detection has been proposed (Tikoo & Malik 2017) for the safety and security purpose. To overcome the existing restrictions, a newer technique is generated using Independent Component Analysis (ICA), Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA) and Neural Network that are utilized for segmentation and face recognition method. The hybrid integration of PCA with Singular Value Decomposition was developed (Saini & Rana 2014) to detect the facial expressions. SURF (Speed Up Robust Feature) is utilized as a feature similarity matching based on the determinant of Hessian matrix. The SVM classifier used for the classification of facial expressions and for effective face detection on cluttered scenes. The hybrid integration of PCA and SVD are utilized for dimension reduction. The experimental results show the accuracy of 98.79% and recognition rate of 67.79%.

3. PROPOSED METHODOLOGY
Our proposed methodology undergoes based machine learning and optimization techniques using the image processing techniques are developed to detect the facial expressions. Figure 1 shows that the overall proposed work of HAKELM-CSO for face detection.
The datasets are collected from the available human expression of 256x256 data sets. Pre-processing is done by the wiener filter to reduce the unwanted noise such as salt and pepper that is created during the image acquisition and to improve the image quality. Gesture extraction done by GLCM to extract the particular skin region is facial detection. The extracted gestures of the face skin regions are selected by the modified firefly to reduce the processing time. Finally, the HAKELM technique is utilized to classify and recognize the face detection and image expression which is optimized by 68 CSO for efficient classification. The algorithm steps for HAKELM-CSO are given below. Algorithm steps:

**Step 1:** The facial image of 256x256 is taken from the given each dataset. The given image is read and converted into a gray image.

**Step 2:** The input images are pre-processed by the wiener filter to remove the noises.

**Step 3:** The gesture extraction process is done to extract the relevant gestures from the facial expression images by Grey Level matrix.

**Step 4:** The extracted gesture is selected by Modified Firefly algorithm.

**Step 5:** The selected images are classified by HAKELM.

**Step 6:** Chicken Swarm Optimization is used to optimize the kernel parameters evaluated from HAKELM.

**Step 7:** The resultant facial images are used to classify the facial expressions.

**Step 8:** Performance measure of Accuracy, Sensitivity and Specificity are compared to estimate the accurate classification of facial expression recognition.

### 4. Results and Discussion

The experimental evaluation of HAKELM with CSO is simulated by the MATLAB software. The main aim of this method is to classify the various facial expressions to identify the patient’s expressions. The performance of HAKELM compared with existing algorithms such as SVM (Li Xia 2014) and PCA. Then the trained image are compared with the query image and the facial expressions are classified as normal, happy, sad, surprise, angry and disgust.
Figure 2. Dataset of facial expression

Figure 3. Classification evaluation of Facial expressions using Mat lab
The performance of HAKELM has been calculated in terms of Accuracy, Sensitivity and Specificity and the values are obtained from the confusion matrix. These measured values are evaluated in terms of true positive, true negative, false positive, and false negative.

\[
\text{Sensitivity} = \frac{TP}{(TP+FN)} \times 100
\]

\[
\text{Specificity} = \frac{TN}{(TN+FP)} \times 100
\]

\[
\text{Accuracy} = \frac{(TP+TN)}{(TP+TN+FP+FN)} \times 100
\]

The Table 1 shows the comparison analysis of metrics such as Accuracy, Sensitivity and Specificity for the HAKELM and the existing SVM and PCA.

**Table 1.** Comparison analysis of performance metrics

| Performance Metrics | HAKELM | PCA | SVM |
|----------------------|--------|-----|-----|
| Accuracy             | 95.84  | 94.45 | 83.5 |
| Sensitivity          | 90.12  | 91.1 | 82.1 |
| Specificity          | 96.12  | 86.4 | 84.21 |

Fig.4 shows that the graphical representation of comparison of accuracy, sensitivity and specificity for the HAKELM and the existing SVM, PCA. From the graph it proposed HAKELM shows good results to the existing state of algorithms.

