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Implementation of Statistical Techniques for recognition of Eye Expressions

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ABSTRACT

Eye expressions play an important role for facial expression recognition. From last decade facial expression has been focused on human emotion recognition. This research attempts to present recognition of an eye expression using statistical approach. The performance of the system calculated on the basis of covariance matrix. The technique found to be efficient to recognize Happy, Disgust, Surprise, Anger and Neutral expression. The 80% accuracy is achieved on well known Paul Ekman facial expression database.

Key Words: Action Units (AUs), Covariance, Facial Action Coding System (FACS), Standard Deviation.

I. INTRODUCTION

Human faces express different emotions in the form of verbal and non verbal communication. Faces allow us to recognize a person's identity but moreover they carry extent information about a person's emotional state [1]. The face is one of the important components of human being which recognize different emotions such as happy, sad, anger, surprise, disgust and fear as interpreted by the Ekman and Friesen. The said expressions are considered to be six basic expressions [2].

Facial Action Coding System (FACS) is a system for measuring and describing one or more facial movements and is based on the anatomy of the human face, and codes expressions in terms of component movements, called "action units" (AUs). Ekman and Friesen developed the Facial Action Coding System (FACS) in 1977 to describe facial expressions by action units (AUs) [3]. The database consist of 44 FACS AUs, where 30 AUs are related to the contractions of specific facial muscles: 12 are for upper face, 18 are for lower face. AUs can occur either singly or in combination.

The rest of paper is organized into six sections, section 1 explains introduction, section 2 deals with related work, section 3 focuses on use of database, section 4 describes steps of proposed methodology, section 5 covers experimental results and section 6 explain conclusion followed by references.

A) Facial Action Coding System and Facial Expressions

Facial Action Coding System (FACS) is a method of measuring facial activity in terms of facial muscle movements [4] and it is the leading method of measuring facial movement in behavioral science [5]. Facial expressions are the result of one or more facial movements. FACS also provides the rules for AU detection on face image. A human coder decomposes facial expressions in terms of 49 component based movements, which roughly corresponds to the individual facial muscles. Table 1 below describes the upper facial action units recognized with muscular behavior.

Table 1: Upper facial action units with their Muscular behavior

AU Number	Facial Action Name	Muscular behavior
1	Inner brow raiser	Frontalis (pars medialis)
2	Outer brow raiser	Frontalis (pars literalis)
4	Brow lowerer	Depressor glabellae, depressor supercilii, corrugators supercilii
5	Upper lid raiser	Levatorpalpebraesuperioris
6	Cheek raiser	Orbicularis oculi (pars orbitalis)
7	Lid tightener	Orbicularis oculi (pars palpebralis)

II. RELATED WORK

The various techniques have been used for recognition of facial expressions, all techniques extract distinct information and uses number of steps for recognition [5, 6, 19, 21, 22, 24, 25]. Most of the work considered full frontal face for analysis. The system was able to code with 20 action units with support vector machine [7]. Similarly Gabor filters and Support Vector Machine based system for 18 AUs found to be efficient to produce accuracy of 95% [8]. Gabor wavelet and geometric features based system achieved 96% accuracy for classifying twelve facial actions [9, 10].

An Automatic Face Analysis (AFA) system for analyzed the facial expression with recognition of upper face and lower face resulted in 96.4% and 96.7% respectively [11]. Similarly [1][12] based on three modules: facial feature point tracking, dense flow gradient component detection using PCA and high gradient component detection model for recognizing upper face and lower face using HMM. A novel method for Facial Expression Recognition System, analyzed facial expression by haar classifiers, skin detection, feature extraction, feature points tracking, and emotions are classified with the help of Support Vector Machine, achieved 60% accuracy [13].

The uses of statistical method have been described by most of the researchers for face recognition. The statistical method for recognizing the face, by calculating Eigenvectors of Covariance matrix using Row mean and column mean achieved 99.60% and 80.60% of recognition rate [14]. Automatic facial recognition system using Eigen face, PCA and Jacobi's method, considered the Eigen value and Eigen vectors for classification of facial action using Back propagation Neural Network [4, 15, 16, 17]. Method based on Eigen value Decomposition using action unit approach and expression identification rate was 80% and 100% for four and two people respectively [18]. A fully automatic framework is developed to analyze facial action units, with the help of upper facial muscle movements using two dimensional principle component analysis (2DPCA) [19]. A system based on Support Vector Machines recognized higher accuracy of 69.3% for individual action unit and 62.5% for combination AUs [5].

The Canny Edge detector is used to localize the face images [20]. Active Appearance Model (AAM) [21] [22] can also be used to classify expressions [23].

The fusion approach is also implemented for the recognition of facial expression. Hidden Markov Model (HMM) with Neural Networks is useful for novel accurate classifier which recognizes AU and intensity variations of expression [24]. The Support Vector Machines (SVM) and Hidden Markov Model (HMM) classifier is implemented to model time which gives improved classification accuracy [25].

I. DATABASE SELECTION

Images are tested from the commonly known database - Paul Ekman's Facial Expression database (FACS database), which contains more than 1100 image sequences containing over 150 distinct actions or action combination [26]. The database considered 24 subjects, which includes 12 males and 12 females (ages ranged from 19 to 61 years). The database contains facial expressions such as Happy, Disgust, Anger, Surprise and Neutral. From the database, 10 images (two images of each expression) are considered as training set and similarly 10 images as testing set.

