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Feature Extraction of Human Facail Expressions Using Haar Wavelet and Neural network

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Abstract

One of the challenging and active research topics in the recent years is Facial Expression. This paper presents the method to extract the features from the facial expressions from still images. Feature extraction is very important for classification and recognition process. This paper involve three stages which contain capture the images, pre-processing and feature extractions. This method is very efficient in feature extraction by applying haar wavelet and Karhunen-Loève Transform (KL-T). The database used in this research is from Cohen-Kanade which used six expressions of anger, sadness fear, happiness, disgust and surprise. Features that have been extracted from the image of facial expressions were used as inputs to the neural network to recognize the facial expression .The recognition rate in this research was 90.5%.

Keywords: Facial expressions, Haar wavelet, K-L Transform, Features extraction, Neural network**.**

استخلاص معالم تعابير وجه الانسان باستخدام تحويلات هار المويجيه والشبكه العصبيه الصناعيه

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الخلاصة:

واحدة من المواضيع البحثية الصعبة والفعاله في السنوات الأخيرة هو تعابير الوجه. تقدم في هذا البحث طريقة لاستخلاص معالم من تعابير الوجه من الصور الثابتة. عمليه استخلاص المعالم مهمة جدا في عمليه التصنيف والتمييز. وتتضمن هذه الدراسه مراحل والتي تحتوي على :التقاط الصور ،مرحله قبل المعالجه، مرحله استخلاص المعالم من اجل توظيفها في عمليه التمييز . هذه الطريقه فعالة جدا في استخراج ميزة من خلال تطبيق التحويل المويجي الهار ومن ثم استخدام تحويل KL–T تم الاختباربالاعتماد على قاعده بيانات كوهن –كاند لست تعابير هي الغضب والخوف والحزن، السعادة والاشمئزاز ومفاجأة. واستخدمت الميزات التي تم استخراجها من صورة تعبيرات الوجه كمدخلات في الشبكة العصبيه من اجل القيام بعمليه تمييز الاشخاص . حقق هذا النظام نسبه عاليه من تمييز الاشخاص وصل الى(90.5%).

1. Introduction

Facial expressions are the changes in response to a person's internal emotional states, intentions, or social communications. Facial expressions are known as the best way to identify the person and his reaction in different situation. Facial expressions are useful in determining the conceded emotions which are used to verify wither if the information provided is true or not. Today they are used in combat passport fraud, supporting legal enforcement, in identifying missing children and reducing identity fraud. Also used in the diagnosis of psychopathological stress level data, etc...

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In 1971, Ekman and Frisen discovered six different facial expressions include happiness, sadness, fear, disgust; surprise and anger along with neutral face [1]. Facial expression analysis refers to computer systems that attempt to automatically analyze and recognize facial motions and facial feature changes from visual information. The analysis of facial expression is conceder as a challenging task .as it is similar to so many factors that's make similar expressions looks completely aging, ethnicity, gender makes have a major effect on classification results ,but even when the person is the same [2]. The aim of this research is extract the feature from facial expressions images using Haar wavelet and KL-T in order to classification, and recognition the facial expression from face images.

2. Literature Review

Many researchers have been studies the subject of extraction facial features and using different techniques to extract the features from facial images as described below:

(Sidra Batool Kazmi, Qurat-ul-Ain, M. Arfan Jaffar, 2009)[3]. Introduced method for automatic facial expression recognition. Then the features are extracted by performing three level 2-D discrete wavelet. The resultant reduced feature set database, containing feature set of each image, is then used for classification. The JAFFE database for testing and images belonging to five classes (neutral, happy, sad, angry and surprise) have been considered. The testing is performed 100 times and the promising.

(Iman Makaremi and Majid Ahmadi, 2009)[4].The research present human face recognition technique, the feature extraction is based on wavelet coefficient. And Haar wavelet used for extract the features. The wavelet coefficients have been normalized between 0 and 1 for representation. Database includes 400 different pictures of 40 individuals. And the features represent input to the Hidden Markov Model (HMM).

