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HUMAN EMOTION RECOGNITION USING THERMAL IMAGE PROCESSING AND EIGENFACES

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ABSTRACT

As peoples use body language or non-verbal language such as gesture and facial expression in communication; computers will also be able to communicate humans .In the digital era, there are various computational models are already exist for recognition of different facial expressions (Happy, Sad, Disgust, Angry and neutral) but we are trying to propose a computational model of facial expression recognition of thermal face images using Principal component analysis (eigenfaces for feature extraction) and distance classifier. In this paper, novel framework for thermal image processing presented of facial expression recognition can improve the performance of facial expression recognition.

Keywords: Facial expression, thermal image processing, PCA and eigenfaces.

1. INTRODUCTION

In order to increase the user-friendliness and to design the dialogue flow in a more natural way, the subject of this thesis is centered around adaptive SLDS with particular focus on facial expression recognition.

Facial expression contains abundant human behavior information, and it is the most direct behavior of body feel. Studying and analyzing expression of face will guide to know the internal emotion of the human and human health situation, mental disabilities etc. Sometimes human cannot express their but from face we can judge the feelings of human.

1.1 Thermal Imaging

Thermal imaging technology has long been in use in specialized law enforcement and military applications. We can also used thermal imaging for recognition different expression of human face which can further useful for catching emotional state of the person. Now a day's thermal camera has taken much popularity.

In the light of above situation, we are proposing a computational model for face recognition is quite difficult because faces are complex, multi-dimensional and meaningful visual stimuli. Although face recognition is a high level visual problem, there is a quite a bit of structure imposed on the task. We therefore focused our research towards developing a computational model for human facial expression recognition using eigenfaces of thermal image of face

2. BACKGROUND STUDY

In order to interact socially, we must be able to process human faces in diversity of ways. There is vast amount of literature on cognitive psychology attesting capabilities of human at identifying faces. Most of work to date has been on facial expression recognition like Happy, sad, disgust, angry and neutral with the different parameter like EEG (Electroencephalography), ECG (Electrocardiography) and GSR (Galvanic skin response). Walker- Smith [1], investigated recognition for facial identity, expression, and orientation in a successive face comparison task. 10 females (aged 18-31 yrs) made same-different judgments about pairs of face photographs that could differ in any one of these respects. Overall recognition performance for identity alterations was superior to that for expression and orientation changes.

Ekman and Paul [2], presented Cross-cultural research on facial expression and the developments of methods to measure facial expression are briefly summarized. Yamada [3], two experiments involving a total of 128 college students studied the recognition of facial expression of emotions through the movement of facial features and the relationships between those movements. Leonardo Trujillo [4], presented an algorithm for discriminating the facial expression by using eigenfaces for feature extraction and support vector machine for classification. Irene Kotsia[5], In this paper, novel methods for facial expression recognition in facial image sequences are presented. By the using candied grid nodes to face landmark depicted and SVM classifier that are used to recognize the six facial expression.

Guotai Jiang [6], The Author has completed the automatic calculation of area, girth, circularity and angles, which supposed to be the parameter vector of interesting region of different expression. Y.Yoshitomi [7], have presented a method with thermal image processing by measuring the local temperature-difference between the averaged neutral and the unknown expression faces and Neural Network classifier to be used for the classification. Zhaoyu Wang [8], proposed a spontaneous facial expression recognition method by using feature-level fusion of visible and thermal infrared facial images, K-Nearest Neighbors classifier used for classification. Yasunari Yoshitomi [9], presented to recognize the emotional expressions of human by the voice and face ,for the voice they have trained the system with HMM of different expressive voice samples and or the facial expression, they used features parameters from thermal images in addition to visible images and trained with NN for recognition. Ying Zilu [10], presented a Novel approach to facial expression based on the combination of Non-negative Matrix Factorization (NMF) and Support Vector Machine (SVM). A recognition rate of 66.19% was obtained. In the light of the above literature review it can be concluded that classification of human facial expression which is mentioned above is not yet present with thermal image of faces. This research is attempts to build classifier which will able to calculate the distances of facial feature of expressive face from the neutral face.

3. RESEARCH METHODOLOGY

In this study, thermal image of human face were produced by two ways either from thermal camera or we can change manually by converter. We have used the eigenfaces approach to extract the features of the faces and by using the PCA ,we can go for the dimensionality reduction as we know that high dimensionality can prove the system inaccurate .A computational model which has been high dimensionality will generally have poor predictive performance.

