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An Optimized Image Pre-Processing Technique for Face Emotion Recognition System

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ABSTRACT

People share a universal and fundamental set which is displayed by clear facial expressions. Recognition of human emotions through the imaging templates is beneficial in a wide varietyof intelligent and interaction systems programs. Nevertheless, the automated identification of facial expressions image using matching methods suffers with the normal variability with facial recording and features situations. The effective and computationally simple feature extraction and classification technique for emotion recognition is still an open problem in spite of the progress achieved in facial emotion recognition in recent years. Image Normalization and pre-processing is significantpart of recognition systems. Changes in lighting conditions produces decrease of recognition dramatically performance. A novel pre-processing framework is proposed to enhance the image using K-Nearest Neighbor and Cultural Algorithm in this paper. An optimised Image Enhancement technique is proposed for improving the classification of the human face emotion recognition system in this work.

KEYWORDS: Human Emotion, Image Processing, Image Noise removal, image enhancement, K-Nearest Neighbor, Cultural Algorithm

1. INTRODUCTION

Emotion recognition will be definitely playing an important role in the field of computer vision. The ability to build intelligent systems that accurately recognize emotions became a closer reality with the recent rise and popularization of Machine Learning [1] and Deep Learning [2] techniques. However, this nagging issue is been shown to be increasingly more complex using the development of fields which can be directly associated with emotion recognition, such as neurology and psychology. Facial expressions, ElectroEncephaloGram(EEG) signals [3], Gestures, Micro-expressions, Modulation of Voice, and surrounding context are a handful of terms which have a robust effect when determining

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emotions in a human. When each one of these variables are pieced alongside the problems and limitations regarding the currentComputerVision, Emotion Recognition could possibly get very complex. Face detection methods have the ability to generate leaping boxes that subtend recognized faces,that are the specified Region of Interest (ROIs) for a conventional Facial Expression Recognition (FER) system. This process continues to be complicated, and it's also not guaranteed that every real face will probably be detected in a given input image [3]. This is especially valid when obtaining images from an uncontrolledenvironment where there could be movement, great distance, different poses, harsh lighting conditions, and another aspect [4].

Human emotion detection is applied in a lot of areas necessitating additional security information on the individual. It could be regarded as a secondstep face detection where we possibly may have to put up a moment layer of security, where together with the face, and the emotion can be detected. Human emotions may be classified as: happy, surprise, neutral, disgust, contempt, anger, and fear. These emotions are particularly subtle. Facial muscle contortions are particularly minimal and finding these variations can be extremely challenging as even a smalldifference in numerous expressions [5]. Sometimes the same people expression might vary when it comes to emotion that are hugely context dependent [6].

An optimized image pre-processing technique is proposed to enhance the quality of the facial image for improving the classification of the human emotion using KNN and Cultural Algorithm (CA) [7] through this paper. KNN [8] is just one of the most classification algorithms whereas CA is used to take optimized K value when it comes to KNN.

1.1 Background Study on Image Enhancement and Noise Removal

Recent times, image enhancement happens to be a factor of several important image and applications of computer vision. Image enhancement requires getting a graphic and enhancing it visually, commonly considering advantageous asset of a reaction to stimuli that are visual. Sequences of enhancement methods are extensively utilized to enable the introduction of a remedy for computer image issues. A most of these techniques focused on low illumination or highmagnification problems connected with noise persist. In an Image Enhancement technique [9], it is observed that why; noise removal is still an importantimage task. Image noise presents excessive or undesiredinformation can happen through the image capture, acquisition, processing and transmission, and can even be dependent or in addition to

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the image content. The noise can be modeled with either a Gaussian, Uniform or Salt-and-Pepper distribution [10] in typical images. A filter is one thing that attenuates or enhances frequencies that are particular to visualize when you look at the frequency domain. Image filters are primarily applied to alter the characteristics of images such as colors, size, shading, and others. There is variety of use in image processing operationsimplemented with this filtering includes smoothing, sharpening, and edge enhancement.

2. RELATED WORKS

Bhattacherjee, Payal, and M. M. Ramya [11] utilized Fuzzy Logic for contrast development since it relates to uncertainties in image acquisition. New contrast development of facial images predicated on new enhanced fuzzy set theory is suggested. This paper geared towards adaptive fuzzyenhancement of facial images for pain evaluation. Every emotion is connected with certain mix of action units.

