FACE RECOGNITION USING FACIAL FEATURES AND OBJECTS MATCHING IN UNCONSTRAINED IMAGES

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ABSTRACT:
Detection of human posture is a research topic in visual research which finds its application in many areas such as intelligent digital content manager, social robotics and human activity reorganization, crowd behavior analysis and control, etc. Apart from this human posture detection is also used in pedestrian detection, 2D-3D animation, surveillance and robotics. Using the human posture detection method in real system is a challenging problem. As it require to compute the detection process in real time. Parallel computation provides the functionality to run the computation in minimum time utilizing all the resources. The developed algorithm will give better face recognition rate which is independent of variation in pose, lighting, expression, background, race etc. Many of these databases might be created under controlled conditions to facilitate on the face recognition problem to study the specific parameters. These parameters contain many variables such as camera quality, lighting position, pose, expression, background, occlusion, age, and gender. While there are many applications for face recognition technology in which one can control the parameters of image acquisition, there are also many applications in which the practitioner has little or no control over such parameters. This work is provided as an aid in studying face recognition problem as unconstrained. The existing database represents an initial attempt to provide a set of labeled face photographs in their everyday lives spanning the range of conditions typically encountered by people. This work describes a face detection system which goes beyond traditional face detection approaches normally designed for single faced images to few faces. The system described in this paper has been designed while taking into account of spatial coherence contained in multiple face detection. The resulting system constructs a feature based model for each detected face, and searches them using various model information in the database. It provides a feasible way to locate the positions of two eyeballs, near and far corners of eyes, midpoint of nostrils and mouth corners from face image. This approach would help to extract useful features on human face automatically and improve the accuracy of face recognition.

Keywords: Face detection, Face recognition, Feature localization, Unconstrained Faces

INTRODUCTION

Human posture detection is a useful tool for higher-level applications that rely on visual input such as images and videos. For intelligent systems such as human-computer interaction
and robotics understanding human activities are the solution to the many problems. The human posture detection system can be used for intelligent digital content manager in which images that contain human posture are automatically separated and tag for the image is generated. It can be used in social robotics and human interaction system where social behavior of the human is studied. For example autonomous mobile robots in the workplace or home could interact more seamlessly with the humans in their environment, if they could reliably detect their presence. Recognizing human face automatically by computer is very difficult. Face recognition has been widely applied in security system, credit-card verification, and criminal identifications, teleconference and so on. Face recognition is influenced by many complications, such as the differences of facial expression, the light directions of imaging, and the variety of posture, size and angle. Even to the same people, the images taken in different surroundings may be unlike. The problem is so complicated that the achievement in the field of automatic face recognition by computer is not a simple task.

Recently, techniques achieved in the researches for the detection of facial feature points can be broadly classified as: (i) approaches based on luminance, chrominance, facial geometry and symmetry, (ii) template matching based approaches [2,3], (iii) PCA based approaches [1,4,9], and the combination of the above approaches along with curvature analysis of the intensity surface of the face images [5]. Also other facial feature detection approaches exist. Feris et al. present a technique for facial feature localization using a two-level hierarchical wavelet network [6]. Facial feature extraction has become an important issue in automatic recognition of human faces. Detecting the basic feature as eyes, nose and mouth exactly is necessary for most face recognition methods. This report describes a database of human face images designed as an aid in studying the problem of unconstrained face recognition. Face recognition is the problem of identifying a specific individual, rather than merely detecting the presence of a human face, which is often called face detection. The general term “face recognition” can refer to a number of different problems including, but not limited to, the following. Given two pictures, each of which contains a face, decide whether the two people pictured represent the same individual. Given a picture of a person’s face, decide whether it is an example of a particular individual. This may be done by comparing the face to a model for that individual or to other pictures of the individual.

![Figure 1. Unconstrained faces at indoor and outdoor taken from database.](image-url)
Given a picture of a face, decide which person from among a set of people the picture represents, if any. Thesis often referred to as the face verification paradigm. The unconstrained faces are designed to address the first of these problems, along with multiple face detection and next as the pair matching problem. The main motivation for the database, which is discussed in more detail below, is to provide a large set of relatively unconstrained face images. By unconstrained, we mean faces that show a large range of the variation seen in everyday life. This includes variation in pose, lighting, expression, background, race, ethnicity, age, gender, clothing, hairstyles, camera quality, color saturation, focus, and other parameters. Example image with as position, pose, lighting, expression, background, camera quality is shown in Figure 1.

