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A new real time face recognition Algorithm to be used in nuclear facilities

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Abstract: A biometric hybrid algorithm is proposed for face recognition in real time. The algorithm first uses Huffman code compression to represent the image in a small size binary format. The binary vector is then fed as input to the First Adaptive Resonance Theory network, ART1, which is an unsupervised neural network, for image recognition. It is shown that the algorithm performs well on both live images and popular images databases. The algorithm is also compared with the performance of other face recognition algorithms as PCA and Eigen faces and the results prove that the proposed algorithm outperforms the other two algorithms. The extremely small recognition time of the algorithm makes it very suitable for use in emergency situations where recognition time is crucial as in case of fire occurrence in buildings which uses radiation materials or in nuclear power plants.

Keywords: Huffman code, face recognition, Adaptive resonance theory.

1. Introduction

Biometric pattern recognition systems are widely used in security areas. Nuclear power buildings are an example of such areas requiring high-level of security systems. These systems use unique human characteristics such as fingerprints, iris, hand geometry, hand vein, voice, retina, face, to enable differentiation among human beings. Facial research in computer vision can be divided into several areas, such as face recognition, face detection and facial expressions analysis. Face recognition systems have a wide range of applications e.g. human-computer interaction, image and film processing, and security applications where real-time subject identification and authentication is a requirement in emergency situations. The biggest challenge in designing and implementing a robust face recognizer is that a human face can undergo several transformations such as using different face accessories, changing facial expressions, changing hair or beard style. In general, face recognition is carried out in four phases a) Image Acquisition, b) Preprocessing, c) Feature Extraction and d) Matching. The human face recognition techniques normally are applied to frontal faces. Recognition methods are Eigen faces, Artificial Neural Networks (ANN), Dynamic Link Architecture, Hidden Markov Models (HMM), Graph Matching, Geometrical Feature Matching, Template Matching, 3D Morph able Model, Line Edge Map (LEM), Support Vector Machine (SVM) and Multiple Classifier Systems (MCS). The following section describes each phase.

Emergency face recognition is one of the essential aspects in life safety systems. The system should, if correctly designed, installed and maintained, reduce the possibility of an accident or loss of life in emergency events as accidents in nuclear plants. In this paper, an algorithm for real time face recognition is proposed. Huffman code is used for compressing images of different faces and only code words of the images are considered to create features of faces. After that, the first adaptive resonance algorithm ART1 [1] is applied for producing the face recognition. The novelty of the algorithm is the combination of Huffman algorithm with ART1. The research paper is organized into the following sections. Overview of the related work is given in section 2. ART1 algorithm is described in section 3.Theproposed algorithm is explained in section 4. Section 5 discusses the performance analysis of the proposed algorithm and other similar-function algorithms and the results. Conclusions are given in Section 6.

2. Related Work

M Bicego et al., [2] presented HMM and wavelet coding based face recognition system. For each face image a sequence of overlapping sub images is extracted and then wavelet coefficients are compared for each of the images. Virenndra P Vishwakarma et al., [3] proposed an approach for face recognition using DCT coefficients rescaling for illumination normalization. M AAnjum et al., [4] presented the double dimension reduction based face recognition. Byung-Joo Oh [5] proposed Radial Basis Function [RBF] network based on LDA for face recognition. A Abbas et al., [6] proposed a method to eliminate the expression and illumination invariant preprocessing techniques for face recognition. Smoothing the image to remove image details using wavelet transforms, the expression variation effect is eliminated and combining this method with DCT method to eliminate illumination variations. M P Mahyabadi et al.,

