Feature Extraction of Human Facail Expressions Using Haar Wavelet and Karhunen-Loève Transforms

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ISSN: 2231-8852

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 KL-T. Cohn-kanade 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.

Keywords: Facial expressions, Haar wavelet, K-L transform, features extraction

1. Introduction

Facial expression known to be the best way to identify the person and his reaction in different situation .Facial expression is useful in knowing the conceded emotions which are used in verify wither if the information provided is true or not. Today it is used in combat passport fraud, supporting legal enforcement, in identifying missing children and reducing identity fraud. Also it's also used in the diagnosis of psychopathological stress level data and so on. Facial expressions are the facial changes in response to a person's internal emotional states, intentions, or social communications. In 1971, Ekman and Frisen discovered six different facial expressions include happiness, sadness, fear, disgust, surprise and anger along with neutral face (Tanvi Sheikh, Shikha Agrawal, 2012). 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 (Chulhee Lee, David Landgrebe, 2009).The aim of this research is extract the feature from facial expressions images using Haar wavelet and KL-t hat can be embedded within classifiers.

This paper is organized as follows. The previous related works are discussed in presented in section 2. In section 3, the analysis of the facial expression has been presented. The process of features extraction is described in section 4. Section 5 explains the details process of the proposed approach. Lastly, the conclusion of the paper has been reported in section 6.

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. This section reports the previous work related to facial feature extraction proposed in the literature. The work in (Sidra Batool Kazmi, Qurat-ul-Ain, M. Arfan Jaffar, 2009) introduces a method for automatic facial expression recognition. The process of feature extraction starts 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 result is promising.

The work in (Iman Makaremi and Majid Ahmadi, 2009) proposed a human face recognition technique that extracts the feature based on wavelet coefficient. 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).

Furthermore, the work presented in (Ongalo P. N. Fedha, et al., 2012) 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) presents a method contain recognizing different hand gestures, the features of hand were extracted using K-L Transform technique and finally the input gesture was recognized using proper classifier. In this system, the tested for 10 different hand gestures and recognizing rate obtained was 96%.

The work in (S. Adebayo Daramola Tiwalade Odu , Olujimi Ajayi, 2014) proposes a 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.

Lastly, (Jyoti Chopra, Mandeep Singh, 2014) 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 of 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 (Suja , Shikha Tripathi and Keerthana, 2013). 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 (Muhammad Hameed Siddiqi and Sungyoung Lee, 2013). Basic facial expressions which are typically recognized by psychologists are: happiness, sadness, fear, anger, disgust and depicted 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. 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 ((Muhammad Hameed Siddiqi and Sungyoung Lee, 2013).

Figure 1: Samples of simple facial expressions images

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 (Sangeeta Narsing Kakarwal, 2012). Wavelet domain is shown to provide a good match to the space-frequency characteristics of natural images. Its good localized time/frequency characteristics (Miryala Chandra Mohan, 2010).

The Haar wavelet applies a pair of low-pass and high-pass filters to image decomposition first in image columns and thenin image rows independently are demonstrated in Figure 2. As a result, it produces four sub-bands as the output of the first level Haar wavelet (Sangeeta Narsing Kakarwal, 2012). 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.

