Literature Survey on Face Localization

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***Abstract*— The face of human conveys a lot of information about identity and emotional state of the person. Face Recognition or Facial Expression Recognition is one of the exciting and challenging field , it has important applications in many area such as identification for law enforcement, personal identification among others,authentication for banking and security system access.Extracting effective features from the human face is an important step for successful facial recognition.In this literature survey, we mainly focus on three phases, namely face representation, feature extraction and classification.The face representation part deals with the how to model a face and determines the successive algorithm for detection and recognition.In the feature extraction phase , most unique and useful features of image are extracted.In the classification phase, the face image is compared with the images stored in the database.Through this literature survey we should first try to identify features of face for face detection and later on we should focus on face identification.**

Keywords: *Feature Extraction, Classification, Pattern Detection, PCA ,SVM,Neural Network ,Histogram*

I. INTRODUCTION

FACE DETECTION is a fundamental task for applications such as face tracking ,red-eye removal ,face recognition and face expression recognition.Most of face detection algorithms consider face detection as a binary or two-class classification problems.It looks a simple classification problem but when it comes to implementation ,it is very complex to build a good face classifier.A first step of any face detection system is detecting the locations in images where faces are present.However, face detection from a single image is challenging task because of variation in location,scale,orientation and pose.Facial expression,occlusion and lighting conditions also change the overall appearance of face.

After examining a several research paper finally we are able to derive a definition of *face detection*:Given an arbitrary image ,1^{st} task is to determine whether or not there are any faces in the images and if present, we need to find the image location.The challenges associated with face detection can be attributed to the following factors[4]:

- **Image Orientation.** Face images directly vary for different rotations.
- **Facial expression.** The appearance of faces are directly affected by the person's facial expression.
- **Effect of Structural Components.** Facial features such as beards,mustaches and glasses may or may not be present in image and there is variety among those components including size,color and shape.
- **Pose.** The images of a face vary due to the relative camera-face pose (frontal, 45 degree,upside-down).
- **Imaging conditions.** When the image is captured,factors such as lighting (spectra, source distribution and intensity) and camera characteristics (sensor response, lenses) affect the appearance of a face.
- **Occlusion.** Faces may be partially occluded by other objects. In an image with a group of people, some faces may partially occlude other faces.

Face localization aims to determine the image position of a single face, this is a simplified detection problem with the assumption that there is only single face in image. The goal of facial feature detection is to detect the presence and location of features, such as eyes,nose, nostrils, eyebrow, mouth, lips, ears, etc., with the assumption that there is only one face in an image.Face recognition and face identification compares an input image against a database and report a match ,if any.

II. THE PARADIGM OF THE FACE DETECTION

A model for face detection is shown in Figure 1.The process of face detection can be split in to three main phases.These are face representation (as Input Image),feature extraction and classification by classifier.Face representation is the first task, that is, how to model a face,For the initial-level goal is to determine whether or not the given image represents a face.In the feature extraction phase , most unique and useful features of face images are extracted.In the classification phase , whether image is faced or non-faced is determine by the classifier.

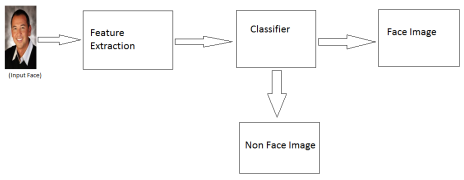

Fig. 1. Process of Face Detection

III. Categorization of Methods for Face Detection (Single Image)

After doing a brief survey on face detection we come to point that,We classify single image detection methods into four categories and methods are listed below:

- **Appearance-based methods:** The models (or templates) are learned from a set of training images which should capture the representative variability of facial appearance. These learned models are then used for detection The appearance-based methods are used for face detection with eigenface , neural network ,Support Vector Machine(SVM) and Naive Bayes Classifier.
- **Template matching methods.** Several standard patterns of a face are stored to describe the face as a whole or the facial features separately.The correlations between an input image and the stored patterns are computed for detection. These methods have been used for both face localization and detection.
- **Knowledge-based methods.** These rule-based or knowledge-based methods employ human knowledge of what constitutes a typical face (employ knowledge of the components of the face).The rules reflect the relationship between facial features.These methods are mainly designed for face localization.
- **Feature-based methods:** These methods aim to find structural features that exist even when pose,viewpoint or lighting conditions vary.These methods are designed normally for face localization.The facial features, texture,skin color and multiple features are various approach for the feature based face localization.

