International Journal of Engineering & Technology, 7 (4) (2018) 4151-4156

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET
doi: 10.14419/ijet. v7i4.20358
Research paper

Emotion based mental retardation recognition framework (EMRRF) using HPSO-ANN technique

A. Vijaya Kumar [1] *, Dr. R. Ponnusamy [2]

[1] Research Scholar, Bharathiar University, Coimbatore, India
[2] Professor, Department of CSE, CVR College of Engineering, Hyderabad, Telangana, India
**Corresponding author E-mail: a.vijayakumar@hotmail.com*

Abstract

Linking the human emotion with the reduced brain skill of that particular person becomes the social competent concept. Various research methods has been conducted to predict the mental retardation of people which concludes that the human emotions can be used to predict them successfully. It is due to uncontrollable emotional states of mentally retarded people comparatively than the normal mental age people. The mentally retarded people cannot control their facial emotions which is more difficult to decode. Finding stable emotions of people can be used to predict the solutions of requirements. There are no research work has been available to accurately predict the emotional behaviour of humans. The main goal of this research work is to introduce the system to predict the varying emotional state of people accurately. This is attained by introducing the new framework namely Emotion based Mental Retardation Recognition Framework (EMRRF) which can recognize the different kind of emotions. In this work, input videos are preprocessed first to differentiate the required object from the noisy pixels and background portions. After preprocessing, feature extraction is performed to predict the emotions where the extracted features are color, texture and shape features. The extracted features are learned by applying the Hybridized Particle Swarm Optimization and Artificial Neural Network (HPSO-ANN) to ensure the accurate prediction of required object emotional state present in video. The overall experimentation of the research work is done in the matlab simulation environment from which it is proved that the proposed research method leads to better result than the existing research works.

Keywords: *Background Subtraction; Emotion Recognition; Feature Extraction; Mental Retardation; Video Processing.*

1. Introduction

Mental Retardation (MR) is a most important clinical disorder found in many people whose abnormal condition/changes that is etiopathogenesis cannot be understood. This becomes the important concern of public due to its effects. Mental retardation is defined as the state of human beings with pool growth of mind. That is peoples with MR would have skills which is lesser when compared with the skills of similar age people. The MR people would have reduced level intelligence i.e. cognitive, language, motor, and social abilities [1]. Both kinds of people with and without mental/physical disorder would be caused with retardation. Yet, mentally retarded people caused with all kind of mental disorders [2]. The risk level of mentally retarded people is high who can cause/affected by physical abuse. Social environment started to support the adaptive behaviour of people which cannot suitable in all situations in case of presence of mild mental retardation. A survey conducted on human behaviour concludes that the 1-10% people affected with the MR for which medicine identification is more challenging.

Thinking capability is the most important factor for predicting and understanding the human emotions. Various existing research works concludes that the MR people cannot predict their and others emotional states whereas similar age normal mental state people can control their emotional states with face expressions. Thus the prediction of emotional states leads to improved solutions which can resultant with accomplished task [4]. Emotion is used to change the focus of individuals towards some processes. The emotions are not actions performed by persons which is experience attained by them [5]. The emotions can happen due to various reasons such as individual persons self-thinking or other thoughts. This is result of some actions performed by persons or others. The emotions can result with the learned knowledge which can be expressed through their activity or through body responses. The emotions can be differed under subjective and objectives focus. These emotions can be shown via expression in body language or non-verbal attitude.

The basic kind of emotions can be found in the different types of facial expression. Emotion can be also be expressed through movement of body and their positioning. Thus it is confirmed that the emotions can be expressed through both linguistic and paralinguistic cues. Here, samples of linguistics cues are semantic contents obtained through spoken information and paralinguistic cues are face expressions, vocal prosody, physical gestures and body postures [6]. Emotion prediction enables persons to generate conclusions about the attitude and characteristics of other persons. Emotions can identify the actions carried out by individual persons and sudden changes in the actions. Thus it can be concluded that the emotion is an interconnection between the actions and response found from persons which can be used for further communication and interaction with other individuals [7]. Generally, normal skilled person can able to differentiate the emotions of persons that is whether the corresponding person are happy, furious or surprised and can predict the humans personal development in terms of broadcast. The increasing popularity of social competence level required efficient framework to accurately identify the emotion expression.