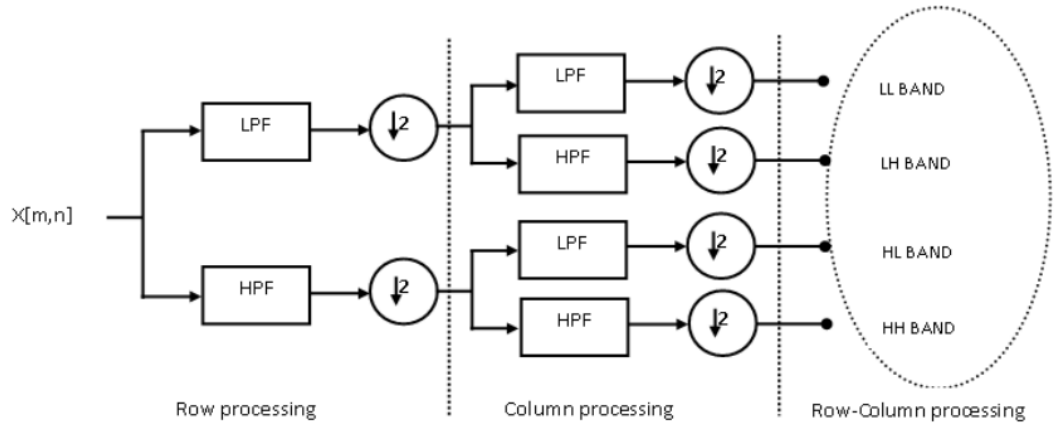

Figure 2: Decomposed Image using Haar wavelet transform.

The process can then be repeated to compute multiple scale wavelet decomposition, as in the three scales DWT (Miryala Chandra Mohan, 2010).

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

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

$$T = HFH \ldots\ldots\ldots (3)$$

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

$$h0(z) = h00(z) = \frac{1}{\sqrt{N}}\ , Z\epsilon[0,1] \ldots\ldots (4)$$

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 $p \neq 0$.

The Karhunen-Loève transform (KLT) is defined as the linear transformation (Dony, R.D., 2001), the Eigen vectors obtained using K-L Transform, KL-T is a powerful tool for analyzing data and by reducing the number of dimensions (Suja , Shikha Tripathi and Keerthana, 2013). KL-Transforms minimize the total mean squared error (Adebayo Daramola Tiwalade Odu & Olujimi Ajayi, 2014). The Karhunen–Loève theorem is random variables and the expansion basis depends on the process (Dony, R.D., 2001).

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

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

$$Y = [W]^{T} X \ldots\ldots (7)$$

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:

$Y = W_i^T X$ …….. (8)

5. The Proposed Approach

There are many steps need to be performed in order to extract the features based on Haar wavelet transform which is orthogonal wavelet transform and KL-Transform. The details steps of the proposed approach are explain as follow:

5.1 Steps of proposed approach

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 Karhunen-Loève transform (KLT) 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. The proposed approach is illustrated in Figure 3 which is containing the details process flow of facial feature extraction process.
9. 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.
10. 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 Figure 4.

