

FACE DETECTION AND FACIAL EXPRESSION RECOGNITION SYSTEM USING 2DPCA

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Abstract: Face Detection and Facial Expression Recognition System from image is a popular topic in biometrics research. Facial expressions not only to express our emotions but also to provide important cues during social interactions such as level of interest, our desire to take a speaking turn and to provide continuous feedback on the understanding of the information conveyed. Identification and classification of emotions by computers has been a research area. Recognition algorithm is used to classify given images with known structured properties, which are used commonly in most of the computer vision applications. The goal of this project is to design and implement the facial expression Detection and recognition system. On a basis of the extensive study of different approaches to the problem of face action representation, appropriate algorithms are selected for each stage of a system. This 2DPCA algorithm can be easily implemented in any programming language on a digital computer. 2DPCA algorithm is found to be very accurate and more effective. The actual advantages of 2DPCA face based identification over other biometrics are uniqueness and acceptance. As human face is a dynamic object having high degree of variability in its appearance, that makes face detection a difficult problem in computer vision. In this field, accuracy and speed of identification is a main issue.

Keywords: human face, Two Dimensional Principal Component Analysis, Eigen values, effectiveness and accuracy.

I. INTRODUCTION

Face plays significant role in social communication. This is a 'window' to human personality, emotions and thoughts. According to the psychological research nonverbal part is the most informative channel in social communication. Verbal part contributes about 7% of the message, vocal – 34% and facial expression about 55%. Due to that, face is a subject of study in many areas of science such as psychology, behavioral science, medicine and finally computer science. Over the last few decade lots of work done in facial Expression detection and recognition as it's a best way for person identification because it doesn't require human cooperation, so that it became a hot topic in biometrics. Since lots of methods are introduced for detection and recognition which considered as a milestone. Although these methods are used several times for the same purpose separately for limited number of datasets in past but there is no work found who provides overall performance evaluation of said methods altogether by testing them on tough datasets details of

datasets will be provided. In the field of computer science much effort is put to explore the ways of automation the process of face detection and segmentation. Several approaches addressing the problem of facial feature extraction have been proposed. The main issue is to provide appropriate face representation, which remains robust with respect to diversity of facial appearances. Face recognition system is a complex image-processing problem in real world applications with complex effects of illumination, occlusion, and imaging condition on the live images. It is a combination of face detection and recognition techniques in image analyzes. Detection application is used to find position of the faces in a given image. Recognition algorithm is used to classify given images with known structured properties, which are used commonly in most of the computer vision applications. These images have some known properties like; same resolution, including same facial feature components, and similar eye alignment. These images will be referred as "standard image" in the further sections. Recognition applications uses standard images, and detection algorithms detect the faces and extract face images which include eyes, eyebrows, nose, and mouth. That makes the algorithm more complicated than single detection or recognition algorithm. The first step for face recognition system is to acquire an image from a camera. Second step is face detection from the acquired image. As a third step, face recognition that takes the face images from output of detection part. Four step is person identity and final step as a result of recognition part. An illustration of the steps for the face recognition system is given in Fig 1.1.

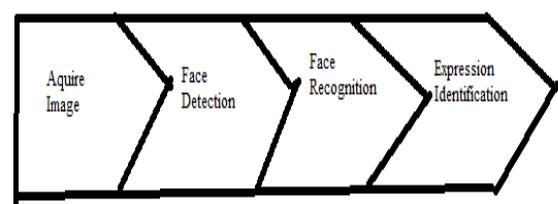


Figure.1 Steps of Face Recognition System Applications
Methods for face detection and recognition systems can be affected by pose, presence or absence of structural components, facial expression, occlusion, image orientation, imaging conditions, and time delay (for recognition). Available applications developed by researchers can usually handle one or two effects only; therefore they have limited capabilities with focus on some well-structured application. A robust face recognition system is difficult to develop

