International Journal of Engineering Research in Electronic and Communication Engineering (IJERECE) Vol 3, Issue 5, May 2016

An Approach for Face Detection Using HAAR Features for Automatic Attendance System

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***Abstract*— Human face detection has a wide application in biometric and security fields. It finds its application in photography, video surveillance and in many other areas. This paper proposes a face detection approach using Viola Jones algorithm with a Haar features converted to integral image to decrease the computational complexity. AdaBoost algorithm is used for feature selection and attentional cascade for fast rejection of non-face windows. This approach performs fifteen times faster than other face detection algorithms. This method is implemented in college for automatic class attendance system, which takes real time image as input and detects faces crops the face region and display along with their count, which helps in taking automatic attendance. With a high accuracy, the detected faces along with the count are updated. An improved result for face detection and accuracy is obtained using this algorithm.**

Keywords- face detection, haar features, Integral image, Adaboost algorithm

I. INTRODUCTION

Face detection has been regarded as the most complex and challenging problem in the field of computer vision, due to the large intra-class variations caused by the changes in facial appearance, lighting, and expression. Such variations result in the face distribution to be highly nonlinear and complex in any space which is linear to the original image space. Moreover, in the applications of real life surveillance and biometric, the camera limitations and pose variations make the distribution of human faces in feature space more dispersed and complicated than that of frontal faces. It further complicates the problem of robust face detection.

During the past few years, considerable progress has been made in face detection and face recognition on video based system. Many algorithms and methods have been developed for detection and recognition of face. Tremendous interest in automatic processing of digital images and videos due to wide range availability of power and low-cost desktop embedded computing. It finds application in biometric authentication, video surveillance, human-computer interaction and security system. In face recognition system the first step is face detection. The face detection can be based on Skin Color, Motion, Facial appearance or combination of all these parameters. Face detection locate the exact position and size of the human face in the image or in video frame. For face detection they are many classifiers like Adaboost algorithm classifier and Support Vector Machine classifier.

The viola Jones algorithm for face detection involves three main steps. First step is 'Integral image': based on the features used by the detector, it will compute very fast. Second step is 'learning algorithm': it selects the main visual features and affords real efficient classifiers. Third step is 'cascade': it joins the classifiers in cascade which makes the background region in the image to be cast away and mainly focus on the object like regions. It is fifteen times quicker than any other technique. The feature selection is done by using Local Binary patterns.

II. FACE DETECTION SYSTEM OVERVIEW

The basic principle of the Viola-Jones algorithm is to scan a sub-window capable of detecting faces across a given input image. The standard image processing approach would be to rescale the input image to different sizes and then run the fixed size detector through these images. This approach turns out to be rather time consuming due to the calculation of the different size images. Contrary to the standard approach Viola-Jones rescale the detector instead of the input image and run the detector many times through the image – each time with a different size. At first one might suspect both approaches to be equally time consuming, but Viola-Jones have devised a scale invariant detector that requires the same number of calculations whatever the size. This detector is constructed using a so-called integral image and some

simple rectangular features reminiscent of Haar wavelets. The Viola Jones algorithm has the following stages

- Haar features
- Integral image
- Adaboost learning algorithm
- cascading

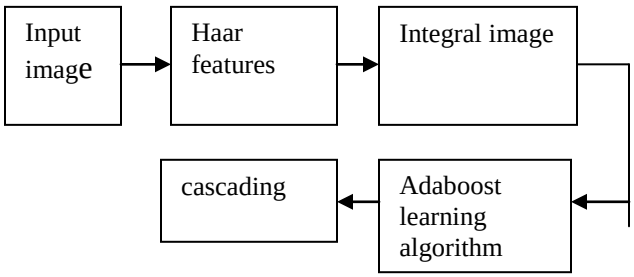

Fig 1: Block Diagram of Face Detection System

A. HAAR features

Haar features are more similar to convolution kernel, which are used to detect the presence of that feature in the given image. So we have the haar features, which are generally used in viola jones algorithm.