In this paper, Emotion based Mental Retardation Recognition Framework (EMRRF) is proposed to accurately recognize the

Copyright © 2018 A. Vijaya Kumar, Dr. R. Ponnusamy. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

mental retardation by considering the different types of emotions of various people. The experimental evaluation of the proposed system is compared with the existing methods in terms of accuracy, PSNR and MSE.

2. Related works

Vries et al. 2001 [8] attempted to analyze the mental retardation of 29 patients who are suffered from subtelomeric defect. This analysis has been carried out by considering the information about the patients such as family and birth history, facial dysmorphism, and congenital malformations. This analysis outcome has been compared with the disease controlled 110 children who are suffered from MR. The training information has been gathered from the children shoes etiology is unknown with normal standard cytogenetics and no detectable submicroscopic subtelomeric abnormalities. The analysis of this work concluded that the subtelomeric defects indicators are 1) family history of MR, 2) prenatal onset growth retardation, 3) postnatal poor growth / overgrowth, 4) two or more facial dysmorphic features, and 5) one or more non-facial dysmorphic features and/or congenital abnormalities.

Liden & Detraux et al (2009) [9] introduced the new method to predict the facial expression of mentally retarded people. The growth of social relationship highly depends on the accurate identification of emotions through facial expression. Finding the facial expressions of mentally retarded people would be more difficult task in both children and adults when it is compared with the mental age matched controls. However increased population might affect the assumption about the particular emotions.

Various research works has been introduced earlier to predict the emotions of mentally retarded people. Carla C V P de Santana et al. (2014) [10] introduced the framework in which both facial expression prediction and intelligence level testing were conducted by performing the various level of tests. Thus the accurate emotion recognition of children who are diseased with Down syndrome (DS) and typical developing (TD). This work considered the data gathered from 30 DS diseased children and 30 TD diseased children. The overall process of emotion recognition has been done in three stages namely. In the first stage emotion reading is done. In stage 2, emotion data were gathered from different peoples under the monitoring of caretaker. Finally in the third stage, feedbacks are collected from the guardian.

Deshmukh and Fadewa (2017) [11] attempted to predict the mental disease through facial expression. This work utilizes the local binary pattern and hog feature vector to extract the facial expressions. After extraction, learning of the features is done by using Support Vector machine (SVM) to ensure the accurate mental disease prediction. The main goal of this research work is to ensure the early detection of mental disease to ensure proper diagnosis. It is proved that the facial expression is the main factor which can be utilized to predict the mental state of patients which is utilized by the psychiatrist. This research would be very useful in the situation where the patient doesn't open up with the doctors.

Guadalupe Elizabeth Morales (2014) [12] introduce the automatic cognitive processing with the concern of finding the capability of DS diseased patients (PWDS). Here, two simulation studies were introduced to perform emotion prediction. This work utilizes the stimulus onset asynchronous (SOA) as stimuli which would enable patients to learn emotions as emotional or neutral which will be measured in periodic inter stimulus interval. The evaluation of the study proved that the proposed study ensures the better accuracy in prediction which is better than the existing methods.

Various researchers concluded that the mental retardation people face difficulty in emotion prediction [13-15] process. This study proved that the existing methodologies have considerably less specificity in the task of emotion recognition. This is solved in the proposed research method by designing the efficient emotion recognition framework.

3. Mental retardation recognition based on emotions

In the proposed research method, video preprocessing is done initially in order to differentiate the region of interest objects from the background images and noisy pixels. After preprocessing feature extraction is applied to predict the system which would extract the color, texture and shape features, then Hybridized Particle Swarm Optimization and Artificial Neural Network (HPSO-ANN) is applied to learn and predict the emotions of objects present in video. The detailed explanation of the proposed research method is given in the following subsections.

3.1. Processing videos to find mentally retarded people

Video segmentation is the process of reading and collecting contents from the input video. This is most basic step in the video processing step. Video segmentation is the most important step locating peoples and vehicles present in the video to perform scene interpretation and tracking. Here initially videos are divided into multiple frames based on which video retrieval is done accurately. After framing, automated video indexing is applied to integrate the feature information into the video database. Here in segmentation process, user would assign the number of frames per second to be processed. This is decided based on video content information and with the concern of probability of missing frames. This count of number of frames per second would be different for the different types of cameras which would be assigned by the users in terms of video contents.