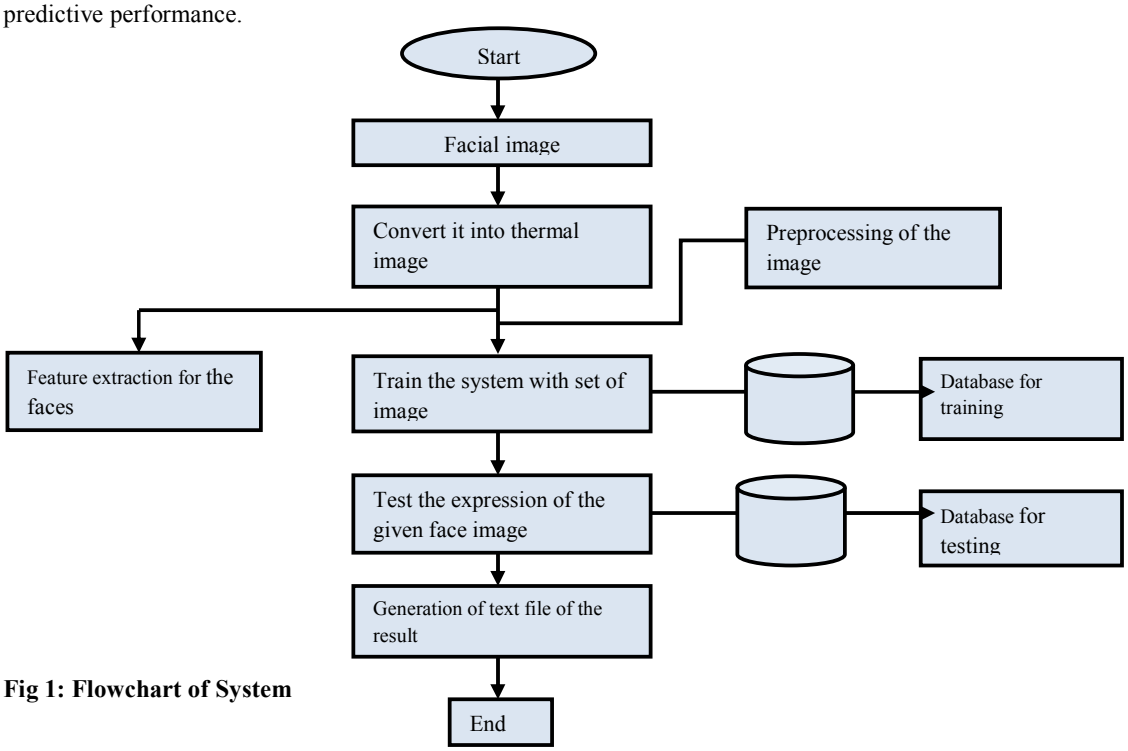

Fig 1: Flowchart of System

3.1 The Eigen faces Approach

The idea of using eigenfaces was motivated by a technique developed by Sirovich and Kirby (1987) for effective representing picture of faces using principal component Analysis. Starting with an ensemble of original face images, they calculated a best co-ordinate system for image compression. The eigenfaces approach suggested to us that an information theory approach of coding and decoding face images may give insight into the information content of face images emphasizing the significant local and global features.

In the language of information theory, we want to extract the relevant information in a face image, encode it as efficiently as possible, and compare one face encoding with a database of models encodes similarly.

In the world of Mathematics, we try to find the principal components of the distribution of faces or eigenvectors of the covariance matrix of the set of thermal face images. Each image location contributes more or less to each eigenvector, so that we can display the eigenvector as sort of ghostly face which we call an eigenfaces

A simple approach to extracting the information contained in an image of a face is to somehow capture the variation in a collection of face images, independent of any judgment of feature and use this information to encode and compare individual face images.

Principal Component Analysis (PCA): Seek directions in which it is more efficient to represent the data. This is particularly useful for reducing the computational effort. To understand this, suppose we get 60 such directions, out of these about 40 might be insignificant and only 20 might represent the variation in data significantly, so for calculations it would work quite well to only use the 20 and leave out the rest. This is illustrated by this figure:

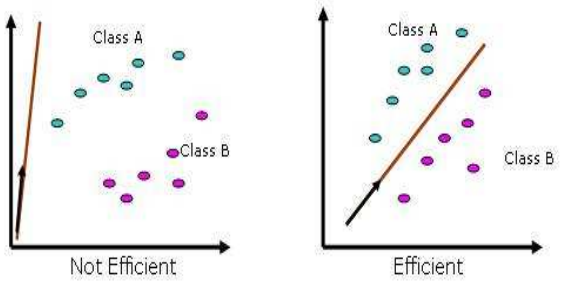

Fig 2: Demonstration of PCA

3.2 Steps of the recognition process

1. Initialization: Acquire the training set of face images and calculate the eigenfaces, which define the face space.
2. When a new face image encountered , calculate a set of weights based on input
3. Determine if the image is a face at all (whether known or unknown) by checking to see if the image is sufficiently close to “face space”
4. If it is a face, classify weight pattern as either a known person or as unknown person.