Amrapur, Basavaraj [12] utilized snake or active contourwhen it comes to segment of facial facts. The important facial characteristics gathered from images are used to verify (or) identify the human face.

Rathika, N., P. Suresh, and N. Sathya [13] explained a novel approach LS enhancement method utilizing Column-Wise Sliding Neighbourhood Operations (CWSNO) and General Sliding Neighborhood Operation (GSNO) and pulls the Principal Components Analysis (PCA) features with three straight ways such as median, mean and mode that are then categorized with Minimum Distance (MD) classifier using LOOCV (Leave One Out Cross Validation) of Re-Sampling Method (R-SM) to identify the faces.

Zhilali et. al [14] have proposed a technique to extract facial features based on the Local Binary Pattern (LBP) with lighting affect. In the LBP method, it alters the face traits by acquiring the binary type through the thresholding result around pixels or commonly called neighbors pixels.

Oloyedeet al [15] introduced a new evaluation method for enhancing the performance of the Meta Heuristic-based Image Enhancement technique. Basically, the authors employed this new evaluation function together with Meta Heuristic-based optimization methods so that you can select instantly the greatest enhanced face image predicated on a linear combination of various key quantitativemeasures.

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Oulefkiet al [16] aimed the effectiveness of the Contrast Limited Adaptive Histogram Equalization (CLAHE) protocol for face pre-processing. Fuzzy Inference System is applied to improve the annoyance of non-uniform illumination of face images in a targeted and precise manner. As a result, the illumination problem is occurred due to low-light. Initially, the input face image is divided in to two sub-regions which are equal. Finally, in each sub region the sum of brightness plus the face used in the whole to normalise or not.

Yang et al [17] suggested a GPU based Region Covariance Filter (RCF) Retinex, that could boost region covariance filter with CUDA. It's expansion is really feasible to utilize CUDA to parallel the region covariancebecause of its successive convolution operations, therefore it may receive the illumination image quickly.

Ilyas et al [18] recommended a Face Recognition (FR) system divided in to three steps: the face viola-Jones algorithm, facial image enhancement utilizing Adaptive Histogram Equalization algorithm (AHE) and show learning for classification.

Ravinaik, D., et al [19] introduced a novel conceptmodify the current power law transform to boost excellence of face region for better identification. The Double Density Dual Tree Discrete Wavelet Transforms (DDDTDWT) is employed to extract features. The Euclidian distance (ED) is employed to suit the acquired popular features of database and test face images to calculate performance variables.

Bendjillali, Ridha Ilyas, et al [20] presented a Face Recognition (FR) system divided in to three steps: the viola-Jones face algorithm, facial image enhancement using Modified Contrast Limited Adaptive Histogram Equalization algorithm (M-CLAHE), and show learning for classification.

3. PROPOSED PRE-PROCESSING TECHNIQUE FOR FACE RECONGITION

3.1 K Nearest Neighbor Technique

The K-Nearest Neighbor algorithm (K-NN)is a non-parametric method used for classification and regression in pattern recognition. Both in cases, the input is made from the K training are closest examples in the feature space. K-NN is a kind of instance-based learning. A test example classification is shown when look at the figure 1. When the test sample is a big dot within the circles that will be classified both into the high grade of triangles or even the next class of squares. If K=5 (dashed line circle) it really is designated into the second class you can find 3 squares and 2 triangles inside that circle. If K=3 (solid

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line circle) it really is assigned into the second class because here 1 triangle and 2 squares within that circle. It could be useful in the event that weight contributions regarding the neighbours are believed considering that the nearer neighbours contribute significantly more than the distant ones. As an example, in a commonweighting, individual neighbour is assigned to a weight of *1/d*if'd' is the exact distance into the neighbour. The shortest distance among any two neighbours is often a straight-line, the exact distance is recognized as Euclidean distance [19]. The limitation regarding the K-NN algorithm could it be's responsive to the local configuration of data. The entire process of transforming the input data to a collection of features is recognized as Feature extraction. In Feature space, extraction is taken put on raw data before applyingKNN algorithm.