3.1.1. Color image segmentation

Similar object segmentation is denoted by utilizing the less number of bits. Segmentation of object is useful is various application such as storage of turner in which color based segmentation would lead to accurate outcome [16]. This color segmentation task used to be more faster and flexible method comparatively than monochrome processing method. Thus it is proved that the color is a novel dimension for the video processing method. This process is made simpler by training the computer to learn the image color in terms of mean and standard deviation. This work applied moment based method to predict the parameter values from the input video samples.

3.1.2. Foreground segmentation

Required object segmentation from the video frames found to be more important and difficult task in the image processing domain. This process is utilized in the various field applications such as video surveillance, teleconferencing, video editing and human computer interface and so on. This would work measure the background difference value in terms of multiple thresholds in order to construct the initial foreground masks. First extracted foreground regions is classified into four categories in terms of reliability. After categorization, shadow regions are removed based on color components. Then labelling of each object is done by utilizing their unique identification number [17]. After labeling boundary smoothening is done on the foreground images and then holes present in the region of interest would be eliminated. This is done by introducing the silhouette extraction which is applied on each object in the videos. However silhouette extraction method tends to reduce in its performance due to its ability of covering all regions present in the object including holes. At last holes in the object are prediction with the help of region growing technique which will lead to final foreground mask generation.

3.1.3. Background subtraction

The background subtraction is applied on every input image to separate the persons from the entire image and generate a mask. This process is performed in two steps [16-17]. In the first step,

channel wise subtraction of pixel is done on background image to separate the foreground image. The output channel differences obtained are summed up together based on which threshold value is calculated for the each and every image. Based on threshold value masked pixels are set as white and remaining pixels applied as black.

3.2. Feature extraction

Feature extraction is the most important process in the image processing based applications such as content based video retrieval, shot detection. This becomes the most attractive steps due to consideration of various videos that are captured using different cameras. Edge of an image plays more vital role in detection of objects which is utilized in various computer vision methods which can be used for prediction of edges in images and objects. Edge is defined as the group of linked pixels that present within the boundary area of two regions [18- 19]. Shape descriptor is applied to extract the shape feature which is based on group of numbers. This descriptor tried to find the shape of objects accurately. Content retrieval accuracy highly depends on the outcome of shape descriptors which can predict the similar shape features from the database. This feature descriptor would be represented in the vector format. This would classify the different kinds of features which is explained as follows:

- General features: Application oriented features such as color, texture, and shape [20-22]. Based on abstraction level these features can be categorized as follows:
- Pixel-level features: Features calculated at each pixel, e.g. color, location.
- Local features: Features calculated over the results of subdi-vision of the image band on image

3.2.1. Color

The color feature is most frequently utilized visual feature in the task of image retrieval [23]. The color feature based image classification leads to various benefits which is given as follows:

- Robustness. The color histogram is dependent to the image rotation, which is done based on axis level. The smaller change occurred due to image rotations will get reflected and it is non-sensible to those changes such as histogram resolution and occlusion.
- Effectiveness. The color feature ensures the high similarity between the query image submitted and the retrieve image from the database.
- Implementation simplicity. The color histogram prediction process is more simpler which includes the tasks of image scanning, labelling color values based on resolution of histogram and generating the histogram by using the color components information as indices.

3.2.2. Texture

Texture also plays more important role in image retrieval tasks similar to the color feature. Texture is found to be stronger region descriptor that can be utilized to ensure the accurate retrieval outcome. Generally texture cannot be used to find the similar image from the database. The main purpose of texture is to categorize the textures images from the non-textures images from the database whose outcome would be then integrated with the other features such as color based on which image retrieval can be done effectively. Texture found to be the most important factors in the process of classification and recognition of objects which can accurately predict the similarities between the images present in the multimedia database. The representation of texture is represented in two categories, such as structural and statistical [24]. The examples of statistical methods are Fourier power spectra, co-occurrence matrices, shift invariant principal component analysis (SPCA), Tamura features, World decomposition, Markov random field, fractal model, and multi-resolution filtering techniques such as Gabor and wavelet transform, characterize texture by the statistical distribution of the image intensity.

3.2.3. Shape

This feature is used to retrieve the more similar images from the databases that sharing similar values of shape which increases the accuracy of content retrieval system. It is most important visual feature utilized to describe the image content. The definition of shape content information utilized for image retrieval is more difficult due to present of varying shapes where similarity finding will be more difficult. The processed performed in the shape based image retrieval task are feature extraction and similarity measurement. The process shape descriptors are classified into two categories namely, region based and contour based method [25-26]. Region based method utilize the entire are of given input image for feature extraction, whereas contour based method will only utilize the information present in the contour of objects.