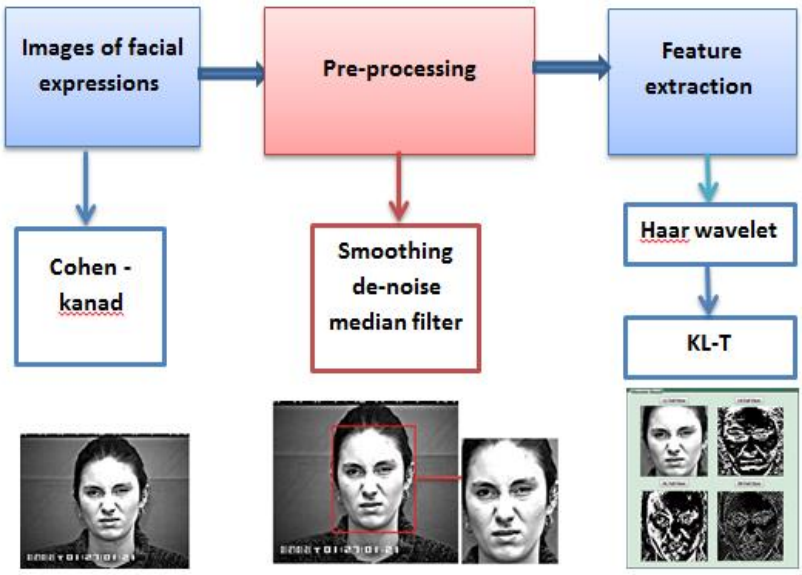

Figure 3: The details process flow diagram of the proposed approach

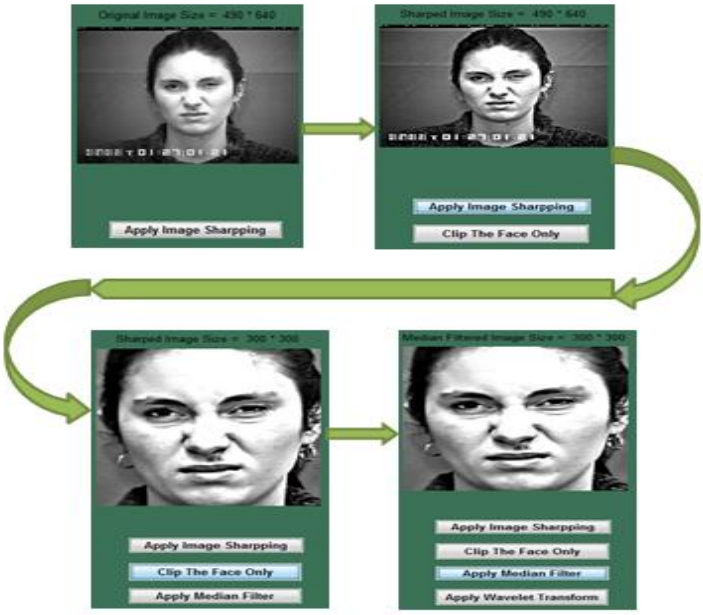

Figure 4: illustrate step of pre- processing

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 Figure 5 demonstrates the image after the Per-processing into four parts and applied to work on (LH) (Prachi Agarwal & Naveen Prakash, 2013).

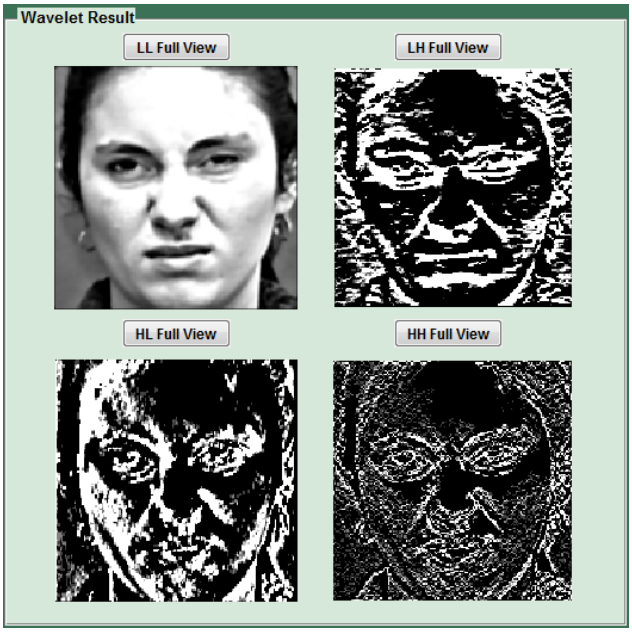

Figure 5: Decomposed Image using Haar Wavelet Transform

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 Eigen Value has Eigen Vector, and then choose the column that value of 151 which is the highest value. This method was a method to improve the process of extract of features. 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 Eigen vectors. The result of use KL-T illustrate in Figure 6.