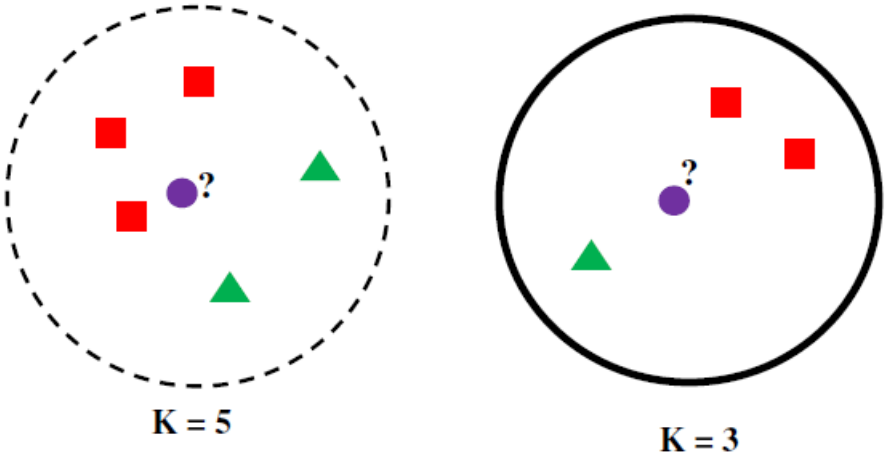

Figure 1: A K-Nearest Neighbor

3.2 Cultural Algorithm

The CA is adualinheritance that defines evolution in human culture at both the macro-evolutionary level, which requires place inside the belief space, as well as the micro-evolutionary level, which happens in the population space. CAis made from a social population belief space. Connection with individuals selected through the population space because of the acceptance function is employed to build problem solving knowledge resides when look at the belief space. The belief space manipulates and stores the ability acquired through the connection with individuals when look at the population space. The evolution can be controlled by this knowledge regarding the population component in the form of the influence function. Because of this, CA can offer a explicit global knowledge mechanism and a helpful framework within which to model self-adaptation in an EC system. The populace level element of the culturalalgorithm be Evolutionary Programming (EP). The worldwide

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knowledge which has been learned because of the population should be expressed with regards to both normative andsituational knowledge. In this algorithm, first the belief space in addition to population space are initialized. Then, the algorithm shall repeat processing for every single generation until a termination condition is achieved. People are evaluated making use of the performance function. The two amounts of Cultural Algorithm communicate by using the acceptance function together with influence function. The acceptance function determines which folk from the current population isselected to impact the belief space. The selected individuals' experiences that are generalized and applied to modify the existing beliefs when look at the belief space through the update function. This new belief able to be employed to guide and influence the evolutionary process when it comes to next generation. Cultural Algorithms as explained here comprise of three components. First, there was a population component which contains the socialpopulation be evolved in addition to mechanisms for the reproduction, evaluation and modification. Second there was a belief space that presents the bias which has been acquired because of the population during its problem-solving process. The thirdcomponent is the communications protocol which is used to look for the interaction amongst the population and their beliefs. Cultural Algorithm is in-depth analysis regarding the superiority regarding the originalevolutionon the cornerstone of drawing from the social (cultural) evolution theory when look at the social sciences [21].

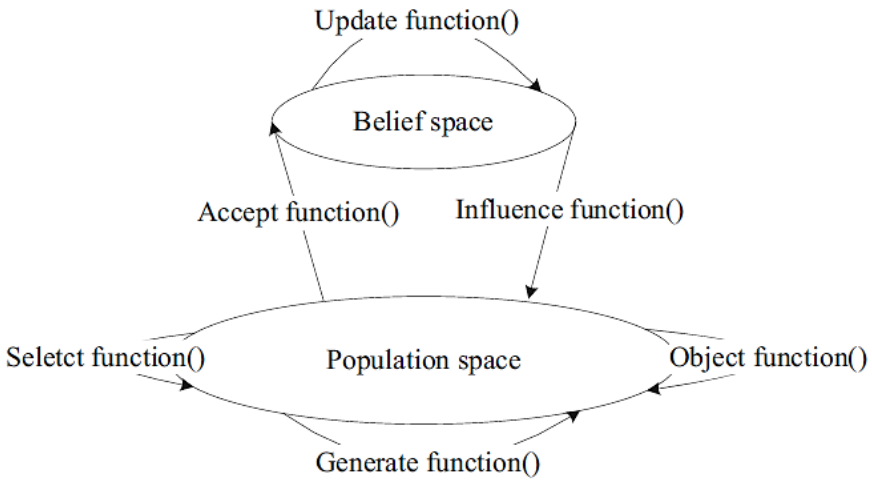

Figure 2: Cultural Algorithm Framework

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3.2 Proposed Optimized Pre-Processing Technique

