REAL TIME FACE DETECTION AND TRACKING USING OPENCV

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Abstract: Face detection which is the task of localizing faces in an input image is a fundamental part of any face processing system. The aim of this paper is to present a review on various methods and algorithms used for face detection etc. Three Different algorithms i.e. Haar cascade, adaboost, template matching were described Finally it includes some of applications of face detection.

In this paper, we represent a methodology for face cdetection robustly in real time environment. Here we use Harr like classifier and adaboost algorithm to track faces on OpenCV platform which is open source and developed by Intel.

Keywords: Face Detection, Adaboost, Harr like feature, computer vision, OpenCv.

I. INTRODUCTION

Face detection is a computer technology that determines the locations and sizes of human faces in arbitrary (digital) images. It detects facial features and ignores anything else, such as buildings, trees and bodies. Human face perception is currently an active research area in the computer vision community. Human face localization and detection is often the first step in applications such as video surveillance, human computer interface, face recognition and image database management. Locating and tracking human faces is a prerequisite for face recognition and/or facial expressions analysis, although it is often assumed that a normalized face image is available.

II. RESEARCH PROBLEM

In order to locate a human face, the system needs to capture an image using a camera and a frame-grabber to process the image, search the image for important features and then use these features to determine the location of the face. For detecting face there are various algorithms and methods including skin colour based, haar like features, adaboost and cascade classifier Colour is an important feature of human faces. Using skin-colour as a feature for tracking a face has several advantages. Color processing is much faster than processing other facial features [10].

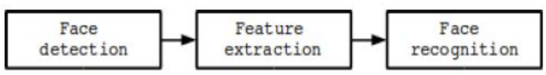

Fig 1. A generic face recognition system

The input of a face recognition system is always an image or video stream. The output is an identification or verification of the subject or subjects that appear in the image or video. Some approaches [3] define a face recognition system as a three step process (Figure 1). From this point of view, the Face Detection and Feature Extraction phases could run simultaneously.

III. RELATED WORK

Face detection is defined as the procedure has many applications like face tracking, pose estimation or compression.
The next step -feature extraction- involves obtaining relevant facial features from the data. These features could be certain face regions, variations, angles or measures, which can be human relevant (e.g. eyes spacing) or not. This phase has other applications like facial feature tracking or emotion recognition. Finally, the system does recognize the face. In an identification task, the system would report an identity from a database. This phase involves a comparison method, a classification algorithm and an accuracy measure. This phase uses methods common to many other areas which also do some classification process -sound engineering, data mining et al. These phases can be merged, or new ones could be added. Therefore, we could find many different engineering approaches to a face recognition problem. Face detection and recognition could be performed in tandem, or proceed to an expression analysis before normalizing the face [9]. In some cases, face images stored in the data bases are already normalized. There is a standard image input format, so there is no need for a detection step. An example of this could be a criminal data base. There, the law enforcement agency stores faces of people with a criminal report. If there is new subject and the police has his or her passport photograph, face detection is not necessary. However, the conventional input image of computer vision systems is not that suitable. They can contain many items or faces. In these cases face detection is mandatory. It's also unavoidable if we want to develop an automated face tracking system. For example, video surveillance systems try to include face detection, tracking and recognizing. So, it's reasonable to assume face detection as part of the more ample face recognition problem.ess of

extracting faces from scenes. So, the system positively identifies a certain image region as a face.

Face detection is, therefore, a two class problem where we have to decide if there is a face or not in a picture. This approach can be seen as a simplified face recognition problem. Face recognition has to classify a given face, and there are as many classes as candidates. Consequently, many face detection methods are very similar to face recognition algorithms. Or put another way, techniques used in face detection are often used in face recognition.

Methods are divided into four categories. These categories may overlap, so an algorithm could belong to two or more categories. This classification can be made as follows:
Knowledge-based methods. Ruled-based methods that encode our knowledge of human faces. .Feature-invariant methods. Algorithms that try to find invariant features of a face despite it's angle or position. .

Template matching methods. These algorithms compare input images with stored patterns of faces or features.

Appearance-based methods. A template matching method whose pattern database is learnt from a set of training images.