[7] investigated face detection based on PCA and Adaptive Resonance Theory (ART) neural network. Vector dimension is reduced by using PCA and neural network classifier ART is used for face recognition. Gualberto Aguilar-Torres et al., [8] proposed a face recognition algorithm using Discrete Gabor Transform (DGT). The face image features vector is extracted using DGT and then feed into a multilayer perceptron to carry out the recognition task. Paul Nicholl and Abbes Amira [9] proposed a method to determine automatically the most discriminative coefficients for eigenfaces in a DWT/PCA face recognition system based on their interclass and intra-class standard deviations. Ziad M, Hafed and Martn D Levine [10] developed DCT based face recognition system. DCT tries to extract features and invokes certain normalization techniques to increase performance to variations in facial geometry and illumination. Hazim Kemal Ekenel and Rainer Stiefelhagen [11] proposed local appearance based face recognition algorithm. Imran S, Bajwa et al., [12] presented PCA classification system to classify the different types of single-layered and multi-layered clouds. Qeethara, Kadhim, Al-Shayea et al., [13] concentrated on recognition rate of face recognition algorithms. The algorithms examined are: PCA, 2D-PCA column direction, 2D-PCA in row direction and Two Dimensional Two Directional PCA. Yuehui Chen et al., [14] proposed a face recognition approach by using DCT and hybrid Flexible Neural Tree (FNT) classification model. SarawatAnam et al., [15] proposed a face recognition system using genetic algorithm and back-propagation neural network. Zong X Lin et al., [16] proposed a practical preprocessing method to recover the vertical pose variation for the face recognition module of the intelligent robot guard. P Abouzar et al., [17] proposed a face recognition algorithm based on Wavelet Transform (WT) and DCT. Ronny Tjahyadi et al., [18] discussed the face recognition problem via energy histogram of the DCT coefficients. Chengjun Liu [19] presented learning the Uncorrelated Color Space (UCS), the Independent Color Space (ICS), and the Discriminating Color Space (DCS) for face recognition. Yuchui Chen and Yaou Zhao [20] proposed face recognition using DCT and hierarchical RBF model. B Yognannarayna [21] presented an algorithm on illumination variation in face recognition based on the phase of analytic image. FadiDornaika and Bogdan Raducanu [22] proposed 3D head pose and facial actions real time tracker in monocular video sequences. Automatic 3D face pose initialization scheme for real time tracker employed 2D face detector and an eigenface system. Chao-Kuei Hsieh et al., [23] proposed the regularization based optical flow algorithm by using constraints on given point correspondences to compute precise pixel displacements and intensity variations. Wen-Hui Yang and Dao-Qing Dai [24] proposed two dimensional maximum margin feature extraction for face recognition. 2D two directional feature extractions based on maximal margin criterion and then LDA is performed in the 2D two directional maximal margin criterion subspaces. Satyanadh Gundimada and Vijayan K Asari [25] presented multisensory images based face recognition on localized kernel eigenspaces. Modular kernel eigenspaces approach on the phase congruency feature maps extracted from the visual and thermal images individually. Hongliang Li et al., [26] presented automatic face segmentation for real time video for face recognition Srinivas Nagamalla and Bibhas Chandra Dhara [27] presented face recognition algorithm using facial landmarks such as eyes, lips, mouth and lips. Sidra BamodelKazmi et al., [28] presented automatic recognition of facial expressions from face images by using DWT features to a bank of five parallel neural networks. Kazuhitoand Hirokazu [29] proposed method contains a feature based on the hybridization of two unsupervised neural networks, Self-Organizing Maps (SOMs) and Fuzzy Adaptive Resonance Theory (ART), which has a seamless mapping procedure.

3. Art1 Network

The stability-plasticity dilemma remained unresolved for many conventional artificial neural networks. The ability of a net to learn new patterns at any stage of learning without losing the previously learnt patterns is called its plasticity. A stable net does not return any pattern to a previous cluster. Conventional nets cannot learn a pattern while being presented for the first time to them. A real network is constantly exposed to changing patterns; it may never see the same training vector twice. Under such a circumstance the back propagation networks can learn nothing with continuously modifying their weights. ART1[30] nets are designed to be both plastic and stable. The ART1 network is a vector classifier. It accepts an input vector and classifies it as one of the categories depending upon which of the stored pattern it resembles within a specified tolerance otherwise a new category is created by storing that pattern as an input vector. No stored pattern is modified if it does not match the current input vector within a specified tolerance; hence the stability- plasticity dilemma is solved. ART1 is designed for classifying binary vectors. The classification process through ART involves three steps; recognition, comparison and the search phase. During learning, one input vector is presented to the network. The degree of similarity is controlled by vigilance parameter ρ (0-1).

