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A Study of Various Face Detection Methods

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Abstract: Because of image-databases and "live" video information is growing more and more widespread, their intelligent or automatic examining is becoming exceptionally important. People, i.e. human faces, are one of most common and very specific objects, that we try to trace in images. Face detection is a difficult task in image analysis which has each day more and more applications. We can define the face detection problem as a computer vision task which consists in detecting one or several human faces in an image. It is one of the first and the most important steps of Face analysis. In this paper we presented various methods of face detection, which are commonly used. The seminal Viola-Jones face detector is first reviewed. We after that survey a variety of techniques according to how they extract features and what learning algorithms are adopted. These methods are Local Binary Pattern (LBP), Adaboost algorithm, SMQT Features and SNOW Classifier Method and Neural Network-Based Face Detection. It is our hope that by reviewing the numerous existing algorithms, we will see yet better algorithms developed to solve this fundamental computer vision problem. In this survey, we categorize the detection methods on the basis of the object and motion representations used, present thorough descriptions of representative methods in each category, and look at their pros and cons.

Keywords: Face detection, Viola-Jones face detector, Local Binary Pattern (LBP), Adaboost algorithm, SMQT Features and SNOW Classifier, Neural Network-Based Face Detection.

I. INTRODUCTION

With the rapid increase of computational powers and availability of recent sensing, investigation and representation equipment and technologies, computers are becoming extra and more intelligent. Numerous research projects and commercial products have demonstrated the capability for a computer to interact with human in a natural way by looking at people through cameras, listening to citizens through microphones, and reacting to people in a friendly behavior [1].One of the fundamental techniques that enables such natural human-computer interaction (HCI) is face detection. Face detection is the step stone to the entire facial analysis algorithms, including face alignment, face relighting, face modeling, face recognition, head pose tracking, face verification / authentication, facial expression tracking/recognition, gender/age recognition, and lots of more. Only when computers can recognize face well will they begin to truly understand people's thoughts and intentions. Given an arbitrary image, the goal of face detection is to determine whether or not there are any faces in the image and if the image is present then it return the image location and extent of each face [2]. While this appears as a trivial task for human beings, it is an extremely tough task for computers, and has been one of the top studied research topics in the past few decades. The difficulty associated with face detection can be attributed to many variations in scale, location, orientation (in-plane rotation), pose (out-of-plane rotation), facial expression, occlusions, and lighting conditions.

II. FACE DETECTION

Face detection determines the presence and location of a face in an image, by distinguishing the face from all other patterns present in the scene. This requires appropriate face modeling and segmentation. The approach should also take into account the sources of variation of facial appearance like viewing geometry (pose), illumination (color, shadowing, and self-shadowing), the imaging process (resolution, focus, imaging noise, perspective effects), and other factors like Occlusion[3]. Alternatively, face detection can be carried out by using the entire face [4], [5], making occlusion difficult to handle. Face detection methodologies classified on the basis of the image information used to aid in detection—color [6], geometric shape [7], or motion information [8], [9].The following figure shows the process of detection in a still image or image sequence.

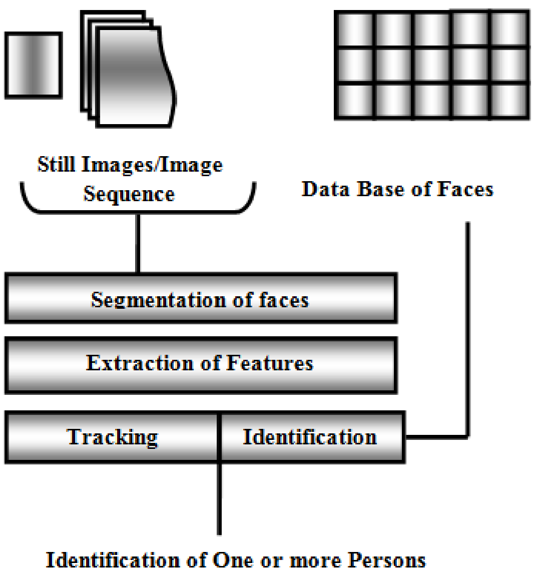

Fig.1. Process of Detection.

III. METHODS OF DETECTION

The following methods are generally used to detect the faces from a still image or a video sequence.

