Understanding Real-Time Face Detection Techniques

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***Abstract*:- This paper presents a survey on various methods of face detection. We will study the recent advances in the field of face detection for the past decade. We will then see the various techniques according to how they extract features and what learning algorithms are adopted. We attempt to design an E-Watchmen System. Hence, we explore various face detection techniques which capture the image. We will study about the different researches done in the field of face detection and will be using one of them in our system.**

INTRODUCTION

E-Watchman System is used in two key modes, watching for known alerts in real-time and alerting about the unusual events. Typically, watching for alerts requires face detection and real-time alerting is a localized function, eg., the owner receives and reacts to the "intruder alert warning". Whereas unusual events may include warning the owner about the improbability of the predetermined activity. This system monitors the behavior, activities, or other movements, usually of people for the purpose of alerting or protecting them.

While applying face detection to provide real-time alerting, we determine the locations and sizes of human faces in digital images. It is used to detect face and ignore anything else, such as bodies, trees and buildings. The problem of finding and analyzing faces is a foundational task in computer vision. However, face detection is not straightforward because it has lots of variations of image appearance, such as pose variation (front, non-front), occlusion, facial expression, image orientation and illuminating condition. Many novel methods have been proposed to resolve each variation listed above. For example, the template-matching methods are used for face localization and detection by computing the correlation of an input image to a standard face pattern. The approaches like feature invariant approaches are used for feature detection of eyes, mouth, ears, nose, etc. The appearance-based methods are used for face detection with eigenface, neural network, and information theoretical approach.

RELATED WORK

The problem of face detection has been studied extensively. Face detection is defined as the procedure has many applications like face tracking, pose estimation or compression. Face detection is a two class problem where we have to decide if there is a face or not in a picture. A wide spectrum of techniques have been used including template matching, model based detection, neural networks, maximal rejection classification, support vector machines (SVM) and color analysis. However, it is very difficult to design algorithms that work for all image background, races, sizes and geometries, and illuminations. As a result, face detection remains as much an art as science.

Methods of face detection are divided into different categories. This classification can be made as follows:

Skin color model-based approaches build a skin color model using Gaussian normal distribution since color is one of the most widely used visual features in face detection. Specifically, models convert the color image into an appropriate color space, such as YIQ, YCbCr, or HSI, to find skin color. These color spaces are more robust to the illuminations than the RGB color space and therefore are suitable for face detection under different lighting conditions.

Feature-based approaches first process the input image to identify and extract (and measure) distinctive facial features such as the eyes, mouth, nose, etc., as well as other fixed basis of comparisons or marks, and then compute the geometric relationships among these facial points, hence reducing the input facial image to a vector of geometric features. Standard statistical pattern recognition techniques are then employed to match faces using these measurements. Though different people have different skin color, human skin color is a powerful feature that is used to detect faces. Several studies have shown that the basic difference based on its intensity chrominance instead.

In Image based approach, there is a face pattern standard predefined is used to match the segment in the image to

determine whether they are faces or not. To classify regions face or non-face classes it uses training algorithms. Image based techniques depends window multi-resolution scanning detect faces, thus these techniques have high detection rates but slower than the techniques of feature-based. Examples of techniques images based are Eigen-faces and neural networks. This approach has the advantage of simple implementation, but it cannot deal effectively with the variation in shape, pose and scale.

Template based approach used several templates to find out the face class and extract facial features. The template matching compares the face candidate image with the face template, checks the level of similarity and concludes whether it is human face or a non-face. The gray color is chosen as color space for the template matching because the best results have been obtained experimentally. The face template is an image made by averaging all faces on the training images. A few human faces are not detected if only one face template is used.

Edge detection approach is a very important area in the field of Computer Vision. For segmentation and object recognition, edges are used. Edges define the boundaries between regions in an image. They can show where shadows fall in an image or any other distinct change in the intensity of an image.

Wu-Chih Hu, Ching-Yu Yang, Deng-Yuan Huang, and Chun-Hsiang Huang published a paper on face detection that used a three-stage scheme for real-time reliable face detection. It uses feature-based method along with skin color. In first step, based on skin color skin regions are obtained using a YCbCr skin-color model. Then, a face template measure is used to obtain face candidates and a suitable face box is used to effectively remove non-face regions from the face candidates. Lastly, facial features are measured to detect faces from face candidates. The results showed that the method has good performance in the face detection of faces in skin color-like backgrounds, faces in various poses, faces of various races and faces under varying illumination.

Erdem, C.E. presented a hybrid method for face detection in color images. They combined haar feature based face detector along with skin-color filtering. Haar feature based method that has a low number of missed faces but a high number of false detections. Then, using the skin color post-filtering method many of these false detections can be eliminated easily.

Kshirsagar, V.P. proposed a methodology for face recognition based on information theory approach of coding and decoding the face image. It is connection of two stages - Feature extraction by eigenface approach using Principle Component Analysis(PCA) algorithm and recognition using the feed forward back propagation Neural Network. The goal was to implement the system (model) for a particular face and distinguish it from a large number of stored faces with some real-time variations as well.