A. ART1 Basic Architecture

The ART1 network consists of three major components accompanying groups of neurons as shown in figure 1 [1].

1. Input processing field-F1 layer
2. Cluster units –F2 layer
3. Reset mechanism

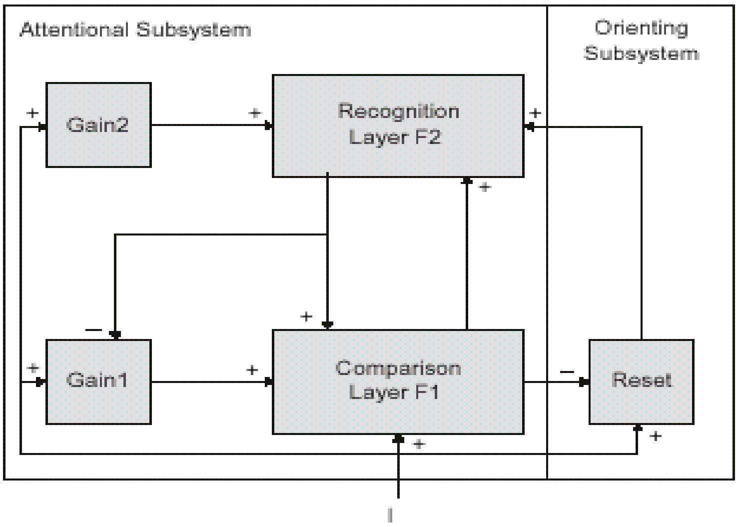

Figure.1: Basic units of the ART1 system

1) Input processing layer:
It is divided into two layers.

- Input portions – F1(a): Represents the given input vector
- Interface portion –F1(b): Exchanges the input portion signal with the F2 layer

2) Cluster units –F2 layer
This is a competitive layer. The cluster unit with the largest net input is selected to learn the input pattern. The activation of all other F2 units is set to zero. F1(b) is connected to F2 layer through bottom-up weights $b_{ij}$and F2 layer is connected to F1(b) layer by top down weightt$_{ij}$.

3) Reset Mechanism
Depending on the similarity between the top down weight and the input vector, the cluster unit is allowed to learn a pattern or not. This is done at the reset unit, based on the signals it receives from the input and interface portion of the F1 later. If the cluster unit is not allowed to learn, it becomes inhibited and a new cluster unit is selected for learning. It dictates the three possible states for F2 layer neurons; they are namely active, inactive and inhibited. The difference between the inactive and inhibited is that for both the cases activation state of F2 unit is zero. In its inactive state, the F2 neurons are available in next competition during the presentation of current input vector which is not possible when the F2 layer is inhibited.

B. ART1Algorithm
The binary input vector is presented to F1 (a) layer and is then passed on to F1 (b) layer. The F1 (b) layer sends signal to F2 layer over weighted interconnection path (Bottom-up weights). Each F2 unit calculates the net input. The node with the largest input is the winner and its activation state is 1. All the other nodes in F2 layer are considered to have activation state of 0 but not inhibited and the reset is true. The winning node of F2 layer alone is eligible to learn the input pattern. The signal is sent from F2 layer to F1 (b) through weighted interconnections which are top down weights. The activation vector X of the F1 (b) layer are considered to be active if they receive non-zero weights both from F1 (a) and F2 layer. The norm of the vector ||X|| renders the number of components in which the top-down weight vector for the winning unit (t_{ij}) and the input vector S are both 1. Depending upon the ratio of norm of x to norm of S □ □||x||/|| s|| □ , either the weights of the winning cluster units are adjusted or the reset mechanism is rescheduled. The whole process is repeated until either a match is found or all neurons in the F2 layer are inhibited.