3.3. Emotion recognition to detection mentally retarded people

Hybrid Particle Swarm Optimization-Artificial Neural Network (HPSO-ANN) is brought in the proposed system, to enhance the video recognition results of the entire system. HPSO-ANN proved to provide increase accuracy in training and testing outcome. The weight values of training input pattern given to the neural network would be altered to ensure the accurate outcome by using PSO algorithm. At the time of learning process, the proposed network would be initialized with the number of layers based on size of video dataset, number of hidden layers and the number of middle layers. The number of input and output layers would be decided with the concern of increased testing accuracy based on which training process would be carried out. The training procedure would process the noisy training data initially to improve the video quality. The main goal of this learning task is to decrease the cost function value in terms of error signal $e_i(t)$ based on weight values. The output obtained from the neural network would be considered as the actual output. Here an MSE value is utilized by integrating it with the cost function values in order to measure the error values obtained.

$$J = E\left[\frac{1}{2}\sum_i (e_i(t))^2\right] \quad (1)$$

$$= E\left[\frac{1}{2}\sum_i d_i(t) - y_i(t))^2\right] \quad (2)$$

Where E represents the statistical expectation parameter and summation is used to integrate neurons to obtain output layer value. Here the weight adjustment is done based on desired signal value di(t). The processing outcome of this work concludes that the newly generated signal $d_i(t) + n_i(t)$ is found to better for prediction outcome of output neural I instead of utilizing the desired signal value di(t). here ni(t) denotes the noise. This noises is assumed as white Gaussian noise which is different from the input signals xk(t) and the desired signals $d_i(t)$. The cross validation of ANN method needs to be periodically to ensure the optimal outcome. ANN is utilized in various application such as prediction, classification, time series projection and so on due to is benefit of satisfying the increased demands of operating the different structures and features.

ANN model is a generalized form of biological nervous system which is represented with the help of mathematical model. This method works based on simple neural to perform simple tasks. This is most basic processing factor of neural networks. The synapses in the brain system are used to alter the weights assigned in the path connection by adjusting the values of input signals. The non-linear representation of neuron network is specified by using transfer function. It is done in the simplified way. The measurement process of taken weighted sum values of input signals is done by using neuron impulse which is then processed using transfer function. The computation process of neuron network is represented as follows:

$$o = f\left(\sum_{j=1}^{n} w_j x_j\right) \quad (3)$$

Where w_j represents the weight vector value, x_j is the neuron input values. The basic neuron layers utilized in the ANN architecture is input, hidden, and output layers. Here the flow of signal is performed from input layer to output layer which is based on feed forward direction.

The system end up balanced in the taking in the examples from the preparation set amazingly, on the off chance that it over-prepared, so it prompts wrong examples outside the preparation set. The preparation speed is diminished attractively, when the ANN has bad marks at the season of dynamic conduct. To redress this issue, the HPSO-ANN approach is upgraded regarding neuron determination. The system is insufficient to take in the connections in the midst of the information and the augmented mistake, in view of the few shrouded neurons. Colossal concealed neuron guarantees legitimate learning and the system can consummately anticipate the information, which has been prepared. The HPSO-ANN gathers the feeling highlights with MFCC, vitality, pitch, force and formants.

PSO calculation begins by instating an arbitrary swarm of M particles for weight enhancement in ANN. The wellness of each molecule is processed in light of the wellness work, at each age. The calculation gathers and equally substitute the best past position of each molecule (pbesti, I =1,2,...,M) and additionally an individual best molecule (gbest). In PSO, the speed and position of each molecule were substituted by stage. The advancement based video grouping, required to decide the weight estimations of ANN. The normal mistake concedes the boisterous video flag and the assessed commotion motion in each edge are used as the cost work. Wellness particles have less cost work esteems.