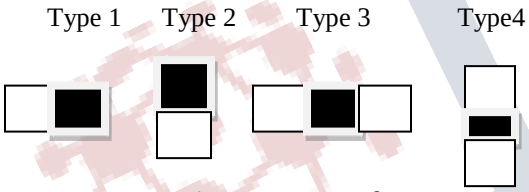

Figure 2: HAAR features

So if we at these haar features, what does it simplifies is that a black region is replaced by +1 and white region is replaced by -1. If we want to apply this mask to an image, we just need to subtract the pixel under white region by the pixel under black region and the output is a single value.

Viola Jones uses 24*24 sub window on an image and then calculate its features all over this image. Now, if we apply this 2 pixel feature over the face and calculate the value and so on move it across the entire image till we end up reaching the bottom corner pixel of the image. This 2 pixel feature now increase the size of this feature, then it should be made 2pixel white and 2 pixel black. So now this feature is of 4 pixel sizes and now we apply the same feature again all over the image by shifting it 1after 1 pixel and we get the value. And again we make 4pixel white and 4 pixel black and again apply it to the image, similarly samething is done by increasing the size and width of all feature and moving it around the entire image. If we consider all the variation, size, position of all these features we end up calculating about 160,000 features in this 24*24 window. The evaluation of this huge set of features looks practically very difficult. So we need to eliminate the redundant features or features which are not used and select those features which are very useful to us. Now let us bring into picture something called as integral image.

B. Integral image

Every single time if we need to sum up all pixels in black region and sum up all pixels in white region. So whenever we want to calculate the sum of this area, it does not look computationally efficient, when we want to calculate in real time and it becomes very lenthy that is because of so many features. So viola jones has come up with an idea, basically it is a trick to solve this problem, that is called ad integral image.

The basic idea behind integral image is say if we want to calculate any feature, we need not to sum up all the pixels rather we use the corner corner values of the patch and do the simple calculation.

The first step of the Viola-Jones face detection algorithm is to turn the input image into an integral image. This is done by making each pixel equal to the entire sum of all pixels above and to the left of the concerned pixel. This is demonstrated in below Figure 3.

1	1	1
1	1	1
1	1	1

Input image

1	2	3
2	4	6
3	6	9

Integral image

Figure 3: The Integral Image

This allows for the calculation of the sum of all pixels inside any given rectangle using only four values. These values are the pixels in the integral image that coincide with the corners of the rectangle in the input image. This is demonstrated in Figure 4.

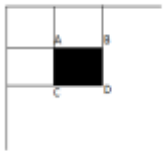

Figure 4: sum calculation

Sum of grey rectangle = D - (B + C) + A

Since both rectangle B and C include rectangle A the sum of A has to be added to the calculation. It has now been demonstrated how the sum of pixels within rectangles of arbitrary size can be calculated in constant time. The Viola-Jones face detector analyzes a given sub-window using features consisting of two or more rectangles.

C. Adaboost algorithm

As stated above there can be calculated approximately 160,000 feature values within a detector at base resolution. Among all these features some few are expected to give almost consistently high values when on top of a face. In order to find these features Viola-Jones use a modified version of the AdaBoost algorithm developed by Freund and Schapire in 1996.

Ada Boost is a machine learning boosting algorithm capable of constructing a strong classifier through a weighted combination of weak classifiers. (A weak classifier classifies correctly in only a little bit more than half the cases.) To match this terminology to the presented theory each feature is considered to be a potential weak classifier.

Since only a small amount of the possible 160,000 feature values are expected to be potential weak classifiers the AdaBoost algorithm is modified to select only the best features.

An important part of the modified AdaBoost algorithm is the determination of the best feature, polarity and threshold. There seems to be no smart solution to this problem and Viola-Jones suggest a simple brute force method. This means that the determination of each new weak classifier involves evaluating each feature on all the training examples in order to find the best performing feature. This is expected to be the most time consuming part of the training procedure.

The best performing feature is chosen based on the weighted error it produces. This weighted error is a function of the weights belonging to the training examples. As seen in Figure 5 the weight of a correctly classified example is decreased and the weight of a misclassified example is kept constant. As a result it is more 'expensive' for the second feature (in the final classifier) to misclassify an example also misclassified by the first feature, than an example classified correctly. An alternative interpretation is that the second feature is forced to focus harder on the examples misclassified by the first. The point being that the weights are a vital part of the mechanics of the Ada Boost algorithm.