which works under all conditions with a wide scope of effect. There is an important problem in applying the above mentioned methods which we should take into account, however. In the PCA-based face recognition technique, the 2D face image matrices must be previously transformed into 1-D image vectors [4], and the resulting image vectors of faces usually lead to a high-dimensional image vector space. Obviously, it is difficult to evaluate the covariance matrix accurately due to its large size and the relatively small number of training samples. On the other hand, the matrix to- vector transform may also cause the loss of some useful structural information embedding in the original images. To overcome the problems, a straightforward image projection technique, called two-dimensional principal component analysis (2DPCA), is developed by Yang et al. [12] for image feature extraction. As opposed to the conventional PCA, the 2DPCA is based on 2-D matrices rather than 1-D vector; that is, the image matrix does not need to be previously transformed into a vector. Instead, an image covariance matrix can be constructed directly using the original image matrices. In contrast to the covariance matrix of the PCA, the size of the image covariance matrix using the 2DPCA is small. As a result, the 2DPCA has two important advantages over the PCA. First, the size of covariance matrix using the 2DPCA is much smaller, so it is easier to evaluate the covariance matrix accurately. Second, the 2DPCA computes the corresponding eigenvector more quickly than that of the PCA, so less operation time is required [11]. However, there is an important problem in applying 2DPCA method which should be mentioned. In the 2DPCA model, the mean matrix, which is generally estimated by the class sample averages of all training samples, is used to character the total scatter matrix, so the average of training samples plays a critical role in the construction of the total scatter matrix and finally affects the projection directions of the 2DPCA. In addition, the problem of machine recognition of human faces continues to attract researchers from disciplines such as image processing, pattern recognition, neural networks, computer vision, computer graphics, and psychology. In identification problems, the input to the system is an unknown face, and the system reports back the determined identity from a database of known individuals, whereas in verification problems, the system needs to confirm or reject the claimed identity of the input face. The solution to the problem involves segmentation of faces (face detection) from cluttered scenes, feature extraction from the face regions, recognition or verification. Robust and reliable face representation is crucial for the effective performance of face recognition system and still a challenging problem. Feature extraction is realized through some linear or nonlinear transform of the data with subsequent feature selection for reducing the dimensionality of facial image so that the extracted feature is as representative as possible. PCA is a useful statistical technique that has found application in fields such as face recognition and image compression, and is a common technique for finding patterns in data of high dimension. PCA is a powerful tool for analyzing data [7].A

straightforward image projection technique, called two-dimensional principal component analysis (2DPCA), is developed for image feature extraction. As opposed to conventional PCA, 2DPCA is based on 2D matrices rather than 1D vectors. That is, the image matrix does not need to be previously transformed into a vector. Instead, an image covariance matrix can be constructed directly using the original image matrices. In contrast to the covariance matrix of PCA, the size of the image covariance matrix using 2DPCA is much smaller. As a result, 2DPCA has two important advantages over PCA. First, it is easier to evaluate the covariance matrix accurately. Second, less time is required to determine the corresponding eigenvectors.

II. LITERATURE REVIEW

HISTORY

Face recognition is a biometric approach that employs automated methods to verify or recognize the identity of a living person based on his/her physiological characteristics. In general, There are numerous possible applications for facial image processing algorithms. The most important of them concern face recognition. In this regard, one has to differentiate between closed worlds and open world settings. In a closed world application, the algorithm is dedicated to a limited group of persons, e.g. to recognize the members of a family. In an open world context the algorithm should be able to deal with images from "unknown" persons, i.e. persons that have not been presented to the system during its design or training. For example, an application indexing large image databases like Google images or television programs should recognize learned persons and respond with "unknown" if the person is not in the database of registered persons [18]. Concerning face recognition, there further exist two types of problems: face identification and face verification (or authentication). The first problem, face identification, is to determine the identity of a person on an image. The second one only deals with the question: "Is „X“ the identity of the person shown on the image?" or "Is the person shown on the image the one he claims to be?". These questions only require "yes" or "no" as the answer. The databases used in developing face recognition systems rely on images of human faces captured and processed in preparation for implementing the recognition system. The variety of information in these face images makes face detection difficult. For example, some of the conditions that should be accounted for, when detecting faces are:

- Occlusion: faces may be partially occluded by other objects
- Presence or absence of structural components: beards, mustaches and glasses
- Facial expression: face appearance is directly affected by a person's facial expression
- Pose (Out-of Plane Rotation): frontal, 45 degree, profile, upside down
- Orientation (In Plane Rotation): face appearance directly varies for different rotations about the camera's optical axis
- Imaging conditions: lighting (spectra, source

distribution and intensity) and camera characteristics (sensor response, gain control, lenses), resolution

- Facial feature extraction (for local face recognition)
1. To detect the presence and location of features such as eyes, nose, nostrils, eyebrow, mouth, lips, ears, etc
 2. Usually assume that there is only one face in an image
- Human pose estimation and tracking

III. PROPOSED METHODOLOGY

The goal of this project is to design and implement the Face Detection and Facial expression recognition system. On a basis of the extensive study of different approaches to the problem of face action representation, appropriate algorithms are selected for each stage of a system.

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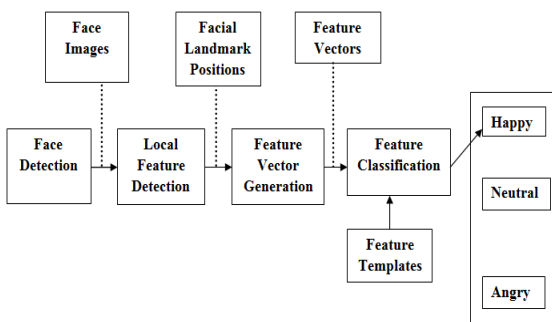


Figure. 2: Generalize model of Automatic Facial Expression Recognition System

2DPCA Face Recognition Model

Normally, the PCA-based face recognition methods, the 2D face image samples usually have been transformed into 1D image vectors by some technique like concatenation. 2DPCA model is a method that uses the 2D features, which are features obtained directly from original vector space of a face image rather than from a vectorized 1D space.