(Ongalo P. N. Fedha, Huang Dong Jun & Richard Rimiru , 2012)[5]. This paper introduced a novel face expression recognition scheme based on Haar discrete wavelet transform and a neural network classifier .the proposed Experiments for evaluation were carried out on JAFEE database presenting the six facial expressions, 'angry', 'disgusting ،'fear', 'happy', 'sad', 'surprise' and the results that the proposed method can perform at 81% accuracy.

(Joyeeta Singha, Karen Das, 2013)[6]. This paper present method contain recognizing different hand gestures, the features of hand were extracted using K-L T technique and finally the input gesture was recognized using proper classifier. In this system, the tested for 10 different hand gestures.

(S. Adebayo Daramola Tiwalade Odu , Olujimi Ajayi, 2014)[7].This method involves decomposition of captured face image into four sub-bands using Haar wavelet transform thereafter shape and texture features are extracted from approximation and detailed bands respectively. Test results prove that the method is robust enough to reduce the effect of varying face pose for effective face recognition.

(Jyoti Chopra, Mandeep Singh, 2014)[8].This research introduced combined approach of Haar Wavelet transform and 1D Correlation coefficient for face recognition. Viola-Jones algorithm was a method for detect the face from background. ORL database was used in this paper, and used 390 images stored database for proceeding. System is more accurate to recognize the face at different poses and speedy.

3. Analysis the facial expression

Expression refers to the changes of a person as seen on his or her face; expression usually refers to the change of a visual pattern over time [9]. It is one of the most satisfactory biometrics, and it has also been the most widespread method of recognition that human uses in their visual interactions, [10]. Basic facial expressions which are typically recognized by psychologists are: happiness, sadness, fear, anger, disgust and surprise as in Figure-1. In terms of the natural interfaces between humans and computers, facial expressions open up an opportunity to communicate basic information regarding various needs and demands to the machine.

Figure 1- illustrate simples of facial expressions images.

The Facial Action Coding System (FACS) the brainchild of Ekman and Friesen in 1978 is recognized as the most comprehensive standard for describing facial expressions [10].

4. Feature extraction

Feature extraction means getting the distinguishable features from each facial expression shape [10]. The feature extraction is used to reduce the dimension of the face space by transforming it into feature representation [11. Wavelet domain is shown to provide a good match to the space-frequency characteristics of natural images. Its good localized time/frequency characteristics [12]. In the Figure-2 below the Haar wavelet applies a pair of low-pass and high-pass filters to image decomposition first in image columns and then in image rows independently. As a result, it produces four sub-bands as the output of the first level Haar wavelet. The haar wavelet separates an image into a lower resolution approximation image (LL) as well as horizontal (HL), vertical (LH) and diagonal (HH) detail components.

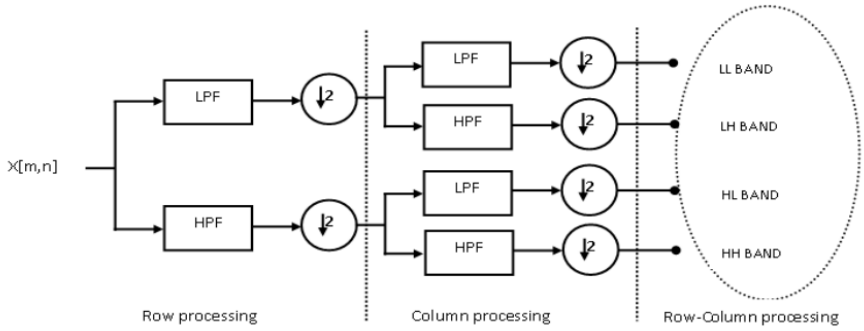

Figure 2- illustrate Decomposed Image using Haar wavelet transform [11].