$$J_i = \frac{1}{N+1}\sum_{k=0}^{N}[d(k) - y_i(k)]^2 \quad (4)$$

Where N is the video sample count in each edge, and y (k) is the yield. At the point when Ji is least, at that point the parameters indicates the best estimation and create bring down mistake rate. On the off chance that the blunder esteems between the preparations and testing is lesser means then the weight esteems are made higher .The situation of each molecule in the swarm is a contender for the coefficients, in the PSO-based enhancement video order. After specific cycles, the ideal element (feeling highlight) is figured in light of the position vector of the best (worldwide) molecule in the swarm (gbest). At that point, these highlights were partitioned all the more precisely by using the advanced qualities. The Particle Swarm enhancement (PSO) is acquired this work, to deal with the smoothing highlights and non-acknowledgment includes ideally. With the assistance of PSO particles, the ANN learning process is upgraded. The best wellness esteem is processed to refresh the neighborhood best and worldwide best qualities in the PSO calculation, which focuses on improving the whole feeling characterization exactness. PSO calculation enhances the ANN design, which will raise the ideal feeling acknowledgment results by amplifying the intermingling speed. For each preparation design

1) Map the training video into the network
2) Train the input network model by leaning the training video dataset until convergence of error value reached $e_{th} = 0.1$for a specific number of training epochs τ=100 that is specified by the user.
3) Considered the input nodes and hidden nodes are assigned with five emotions
4) Measure the output value of input neuron layer with the help of hidden layer which is mapped to output layer
5) Measure the error value of ANN based on testing data set
6) If the obtained error is large and unaccepted then label ANN has irrelevant network and go to next step
7) Else end the training process until it reaches$e_{th} = 0.1$. The measurement error value E is done by utilizing the following equation.

$$E(w, v) = \frac{1}{2}\sum_{i=1}^{k}\sum_{p=1}^{C}(S_{pi} - t_{pi})^2 \quad (5)$$

Where k represents the count input patterns and c is number of output neurons. t_{pi} and S_{pi} represents the target and actual output values obtained for the ith input pattern from the pth output neuron. The computation of actual output value S_{pi} is calculated based on following equation.

$$S_{pi} = \sigma(\sum_{m=1}^{h}\delta((x_i)^T w_m)v_m) \quad (6)$$

Where h represents the count of hidden nodes in ANN, x_i represents the input patterns in n dimension where i=1,2,..k. w_m represents the weight value of link between the input layer and hidden layer where m=1,2,..,h, v_m. σ represents the activation function and δ represents the hidden layer hyperbolic tangent function.

8) Integrate one hidden node with the hidden layer and initialize its weight value randomly to start the training process
9) Run PSO algorithm
10) Initialize the swarm of particles with random values of position and velocity
11) The calculation procedure of fitness function value is given in below equation

$$v_i(t+1) = w \times v_i(t) + \left(c_1 \times \text{rand} \times \left(\text{Pbest}(t) - x_i(t)\right)\right) + \left(c_2 \times \text{rand} \times \left(\text{Gbest}(t) - x_i(t)\right)\right) \quad (7)$$

Where w represents the weights which is ranged between 0 to 1. VI is the velocity of particles, c1, c2 are speeding parameters, Pbest indicates the best value of particle i and x_i is the particle in swarm and Gbest is the global best value of swarm of particles.

12) The calculation new particle fitness value is given as follows:

$$x_i(t+1) = x_i(t) + v_i(t+1) \quad (8)$$

13) PSO generates the optimal solution for the ANN learning rate parameters in addition to the weight value among the input and hidden nodes
14) If ANN could not predict the feature values then
15) Check the error cost values of neurons
16) Boot the weight updating process
17) Apply PSO to find the optimal features based on best fitness values
18) Update the global best solutions
19) Classify video output emotions as happy, fear, sad, surprise, anger and disgust based on above extracted features
20) Emotions are classified more accurately

3.3.1. Mental retardation recognition

In this paper, mild to moderate mental retardation peoples were approached to recognize the emotions of persons based on facial expression. A time limit of five minutes was allowed for each participant to respond to each picture. Their responses to each emotion was scored and recorded by the researcher and a co-rater using a four point rating scale (described below in scoring). Cohen's Kappa value (for inter-rater agreement) was found to be .90 indicating 'almost perfect' concordance for each of the tasks. This scoring method [9] was used for scoring all the tasks.

4. Results and discussion

The experimental evaluation of the proposed research method Emotion based Mental Retardation Recognition Framework (EMRRF) is done this section which proves that the prediction of mental retardation can be done accurately. The performance metrics were assumed as Peak Signal to Noise Ratio (PSNR) [27-28], Mean Square Error (MSE) [29-30], and accuracy were evaluated by existing approaches like ANN and proposed EMRRF.



Fig. 1: Ekman and Friesen's Faces for Basic Emotions with Mild to Moderate Mental Retardation.