IV. SVM based Face Detection

The primary goal of SVM is to find hyperplane that separates the two categories but in real life most of the time we have to deal that kind of data that cannot be separated by linear separable plane, so we need to map all the points to feature space using specific type of kernel.After separating the points in the feature space we can map the points back to the input space with a curvy hyper plane[2]. These system detects face by scanning an image for face-like pattern at different possible scales by dividing the original image in to into overlapping sub-images and classifying them using a SVM to determine the appropriate class (face/non-face).In SVM based face detection , following preprocessing[1] needs to performed:

- **Masking :**This step is mainly used for dimensionality reduction.This step is important in the reduction of background patterns that introduce unnecessary noise in the training process.
- **Illumination Correction :** In this step variation in face because of light and heavy shadows is unmasked.
- **Histogram Equalization :**A histogram equalization is performed over the patterns in order to compensate for differences in illumination brightness,different cameras response etc.

V. Neural Network based Face Detection

In Neural Network based face detection, a retinally connected neural network examine small windows of an image and decides whether each window contains a face. The weights and biases are initialized with small random values and updated incrementally, such that the performance of the detector improves producing a more accurate decision boundary for the problem[3]. Once trained, the network can be used to classify previously unseen images, indicating whether they contain faces or not, based-on the location of the input relative to the decision boundary formed during training. The first component of the system is the filter that receives an input region of image and generates an output ranging from +1 to -1, indicating +1 for presence of face and -1 for absence of face respectively. To detect face anywhere in input image filter is applied at every location in the image.This filter must have some invariance to position and scale.The filtering algorithm is work as follow:

- First preprocessing step is applied to window of an image.The window is passed to neural network, which decides whether window contains a face or not.The preprocessing attempts to equalize the intensity across the window. We fit a function which varies linearly across the window to the intensity values in an oval region inside the window Pixels outside the oval may represent the background , so those intensity values are ignored.
- The linear function will approximate the overall brightness of each part of the window, and can be subtracted from the window to compensate for a variety of lighting conditions. Then histogram equalization is performed, which non-linearly maps the intensity values to expand the range of intensities in the window. The histogram is computed for pixels inside an oval region in the window.
- The preprocessed window is than passed through a neural network.The network has connection to input layer and this input are also passed through hidden layers.Hidden layers detect some local features that might be important for face detection.In particular,the horizontal stripes allow the hidden layers to detect features such as mouths or pairs of eyes , while the hidden units with square receptive fields might detect features such as individual eyes, the nose, or corners of the mouth.

VI. PCA based Face recognition

PCA is a mathematical procedure that uses an orthogonal transformation to convert set if values of possibly correlated F face images into a set of values of K uncorrelated variables called Eigenfaces[5]. The number of eigenfaces is always less than or equal to number of original face images , i.e $F < K$. This transformation is defined in such a way that the first principal component shows the most dominant (features) of the images and each succeeding component in turn shows the next most possible features under the constraint that it be uncorrelated the preceding components.

To reduce the calculations needed for finding principal components,the dimensionality of the original images is reduced before they are calculated.if we are not utilizing PCA for dimensionality reduction than we need n^2 eigen faces.
Since principal components show the major direction/features of data and each proceeding components shows less features and more noise.Only Few first principal components(say F) are selected whereas the rest of the last components are discarded.These F principal components can safely represent the whole original dataset(for our case that is image) because they depict the major features that make up the image.once we find the F principal components than each variable in the original dataset(image) can be represented in terms of these F principal components(Linear weighted sum or linear combination). By representing data point in this way (as a combination of F principal components) reduce the number of values (reduced to F) needed to recognize image.This makes the recognition process faster and error free.The result of PCA is usually discussed in terms of component scores how much of F principal components are needed to represent the image.

VII. CONCLUSIONS

Through this literature survey and Machine Learning as a academic subject , we can realize the importance of face detection in real life.Face detection is machine learning problem that identifies human faces in images or video.It detects human faces which might used for recognition particular face.The face detection is being used in a variety of application nowadays. With the help of literature survey we have examine several method for face detection and for face recognition so as a part of academic project we can implement one of the method that is mentioned in literature survey for the face localization.

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