Step1. Initialization of parameters and weights

L □ 1 & 0 □ □ ρ ≤1

$$0 < b_{IJ}(0) < \frac{L}{L - 1 + n}$$

Where n is the number of components in the input vector $t_{ij}(0)$ □ 1
For each training input
Step2. Activation states of all F2 neurons are set to zero and all F1 (a) neurons are assigned to the input vector S.
Step3. Computation of norm of S= (|| S||) $\sum s_i$

Step4. Sending signals from F1 (a) to F1 (b) layer x_i □ □s_i
For each F2 node that is not already inhibited
Step5. Calculation of net input of that particular F2 node provided the 'reset' is true.
$y_j = \sum (b_{ij} x_i)$
Step6. Finding highest y_j among all y_j's.
Step7. Re-computation of x of F1 (b) layer. x_i □ □st_{ij}
Step8. Computation of the norm of vector x= $||X|| = \sum x_i$
Step9. Test for reset, if $\{ \frac{||x||}{||s||} \} < \rho$ □ □ □ □ , the j^{th} node is inhibited

Continue from Step 5.If □ □ if $\{ \frac{||x||}{||s||} \} > \rho$

Step10.Updation of weights for node j,

$b_{IJ} = \frac{Lx_i}{L-1+||x||}$ & $t_{ji(new)}$ □ □x_i

- No change in top-down or bottom up weights.
- No reset
- Maximum number of epochs exceeded

Normalization of data matrix:
All the elements in the scaled matrix are lying between 0-1.
The linear scaling function for zero to one transforms a variable x_k into x^*_k in the following way:

$$x^*_k = \frac{\min(x_k)_{\text{for all j's}}}{\max(x_k)_{\text{for all j's}} - \min(x_k)_{\text{for all j's}}}$$

where, k and j are column and row of the data matrix respectively.

4. The Proposed Algorithm

Image representation is a fundamental concept in image processing. Bi-level image representation is the basic form to code image data. The contribution of the work in this paper is the novelty of combing Huffman algorithm of image compression with ART1 network for face recognition. The work done so far was represented in section II. The proposed Real Time Face Recognition (RTFR) technique consists of the following two main stages. The first stage is Huffman coding algorithm which codes face image data in a compact form to minimize the file size stored and converts it to a binary format suitable for input toART1 network. The second stage appliesART1 algorithm in order to recognize the face of the input vector (received from Huffman code words). The recognition time is very small with high Hit rate for preserved faces and new introduced faces, since ART has solved the stability–plasticity dilemma. Moreover the CPU time consumed for recognition in the RTFR algorithm is very low since ART1 has no memory and the calculations of resonance learning between the two layers are performed in parallel. The following subsections represent the two stages in details.

4.1 Feature Extraction (Huffman coding stage)

In this stage, we extended the Huffman coding scheme proposed in [29] to obtain a shape descriptor features and a compression method. Since the accuracy is very important in the face recognition process, the lossless integer to integer Huffman coding is used for producing the codeword or each face image. Huffman algorithm creates a code tree (called Huffman tree) on the basis of probability distribution. The algorithm starts by creating for each symbol a leaf node containing the pixel number symbol and its probability. The two nodes with the smallest probabilities become siblings under a parent node, which is given a probability equal to the sum of its two children's probabilities. The combining operation is repeated, choosing the two nodes with the smallest probabilities, and ignoring nodes that are already children. The two branches from every no leaf node are next labeled 0 and 1 (the order is not important). The actual codes of the symbols are obtained by traversing the tree from the root to the corresponding leaf nodes representing the symbols; the codeword is the result of the branch labels during the path from root to the leaf node. Figure 2 represents examples of the result codeword after applying the Huffman compression on three face images:

Codeword1 = 0 1 0 1 0 0 1 1 0 1 0 1 1 1 1 0 1 1 1 1 11 1 1 1 10 1 0 0 0 1 0 0
Codeword2 = 0 1 1 1 0 0 1 0 1 1 1 0 0 1 1 1 1 0 1 1 1 1 1 11 1 1 1 0 1 0 0 0 0
Codeword3 = 0 0 1 0 1 0 0 1 0 0 1 1 1 0 1 1 1 1 0 110 1 0 0 0 1 0 0 1 1 1 1 1

Figure 2: example of Huffman codewords

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4.2 Face recognition (ART1 stage)

The pseudo-code of the algorithm used for recognition is given in figure 3:

1- Take image
2- Apply histogram equalization function.
3- Apply Huffman coding function to produce codeword for the image file.
/*Applying ART1 for recognizing the image */
4- If ART1 recognizing image print card of image details
5- Else give alarm there is a new person
6- Stored the new image and the personal data or give alarm for security
7- Print the card details results file.
8- end

Figure 3: pseudo-code of recognition algorithm

5. Performance Analysis of the proposed RTFR algorithm to face recognition

5.1 Category of pictures: The performance of the algorithm was evaluated on two categories; live pictures taken on line from video camera and pictures from popular databases.

a- Live image acquisition: Capture equipment included professional digital video surveillance recorder and professional high-quality photo camera in a computer. The surveillance camera is installed in a room at the height of 2.25 m. The only source of illumination was an uncontrolled outdoor light, which came through two windows on one side. The surveillance camera is able to record in IR night vision mode as well. It was installed at a fixed position and focused on a chair on which participants are seated during shot capturing. Head pose should be as natural as possible.

b- Face database: Two popular face databases, ORL [8] and UMIST [13], are used to demonstrate the effectiveness of the proposed RTFR framework. The ORL database contains ten different images for 40 distinct persons. For some persons, the images were taken at different times, varying the lighting, facial expressions (open / closed eyes, smiling / not smiling) and facial details (glasses / no glasses) in the database of faces adopted (shown in Figure 4). All the images were taken against a dark homogeneous background with the persons in an upright, frontal position; the size of each image is 92x112 pixels, with 256 grey levels per pixel. This database was divided into two sets of 200 training patterns and 200 test patterns. The training database has the first 5 images of each person and the test database has the other images. The UMIST repository is a multiview database, consisting of 564 images of 20 people. Each covers a range of poses from profile to frontal views. Subjects cover a range of race/sex/appearance. Each subject exists in their own directory labeled 1a, 1b, ... 1t and images are numbered consecutively as they were taken. The files are all in PGM format, the size of each image is 92x112 pixels, with 256 grey levels per pixel.

Figure 4: Sample images processed with the algorithm

5.2 Results and Validation

5.2.1 Offline

The research has demonstrated the effectiveness of detecting faces using a view based approach implemented with ART1 neural network. It shows how to align training examples with one another and preprocess them to remove variation caused by lighting and camera parameters. To detect faces, each potential face region is classified according to its pose (front or side), and image plane normalizations are applied and improve contrast. The regions are passed through ART1neural network which classify it as known face or not-, and finally the results are arbitrated to give the final detection result.

Comparing the proposed algorithm with the most famous face recognition algorithms(PCA and Eigen faces), as shown in table 1,with varying degrees of sensitivity of the faces shows the validation of the new face recognition technique. It was able to detect between 96.88% and 98% of faces in a set of the above data base images. Depending on the application, the system can be made more or less conservative. The system has been tested on a wide variety of images, with many faces and unconstrained backgrounds as shown in tables 1and 2.

Table 1: Comparison between PCA, Eigen faces and the proposed RTFR algorithms for ORL image set

Algorithm name	Average CPU time for learnt faces (s)	Hit rate for learnt faces	Average CPU time for unlearnt faces	Efficiency of classifying unlearnt faces
PCA	3.15	81.57%	6.95	79%
Eigen faces	5.85	82.5%	9.15	62%
RTFR	0.065	98%	0.075	96.88%

Table 2: Comparison between PCA, Eigen faces and the proposed RTFR algorithms for UMIST image set.