The reason we are interested in natural variation is that we are interested in the problem of pair matching given a pair of pre-existing face images i.e., images whose composition we had no control over. We view this problem of unconstrained pair matching as one of the most general and fundamental face recognition problems. If normalization is done as preprocess the accuracy of face recognition is improved. These pairs of images shown in Figure 2 will give information about the images in the data base. In this database the images may be present with different scale, rotation, illumination and other changes which belong to same person.

A person may appear in more than one training pair under different imaging parameters. Some images contain more than one face, but it is the face that contains the central pixel of the image which is considered the defining face for the image. Faces are detected and segmented separately for matching them with the database images. Sometimes Faces other than the target face should be ignored as “background”. For multiple individual’s sequences, the system needs more time as more faces are tracked simultaneously per individual in the image. If the image consists of multiple faces, more complex background and extreme lighting conditions, the efficiency is reduced to 85% due to false acceptance and false rejection especially in scene with much partially occluded face or under extreme lighting conditions or with pose and also of different sizes, different colors, and different positions. The block diagram of the proposed method is given below in Figure 3 with different stages of processing. The input image which unconstrained is collected as a query image which may have multiple faces. This image is preprocessed using different techniques but in this work we consider only the faces which are inclined with some angle with image plane. The multiple face detected and on each detected faces an approach based human visual characteristics methods, using the geometry and symmetry of faces are applied. Next the vital feature like eyes, nose and mouth are extracted exactly and quickly. From the extracted features strong key points which are invariant to scale, translation and rotation invariance are found. Further the matching process is continue between the query image key points and keys point of each image in the database.
To achieve the objectives and to understand the producer of face detection and recognition this paper was organized as follows. In Section II, the origin of Labeled Faces under unconstrained stages is discussed. In Section III, The standard face detection problem for a given arbitrary image to determine any faces are present and if the face are present, the location will found for each faces. In Section IV, describe how to extract useful features on human face and its intended use for the unconstrained pair matching problem. he experiment results and discussion are analyzed in section V. Finally, section VI concludes the paper and points out the next research aspects.

2. FACE DETECTION

The standard face detection problem, given an arbitrary image, can be defined as to determine any face -if any- in the image returning the location and extent of each[2,3]. Ideally, the whole procedure must perform in a robust manner for illumination, scale and orientation changes in the subject. Thus, robustness is a main aspect that must be taken into account by any face detector developer. Face detection methods can be classified according to different criteria. In this paper, we have considered the information used to model faces to classify the different face detection techniques into two main families:

- **Pattern based or Implicit:** These approaches work searching exhaustively a previously learned pattern at every position and at different scales of the input image,

- **Knowledge based or Explicit:** These approaches increase processing speed by taking into account face knowledge explicitly and combining cues such as color, face parts and facial geometry and appearance.

Among the different approaches described in the literature, those belonging to the first to tackle the general problem of face detection in still images achieving great performance (and fast in recent developments) for the datasets available[7,8]. On the other hand, the techniques included in the second method provide faster performance, but only in restricted conditions[7,8].However, the problem of real-time face detection in the context of different variation in pose, lighting, expression, background, race, ethnicity, age, gender, clothing, hairstyles, camera quality, color saturation, focus, and other parameters. The direct application of typical face detectors to unconstrained neglects the integration of information which is important in real time. As an example, this direct application will analyze the frame as if it were a still image, forgetting information provided by previous detections such as the position, size and appearance of the face detected.

Therefore, the approach described in this paper makes use of elements of both methods trying to get their advantages, i.e., high performance given by the first method, and speed provided by the second. The integration of other cues helps to improve the final system performance and robustness. Viola–Jones’ [9] is used to detect the faces from the images. Recent implicit face detectors [10,11] have reduced dramatically the processing latency at high levels of accuracy. Particularly the general object detector framework described in[13],
designed for rapid object detection, is based on the idea of a boosted cascade of weak classifiers. For each stage in the cascade, a separate sub classifier is trained to detect almost all target objects while rejecting a certain fraction of the non-object patterns (which were accepted by previous stages). The resulting detection rated, and the false positive rate, F, of the cascade is given by the combination of each single stage classifier rates. The implementation [12] integrated in the Open CV (Open Computer Vision Library) [13] extends the original feature set [13]. As an example, the features achieved for the first stage of, respectively, a frontal face detector, and a head and shoulders detector are presented with examples in the next section. Both detectors are integrated in recent Open CV releases [14]. This schema allows a high image process-ingrate, due to the fact that background region so far for the image are quickly discarded while spending more time on promising object-like regions. Thus, the detector designer chooses the desired number of stages, the target false positive rate and the target detection rate per stage, achieving a trade-off between accuracy and speed for the resulting classifier.