In this proposed Optimized Pre-Processing method relates to KNN and Cultural Algorithm. This algorithm requires the K value for KNN from CA. CA generates the suitable '*k*' number when planning on taking nearly all image pixels when look at the human face recognition.

Step 1:An Initialization of K value for KNN making use of CA. Employing of CA for getting the K optimal value.

Step 1.1: For CA, initialize the people. The population space using the real number coding design individuals (chromosome) within the real number scope [0.0,1.0], by random initializationpopulation of individual variables, each chromosome consists of a set of real numbers in this work.

Step 1.2: Measure the population. The initialize population is split into '*m'* child populations. Every measurements of the young child population isp_k. Then relating to each child fitness function, determine the fitness of each and every individual in child population. Further, it saves the individual with highestfitness value in each child population. The fitness purpose of the *k*-th individual can be formula (1), where $f_{i,k}^{d}$ is the theoretical value of *k*-th individual and $f_{i,k}$could be the critical worth of the *k*-th individual. Then, '*n*' could be the individuals that are total population.

$$f_x(X_i^t) = \frac{\sum_{i=1}^{nt}(f_{i,k}^{d} - f_{i,k})}{n} \quad (1)$$

Step 1.3: In accordance with the averagefitness of each and every individual, put the $P_k * m$ individual in initialize population into m child population. Every person when look at the *k*-th child is theP_k.

Step 1.4: Belief space is initialized.Determining the belief space as$\langle N[n], C[m]\rangle$here N indicatesthe normativeknowledge is comprise regarding the alter period information of variables; and C could be the belief-cells information consist regarding the constrained knowledge, m could be the wide range of cells.The normativeknowledge, a couple of interval information for all the n parameters is defined formally as 4-tuple: $N = \langle I_j, L_j, U_j, adjust_N\rangle$, *j=1,2,…,n* where$I_j$indicates the

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restricted interval of variable *'j'*, and it is certainly a consistent collection of real numbers '*x*' displayed as an ordered number pair:

$$I_j = [l_j, U_j] = \{x | l_j \leq x \leq u_j, x \in R\} \quad (2)$$

The initialization of upper bound and lower bound is given by u_j *and* l_j by the presented domain values. l_j Lower bound performance scores are given by L_j for the parameter j. u_j upper bound performance scores are represented by U_j parameter j. The constrained knowledge$C[i] = \langle Class_i, Cnt1_i, Cnt_2, W_i, Pos_i, Csize_i \rangle$, here$Class_i$represents the *i-th* unit status in belief space, as infeasible or feasible. $Cnt1_i$ and $Cnt2_i$indicates the sheer number of individuals finds in feasible region or infeasibleregion, the original value is 0. $W_i$represents the extra weight of *i-th* unit, in this work the greater the fitness worth of the mechanism, the extra weight value is smaller. $Pos_i$is vector representing the left-most position of corner.$Csize_i$implies the dimensions of the *i-th* unit.

Step 1.5: Generate the new population. Influence function could be the role channel guide individual's evolution when look at the belief space. All kinds of knowledge play their functions in belief space, better cooperation to guide the evolution of the individuals in the population space through the influence function. The evolution stage of the associated with the type of knowledge is very close in different phases of the population space evolution, different knowledge on the influence of the individual size, effect and influence. First evolution, the people spread requires to investigate the individual experience knowledge, search space, need assistance to a far better area to discover search;, in the exact middle of the evolution to boost the effectiveness of separate search to narrow your hunt, beneath the assistance of redrawing search topology, empirical knowledge unit when you look at the solution space of additional accurate search; Late evolution, the search space definitely limited to a nearby area, ultimately causing premature convergence, at this stage, in order to prevent falling into need knowledge, local optimum to help population avoid falling into local optimalpoint. The constrained knowledge to guide the direction of individual evolution in order to solve the problem better, this paper adopts normative knowledge to adjust individual evolutionary step length. The influence function can be given by equation(3), where N (0,1) is a random number obeys guidelines fall probability density function.