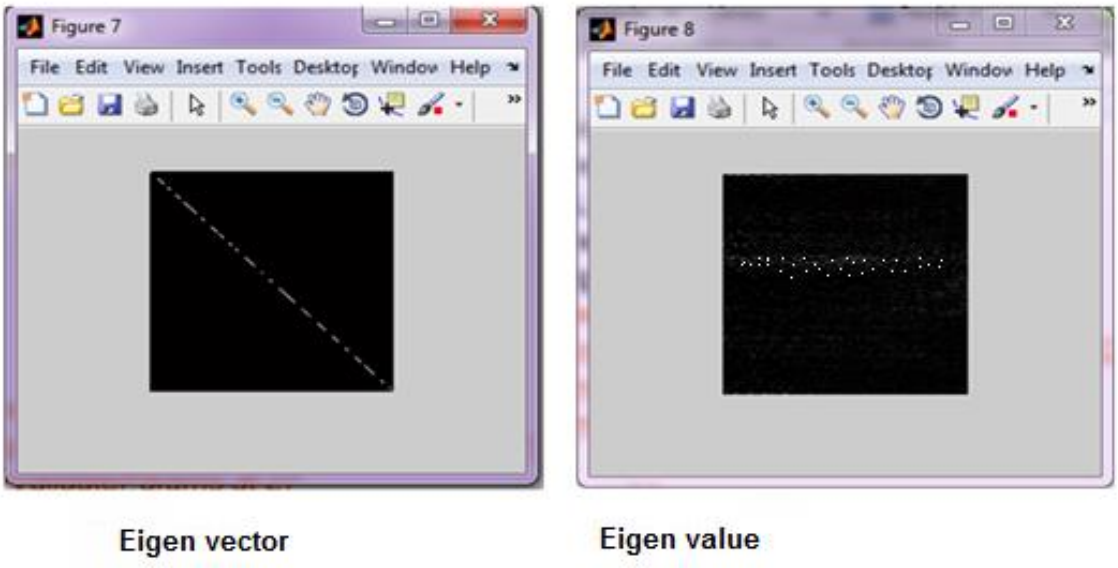

Figure 6: Sample of Eign vector and Eign value

One of the advantage of K-L transform is it can reduce the closely data. Table 1 presents 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 Figure 7.

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
21	68	115	78	54	43	54	44	114	82	95	10	87	11	52	102	114
22	51	117	78	116	81	118	66	116	73	119	65	55	41	117	70	66
23	72	105	148	128	22	115	81	66	49	54	113	116	79	97	8	96
24	46	117	70	97	8	53	108	97	9	118	70	106	145	117	81	118

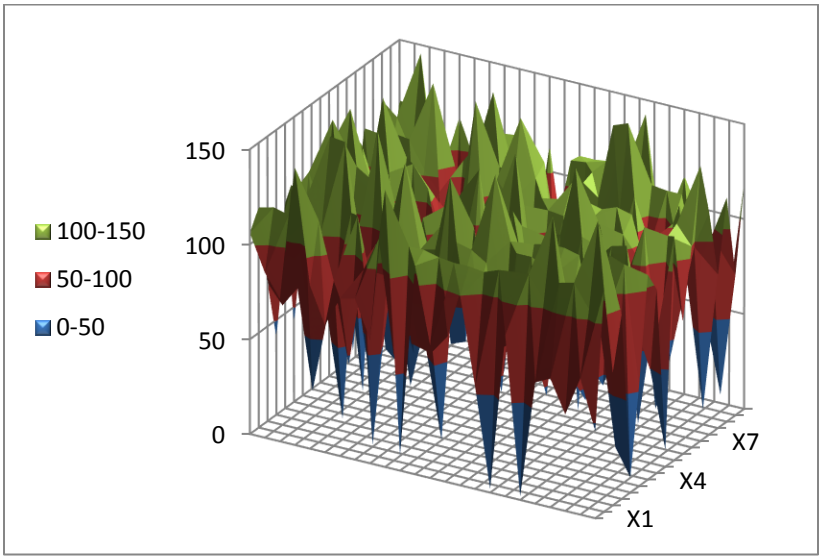

Figure 7: The top 50 highest values represent green color

6. Conclusion

In this paper a facial feature extraction method has been proposed. The proposed method used hybrid approach by implement the haar wavelet transform to extract 50 point center in the facial expressions images, and The Karhunen–Loève (KL-T) where it was obtain the best features of a data set of images by selecting the 50 highest point and then determine eigenvector and arranged in ascending order and choose the best features. Cohn–Kanade database used in this research. This method improved the process of choosing features and thus improved the process of classifying expressions the face.

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