II. IMPLEMENTATION OF STATISTICAL TECHNIQUES

From the selected database, input image is resized with same dimension for training and testing. We have concentrated on upper facial part that is left and right eye together to recognize the expression. The applications of statistical techniques such as mean, standard deviation and covariance used for recognition described in Fig. 1. The performance of system calculated on the basis of covariance matrix.

The significance of mean is to identify the central location of the data and used for measure of variability depends upon the data points that is they may be very close, very far or equal to the mean, then standard deviation will be small, large or 0 respectively. Similarly, covariance measures the degree to which two variables change or vary together (i.e. co-vary). The variables are positive if they vary together in the same direction, if one variable tends to be above its expected value and the other is below, then the covariance between the two variables is negative. If there is no linear dependency between the two variables, then the covariance is 0.

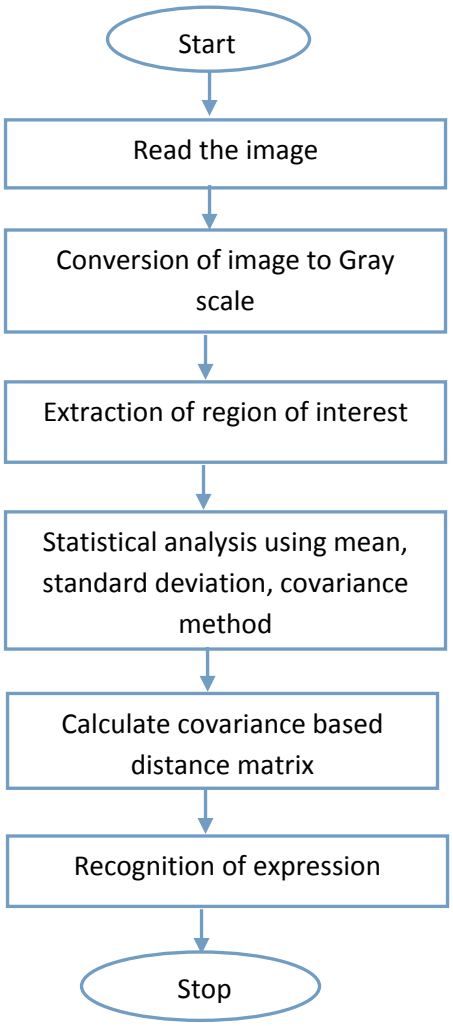


Figure 1: Flow diagram for facial expression recognition.

III. EXPERIMENTAL ANALYSIS

This work has become first approach towards recognition facial expression on the basis of ROI selected image. For this experiment we selected 20 training and testing images having anger, disgust, happy, neutral, surprise emotions. The labeling of the training images and expression are described in Table 2. The Table 3 describes covariance based expression recognition for anger. The covariance based distance matrix is described in Table 4.

Table2: Labeling of the training images and expression.

Training Sample	Emotion
X1	Anger
X2	Anger
X3	Disgust
X4	Disgust
X5	Happy
X6	Happy
X7	Neutral
X8	Neutral
X9	Surprise
X10	Surprise

Table 3: Covariance based expression recognition for Anger images.

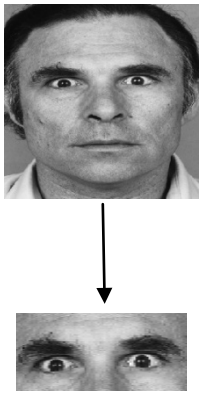
Testing		Training	
		Training Sample	Covariance
		X1	2.23
		X2	**0.76**
		X3	4.12
		X4	5.58
		X5	2.94
		X6	4.48
		X7	3.89
		X8	3.18
		X9	2.53
		X10	4.96
		Minimum value	**0.76**
Mean: **142.36**	STD: **16.02**	Recognized Expression	**Anger**

Table 4: Covariance based distance matrix

Testing set	Training Set	X1 Anger	X2 Anger	X3 Disgust	X4 Disgust	X5 Happy	X6 Happy	X7 Neutral	X8 Neutral	X9 Surprise	X10 Surprise
	Y1 Anger	**1.15**	1.44	7.7	10.54	5.56	8.46	7.34	6.00	4.78	9.37
	Y2 Anger	2.23	**0.76**	4.12	5.58	2.94	4.48	3.89	3.18	2.53	4.96
	Y3 Disgust	6.67	6.36	**4.33**	46.46	24.53	37.31	32.38	26.48	21.09	41.29
	Y4 Disgust	8.44	5.44	22.34	**4.15**	15.96	31.93	21.07	22.66	18.05	26.87
	Y5 Happy	6.16	7.53	8.28	11.21	**5.91**	9.00	7.81	6.38	5.68	9.96
	Y6 Happy	9.47	14.50	24.30	32.89	17.36	**4.41**	22.92	18.74	14.93	29.22
	Y7 Neutral	18.42	13.95	21.33	28.86	**5.24**	23.18	20.11	16.45	13.10	25.65
	Y8 Neutral	10.18	10.72	9.29	12.58	6.64	10.10	8.77	**7.17**	5.71	11.18
	Y9 Surprise	19.01	8.14	9.77	10.04	10.55	6.84	9.73	5.37	**0.47**	0.93
	Y10 Surprise	9.42	13.96	21.40	28.96	15.29	**3.25**	20.18	6.58	13.14	25.73

IV. RESULTS AND CONCLUSION

Eyes carry major part of expression. Through this experiment we attempt to recognize the expression using eyes only. The technique used resulted in providing 80% of recognition rate. The research can be extended to improve the recognition rate by implementing various other techniques. It is assumed that if the recognition rate of component of face is increased it will result in enhancing the recognition rate of full face.

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