Real time Face Detection

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Abstract— Face detection puts forth a challenging problem in the field of Computer Vision. Detecting faces in real time have many applications especially in the safety and security domain. The primary aim of Face detection algorithms is to detect faces in an image or in a video stream successfully so that they could be further used for applications such as Face recognition. Object detection systems developed traditionally have had a lot of success in detecting objects such as humans, cars, buildings etc. but real time face detection presents a new challenge. In this paper, we provide efficient and robust face detection algorithms which adapt to real-world situations like the face being in poor light conditions, multiple faces in a window, pose, different orientations, varied expressions, to detect faces with maximum accuracy.

Keywords— Face detection, AdaBoost Algorithm, Cascade Classifier, Haar cascade classifier, Local binary pattern classifier, Histogram of oriented gradients, Haar-Like features, Viola-Jones.

I. Introduction

Real-time Face detection lies in the field of Computer Vision. In the recent decade, face recognition[7] has come up as an intriguing field and face detection is the first step that comes up in this aspect. To detect faces in a window which possibly consists of multiple objects as well as faces is not an easy task. Conventional algorithms for face detection were accurate when the face was properly aligned and under suitable conditions but failed to produce expected results when they came across real world situations. They worked on colored images. But colored images greatly reduced the accuracy and efficiency of face detection and recognition as colors increase the data complexity by mapping pixels onto a high dimensional matrix. A breakthrough was achieved in this field when ViolaJones [1] proposed their algorithm for real time face detection and recognition. It was also known by this time that the images in gray scale produced far better results than colored images. The algorithms proposed in this paper work on gray scale images to detect faces in real time with high accuracy. OpenCV provides us two cascade classifiers namely haar cascade and the local binary pattern classifier. The Haar cascade classifier when combined with the Ada boost algorithm produces extremely accurate outputs for face detection. The local binary pattern classifier on the other hand is a lot faster than the haar cascade classifier but 10-20% less accurate. To detect faces on an embedded system, LBP proves to be the better choice because it does all the calculations in integers. Haar uses floats which do not work very well with embedded or mobile systems.

II. RELATED WORK

Face detection is usually the first step towards many facerelated technologies [9], such as face recognition or verification. However, face detection itself can have very useful applications. The most successful application of face detection would probably be photography. When you take a picture of your friends, the face detection algorithm built into your digital camera detects where the faces are and adjusts the focus accordingly. Head pose estimation is another application that heavily relies on face detection. Estimating the head pose is useful in the settings of automated guided cars, where an incar device runs the head pose estimation algorithm to detect the drowsiness of the driver. Yang, Kriegman, and Ahuja [2] presented a classification for face detection methods. These methods were divided into four categories, and the face detection algorithms could belong to two or more groups. The knowledge-based method depends on the set of rules, and it is based on human knowledge to detect the faces. The featurebased method is to locate faces by extracting structural features of the face. It is first trained as a classifier and then used to differentiate between facial and non-facial regions. The idea is to overcome the limits of our instinctive knowledge of faces. Template Matching method uses predefined or parameterized face templates to locate or detect the faces by the correlation between the templates and input images. The appearance-based method depends on a set of delegate training face images to f i n d out face models. The appearance-based approach is better than other ways of performance. In general, appearance-based methods rely on techniques from statistical analysis and machine learning to find the relevant characteristics of face images. This method is also used in feature extraction for face recognition.

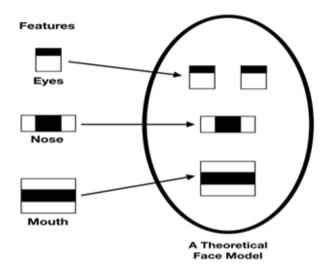
New methods that use global features of the faces had started to develop way back in the 90s. Turk and Pentland proposed Eigenfaces [4] based on Principal Component Analysis.