A. *Viola Jones Face Detection Algorithm:*

The Viola–Jones object detection framework [10] is the first object detection framework to provide competitive object detection rates in real-time proposed in 2001 by Paul Viola and Michael Jones. Even though it can be trained to detect a variety of object classes, it was motivated mainly by the problem of face detection. This face detection framework is capable of processing images extremely rapidly while achieving high detection rates. There are three key assistance.

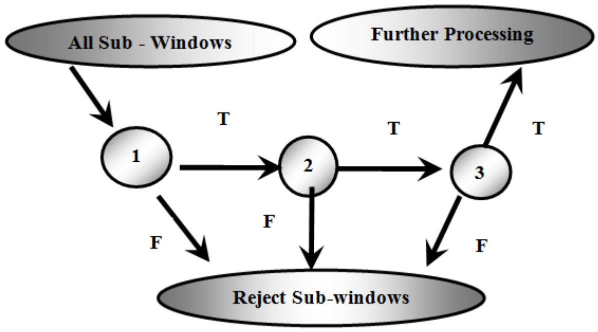

Fig.2 Detection process by using viola – Jones algorithm.

- The first is the introduction of a new image illustration called the "Integral Image" which allows the features used by our detector to be computed very quickly
- The second is an easy and efficient classifier which is built using the AdaBoost learning algorithm to select a small number of critical visual features from a very large set of potential features.
- The third contribution is a process for combining classifiers in a "cascade" which allows background regions of the image to be quickly discarded while spending more computation on promising face-like regions.

1. *Advantages:*

- It is the most admired algorithms for face detection in real time.
- The main advantage of this approach is uncompetitive detection speed while relatively high detection accuracy, comparable to much slower algorithms.
- High accuracy. Viola Jones gives accurate face detection.
- Constructing a cascade of classifiers which totally reduces computation time while improving detection accuracy.
- The Viola and Jones technique for face detection is an especially successful method as it has a very low false positive rate.

2. *Disadvantages:*

- Extremely long training time.
- Limited head poses.
- Not detect black Faces.

B. *Local Binary Pattern (LBP)*

The local binary pattern (LBP) technique is very effective to describe the image texture features. LBP has advantages such as high-speed computation and rotation invariance, which facilitates the broad usage in the fields of image retrieval, texture examination, face recognition, image segmentation, etc. Recently, LBP [11] was successfully applied to the detection of moving objects via background subtraction. In LBP, every pixel is assigned a texture value, which can be naturally combined with target for tracking thermo graphic and monochromatic video. The major uniform LBP patterns are used to recognize the key points in the target region and then form a mask for joint color-texture feature selection.

1. *Advantages:*

- Effective to describe image texture Feature.
- Used in Texture analysis, Image Retrievals, face recognition and Image segmentation.
- Detection of moving object via Background Subtraction.
- It is a Simple Approach.
- Computationally simple than Haar Like feature and fast.
- The most vital properties of LBP features are tolerance against the monotonic illumination changes and computational simplicity.

2. *Disadvantages:*

- Proposed method is not sensitive to small changes in the Face Localization.
- Using larger local regions increases the errors.
- It is insufficient for non-monotonic illumination changes.
- Not accurate.
- Only used for binary and grey images.

C. *AdaBoost Algorithm for Face Detection*

Boosting is an approach to machine learning based on the idea of creating a highly accurate prediction rule by combining many relatively weak and incorrect rules. The AdaBoost algorithm was the first practical boosting algorithm, and one of the most widely used and studied, with applications in numerous field. Using boosting algorithm to train a classifier which is capable of processing images rapidly while having high detection rates. AdaBoost is a learning algorithm which produces a strong classifier by choosing visual features in a family of simple classifiers and combining them linearly. Although AdaBoost [12] is more resistant to over fitting than many machine learning algorithms, it is repeatedly sensitive to noisy data and outliers .AdaBoost is called adaptive because it uses multiple iterations to generate a single composite strong learner. AdaBoost creates the strong learner (a classifier that is well-correlated to the true classifier) by iteratively adding weak learners (a classifier that is only slightly correlated to the true classifier). Throughout each round of training, a new weak learner is added to the group and a weighting vector is adjusted to focus on examples that were misclassified in preceding rounds. The outcome is a classifier that has higher accuracy than the weak learners' classifiers.

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1. *What's Good About Adaboost:*
- Can be used with numerous different classifiers.
- Improves classification accuracy.
- Commonly used in many areas.
- Simple to implement.
- Not prone to overfitting.