The steps of 2DPCA face recognition model are given below.

- Acquire face images to form a training set (X_1, X_2, \dots, X_N)
- Extract features using 2DPCA for each training sample and each testing sample.
- Classify and recognize the image.
- Give the result of recognition.

IV. APPLICATION

A. Application of Face Detection

Face recognition is used for two primary tasks:

- Verification (one-to-one matching): When presented with a face image of an unknown individual along with a claim of identity, ascertaining whether the individual is who he/she claims to be.
- Identification (one-to-many matching): Given an image of an unknown individual, determining that person's identity by comparing (possibly after encoding) that image with a database of (possibly encoded) images of known individuals.

There are numerous application areas in which face recognition can be exploited for these two purposes, a few of which are outlined below.

- Security (access control to buildings, airports/seaports, ATM machines and border checkpoints; computer/ network security; email authentication on multimedia workstations).
- Surveillance (a large number of CCTVs can be monitored to look for known criminals, drug offenders, etc. and authorities can be notified when one is located; for example, this procedure was used at the Super Bowl 2001 game at Tampa, Florida; in another instance, according to a CNN report, two cameras linked to state and national databases of sex offenders, missing children and alleged abductors have been installed recently at Royal Palm Middle School in Phoenix, Arizona).
- General identity verification (electoral registration, banking, electronic commerce, identifying newborns, national IDs, passports, drivers' licenses, employee IDs).
- Criminal justice systems (mug-shot/booking systems, post-event analysis, forensics).
- Image database investigations (searching image databases of licensed drivers, benefit recipients, missing children, immigrants and police bookings).
- "Smart Card" applications (in lieu of maintaining a database of facial images, the face-print can be stored in a smart card, bar code or magnetic stripe, authentication of which is performed by matching the live image and the stored template)
- Multi-media environments with adaptive human computer interfaces (part of ubiquitous or context aware systems, behavior monitoring at childcare or old people's centers, recognizing a customer and assessing his needs)
- Video indexing (labeling faces in video)
- Witness face reconstruction.

In addition to these applications, the underlying techniques in the current face recognition technology have also been modified and used for related applications such as gender classification, expression recognition and facial feature recognition and tracking; each of these has its utility in various domains: for instance, expression recognition can be utilized in the field of medicine for intensive care monitoring while facial feature recognition and detection can be exploited for tracking a vehicle driver's eyes and thus monitoring his fatigue as well as for stress detection. Face recognition is also being used in conjunction with other biometrics such as speech, iris, fingerprint, and ear and gait recognition in order to enhance the recognition performance of these methods.

B. Application of Expression Recognition From Faces

Huge amount of different information is encoded in facial movements. Observing someone's face we can learn about his/her:

- affective state, connected with emotions like fear, anger and joy and moods such as euphoria or irritation
- cognitive activity (brain activity), which can be perceived as concentration or boredom

- personality features like sociability, shyness or hostility
- truthfulness using analysis of micro-expressions to reveal concealed emotions
- psychological state giving information about some disorders helpful with diagnosis of depression, mania or schizophrenia.

Due to the variety of information visible on human face, facial expression analysis has applications in different fields of science and life.

Firstly, teacher's uses facial expression analysis to adjust the difficulty of the exercise and learning pace on a base of feedback visible on student's faces. Virtual tutor in e-learning proposed by Amelsvoort and Kraemer provides student with suitable content and adjusts the complexity of courses or tasks by the information obtained from student's face. Another application of FERS is in the field of business where the measurement of people's satisfaction or dissatisfaction is very important. Usage of this application can be found in many marketing techniques where information is gathered from customers by surveys. The great opportunity to conduct the surveys in the automatic way could be able by using customers' facial expressions as a level of their satisfaction or dissatisfaction. Moreover, prototype of Computerized Sales Assistant, proposed by Shergill et al. selects the suitable marketing and sales methods by the response deducted from customers' facial expressions. Facial behavior is also studied in medicine not only for psychological disorder diagnosis but also to help people with some disabilities. Example of it could be the system proposed by Pioggial et al. that helps autistic children to improve their social skills by learning how to recognize emotions. Facial expressions could be also used for surveillance purposes like in prototype developed by Hazelhoff et al. Suggested system automatically detects discomfort of newborn babies by recognition of 3 behavioral states: sleep, awake and cry. Additionally, facial expression recognition is widely used in human robot and human computer interaction. Kazi et al. proposed Intelligent Robotic Assistant for people with disabilities based on multimodal HCI. Another example of human computer interaction systems could be system developed by Zhan et al. for automatic update of avatar in multiplayer online games.

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