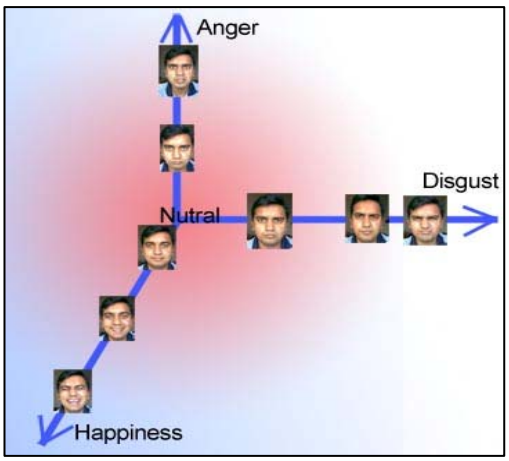
Eigenfaces for Expression Detection



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Introduction: In this project, Eigenfaces[1] are used to classify facial expression. It has been assumed that, facial expression can be classified into some discreet classes (like anger, happiness, disgust or sadness) whereas:

1. Absence of any expression is the "Neutral" expression
2. Intensity of a particular expression can be identified by the level of its "dissimilarity" from the Neutral expression

Representing facial expressions in this way has several advantages. **Firstly**, several kinds of expressions can be represented using only two types of information (**1.** class that an expression belongs to and **2.** intensity of the expression). The picture illustrates such idea where three axes represents three expressional classes and the distance from origin (Neutral) represents the intensity. **Secondly**, it is possible to identify an expression as a mixture of two or more expressions (such as 60% anger, 20% disgust and 20% sad etc.). Although in the current project there is no provision for such multiple expression, but it is possible to easily add this provision.

Picture Database: Since the main purpose of this project is facial expression recognition (Not face detection), therefore, the sample pictures are taken under special consideration to ease up the face detection process. Each picture is taken under the condition that, only face is the largest skin colored continuous object in the frame. There are two sets of pictures. One is used for training purpose and another is used for testing. The training pictures are located into the ".\Images" Folder. Cropped versions of these images are placed into the ".\Images\Cropped" folder. Every picture in this set is sorted in an ascending order of expressional intensity. The pictures are classified in the following expressional classes:

1. Image001 to Image013 = Happy
2. Image014 to Image024 = Disgust
3. Image025 to Image034 = Anger
4. Image035 to Image043 = Unhappy
5. Image044 to Image050 = Neutral

Another image set is used for testing purpose. These images are taken in quite an arbitrary fashion. It also includes some expressions that are not contained in the training set like "Surprise" (Image004) and "Confused" (Image005). The original images of this set are located in the ".\Images\Test" folder and a cropped version is located in ".\Images\Test_Cropped ". The MATLAB file "Crop_Face.m" performs the face detection and cropping task for both test sets. It utilizes the file "detect_face.m" for detection of face using skin color detection system [2] [3]. The file "Main.m" always uses the cropped versions to perform expression recognition process.

Toolboxes Required:

1. Image Processing Toolbox (For Resizing Image)
2. Statistics Toolbox (For PCA)

Algorithm: This project utilizes Eigenface[1] as a method of classifying facial expression. Firstly, the train images are utilized to create a low dimensional face space. This is done by performing Principal Component Analysis (PCA) in the training image set and taking the principal components (i.e. Eigen vectors with greater Eigen values). In this process, projected versions of all the train images are also created. Secondly, the test images also are projected on the face space – as a result, all the test images are represented in terms of the selected principal components. Thirdly, the Euclidian distance of a projected test image from all the projected train images are calculated and the minimum value is chosen in order to find out the train image which is most similar to the test image. The test image is assumed to fall in the same class that the closest train image belongs to. Fourthly, in order to determine the intensity of a particular expression, its Euclidian distance from the mean of the projected neutral images is calculated. The more the distance - according to the assumption - the far it is from the neutral expression. As a result, it can be recognized as a stronger the expression.

References:

1. M. Turk and A. Pentland, "Eigenfaces for Recognition", Journal of Cognitive Neuroscience, March 1991
2. Tolga Birdal, Simple Face Detection, http://www.mathworks.com/matlabcentral/fileexchange/23382
3. Yu-Ting Pai, Shanq-Jang Ruan , Mon-Chau Shie, Yi-Chi Liu , "A Simple And Accurate Color Face Detection Algorithm In Complex Background", Low Power Systems Lab, Department of Electronic Engineering, National Taiwan University of Science and Technology, No.43, Sec.4, Keelung Rd., Taipei, 106, Taiwan, R.O.C. E-mail: sjruan@mail.ntust.edu.tw