Face Detection In Computer Vision Area

In survey [4] two terms face detection and face localization are explained as follows; **Face Detection :** Given an arbitrary image, the goal of face detection is to determine whether or not there are any faces in the image and if present, return the image location and extent of each image.
Face Localization: It aims to determine the image position of a single face; this is a simplified detection problem with the assumption that an input image contains only one face [5], [6]. As our main purpose of face detection is finding a search area for eye detection, we need a fast face detection method independendent of the structural components of face such as beard, mustache. Although simple methods could be chosen without making detailed research about previous work on face detection we prefered to search surveys and categorize face detection methodsin the literature. Human vision system can easily detect and recognize faces in images. The performance of the human vision system is so high that it can detect not only a single face but multiple faces in the same scene having different pose, facial expression, lightening conditions, scales, orientation etc. Also faces do not have to be complete that is; a partial view of a face is enough for humans to detect them in images. Unfortunately in todays computer vision technology no system can achieve that performance. Their operations depend on controlled conditions. There are about 150 different techniques for face detection in images although they share some common methods through their ways. A detailed survey about various face detection methods is given in Yang's survey [4] and classified into four categories. Also in [7], another survey about face detection methods is given. Using these two surveys, details about previous face detection methods are explained below;

3.1 Knowledge-Based Methods

These rule-based methods encode human knowledge of what constitutes a typical face. Usually, the rules capture the relationships between the facial features. These methods are designed mainly for face localization.
In this approach, methods use simple rules to describe features of a face such as; a face often appears in an image with two eyes that are symetric to each other, a nose and a mouth. The relationships between features can be respresented by their relative distances and positions.
Problem with this approach is; it is difficult to translate human knowledge into welldefined rules. If these rules are strict than they may fail to detect faces that do not pass all the rules. But on the other hand if the rules are too general than there may be many false detections.
One popular work about this approach was performed by Yang and Huang [8]. They used a hierarchical knowledge-based method to detect faces. Their systems consists of three levels of rules. At the highest level, all possible face candidates are found by scanning a window over the input image and applying a set of rules at each location. The rules at higher level are general descriptions of what a face looks like while the rules at lower levels rely on details of facial features. A multiresolution hierarcy of images is created by averaging and subsampling.

3.2 TEMPLATE MATCHING METHODS.

Template matching method that finds the similarity between the input images and the template images (training images). Template matching method can use the correlation between the input images and stored standard patterns in the whole face features, to determine the presence of a whole face features [16]. This method can be used for both face detection and face locations. In this method, a standard face (such as frontal) can be used. The advantages of this method are that it is very simple to implement the algorithm, and it is easily to determine the face locations such as nose, eyes, mouth etc based on the correlation values. It can be apply on the various variations of the images such as pose, scale, and shape. Sub-templates, Multi resolutions, and Multi-scales have been proposed to achieve the shape and the scale invariance and localization method based on a shape template of a frontal view face [13]. A Sobel filter is used to extract the edges.

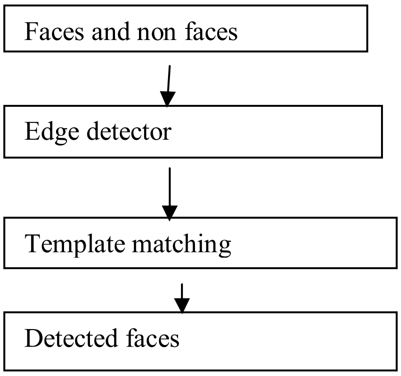

Fig 2. Block diagram of template matching method

IV. ALGORITHMS OF FACE DETECTION

4.1 Haar like feature:

Haar-like wavelets are binary rectangular representations of 2D waves. A common visual representation is by black (for value„ minus one□) and white (for value „plus one□) rectangles. The figure below shows a cut through a binary wavelet between x = 0 to x = 1. The square above the 0-1-interval shows the corresponding Haar-like wavelet in common black-white representation. The rectangular masks used for visual object detection are rectangles tessellated by black and white smaller rectangles. Those masks are designed in correlation to visual recognition tasks to be solved, and known as Haar-like wavelets. By convolution with a given image they produce Haar-like features.[11],[12].

Face detection is gaining the interest of marketers. A webcam can be integrated into a television and detect any face that walks by. The system then calculates the race, gender, and age range of the face. Once the information is collected, a series of advertisements can be played that is specific toward the detected race/gender/age. Face detection is also being researched in the area of energy conservation.