With the integral image, the computationally efficient features and the modified AdaBoost algorithm in place it seems like the face detector is ready for implementation

D. The cascaded classifier

The basic principle of the Viola-Jones face detection algorithm is to scan the detector many times through the same image – each time with a new size. Even if an image should contain one or more faces it is obvious that an excessive large amount of the evaluated sub-windows would still be negatives (non-faces). This realization leads to a different formulation of the problem: Instead of finding faces, the algorithm should discard non-faces.

The thought behind this statement is that it is faster to discard a non-face than to find a face. With this in mind a detector consisting of only one (strong) classifier suddenly seems inefficient since the evaluation time is constant no matter the input. Hence the need for a cascaded classifier arises. The cascaded classifier is composed of stages each containing a strong classifier. The job of each stage is to determine whether a given sub-window is definitely not a face or maybe a face. When a sub-window is classified to be a non-face by a given stage it is immediately discarded. Conversely a sub-window classified as a maybe-face is passed on to the next stage in the cascade. It follows that the more stages a given sub-window passes, the higher the chance the sub-window actually contains a face. The concept is illustrated with two stages in Figure 5.

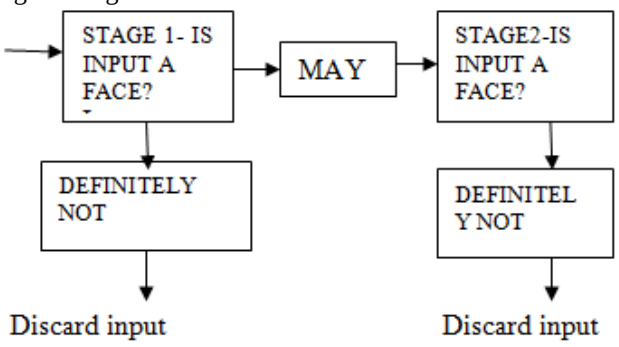

Figure 5: the cascade classifier

In a single stage classifier one would normally accept false negatives in order to reduce the false positive rate. However, for the first stages in the staged classifier false positives are not considered to be a problem since the succeeding stages are expected to sort them out. Therefore Viola-Jones prescribes the acceptance of many false positives in the initial stages. Consequently the amount of false negatives in the final staged classifier is expected to be very small.

Viola-Jones also refer to the cascaded classifier as an attentional cascade. This name implies that more attention (computing power) is directed towards the regions of the image suspected to contain faces.

It follows that when training a given stage, say n, the negative examples should of course be false negatives generated by stage n-1.

III METHODOLOGY

In order to verify our algorithm, we tested it on real images. The input images of our classmates are taken for the purpose of attendance system application. The vision cascade object detector uses Viola Jones algorithm and trained classification model for detection. In order to train the different stages of the cascaded classifier, it requires a positive samples are to be trained – that is, images of faces. The faces used in this project were taken from students of our college. so that it can be implemented for automatic attendance system by updating the counts for the detected faces.

After training the samples, the cascade classifier will detects the region of interest. Then we extracted the facial features using Haar features. After that a face tracking is done.

The first step in real time face detection is, giving the input image containing students of the class in order the take attendance through the system.

After the input is given, the system detects for the face in the image after training it with the positive samples. Then it detects for the facial feature in the face. Once the facial feature gets extracted, the face get tracked.

Totally there are 16 students in our class. An image of 8 students are given to detect the faces.

Figure 6: detected faces of 8 students

And finally the detected faces are all displayed Once the face detection is done for the input image of class students, the count of the total number of students get updated.

Figure 7: Detected face along with their count

Figure8: Detected faces of other 8 students

Figure 9: Detected faces with their count of other 8 students

So totally all 16 are getting detected. The class strength is 16 and all faces are getting detected. So the accuracy is very high. Thus, we can say, our algorithm can detect multiple faces of different sizes with a wide range of facial variations in an image. One of the challenging tasks in face detection is detecting faces in groups and our algorithm gives very excellent detection accuracy.

IV CONCLUSION

We through this research paper are putting forth a humble effort in the form of an algorithm to detect faces under varied conditions. Thus we proposed an efficient method for face detection using Viola Jones algorithm with a Haar features. Our algorithm improves the detection speed as well as detection rate. With the high accurate face detection system, the count of the automatic attendance system of students is taken accurately.

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