3. Extraction of Face features

In order to perceive and recognize human faces, we must extract the prominent characteristics on the faces. Usually those features like eyes, nose and mouth together with their geometry distribution and the shape of face is applied.

3.1 Locating the face-area

Firstly, we locate the general area of face from the whole image. According the a priori knowledge of human faces, the face-area can be matched by the normalized face model. The matching of face model is based on the relativity of luminance and the distributing of the whole luminance pattern of face images. Before matching the face model, we calculate the symmetry and the distributing of luminance and grads of local area, then get rid of the images which have no face obviously. It can accelerate the matching of face model by using a priori knowledge of luminance and grads.

In fact, the sub-image and model used to match is relatively small, about one quarter of the original image, so as to make it robust to the change of scale and rotation of the image and accelerate the matching of face model. The matching of face model is based on the relativity of luminance and the distributing of the whole luminance pattern of face images. Before matching the face model, we calculate the symmetry and the distributing of luminance and grads of local area, then get rid of the images which have no face obviously. It can accelerate the matching of face model by using a priori knowledge of luminance and grads. In fact, the sub image and model used to match is relatively small, about one quarter of the original image, so as to make it robust to the change of scale and rotation of the image and accelerate the matching of face model [15].

3.2 Locating the eyeballs and the corners of eyes

Then we begin to search the two eyeballs, viz. the centers of eyes, in face-area. To detect the eyes is very important in face feature extraction. Common method to locate eyes is based on the property of valley points of luminance in eye-areas. The valley point searching can be directional projection and the symmetry of two eyeballs to locate eyes. In a general way we can improve the accuracy of location by using the relationship between two eyes. Firstly, we need to locate the sensitivity area of two eyes. The centers of eyes are located by searching the
valley points in the local luminance image. Projecting the grads image in the top left and top right areas of face, and then normalizing the histogram got by directional integral projection, we can locate the probable position of the eyes in Y direction based on the valley point in horizontal integral projection image. Then let the x coordinates to change in a large scope, so we can find the valley point in x direction of this area. The detected points are regarded as centers of two eyes[15].

3.3 Locating feature point of nose-area
We define the feature point in nose-area to be the midpoint of two nostrils in this paper. The nose is less important than eyes for face recognition, but the midpoint of two nostrils is relatively stable, and we can use it as the datum mark of normalization to do the pre-treatment of face images. Firstly, we choose the strip region of two eyeballs width to get integral projection curve in y direction [8]. Then we search along the projection curve down from they coordinates of eyeballs and find the first valley point to be they-coordinates of nostrils. Through adjusting the value between peak and valley points, we can eliminate the big burrs on the curve caused by scars on face or wearing glasses etc.

3.4 Locating the mouth corners
Mouth has almost the same importance as eyes for face recognition. The shape and size of mouth change greatly because of the variety of face expression. And the whiskers could interfere with mouth-area to be recognized. So it has great significance for face recognition to extract the mouth feature points exactly. Since the corners of mouth have little alteration effected by expression and it can be located easily, so we define the two mouth corners as the feature points of mouth-area with some other strong key point which may be the edges of lips from the image.

4. FACE FEATURE EXTRACTION AND MATCHING
Applying human visual property in the recognition of faces, people can identify face from very far distance, even the details are vague. That means the symmetry characteristic is enough to be recognized. Human face is made up of eyes, nose, mouth and chin etc. There are differences in shape, size and structure of those organs, so the faces are differ in thousands ways, and we can describe them with the shape and structure of the organs so as to recognize them. One common method is to extract the shape of the eyes, nose, mouth and chin, and then distinguish the faces by distance and scale of those organs. The other method is to use deformable model to describe the shape of the organs on face subtly. We can tell the characteristics of the organs easily by locating the feature points from a face image. If we normalized the characteristics which have the properties of scale, translation and rotation invariance, we can normalize the faces in the database through pre-treatment, so as to extend the range of database, reduce the storage and recognize the faces more effectively.
Additionally, the selection of face feature points is crucial to the face recognition. We should pick up the feature points which represent the most important characteristics on
the face and can be extracted easily. The number of the feature points should take enough information and not be too many. If the database has different postures of each person to be recognized, the property of angle invariance of the geometry characteristic is very important. According to these, we can get other feature points extended by them and the characteristics of face organs which are related and useful to face recognition.

In addition, the features are highly distinctive, which allows a single feature to be correctly matched with high probability against a large database of features, providing a basis for object and scene recognition [16]. When locating the feature points, we should set the searching area of the points firstly. In this paper, they are called the invariant features are extracted by using the following steps. Following are the major stages of computation used to generate the set of image features:

**Scale-space extrema detection**: The first stage of computation searches over all scales and image locations. It is implemented efficiently by using a difference-of-Gaussian function to identify potential interest points that are invariant to scale and orientation.