Peak Signal to Noise Ratio (PSNR): PSNR is defined as the ratio between the quality signals obtained with the noised signals. It is found that the PSNR ratio has considerable effect on the video content representation. It can be also observed that it is the logarithmic function of peak value of image and Mean Square Error (MSE).

$$\mathrm{PSNR} = 10\log_{10}\left(\mathrm{MAX}_{\mathrm{I}}^{2}/\mathrm{MSE}\right) \quad (9)$$

Mean Square Error (MSE): Mean Square Error (MSE) is used to predict the error value which is a variation between the estimated value and the actual value obtained.

$$\mathrm{MSE} = \frac{1}{\mathrm{mn}}\sum_{\mathrm{i}=0}^{\mathrm{m}-1}\sum_{\mathrm{j}=0}^{\mathrm{n}-1}[\mathrm{I}(\mathrm{i},\mathrm{j}) - \mathrm{K}(\mathrm{i},\mathrm{j})]^{2} \quad (10)$$

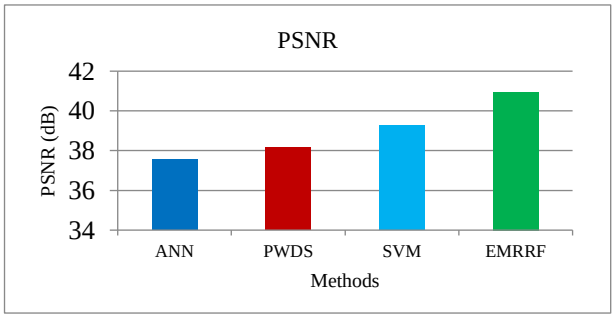


Fig. 2: PSNR Comparison vs. Methods.

From the above Figure 2, it can be observed that the comparison metric is computed among the pre-processing methods with respect to PSNR metric. In x-axis the algorithms are considered and in y-axis the PSNR value is considered. The proposed EMRRF algorithm provides higher PSNR value of 40.95 dB which is 3.39 dB higher when compared to ANN method. The result confirms that the proposed system gains greater speech recognition results.

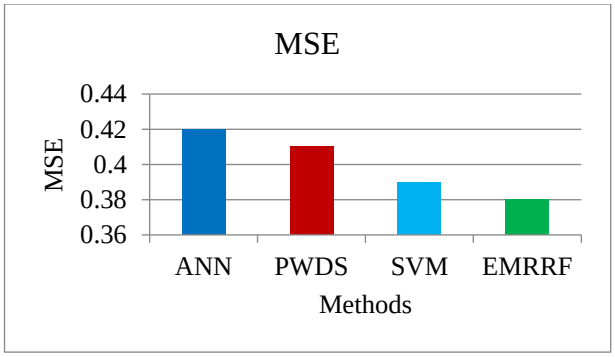


Fig. 3: MSE Comparison vs. Methods.

From the above Figure 3, it can be observed that the comparison metric is computed among the pre-processing methods with respect to MSE metric. In x-axis the algorithms are considered and in y-axis the MSE value is considered. The result confirms that the proposed system gains greater speech recognition results.

Accuracy is defined as the ability of network to correctly predicting the outcome which is measured in terms of total actual classification parameters $(\mathrm{T_p} + \mathrm{T_n})$ which is classified by the sum of the classification parameters $(\mathrm{T_p} + \mathrm{T_n} + \mathrm{F_p} + \mathrm{F_n})$. The accuracy is computed as like :

$$\mathrm{Accuracy} = \frac{\mathrm{T_p}+\mathrm{T_n}}{(\mathrm{T_p}+\mathrm{T_n}+\mathrm{F_p}+\mathrm{F_n})} \quad (11)$$

Where TP termed as number of correct recognition, Tn is termed as number of inaccurate recognition over the positive sample, $\mathrm{F_p}$ is termed as number of incorrect predictions over negative instance, and $\mathrm{F_n}$ is known the amount of correct predictions that an instance is positive.

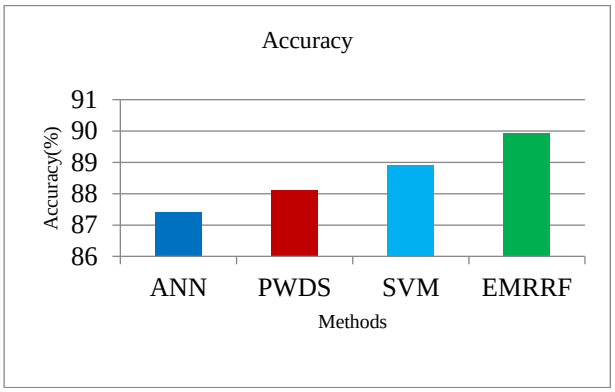


Fig. 4: Accuracy Comparison.