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$$v_{i,j}^{k}(t+1)=\begin{cases}x_{j,i}^{k}(t)+\left|size\left(I_{k}^{k}\right).N(0,1)\right|;x_{j,i}^{k}(t)<s_{i}^{k}(t)\\x_{j,i}^{k}(t)-\left|size\left(I_{k}^{k}\right).N(0,1)\right|;x_{j,i}^{k}(t)>s_{i}^{k}(t)\\x_{j,i}^{k}(t)+size\left(I_{k}^{k}\right).N(0,1);x_{j,i}^{k}(t)=s_{i}^{k}(t)\end{cases} \quad (3)$$

To prevent the premature convergence of proposed algorithm, also to raise the diversity regarding the population, add the operation of mutation and crossover inside the algorithm. The equation gives the crossover operation:

$$v_i^{t+1}=v_i^{t+1}*0.5+x_i^t*0.5 \quad (4)$$

Mutation Operation is given by:

$$v_i^{t+1}=\begin{cases}v_i^{t+1}*0.5\ if\ (rand()<0.2)\\v_i^{t+1}\quad Others\end{cases} \quad (5)$$

Step 1.6: Protection of Immature. It shields this new child population in addition to worstone who has got the most effective individual fitness value, and are not able to secure them when their brand-new evolutions are far more than fitness years.

Step 1.7:Set the child population. In the event that performance regarding the old child population is bad in twenty decades, we're going to replace these with a newchild.

Step 1.8:Evaluate new population. The fitness of each individual from the new child population is evaluated use the fitness function.

Step 2:The distance or proximity regarding the neighbors is generally computed predicated on Euclidian distance using the followingequation.

$$d(x,y)=\sqrt{\sum_{j=1}^{n}\left(x_i-y_j\right)^2} \quad (6)$$

Where $d(x,y)$ is the Euclidean distance between vector x and y. $x_i$and y_j is the objects.

Step 3: Sort the distance and take the k-nearest neighbour.

Step 4: Gather the categories of nearest neighbour by means of CA.

Step 4.1:The belief space is updated in CA: in accordance with the enhance principles of child constrained knowledge and child normative knowledgeby the update

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function. The update function into the kth individual can be formula (7) and (8). Child constrained knowledge is written by:

$$Class_i = \begin{cases} unknown\ \ if\ Cnt1_i{=}0\ and\ Cnt2_i{=}0 \\ feasible\ \ if\ Cnt1_i{>}0\ and\ Cnt2_i{=}0 \\ unfeasible\ if\ Cnt1_i{=}0\ and\ Cnt2_i{>}0 \\ semi_{feasible}\ if\ Cnt1_i{>}0\ and\ Cnt2_i{>}0 \end{cases} \quad (7)$$

Step 4.2:Child Normative Knowledge is given by the equation (8.1 -8.4):

$$l_i^k(t+1) = \begin{cases} x_{j,i}^k & x_{j,i}^k \leq\ l_i^k(t)\ or\ f_k(x_{j,i}^k) < L_i^k(t) \\ l_i^k(t) & Others \end{cases} \quad (8.1)$$

$$L_i^k(t+1) = \begin{cases} f_x(x_j^k) & x_{j,i}^k \leq\ l_i^k(t)\ or\ f_x(x_{j,i}^k) < L_i^k(t) \\ L_i^k(t) & Others \end{cases} \quad (8.2)$$

$$u_i^k(t+1) = \begin{cases} x_{j,i}^k & x_{j,i}^k \geq\ u_i^k(t)\ or\ f_k(x_{j,i}^k) > U_i^k(t) \\ L_i^k(t) & Others \end{cases} \quad (8.3)$$

$$U_i^k(t+1) = \begin{cases} f_k(x_{j,i}^k) & x_{j,i}^k \geq\ u_i^k(t)\ or\ f_k(x_{j,i}^k) > U_i^k(t) \\ U_i^k(t) & Others \end{cases} \quad (8.4)$$

4. RESULT AND DISCUSSION

The face emotion recognition dataset is taken from the Kaggle repository [22]. The dataset is composed of angry, disgust, fear, happy, neutral, sad and surprise emotions. In this work, 100 images from each emotion category is considered to evaluate the performance of the proposed optimized pre-processing technique with the classification techniques like ANN, KNN and SVM.