The process can then be repeated to compute multiple scale wavelet decomposition, as in the three scales DWT [10].

$$\Psi(t) = \begin{cases} 1 & 0 \le t < 0.5 \\ -1 & 0.5 \le t < 1 \\ 0 & else \end{cases} \quad \textbf{(1)}$$

$$\Psi m,nn^{(t)} = 2^{-\frac{m}{2}}\Psi(2^{-m}t - n) \quad \textbf{(2)}$$

$$T = HFH \quad \textbf{(3)}$$

Where F is an N×N image matrix, H is an N×N transformation matrix ،and T is the resulting N×N transform. Then the Haar basis functions are:

$$\mathrm{h}_K(\mathrm{z}) = \mathrm{h}_{pq} = (\mathrm{z}) = \frac{1}{\sqrt{N}}, \mathrm{Z}\epsilon\,[0,1] \quad \textbf{(4)}$$

For the Haar transform ،transformation matrix H contains the Haar basis functions, h k (z). They are defined over the continuous, closed interval z ϵ [0, 1] for k=0, 1, 2, 3, N-1, where N=2n. To generate H, we define the integer k such that k=2p+q-1, where $0 \le p \le n-1$, q=0 or 1 for p=0, and $1 \le q \le 2p$ for $p \ne 0$.

The (KL-T) is defined as the linear transformation [13]. The Eigenvectors obtained using KL-T; it is a powerful tool for analyzing data and by reducing the number of dimensions [9]. KL-Transforms minimize the total mean squared error [7]. The KL-T theorem is random variables and the expansion basis depends on the process [13].

$$x = [\,x1, x2 \ldots xn]^{\,T} \quad \textbf{(5)}$$

$$[C]X = E[(X - M)(X - M)^{\,T}] \quad \textbf{(6)}$$

$$Y = [W]^{\,T} X \quad \textbf{(7)}$$

Were [C] represent covariance matrix, W= linear transformation matrix Xi which are the inputs of the matrix. Each column vector, wi, of [W] is a basis vector of the new space so the output Y can calculate as:

$$Y = W_i^{\,T} X \quad \textbf{(8)}$$

5. The proposed approach

Many steps to extract the features based on Haar wavelet transform which is orthogonal wavelet transform and KL-T.

- **Steps of proposed system**

1. Read the images from database.
2. Implement the sharp image using unsharpen mask with the radius 10 and the amount is 1.

3. Crop the region of interest from the images using cascade object detector and Resize the images to (300,300).
4. Implement median filter on the crop images.
5. Implement the discreet wavelet which separates the image to four part LL, LH, HL, and HH.
6. Implement the (KL-T) to fined highest eigenvector.
7. Chose the higher eigenvector in column (151).
8. Sort to the eigevector ascending. Take the higher 50 value which represent the features that input to the neural network.
9. Training of neural network.
10. Expression's recognition.The proposed approach is illustrated in Figure-3 which is contain

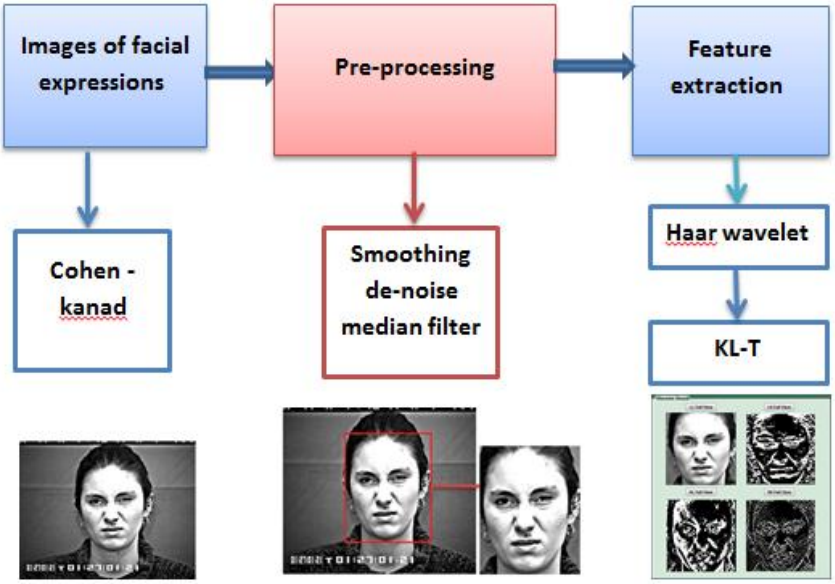

Figure 3- illustrate diagram for proposed system

- Database captures stages: cohn-kanade database for facial expressions used in implement system, it consist of 420 images which contain 10 person and 7 expressions and for each expression 6 images.
- Pre-processing stage: this stage contains the process that enhances the pictures detect the face and implement the median filter; Usefulness of the median filter is to improve the image and noise removal. After the procedure is adjusted to the image size (300 ×300) this process illustrate as in the Figure-4 below.