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Algorithm name	Average CPU time for learnt faces (s)	Hit rate for learnt faces	Average CPU time for unlearnt faces (s)	Efficiencyof classifying unlearnt faces
PCA	4.62	80.5%	5.45	76%
Eigen faces	6.15	81.5%	7.65	61%
RTFR	0.072	97.89%	0.079	98%

In the experiments it is found that there are large obvious differences in time consumption when using these three methods in the recognition. Moreover, when a new sample is added, the time consumed for training the two other algorithms increases more and more with increasing the number of samples. In the proposed algorithm, RTFR, the time is changed with small value. For identification of objects with local features (eyes, nose, mouth, ears) in the image, it is not easy to determine the optimal number of clusters or categories in advance. In the proposed algorithm, finding meaningful recognition of the whole image face is based on the partial characteristics in the codeword of the regions. Hence, it takes less time and is more accurate in obtaining the optimal number of clusters in a target region.

5.2.2 On-line, Real time testing

The new proposed algorithm has been applied on different human faces for recognition in real time. We took ten different images of each of 10 distinct persons. The images were taken at different times, varying the lighting, facial expressions (open / closed eyes, smiling / not smiling) and facial details (glasses / no glasses). All the images were taken against a dark homogeneous background with the persons in an upright, frontal position as shown in figure 5.The size of each image is 92x112 pixels, with 256 grey levels per pixel. On the different images for the person, RTFR first applied a simple histogram equalization on one facial image and divided the facial image to 92*112 pixels. Huffman code algorithm was then applied which is systematically creating code word vector, which is the feature vector of the human face. Finally, ART1 was applied for face recognition

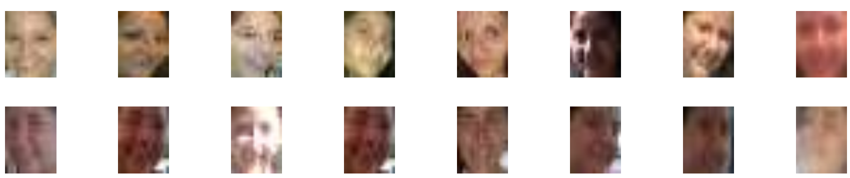

Figure 5: Sample images for one person are processed with the algorithm

Table 3: Comparison between PCA, Eigen faces and the proposed RTFR algorithms for real time image set

Algorithm name	Average CPU timefor learnt faces(s)	Hit rate for learnt images	Average CPU time for unlearnt faces (s)	Efficiency of classification of unlearnt faces
PCA	5.90	80.87%	7.15	74%
Eigen faces	6.85	81.5%	9.15	58%
RTFR	0.079	99%	0.086	98%

The new technique achieved between 98% and 99%hit rates in very short time for learnt faces and unlearnt faces respectively. From the results of the on line testing, it is found that there are large obvious differences in CPU utilization timesbetween the proposed algorithm and the other two; PCA and Eigen faces. Also, the efficiency of the algorithms in dealing with new images differs remarkably between the proposed algorithm and the other two.

6. Conclusions

In this paper, a new algorithm has been proposed for Real Time Face Recognition (RTFR). A new feature extraction method for face recognition has been proposed using the Huffman code. It is proven that the algorithm excels in performance regarding Hit rate and real-time with respect to other algorithms. Moreover, the RTFR model has a number of important advantages including: real time capability, self-stabilizing memory in response to arbitrarily many input patterns, fast adaptive search for best match of input-to-stored patterns, fast learning ability, variable error criteria which permits the variable regulation of category groupings, and successful retention of the stability and plasticity characteristics throughout the operational life of the system. Since the CPU time is shown to be extremely small, the algorithm is most suitable for use in emergency situations where recognition time is crucial to avoid the occurrence of a catastrophe. Such situations could be in the buildings which uses radiation materials or in nuclear power plants in cases of fire occurrence or radiation leakage where the speed of authorized people getting into their rooms is very critical.