Each face image in the training set can be represented exactly in terms of a linear combination of eigenfaces. The number of possible eigenfaces is equal to the number of face images in the training set; however the faces can also be approximated using only the “best” eigenfaces-those that have the largest eigenvalue, and which therefore account for the most variance within the set of face images

3.3 Calculating of eigenfaces

Let a face image I(x, y) be a two dimensional N by N array of intensity values or a vector of dimension.

A typical image of size 256 by 256 describes a vector of dimension 65,536 or equivalently a point in 65,536 dimensional spaces.

The following steps for calculating eigenfaces for different facial expression:

a) Collect a set of characteristics of different facial expression of individuals. This set should include number different types of facial expression.

b) Calculate matrix L .find its eigenvector and eigenvalue and choose the M' highest eigenvectors with the highest associated eigenvalue.

c) Combine the normalized training set of images $\mathbf{U}_l$ according to the below given equation;

$$\mathbf{u}_l = \sum_{k=1}^{M} \mathbf{v}_{lk} \mathbf{\Phi}_k, \qquad l = 1, \ldots, M$$

Figure3 a). Thermal image of "Happy" Expression of human.
b) Eigenface of thermal image.

3.4 Classification of facial expression using eigenfaces

Once the eigenfaces are created by eigenfaces algorithm, identification becomes a pattern recognition task. The eigenfaces span an M' dimensional subspace of the original N^2 image space, the significant eigenvectors of the L matrix are chosen as those with the largest associated eigenvalue.

3.5 Distance Classifier

Now each face in the training set (minus the mean), $\Phi_i$can be represented as a linear combination of these Eigenvectorsu_i:

$\Phi_i = \sum_{j=1}^{K} w_j u_j$m, where u_j's are Eigenfaces.

These weights can be calculated as:

$$w_j = u_j^T \Phi_i$$

Euclidean Distance: The Euclidean Distance is probably the most widely used distance metric. It is a special case of a general class of norms and is given as:

$$\|x - y\|_e = \sqrt{|x_i - y_i|^2}$$

4. RESEARCH EXPERIMENTS AND RESULTS

Facial expression recognition is one of the most challenging tasks in area of affective computing. Affective computing is a branch of Artificial Intelligence that relates to, arises from, or deliberately influences emotion and other affective phenomena.

To access the viability of this approach to facial expression recognition we have performed experiments with stored faces images and built a system to locate and recognize expression of faces in dynamic environment .we first created a dataset of different subject of expression.

Using this dataset we have conducted several experiments to assess the performance. Statistics were collected measuring the mean accuracy as a function of the difference between the training condition and the test condition; the system achieved approximately 97% correct classification.

Fig 4: Sample of our dataset

Table 1: Demonstration of Result

//Test Image	Distance From Neutral	Expression	Best Match
Image001.jpg	14035	happy	Image001.jpg
Image002.jpg	14962	happy	Image002.jpg
Image012.jpg	15670	happy	Image012.jpg
Image013.jpg	14022	happy	Image013.jpg
Image014.jpg	13186	disgust	Image014.jpg
Image015.jpg	12187	disgust	Image015.jpg
Image016.jpg	11943	disgust	Image016.jpg
Image029.jpg	12308	anger	Image029.jpg
Image030.jpg	12002	anger	Image030.jpg
Image031.jpg	15748	anger	Image031.jpg
Image032.jpg	8619	anger	Image032.jpg
Image041.jpg	12049	sad	Image041.jpg
Image042.jpg	13485	sad	Image042.jpg
Image043.jpg	14128	sad	Image043.jpg
Image044.jpg	7888	neutral	Image044.jpg
Image045.jpg	7356	neutral	Image045.jpg
Image049.jpg	7395	neutral	Image049.jpg
Image050.jpg	9850	neutral	Image050.jpg

5. DISCUSSION

In this paper, it is reported that experiments using only facial features which is extracted from PCA and find out the distance between neutral images and expressive. We tried to design a database as close as possible to the real situation of our application. Along the recordings and subsequent experiments, we came across the fact, that we cannot expect pure neutral emotion in our target application.

People do not speak neutral to pets, and actually … do people speak neutral at all? That's an open question, whose answer is strongly related to the specific situation, in our case, to the final application. Facial expressions are very contingent upon the environment. They are not the same at home, in a party, or at the office. Therefore, an emotional database reflecting the real situation is a crucial factor. For the proposed method, we have used some standard database and own created dataset and achieved better accuracy.

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