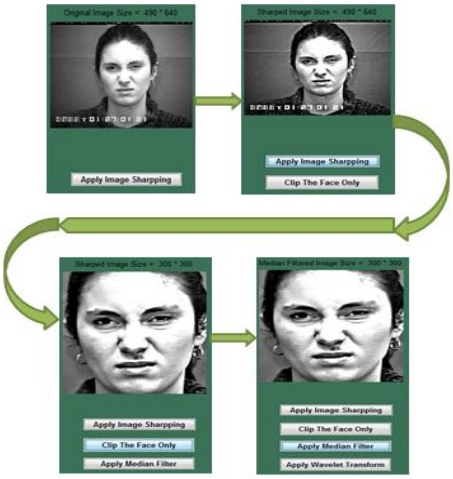

Figure 4- illustrate step of pre- processing

- Feature extraction stage: Haar Wavelet transform has been used to extract features of the reasons for that special type of transform that convert the frequency domain to the spatial

domain. The sub band LH represents the alterations in the image along horizontal directions. In the Figure-5 below has been split image after the Per-processing into four parts [14], [LL], [LH], [HL] and [HH].

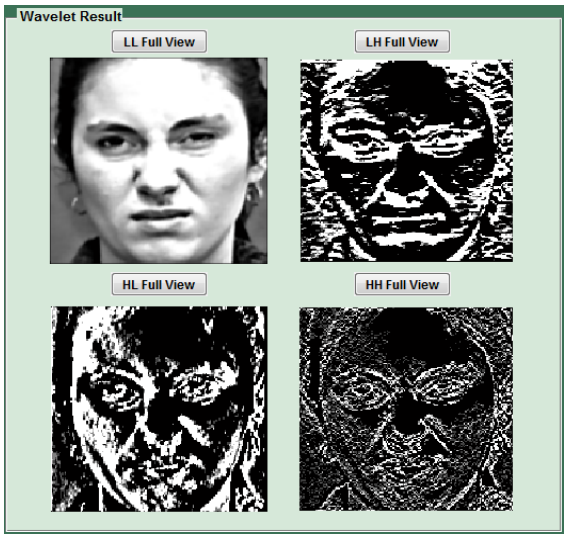

Figure 5- Decomposed Image using Haar Wavelet Transform

- Through the use of Haar wavelet transform to extract the features were extracted 50, used algorithm KL-T, which represents the principle components of the image, which represent each image Eigenvalues with their corresponding Eigenvectors, and then choose the column that value of 151 which is the highest value. This method have improved the classification process. KL-T is based on the grounds that it establishes a new coordinate system whose origin will be at the center of the object and the axis of the new coordinate system will be parallel to the directions of the Eigenvectors. One of the advantage of K-L transform is it can reduce the closely data.

