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International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 3 Issue 5 May, 2014 Page No. 5714-5716

Facial Emotion Detection using Eigenfaces

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Abstract

Humans can accurately interpret and analyze an expressed emotion, which is a hindrance for any machine or computer. This project, under the Machine Vision, aims at designing a system that detects and successfully recognizes human emotions without any human intervention. It makes use of Eigenfaces to quantify the test and training image database into appropriate vectors. It uses principal component analysis of the images of the faces reducing the dimensionality of the training set, converting only those features that are critical for face recognition into Eigen vectors.

Keywords

Feature extraction, Facial expressions, Eigenfaces, training and testing images database

I. Introduction

The " Facial Emotion recognition by Eigen faces " aids in the development of a system that aspires to efficiently classify the emotions displayed by subjects in static images into the six most basic and easily recognizable images, which include: Neutral, Anger, Happiness, Sadness, Surprise and Disgust. The ultimate objective is to design a software that analyzes emotions expressed by subjects on a real-time basis and instantaneously provides an estimation of the individual's state of mind, on the basis of his expressed emotions. This software will have extensive and wide-spread uses in fields such as security, hospitality, law-enforcement etc.

II. Working

System Flow:

The system consists of a database comprising of still images, which are later segregated as the Training images and Test images database. The database images are all acquired of a single subject, under optimum and invariant lighting conditions. The images gathered, pertain to the standard emotions of happiness, anger, sadness, disgust, surprise and neutrality.

1. Image acquisition

An 8 MP (eight megapixel) camera, incorporated within a mobile phone is used for the purpose of taking snapshots of the subject under fixed lighting conditions. Our approach deals with the face recognition and emotion detection by calculation of eigen vectors. A pre-requisite for this method is that, the subject must be photographed under uniform lighting conditions, besides there should be negligible change in the subject's posture and orientation. Frontal shots of the subject are essential for accurate and explicit results.

Fig.(i) Original images

The images obtained are split into two distinct databases: Training images and Test images database.
On an average nearly 40-50 images were part of the Training image database and the Testing images database comprised of nearly 20-25 images.

For the processing of the images our preferred choice was the software platform: Matlab (version R2009b). Matlab provides a number of varied and versatile functions, that cater to various many-fold applications. We primarily made use of the Matlab Image Processing Toolbox, that aided in the processing and feature extraction of our images. We made use of a self-generated database, comprising of images taken of our colleague.

2. Preprocessing Stage

The images are passed through the trainer to detect facial region. This is done with the aid of YCrCb color-space, that lends a predetermined threshold for skin region detection. It is only after this is accomplished that we can proceed with the face-cropping algorithm. Subsequently, gray-scale conversion and histogram equalization of the image is done to ensure uniformity of the garnered images.

Fig. (ii) Preprocessed and Cropped Facial Images

After this point, Eigen vector of the image is calculated. The pixels constituting an image are then concatenated to form a new vector, each image of the database corresponds to a value in the vector. Average values of the vectors are then computed. They are subtracted from the mean Eigen vector and Covariance matrix is subsequently generated. Eigen vector of the covariance matrix is derived, which is better known a Eigenface. Eigen values pertaining to the maximum value of the assessed Eigenfaces are zeroed upon. These form the basis of future calculations and feature extraction.

When the test images are loaded, the same process is carried out on them. Namely, the face region detection and subsequent cropping. The image vector is then imposed on the generated Eigenface. Euclidean distance of the images are evaluated, and then correlated. Neutral face expressions is considered as a citation point, once the Eigenfaces of the test images are procured.

If neutral image is discerned, then it is connoted. Otherwise the Euclidean distance that denotes the difference between the emotions is displayed and the correct expression is zeroed down upon.

The Eigen values corresponding to each expression are distinct, that eases the identification process. At the time of initializing the code a text file which is a pointer file that acts as a label for the images, is stored in the Training images folder. When the result is generated on the basis of each input image, we take the help of the Label file to categorize each image.

Eigenfaces: significance

Eigen faces are preferred as they correlate various feature points of the face as one single unit. In contrast with the FACS approach, the face is never split into relevant action units. This eases the process of analysis and recognition. But a significant drawback of this system is that any minor occlusion of the face, or any variation in camera angles is unacceptable. Also a slight variation is intolerable as there is

a drastic reduction in efficiency of the system. Adequate lighting conditions also need to be maintained. Besides only full-frontal images are preferred, even a 20 percent variation from frontal imaging position leads to an appreciable degradation in quality.

III. Results

On offering the Test images to the trainer, the efficiency was needed to be ascertained. The efficiency of our system for various sets of images was analysed, and it was seen that the efficiency usually varied between 85 to 95 percent.

The following emotions are successfully detected from the Test images:

- Neutral
- Happiness
- Sadness
- Anger
- Disgust
- Surprise

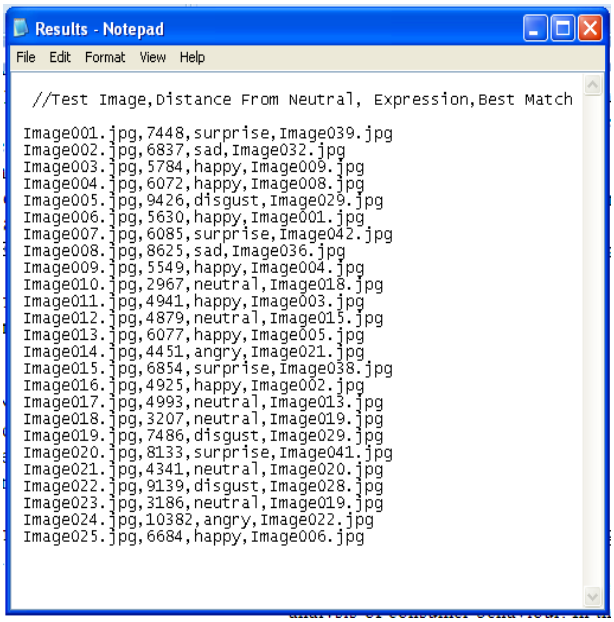

Fig.(iii) Results Generated

The above figure shows the final result generated containing a list of the Test images, the calculated Euclidean distances after comparison of the Test and Training images and the Training images bearing the best match from the above mentioned emotions. The Euclidean distance is computed, citing a Neutral expression as the reference point.

IV. Applications

The applications of facial emotion detection are many-fold and having ultimately anthropological significance. It is of particular importance in the fields of law-enforcement, security, analysis of consumer behaviour and hospitality. In the future, these systems would be preferred, when operating on a real-time basis having live-feed. This would herald a whole new field in human-computer interaction.

V. References

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