Angry

Disgust

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Figure 3: Sample Human Emotions Images for Analysis

4.1 Performance Metrics

Table 1 depicts the performance metrics are used in this proposed work.

Table 1: Performance Metrics

Performance Metrics	Equation
1. Detection Rate	$\frac{TP+TN}{TP+TN+FP+FN}$
2. Sensitivity	$\frac{TP}{TP+FN}$
3. Specificity	$\frac{TN}{TN+FP}$
4. False Positive Rate	1- Specificity
5. Miss Rate	1-Sensitivity

Table 2 depicts the performance analysis of the proposed optimized pre-processing technique with KNN and CA is compared using the classification techniques with ANN

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classifier for the classification of human emotion recognition with proposed technique. Table 3 presents the performance analysis of the proposed optimized pre-processing technique with KNN and CA is compared using the classification techniques with KNN classifier. Table 4 presents the performance analysis of the proposed optimized pre-processing technique with KNN and CA is compared using the classification techniques with SVM classifier.

From the Table 2, Table 3 and Table 4 it is clear that the proposed Optimized Pre-Processing technique with ANN performed better in terms of increased Detection Rate, Sensitivity, Specificity and reduced error rates like FPR, and Miss Rate than the other pre-processing techniques with ANN, KNN and SVM classifiers.

Table 2: Performance of the proposed technique using ANN Classification

Performance Metrics (in %)	Techniques for Pre-Processing of Images		
	Proposed Technique	KNN	CA
Detection Rate	85.06	56.52	53.69
Sensitivity	84.95	56.55	53.68
Specificity	85.17	56.49	53.70
False Positive Rate	14.83	43.51	46.3
Miss Rate	15.05	43.45	46.32

Table 3: Performance of the proposed technique using KNN classification

Performance Metrics (in %)	Techniques for Pre-Processing of Images		
	Proposed Technique	KNN	CA
Detection Rate	78.61	53.55	51.88
Sensitivity	78.43	53.55	51.89
Specificity	78.79	53.52	51.88
False Positive Rate	21.21	46.48	48.12
Miss Rate	21.57	46.45	48.11

Table 4: Performance of the proposed technique using SVM classification

Performance Metrics (in %)	Techniques for Pre-Processing of Images		
	Proposed Technique	KNN	CA
Detection Rate	67.61	49.21	50.31

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Sensitivity	67.72	49.211	50.23
Specificity	67.50	49.21	50.234
False Positive Rate	32.5	50.79	49.766
Miss Rate	32.28	50.79	49.77

5. CONCLUSION

Human Face Recognition and Human Emotion Recognition is a challenging task because of the variability of facial expressions, personal appearances, variant poses and illumination. An optimized image pre-processing technique using KNN and CA is proposed to enhance the quality of the image by removing the noise, illumination in the face emotion images. From the result obtained by the proposed optimized pre-processing technique with ANN classification method givesenhanced detection rate, sensitivity, specificity for finding the human emotion and it also gives less error rates.

REFERENCES

[1] Yaman, Mehmet Akif, Abdulhamit Subasi, and Frank Rattay. "Comparison of random subspace and voting ensemble machine learning methods for face recognition." *Symmetry* 10.11 (2018): 651.

[2] Tripathi, Bipin Kumar. "On the complex domain deep machine learning for face recognition." *Applied Intelligence* 47.2 (2017): 382-396.

[3] Lahane, Prashant, and MythiliThirugnanam. "A novel approach for analyzing human emotions based on electroencephalography (EEG)." *2017 Innovations in Power and Advanced Computing Technologies (i-PACT)*. IEEE, 2017.

[4] Liu, Jianguo, and Blake Woodson. "Deep Learning Classification for Epilepsy Detection Using a Single Channel Electroencephalography (EEG)." *Proceedings of the 2019 3rd International Conference on Deep Learning Technologies*. 2019.