4.2 AdaBoost:

Adaboost is an algorithm for constructing a"strong" classifier as linear combination. Adaboost, short for Adaptive Boosting, is a machine learning algorithm, formulated by Yoav Freund and Robert Schapire[14]. It is a meta-algorithm, and can be used in conjunction with many other learning algorithms to improve their performance. Adaboost is adaptive in the sense that subsequent classifiers built are tweaked in favour of those instances misclassified by previous classifiers. Adaboost is sensitive to noisy data and outliers. In some problems, however, it can be less susceptible to the over fitting problem than most learning algorithms. The classifiers it uses can be weak (i.e., display a substantial error rate), but as long as their performance is slightly better than random (i.e. their error rate is smaller than 0.5 for binary classification), they will improve the final model. Even classifiers with an error rate higher than would be expected from a random classifier will be useful, since they will have negative coefficients in the final linear combination of classifiers and hence behave like their inverses [14].

Adaboost generates and calls a new weak classifier in each of a series of rounds .For each call, a distribution of weights is updated that indicates the importance of examples in the data set for the classification. On each round, the weights of each incorrectly classified example are increased, and the weights of each correctly classified example are decreased, so the new classifier focuses on the examples which have so far eluded correct classification.

V. EXPERIMENTAL RESULTS

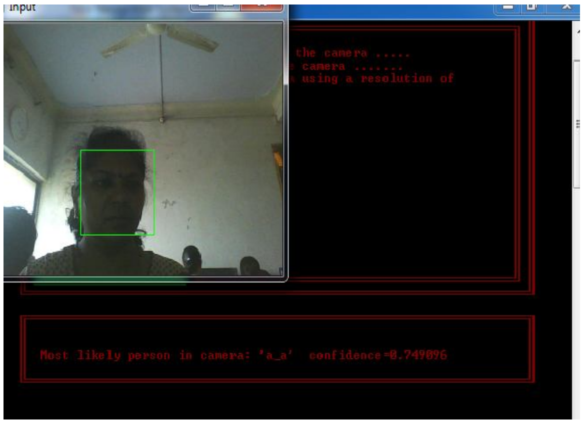

Fig 3. Face detection system

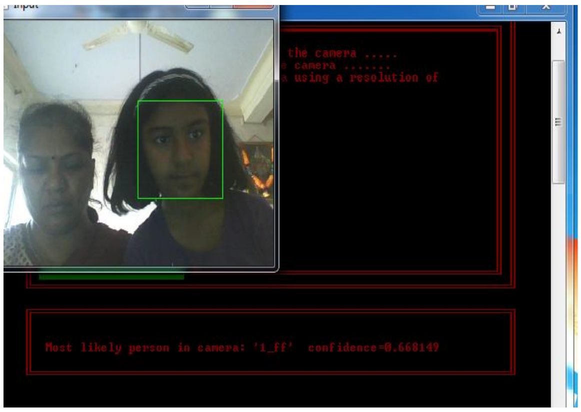

Fig 4. Performance criteria: Confidence

VI. APPLICATIONS

Face detection is used in biometrics, often as a part of (or together with) a facial recognition system. It is also used in video surveillance, human computer interface and image database management. Some recent digital cameras use face detection for autofocus. Face detection is also useful for selecting regions of interest in photo slideshows that use a pan-and-scale Ken Burns effect [17]

VII. DISCUSSION

Different methods and algorithms of face detection have been reviewed in this paper. The choice of a face detection method in any study should be based on the particular demands of the application. None of the current methods is the universal best for all applications. Haar-like features are digital image features used in object recognition. They owe their name to their intuitive similarity with Haar wavelets and were used in the first real-time face detector. A Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region and calculates the difference between these sums[11],[12]. This difference is then used to categorize subsections of an image. The key advantage of a Haar-like feature over most other features is its calculation speed.

In order to be successful a face detection algorithm must possess two key features, accuracy and speed. There is generally a trade-off between the two. Through the use of a new image representation, termed integral images, Viola and Jones describe a means for fast feature evaluation, and this proves to be an effective means to speed up the classification task of the system.

Adaboost, short for Adaptive Boosting, is a machine learning algorithm. Adaboost algorithms take training data and define weak classifier function for each sample of training data. It can be less susceptible to the over fitting problem than most learning algorithms. Bad feature of adaptive boosting is its sensitivity to noisy data and outliers.

The weak classifiers have the task to detect a face. They are performed in a cascade. A search window (sliding window) of 24×24 pixels contains more than 180,000 different rectangular sub-windows of different size.

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