From the above Figure 4, it can be observed that the comparison metric is computed among the existing and proposed method with respect to accuracy. In x-axis the algorithms are considered and in y-axis the accuracy value is considered. The existing methods gives lower accuracy in fact, the proposed system gives higher accuracy for the provided speech sample input.

5. Conclusion

The proposed system designed an Emotion based Mental Retardation Recognition Framework (EMRRF) with the help of different emotions of people. In this paper, initially video processing is done to separate the objects from the background images and noisy pixels. The color, texture and shape features are extracted from the image. Then the Hybridized Particle Swarm Optimization and Artificial Neural Network (HPSO-ANN) is proposed to identify the emotions of objects present in the video. Based on the recognized results the mental retardation is performed. The experimental results show that the proposed system achieves better performance compared with the existing ANN method in terms of PSNR, MSE and accuracy.

References

[1] Russel JA, "Core affect and psychological construction of emotion", Psychol Rev. 2003; 110:145–72. https://doi.org/10.1037/0033-295X.110.1.145.

[2] Shackman JE, Pollak SD, "Experiential Influences on multimodal perception of emotions", Child Dev. 2005; 76:pp.1116–1126. https://doi.org/10.1111/j.1467-8624.2005.00901.x.

[3] Lini Joseph, "Recognition and Understanding of Emotions in Persons with Mild to Moderate Mental Retardation", 2015; springer India Pvt. Ltd. Vol.2, pp.59-66.

[4] Ramchand Hablani, Narendra Chaudhari & Sanjay Tanwani, "Recognition of Facial Expressions using Local Binary Patterns of