[5] Devi, C. Akalya, D. KarthikaRenuka, and S. Soundarya. "A Survey Based on Human Emotion Identification Using Machine Learning and Deep Learning." *Journal of Computational and Theoretical Nanoscience* 15.5 (2018): 1662-1665.

[6] Yang, D., et al. "An emotion recognition model based on facial recognition in virtual learning environment." *Procedia Computer Science* 125 (2018): 2-10.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 6247 - 6261
Received 25 April 2021; Accepted 08 May 2021.

[7] Abdolrazzagh-Nezhad, Majid, HomaRadgohar, and SeyedeNajmeSalimian. "Enhanced cultural algorithm to solve multi-objective attribute reduction based on rough set theory." *Mathematics and Computers in Simulation* 170 (2020): 332-350.

[8] Al-Dabagh, Mustafa Zuhaer Nayef, M. H. M. Alhabib, and F. H. Al-Mukhtar. "Face recognition system based on kernel discriminant analysis, k-nearest neighbor and support vector machine." *International Journal of Research and Engineering* 5.3 (2018): 335-338.

[9] Bora, Dibya Jyoti. "Importance of image enhancement techniques in color image segmentation: A comprehensive and comparative study." *arXiv preprint arXiv:1708.05081* (2017).

[10] Calatroni, Luca, and Kostas Papafitsoros. "Analysis and automatic parameter selection of a variational model for mixed Gaussian and salt-and-pepper noise removal." *Inverse Problems* 35.11 (2019): 114001.

[11] Bhattacherjee, Payal, and M. M. Ramya. "Fuzzy Enhancement for Efficient Emotion Detection from Facial Images." *Soft Computing for Problem Solving*. Springer, Singapore, 2019. 63-77.

[12] Amrapur, Basavaraj. "Active Contour Model Applied to Segmentation of Human Face." *Innovations in Electronics and Communication Engineering*. Springer, Singapore, 2019. 31-36.

[13] Rathika, N., P. Suresh, and N. Sathya. "LS-GSNO and CWSNO Enhancement Processes Using PCA Algorithm with LOOCV of R-SM Technique for Effective Face Recognition Approach." *Journal of Medical Systems* 43.1 (2019): 12.

[14] Zhilali, Abdurrahman Fi, Muhammad Nasrun, and CasiSetianingsih. "Face Reco gnition Using Local Binary Pattern (LBP) and Local Enhancement (LE) Methods At Night Period." *2018 International Conference on Industrial Enterprise and System Engineering (ICoIESE 2018)*. Atlantis Press, 2019.

[15] Oloyede, Muhtahir, et al. "A new evaluation function for face image enhancement in unconstrained environments using metaheuristic algorithms." *EURASIP Journal on Image and Video Processing* 2019.1 (2019): 27.

[16] Oulefki, Adel, Mustapha Aouache, and MessaoudBengherabi. "Low-Light Face Image Enhancement Based on Dynamic Face Part Selection." *Iberian Conference on Pattern Recognition and Image Analysis*. Springer, Cham, 2019.

[17] Yang, Xiaomin, et al. "Implementing real-time RCF-Retinex image enhancement method using CUDA." *Journal of Real-Time Image Processing* 16.1 (2019): 115-125.

[18] Ilyas, BendjillaliRidha, et al. "Enhanced Face Recognition System Based on Deep CNN." *2019 6th International Conference on Image and Signal Processing and their Applications (ISPA)*. IEEE, 2019.

[19] Ravinaik, D., et al. "Face Recognition using Modified Power Law Transform and Double Density Dual Tree DWT." *2019 Fifteenth International Conference on Information Processing (ICINPRO)*. IEEE, 2019.

[20] Bendjillali, Ridha Ilyas, et al. "Illumination-robust face recognition based on deep convolutional neural networks architectures." *Indonesian Journal of Electrical Engineering and Computer Science* 18.2 (2020): 1015-1027.

[21] Yan, Xuesong, Tao Song, and Qinghua Wu. "An improved cultural algorithm and its application in image matching." *Multimedia Tools and Applications* 76.13 (2017): 14951-14968.

[22] https://www.kaggle.com/jonathanoheix/face-expression-recognition-dataset/data#