Table 1- Samples of Features points of facial expressions for one person

	X1	Y1	X2	Y2	X3	Y3	X4	Y4	X5	Y5	X6	Y6	X7	Y7	X8	Y8
1	106	116	73	41	108	41	107	117	82	41	104	125	78	117	89	125
2	87	118	63	123	80	123	79	126	23	95	12	117	88	116	88	118
3	75	116	74	118	67	101	149	101	148	43	102	94	8	118	65	101
4	146	127	22	103	149	116	73	123	80	102	149	97	1	117	74	123
5	86	117	63	67	148	87	10	118	61	115	81	116	65	103	145	97
6	67	87	11	116	61	67	149	115	64	42	118	95	10	93	7	96
7	83	45	120	94	6	93	65	95	10	53	107	98	12	53	108	53
8	85	97	1	43	111	63	67	54	44	95	8	63	82	43	119	43
9	65	115	92	105	145	41	109	56	42	41	106	105	150	105	148	115
10	146	55	110	55	101	97	10	114	68	116	62	98	9	114	70	100
11	8	115	61	53	103	114	66	116	59	128	24	116	56	113	91	116
12	110	115	58	8	143	114	67	96	9	56	47	106	147	55	107	57
13	70	113	68	114	69	115	61	112	93	97	11	42	117	122	2	41
14	97	112	98	112	96	57	44	106	146	115	61	112	99	57	43	41
15	100	112	94	107	150	43	124	113	66	51	111	51	110	41	112	114
16	54	111	66	41	117	111	56	53	106	41	110	124	76	41	106	42
17	2	114	71	116	87	114	80	42	109	93	9	116	64	66	146	115
18	85	115	62	116	60	116	63	104	146	43	113	114	72	104	149	103
19	2	116	64	45	106	116	60	115	84	115	75	117	60	116	75	115
20	64	104	145	116	88	114	70	45	106	44	108	115	87	94	2	114

The above table represents features for facial expressions images for one person for six expressions. It can be illustrated by the top 50 highest values that represent the green color through the Figure-6.

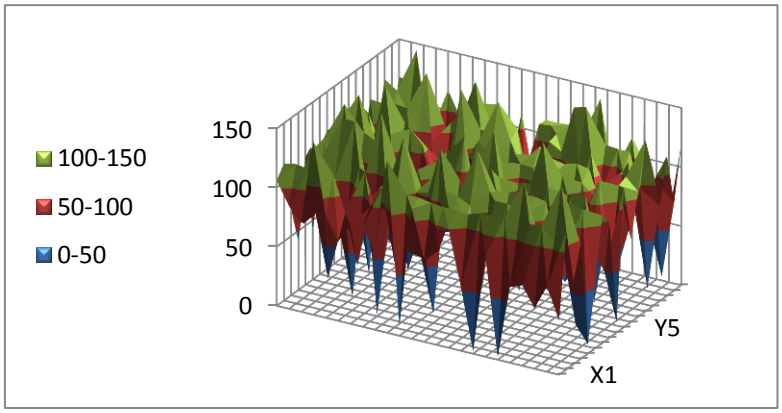

Figure 6- illustrate the highest values

- Recognition of facial expressions stage
  The one neural network was multi perceptron MLP which is used to learning. The initial network had a three hidden layer with six neurons in each, and was trained. The outputs of these networks classified the data into seven different expressions viz. neutral, angry, disgust, fear ،happy, sad, and surprised. The general classification system consisted of many stages [15].
- Step 1: Set initial values of the weights randomly after each iteration, weights should be adjusted to minimize the error. If the output is correct the weights are not changed
- Step 2: calculate the actual outputs of the neurons in this stage is working under the hidden layer
- Step 3: If the output is correct the weights are not changed but if the output incorrect the weights w_i are changed
- Step 4: Increase iteration and repeat the process until the selected error criterion is satisfied [14].