2. *Advantages:*
- No a prior knowledge**.** AdaBoost is an algorithm which only needs two inputs: a training dataset and a set of features (classification functions). There is no need to have any a priori knowledge about face structure.
- Adaptive algorithm. At each stage of the learning, the positive and negative examples are tested by the current classifier. If an example is misclassified, i.e. it cannot clearly be assign in the good class. In order to increase the discriminant power of the classifier these misclassified examples are up-weighted for the next algorithm iterations.
- The training errors theoretically converge exponentially towards 0. Given a finite set of positive and negative examples, the training error reaches 0 in a finite number of iterations.
- Very simple to implement.
- Do feature selection resulting in comparatively simple classifier Fast.
- Simple and easy to Program.
- No former knowledge needed about weak learner.

3. *Disadvantages:*
- The result depends on the data and weak classifiers. The quality of the final detection depends highly on the consistence of the training set. Both the size of the sets and the interclass variability are important factors to take in account.
- Quite slow training. At each iteration step, the algorithm tests all the features on all the examples which requires a computation time directly proportional to the size of the features and examples sets.
- Weak classifiers too complex leads to overfitting.
- Weak classifiers too weak can lead to low margins, and can also lead to overfitting.
- Suboptimal solution. Sensitive to noisy data and outlier.

D. SMQT Features and SNOW Classifier Method
This method consists of two phase. The primary phase is face luminance. The operation of this phase is being performed to get pixel information of an image and further implemented to detection purpose. The second phase is detection. In this phase, local SMQT features are used as feature extraction for object detection. The features were found to be able to cope with illumination and sensor variation in object detection. The split up SNOW is proposed to speed up the standard SNOW classifier. The split up SNOW classifier requires just training of one classifier network which can be arbitrarily divided into several weaker classifiers in cascade. All weak classifier uses the result from previous weaker classifiers which makes it computationally efficient [13].

1. *Advantages*:
- The features were found to be capable to deal with illumination and sensor variation in object detection.
- It was introduced to speed up the standard Snow classifier.
- Computationally efficient.

2. *Disadvantages:*
- If we consider color of the human skin .colors varies less as compared to brightness.
- The majority of the misses includes regions that contain very similar to gray values regions that are present in an image which might detect them as face.
- Experimental outcome using this approach show that the new approach can detect face with high detection rate and low false acceptance rate.

E. Neural Network-Based Face Detection
We present a neural network-based upright frontal face detection system. A rationally attached neural network examines small windows of an image, and chooses whether each window contains a face. The system arbitrates between several networks to improve performance over a single network. This eliminates the complex task of manually selecting nonface training examples, which must be selected to cover the entire space of nonface images [14].

1. First Stage: A Neural Network-Based Filter
The first component of our system is a filter that receives as input a 20x20 pixel region of the picture, and generate an output ranging from 1 to -1, signifying the presence or absence of a face, correspondingly. To detect faces anyplace in the input, the filter is applied at all location in the image. To detect faces bigger than the window size, the input image is repetitively reduced in size (by sub sampling), and the filter is applied at each one size.

2. Second Stage: Merging Overlapping Detections and Arbitration
The raw output from a single network will contain a number of false detections. In this part, we present two strategies to improve the reliability of the detector: merging overlapping detections from a single network and arbitrating among multiple networks.

3. *Advantages:*
- Our algorithm can detect between 78.9% and 90.5% of faces in a set of 130 test images, with an satisfactory number of false detections.
- Less computationally expensive
- Acceptable false detection.

4. *Disadvantages:*
- The detection process is slow due to train the nonface window.
- The result is not so much accurate.
- A number of guidelines for future effort.
- The methodology is complex.

IV. CONCLUSION

In this article, we present an extensive survey of object tracking methods. It is exciting to see face detection techniques be increasingly used in real-world applications and products. For instance, most digital cameras today have built-in face detectors, which can help the camera to do better auto-focusing and auto-exposure. The most straightforward future direction is to further improve the learning algorithm and features. The Haar features used in the effort by Viola and Jones are very simple and effective for frontal face detection, but they are less ideal for faces at random poses. Another interesting idea to improve face detection performance is to consider the contextual information. Human faces are most likely linked with other body parts, and these other body parts can provide a strong cue of faces. In environments which have low variations, adaptation could bring extremely significant improvements to face detection. Unlike in other domains such as speech recognition and handwriting recognition, where adaptation has been indispensable, adaptation for visual object detection has received relatively little attention.

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