The seminal work that had the great impact in the field of face detection in 2000s was by Viola and Jones. The Viola-Jones face detector contains three main ideas that make it possible to build a successful face detector that can run in real time: the integral image, classifier learning with AdaBoost, and the attentional cascade structure.

Different methods and algorithms of face detection are present. The choice of a face detection method in any study should be based on the particular demands of the application. None of the known methods is universally best for all applications. In order to be successful a face detection algorithm must possess two key features, speed and accuracy. Generally, there is a trade-off between the two.

PROPOSED WORK

Our system will work as follows:
Step 1: The camera will detect face and capture the image of the person who is in the range.
Step 2: Then the notification message will be sent to the owner along with the image.
Step 3: The owner will decide whether to give the access to the person or not.
Step 4: The owner has an option to inform the police if a criminal activity is detected.

The technique used will convert the image into grayscale and then using template matching the face is detected. The function shown below converts the captured color frame into gray frame and then the algorithm is implemented.

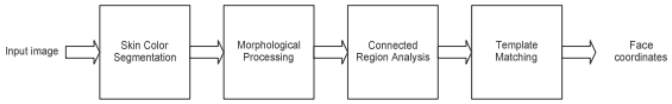
```
private void ProcessFrame(object sender, EventArgs arg)
{
    Image<Bgr, Byte> ImageFrame = capture.QueryFrame();

    if (ImageFrame != null)
    {
        try
        {
            Image<Gray, byte> grayframe = ImageFrame.Convert<Gray, byte>();
            var faces = grayframe.DetectHaarCascade(haar, 1.4, 4, Emgu.CV.CvEnum.HAAR_DETECTION_TYPE.DO_CANNY_PRUNING, new Size(25, 25))[0];
            foreach (var face in faces)
            {
                ImageFrame.Draw(face.rect, new Bgr(Color.Red), 4);
            }

        }
        catch (NullReferenceException excpt)
        {
            MessageBox.Show(excpt.Message);
        }
```

Our method uses rejection based classification. The face detector contains of a set of weak classifiers that sequentially reject non-face regions. First, color segmentation is used for the rejection of the non-skin color regions. A set of morphological operations are applied to filter the clutter resulting from the previous step. The rest of the connected regions are then divided based on their geometry and the number of holes. Lastly, template matching is used to detect zero or more faces in each

connected region. A block diagram of the face detector is shown in the figure below:



Block diagram of face detector

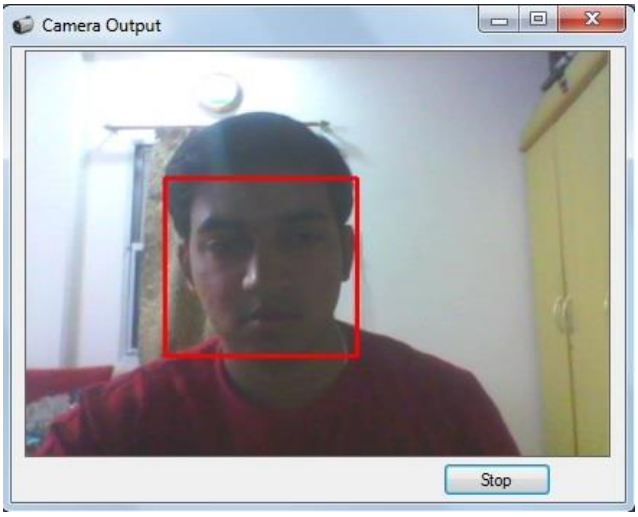
Skin color segmentation: The goal of skin color segmentation is to reject non-skin color regions from the input image. The fact that the color of the human face across all races agrees closely in its chrominance value and varies mainly in its luminance value is used as the basis for this.

Morphological processing: The above figure shows that skin color segmentation rejected non-skin colors from the input image. However, the resulting image has quite a bit of noise and clutter. A series of morphological operations are performed to clean up the image, as shown in figure below. The goal is to end up with a mask image that can be applied to the input image to yield skin color regions without noise and clutter.

Connected region analysis: The image output by morphological processing still contains quite a few non-face regions. Most of these are hands, arms, regions of dress that are of skin color and background portions. In connected region analysis, image statistics from the training set are used to classify each connected region in the image.

Template matching: The basic idea of template matching is to convolve the image with another image (template) that is representative of faces. Searching an appropriate template is a challenge since ideally the template (or group of templates) should match any given face irrespective of the size and exact features.

The final result of this process is shown below in the figure.



APPLICATIONS

Face detection can be used in biometrics, often as a part of (or together with) a facial recognition system. It can also be used in image database management, video surveillance and human computer interface. It will be useful for enhancing the security systems at various organizations. It can be used by wide group of people for different purposes like home security, authorized access to particular area, etc. Hence, reducing the manpower and the capital being invested. Concept of expected and unexpected timing makes the application a parental control application.

CONCLUSION

Different methods and algorithms of face detection have been reviewed in this paper. We have focused on feature extraction and detection aspects of face detection problem. We have presented a face detector with a reasonably good accuracy and running time. However, we will be working on other aspects for better performance and efficiency.

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