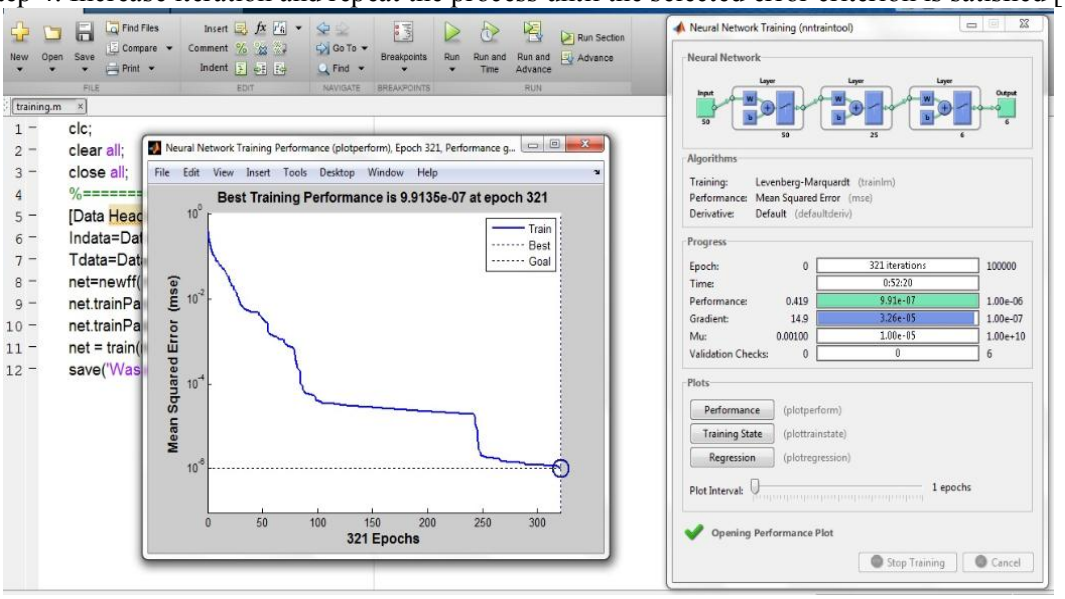

Figure 7- Results of neural network

6. Experimental results

By using Haar wavelet only for extract of features the percentage of recognition was 84.7 %. The average facial expression recognition of proposal method (Haar wavelet- Karhunen-Loève Transforms – Neural Network) is 90.5 %. In a Figure-8 explain the comparison between recognition rates.

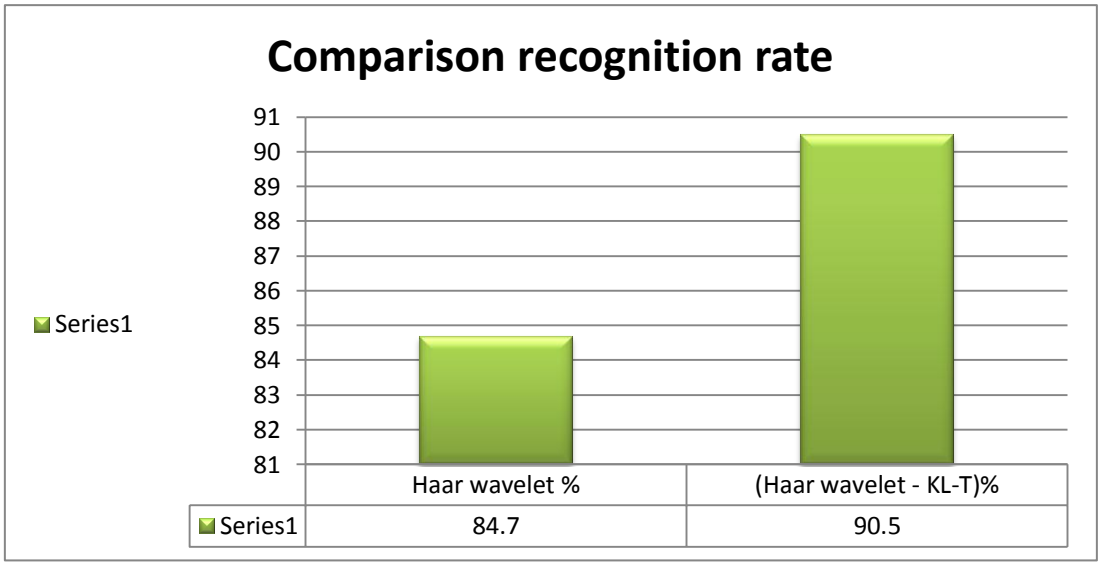

Figure 8- Recognition rates

	(Haar wavelet - KL-T)%	Haar wavelet %
Recognition rate	**90.5**	**84.7**

7. Conclusions

The proposed method was used hybrid approach by implement the Haar wavelet transform to extract 50 point center in the facial expressions images, and The Karhunen–Loève transform (KL-T) where it was obtain the best features of a data set of images by selecting the 50 highest point and then determine eigenvectors and arranged in ascending order and choose the best features. Thes features are representing input for neural network to recognize the facial expressions. Cohn–Kanade database used in this research by using 420 images. This method improved the process of choosing features and thus improved the process of recognition and classifying expressions the face. The recognition rate is 90.5%.

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