References

[1]. Phil Picton, “Neural Networks”, Palgrave Macmillan, 2000.
[2]. Bicego, M.; Castellani, U.; Murino, V., "Using Hidden Morkov Models and Wavelets for Face Recognition", Proceedings of the Twelfth International Conference on Image Analysis and Processing, pp. 52-56, 2003.
[3]. Virenndra, P. Vishwakarma; Sujatha Pandey; Gupta, M. N. , "A Novel approach for Face Recognition using DCT Coefficients Re-scaling for Illumination Normalization", Proceedings of the Fifth International Conference on Advanced Computing and Communications, pp. 535-539, 2007.
[4]. Anjum, M. A.; Javed, M. Y.; Basit, A., "Face Recognition using Double Dimension Reduction,” International Journal of World Academy of Science, Engineering and Technology, vol. 4, pp. 43-46, 2005.
[5]. Byung-Joo Oh. "Face Recognition using Radial Basis Function Network based on LDA", Journal of Science Engineering and Technology, pp. 255-259, 2005.
[6]. Abbas, A.; Khalil, M. I.; M. I. Abdel-Hay, S.; Fahmy, H. M., "Expression and Illumination Invariant Preprocessing Technique for Face Recognition,” Proceedings of the International Conference on Computer Engineering and Systems, pp. 59-64, 2008.
[7]. Mahyabadi, M. P.; Soltanizadeh, H.; Shokouhi, Sh. B., "Facial Detection based on PCA and Adaptive Resonance Theory 2A Neural Network, Proceedings of the Joint Conference by International Journal on Medical Electronics and INTERTECH, session: ENG p501-022, 2006.
[8]. Gualberto Aguilar-Torres.; Gabriel Sanchez-Perez.; Mariko Nakano-Miyatake.; Hector Perez-Meana,“Face Recognition Algorithm using Discrete Gabor Transform, Proceeding of the International Conference on Circuits, Systems and Signals, pp. 227-233, 2008.
[9]. Paul Nicholl.; Abbes Amira, "DWT/PCA Face Recognition using Automatic Coefficient Selection", Fourth IEEE International Symposium on Electronic Design, Test and Applications, pp. 390-393, 2008.
[10]. Ziad, M. Hafed.; Martn, D. Levine, " Face Recognition using Discrete Cosine Transform", International Journal of Computer Vision, vol. 43, no. 3, pp.167-188, 2001.
[11]. Hazim KemalEkenel.; Rainer Stiefelhagen., " Local Appearance based Face Recognition using Discrete Cosine Transform", Proceeding of the Thirteenth Conference on European Signal Processing. 2005.
[12]. Imran, S. Bajwa.; ShahidNaweed, M.;Nadim Asif, M.; Iran Hyder, S., "Feature Based Image Classification by using Principal Component Analysis,” International Journal on Graphics, Vision, and Image Processing, vol. 9, issue 2, pp. 11-17, 2009.
[13]. QeetharaKadhim Al-Shayea.; MuzhirShaban Al-Ani.; MunaSuliman Abu Teamah, "The Effect of Image Compression on Face Recognition Algorithms", International Journal of Computer and Network Security, vol. 2, no. 8, pp. 56-60. Ramesha K et al. / International Journal of Engineering Science and Technology (IJEST), 2010 ISSN : 0975-5462 Vol. 3 No. 1 Jan 2011 502.
[14]. Yuehui Chen.; Shuyan Jiang.; Ajith Abraham, "Face Recognition using DCT and Hybrid Flexible Neural Tree, Proceedings of the International Conference on Neural Networks and Brain", pp. 1459-1463, 2005.

[15]. SarawatAnam.; Md. Shohidul Islam.; Kashem, M. A.; Islam, M. N.; Islam, M. R.; Islam, M. S., "Face Recognition using Genetic Algorithm and Back Propagation Neural Network", Proceedings of the International Multi Conference of Engineers and Computetr Scientists, vol. 1, 2009.