Other methods like Fisher faces or Laplacian faces extract features from face images and perform the nearest neighbor identification using Euclidean distance measure. Babacket al. [3] used a Bayesian approach where a probabilistic similarity measure is used to perform classification. Wright et al. applied the ideas of sparse coding to face recognition: they proposed the Sparse Representation based Classification scheme, a dictionary learning based approach to recognize faces. This method, which can be seen as an improvement over the previous ones, is far more robust and is able to handle occlusions and corruption of face images. LBP [10] was introduced to the field of Computer vision as early as 1994 as a visual descriptor for classification purposes. It has further been found out that LBP when combined with HOG [8], improves the detection performance considerably on many data sets. There are many techniques to detect faces, with the help of these techniques, we can identify faces with higher accuracy. The face detection works as to detect multiple faces in an image. Here we work on OpenCV for Face Detection, and there two classifiers which OpenCV provides.

III. HAAR CASCADE CLASSIFIER

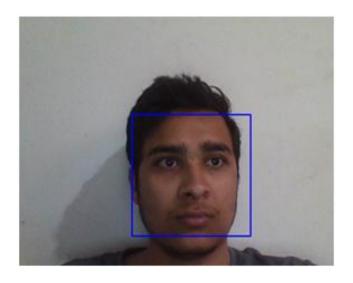
Face detection uses classifiers, which are algorithms that detect what is either a face (1) or not a face (0) in an image. Classifiers have been trained to detect faces using thousands to

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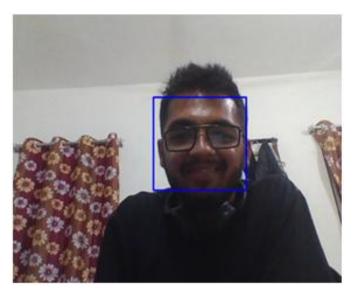


millions of images in order to get more accuracy. The Viola-Jones algorithm [1] is also known as the haar cascade algorithm. The Haar cascade classifier is based on the Haar Wavelet technique to analyze pixels in the image into squares by function. It uses machine learning techniques to get a high degree of accuracy from the training data. Using the integral image concepts to compute the features detected, the Haar Cascades use the AdaBoost learning algorithm which selects a small number of important features from a large set to give an efficient result of classifiers. A Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, then sums up the pixel intensities in each region and calculates the difference between these sums. This difference is then used to categorize subsections of an image. In the Viola-Jones object detection [1], we move a window of target size over an input image, and for each subsection of the Haar Cascade uses machine learning techniques in which a function is trained from a lot of positive and negative images.

 $Value = \Sigma$ (pixels in black area) $-\Sigma$ (pixels in white area)



This process in the algorithm is feature extraction. We use the haarcascade_frontalface_default.xml file provided by OpenCV to detect the frontal face of the person in front of the webcam. A rectangular box is put on the person's face whose dimensions are 130×100 .



Our program loops to take 30 images of the person in front of the camera with a time gap between each click, so that different expressions of the same person can also be captured. The name of the person whose images are being captured is taken as a command line argument. The images taken for each person are stored in a sub directory within our main directory. These images are converted from RGB to gray-scale and captured so that face recognizer modules provided by OpenCV such as the local binary pattern histogram (LBPH) [7] can be trained for these image datasets.

We captured 30 images and stored the frontal face feature set in the named sub directory or the sub folder of the person in gray-scale.





IV. LOCAL BINARY PATTERN AND HISTOGRAM OF ORIENTED GRADIENTS

Local binary pattern (LBP) is a type of a visual descriptor used for classification purposes in computer vision. It was first described in 1994 and since then it has been found to be a powerful feature for texture classification. The histogram of oriented gradients (HOG) [8] is a feature descriptor used in computer vision and image processing for the purpose of object detection. The technique counts occurrences of gradient orientation in localized portions of an image. This method is similar to that of edge orientation histograms, scale-invariant feature transform descriptors, and shape contexts. The only difference is that it is computed on a dense grid of uniformly spaced cells and uses overlapping local contrast normalization for improved accuracy.

V. CONCLUSION

This paper presents an approach for Face detection using the Viola-Jones algorithm [1][5] which can in turn be used for face recognition and applications like surveillance and security. An approach using the LBP [10] along with the HOG classifier [6] was also discussed which could provide us with a very fast training time without compensating the accuracy of our face detection system.

Compared to traditional detection techniques, the ViolaJones detection technique provides us with much more efficient and accurate outputs using images as well as during a live video stream. The results can yet be improved by using higher resolution cameras.

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