**Key point localization**: At each candidate location, a detailed model is fit to determine location and scale. Key points are selected based on measures of their stability.

**Orientation assignment**: One or more orientations are assigned to each key point location based on local image gradient directions. All future operations are performed on image data that has been transformed relative to the assigned orientation, scale, and location for each feature, thereby providing invariance to these transformations.

**Key point descriptor**: The local image gradients are measured at the selected scale in the region around each key point. These are transformed into a representation that allows for significant levels of local shape distortion and change in illumination.

The approach of extracting invariant feature has been named the Scale Invariant Feature Transform (SIFT), as it transforms image data into scale-invariant coordinates relative to local features. An important aspect of this approach is that it generates large numbers of features that densely cover the image over the full range of scales and locations. Atypical image of size 500×500 pixels will give rise to about 2000 stable features (although this number depends on both image content and choices for various parameters). The quantity of features is particularly important for object recognition, where the ability to detect small objects in cluttered backgrounds requires that at least 3 features be correctly matched from each object for reliable identification [17]. For image matching and recognition, SIFT features are first extracted from a set of reference images and stored in a database. A new image is matched by individually comparing each feature from the new image to this previous database and finding candidate matching features based on Euclidean distance of their feature vectors and nearest-neighbor [18]. The key point descriptors are highly distinctive, which allows a single feature to find its correct match with good probability in a large database of features.

5. EXPERIMENTAL RESULT AND DISCUSSION

Viola–Jones detectors perform an exhaustive search in detecting the faces in the image. In the given data the image contains complex and occluded faces are present back
side as shown in Figure 3. Here detecting faces which are of interest and filtering the irrelevant face is an important task for the detector. First part of algorithm is to detect the face in image and mark the face with square boxes as shown in the Figure. Further each face was segmented for getting face region and feature extraction. These segmented images are given in next Figures.

**Figure 3 detecting a face in group of faces**

As a second part of algorithm the detected face regions will be processed for feature extraction and matching. To do this a new image is consider for better presentation with RGB image of size 545x 505 and its is inclined at an angle of 30° to the image plane Figure 4(a). Furthermore, according to the discussion presented above, the image in which the face is in inclined position is considered and preprocessed to get a face aligned with horizontal axis by adjusting the plane rotations Figure 7(b). The face region and each vital region in that face region like left eyes, right eye, nose and mouth regions are detected are marked as shown in Figure4(c) and Figure 4(d).

**Figure 4.(a) Unconstrained Image (b) Preprocessed**

**Figure 5: Process of Detecting Facial Parts**
Figure 6: Eyes, Nose, and Mouth extraction and detection

Finally, the scale invariant feature which is not varying such variables as position, pose, lighting, expression, background, camera quality, occlusion, age, and gender are extracted by using shift invariant feature transform. The features are processed to extract strong invariant feature by analyzing feature descriptor. Weak descriptors are eliminated for avoiding mismatching of key points.

The strong descriptors are selected as feature key points which will participate in matching based on by correlation method between the query image key points and each image with their key points in the data base as shown in Figure 6. The best matching image is considered as faces with same feature like query image the we say the faces is recognized if not face is not present in the database in any of the form.

Figure 6: Feature Key point matching

CONCLUSION

It is well known that it’s difficult to recognize the features exactly on each face images due to the structure complication of human face and specifically in the diversity of face features and shooting angle. This paper proposes a useful approach to recognize the faces from the unconstrained images with various unconstrained condition. Experiment results show that the locating of the feature points is exact and fast, and it would help to increase the accuracy of face recognition. Though we set the scale of face images to be fixed on 336*480, it doesn’t mean any restriction for the size of images. The approach presented in this paper can automatically locate the feature points with high accuracy as for most front face images of luminance, even for some small angle left and right rotation face images, but it is still limited in the application of large angle rotation with reducing of the accuracy and is partly impacted by strong sidelight. Thus in conclusion there are many applications for face recognition technology in which one can control the parameters of image acquisition; there are also many applications in which the practitioner has little or no control over such parameters. The main purpose of the system was to efficiently recognize different individuals using a small region of the face. For this purpose the eye region of face is used to recognize different individuals. Results were tested on two kinds of databases like Yale-B, CASPEAL-RI. The results obtained are satisfactory and the system can be used efficiently for recognition purpose for different applications with more than 81% results.

REFERENCES


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