[16]. Zong, X. Lin,; Wei-Jyun Yang,; Chian, C.; Ho Chin-Song Wu., "Fast Vertical-Pose-Invariant Face Recognition Module for Intelligent Robot Guard", Proceedings of the Fourth International Conference on Autonomous Robots and Agents, pp. 613-617, 2009.

[17]. Abouzar, P.;Yousefi, S.; Setarehdan, S. K., "Hybrid WT Based-DCT Based Face Recognition", IEEE International Conference on Signal Processing and Communications, pp. 963-966, 2007.

[18]. Ronny Tjahyadi.;Wanquan Liu.; SvethaVenkatesh, "Application of the DCT Energy Histogram for Face Recognition", Proceedings of the Second International Conference on Information Technology for Application, pp.305-310, 2004.

[19]. Chengjun Liu, "Learning the Uncorrelated, Independent, and Discriminating Color Spaces for Face Recognition", IEEE Transactions on Information Forensics and Security, vol. 3, no. 2, pp. 213-222, 2008.

[20]. Yuchui Chen.; Yaou Zhao., "Face Recognition using DCT and Hierarchical RBF Model", Proceedings of the Seventh International Conference on Intelligent Data Engineering and Automated Learning, vol. 4224, pp. 355-362, 2006.

[21]. Anil Kumar Sao.; Yognannarayna, B, "Analytic Phase based representation for face recognition", Proceedings of the Seventh International Conference on Advances in Pattern Recognition, pp. 453-456, 2009.

[22]. FadiDornaika.; Bogdan Raducanu, "Three Dimensional Face Pose Detection and Tracking using Monocular Videos: Tool and Applications", IEEE Transactions on Systems, Man and Cybernetics-Part B: Cybernetics, vol. 39, no. 4, pp. 935-943, 2009.

[23]. Chao-kuei Hsieh, Shang-Hong Lai, Yung-Chang Chen, "Expression Invariant Face Recognition with Constrained Optical Flow warping, IEEE Transactions on Multimedia, vol. 11, no. 4, pp. 600-610, 2009.

[24]. Wen-Hui Yang.; Dao-Qing Dai, "Two Dimensional Maximum Margin Feature Extraction for Face Recognition, IEEE Transactions on Systems, Man and Cybernetics-Part B: Cybernetics, vol. 39, no. 4, pp. 1002-1012, 2009.

[25]. SatyanadhGundimada.; Vijayan, K. Asari, "Facial Recognition using Multisensor Images based on Localized kernel Eigen Spaces", IEEE Transactions on Image Processing, vol. 18, no. 6, pp. 600-610, 2009.

[26]. HongliangLi.; King, N. Ngan.; Qiang Liu., Faceseg: "Automatic Face Segmentation for Real Time Video", IEEE Transactions on Multimedia, vol. 11, no. 1, pp. 600-610, 2009.

[27]. Srinivas Nagamalla.; Bibhas Chandra Dhara, "A Novel Face Recognition Method using Facial Landmarks", Proceedings of the Seventh International Conference on Advances in pattern Recognition, pp.445-448, 2009.

[28]. Sidra BatoolKazmi.; Qurat-ul-Ain.; ArfanJaffar, M., "Wavelets Based Facial Expression Recognition using a Bank of Neural Networks", Proceeding of the Fifth International Conference on Future Information Technology, pp. 1-6, 2010.

[29]. k. salio, H. Mado, T.qtani, "Experiment studies with ahybrid model of unsupervised neural network", " Proceeding of the International Joint Conference on ANNS,USA,(2011).

[30]. M.Kandil, M.Salama;;(2009) " Optimization of ART1 Neural Networks using PSO for Fire Recognition", The Proceedings of the 2009 International conference on Image Processing, Computer Vision and Pattern Recognition, Volume II, Las Vegas, USA, 2009.

[31]. N. C. Kavuri and MadhusreeKundu, "ART1 Network: Application in Wine Classification" International Journal of Chemical Engineering and Applications, Vol. 2 , No. 3.,2011.