Important Facial Parts", International Journal of Image Processing (IJIP), Volume (7): Issue (2): 2013; pp.163-167.
[5] Caifeng Shana, Shaogang Gongb, Peter W. McOwanb, "Facial expression recognition based on Local Binary Patterns: A comprehensive study", Image and Vision Computing 27, 2009, pp.803–816. https://doi.org/10.1016/j.imavis.2008.08.005.
[6] Talele Kiran, Tuckley Kushal, "Facial Expression Classification using SupportVector Machine Based on Bidirectional Local Binary Pattern Histogram Feature Descriptor", 978-1-5090-2239-7/16/$31.00 copyright 2016 IEEESNPD 2016, May 30-June 1, 2016, Shanghai, China, 1-4.
[7] X. Feng, M. Pietikainen and A. Hadid, "Facial Expression Recognition with Local Binary Patterns and Linear Programming", Pattern Recognition and Image Analysis, vol. 15, No. 2, 2005, pp.546-548.
[8] De Vries BBA, White SM, Knight SJL, Regan R, Homphray T, Young JD, Super M, McKeown C, Splitt M, Quarrell OWJ, Trainer AH, Niermeijer MF, Malcolm S, Flint J, Hurst JA, Winter RM, "Clinical studies on submicroscopic subtelomeric rearrangements: a checklist", J Med Genet, 2001, 38:pp.145–150. https://doi.org/10.1136/jmg.38.3.145.
[9] Hippolyte, L., Barisnikov, K., Van der Linden, M., & Detraux, J. J., "Facial emotional recognition abilities to emotional attribution: A study in Down syndrome", Research in Developmental Disabilities, 2009, 30, pp.1007-1022. https://doi.org/10.1016/j.ridd.2009.02.004.
[10] Carla C. V. P. de Santana, Wania C. de Souza, and M. Angela G. Feitosa, "Recognition of facial emotional expressions and its correlation with cognitive abilities in children with Down syndrome", Psychology & Neuroscience, 2014, Vol.7, No.2, pp.73-81. https://doi.org/10.3922/j.psns.2014.017.
[11] Deshmukh and Fadewar, "Analysis of Mental Illness Using Facial Expressions", International Journal of Innovative Research in Computer and Communication Engineering, Vol. 5, Issue 1, January 2017.
[12] Guadalupe Elizabeth Morales, Ernesto Octavio Lopez, Claudia Castro-Campos, David Jose Charles and Yanko Norberto Mezquita-Hoyos, "Contributions to the Cognitive Study of Facial Recognition on Down syndrome: A New Approximation to Exploring Facial emotion Processing Style", article in journal of intellectual disability, 2014, Vol.2, pp.124-132.
[13] Kim, J. and André, E., "Emotion recognition based on physiological changes in music listening", IEEE transactions on pattern analysis and machine intelligence, 2008, 30(12), pp.2067-2083. https://doi.org/10.1109/TPAMI.2008.26.
[14] Harrison, A., Sullivan, S., Tchanturia, K. and Treasure, J., "Emotional functioning in eating disorders: attentional bias, emotion recognition and emotion regulation", *Psychological medicine*, 2010, *40*(11), pp.1887-1897. https://doi.org/10.1017/S0033291710000036.
[15] Edwards, J., Jackson, H.J. and Pattison, P.E., "Emotion recognition via facial expression and affective prosody in schizophrenia: a methodological review", *Clinical psychology review*, *22*(6), 2002, pp.789-832. https://doi.org/10.1016/S0272-7358(02)00130-7.
[16] Revathi, R. and Hemalatha, M., "An Emerging Trend of Feature Extraction Method in Video Processing", Academy & Industry Research Collaboration Center (AIRCC), CSCP, 2012, pp. 69–80.
[17] Kim, H., Sakamoto, R., Kitahara, I., Toriyama, T. and Kogure, K., "Robust foreground segmentation from color video sequences using background subtraction with multiple thresholds", *Proc. KJPR*, 2006, pp.188-193.
[18] Yang, M., Kpalma, K. and Ronsin, J., "A survey of shape feature extraction techniques", thesis, 2008, pp.1-38.
[19] Maire, M.R., "Contour detection and image segmentation", University of California, Berkeley, 2009, pp.1-88.
[20] Gupta, N. and Athavale, V.A., "Comparative Study of Different Low Level Feature Extraction Techniques for Content based Image Retrieval", International Journal of Computer Technology and Electronics Engineering (IJCTEE), 2011, Volume 1, Issue 1, pp.39-42.
[21] Gomashe, A.S. and Keole, R., "A Novel Approach of Color Histogram Based Image Search/Retrieval", International Journal of Computer Science and Mobile Computing, 2015, pp.57-65.
[22] Arif, T., Shaaban, Z., Krekor, L. and Baba, S., "Object Classification via Geometrical, Zernike and Legendre Moments", Journal of Theoretical & Applied Information Technology, 6(3), 2009, pp.031 – 037.
[23] Choras, R.S., "Image feature extraction techniques and their applications for CBIR and biometrics systems", International journal of biology and biomedical engineering, 2007, 1(1), pp.6-16.
[24] Zand, M., Doraisamy, S., Halin, A.A. and Mustaffa, M.R., "Texture classification and discrimination for region-based image retrieval", Journal of Visual Communication and Image Representation, 2015, 26, pp.305-316. https://doi.org/10.1016/j.jvcir.2014.10.005.
[25] Patel, M.N. and Tandel, P., "A Survey on Feature Extraction Techniques for Shape based Object Recognition", International Journal of Computer Applications, 2016, 137(6), pp.16-20.
[26] Singh, P., Gupta, V.K. and Hrisheekesha, P.N., "A review on shape based descriptors for image retrieval", International Journal of Computer Applications, 2015, 125(10), pp.27-32.
[27] Huynh-Thu, Q. and Ghanbari, M., "Scope of validity of PSNR in image/video quality assessment", Electronics letters, 2008, 44(13), pp.800-801. https://doi.org/10.1049/el:20080522.
[28] Poobathy, D. and Chezian, R.M., "Edge detection operators: Peak signal to noise ratio based comparison", International Journal of Image, Graphics and Signal Processing, 2014, 10, pp.55-61. https://doi.org/10.5815/ijigsp.2014.10.07.
[29] Köksoy, O., "Multi-response robust design: Mean square error (MSE) criterion, Applied Mathematics and Computation", 2006, 175(2), pp.1716-1729. https://doi.org/10.1016/j.amc.2005.09.016.
[30] Sarbishei, O. and Radecka, K., "Analysis of mean-square-error (MSE) for fixed-point FFT units", IEEE International Symposium on Circuits and Systems (ISCAS), 2011, pp. 1732-1735. https://doi.org/10.1109/ISCAS.2011.5937917.