**5. Conclusion**

The facial expression recognition analysed using Machine Learning (ML) and optimization algorithms. Hybrid Adaptive Kernel based Extreme Learning Machine (HAKELM) algorithm proposed to identify human facial expression based on certain image processing technique. Thus, the performance results shows the proposed HAKELM scheme achieved a more accuracy of 95.5%, sensitivity of 90.12%, precision of 95.1%, specificity of 96.12%, compared to that of the existing algorithms such as PCA and SVM.
6. References

[1] Carcagni, P 2015 Facial expression recognition and histograms of oriented gradients: a comprehensive study (Springer Plus, Vol. 4, no. 1)
[2] Chen X 2015 Facial expression recognition based on edge detection (International Journal of Computer Science and Engineering Survey vol. 6, no. 2) pp 1–7
[3] Datcu D 2005 Machine learning techniques for face analysis (In Proceedings of EUROMEDIA Conference).
[4] Elmansori MM 2011 An enhanced face detection method using skin color and back-propagation neural network (European Journal of Scientific Research vol. 55 no. 1) pp. 80-86.
[5] Feng X 2013 A novel bio-inspired approach based on the behavior of mosquitoes( Information Sciences vol. 233) pp. 87-108.
[6] Ferreira RL 2007 Human–machine interface based on muscular and brain signals applied to a robotic wheelchair (Journal of Physics: Conference Series vol. 90) pp 012-09
[7] Firoozabadi SMP 2008 A human-computer interface based on forehead multi-channel bio-signals to control a virtual wheelchair (In Proceedings of the 14th Iranian conference on biomedical engineering (ICBMME)) pp. 272-277.
[8] Gosavi AP 2013 Facial expression recognition using principal component analysis (International Journal of Soft Computing and Engineering (IJSCE), vol. 3) pp. 2231-2307.
[9] M.Arun Kumar 2020 Face Recognition System For Visually Impaired People (Journal of Critical Reviews vol. 7) pp. 2760-2764.
[10] M.Arun Kumar 2020 An Efficient Aquaculture Monitoring Automatic System for Real Time Applications”, (3rd International Conference on Intelligent Sustainable Systems (ICISS), IEEE )
[11] M. Arun Kumar, 2020, An Efficient Patient Health Monitoring System Using IOT For Health Care Applications, (Waffen-Und Kostumkunde Journal, volume XI) pp.219-222
[12] M. Arun Kumar, 2020 An Efficient Finger Gesture Recognition System Using Image, (4th International Conference on Electronics, Communication and Aerospace Technology (ICECA), IEEE)
[13] M. Arun Kumar, 2019, An Efficient RF Energy Harvesting System for low power applications, (International Journal of Innovative Technology and Exploring Engineering, (IJITEE), volume-9 ) pp.3510 – 3513
[14] M. Arun Kumar and G.Arun Francis , 2017, Survey on various advanced technique for cache optimization methods for RISC based system architecture, (IEEE Xplore Digital Library) pp. 195 – 200
[15] M. Arun Kumar and Dr.C. Arvind Chakrapani, 2017 An Survey of Low Power FFT Processor for Signal Processing Applications, (Journal of Advanced Research in Dynamical & Control Systems) pp. 633-641.
[16] M. Arun Kumar and C.P. Jeba Samuel and L.Saranya And T.Karthik , 2015, Efficient Time Sharing of Traffic Signal Using Wireless Sensor Networks, (International journal of Applied Engineering Research (IJAER) vol. 10 ) pp.19604-19608
[17] Han JS 2003 Human machine interface for wheelchair control with EMG and its evaluation (In Engineering in Medicine and Biology Society vol. 2) pp. 1602-1605.
[18] Harihara Santosh 2016 Improved Face Recognition Rate Using HOG Features and SVM Classifier (IOSR Journal of Electronics and Communications Engineering vol. 11) pp 34-44
[19] Nian, R 2014 Face recognition via sparse coding and extreme learning machine (Cognitive Computation vol 6) pp. 264-277.
[20] Yan S 2005 Face Recognition using laplacian faces (IEEE transactions on pattern analysis and machine intelligence, vol 27 no. 3) pp. 328-340.
[21] Huang GB 2012 Extreme learning machine for regression and multiclass classification (IEEE Transactions on Systems, Man, and Cybernetics vol. 42 no. 2) pp. 13–9.
[22] Jakhar R 2011 Face recognition using bacteria foraging optimization-based selected features (International Journal of Advanced Computer Science and Applications vol. 1 no. 3)
[23] Jang JS 2004 Face Detection using Quantum Inspired Evolutionary Algorithm (In Evolutionary Computation Congress on IEEE vol. 2 pp. 2100-2106).