

# A Review on Face Detection and Recognition Techniques

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## Abstract

The main purpose of this paper is to review the methods of face detection and face recognition with machine learning as a core recognition algorithm. The different methods that are involved has been categorically mentioned where face detection and recognition is taken as the first step for information drawing for many image processing application.

The live capturing and distinguishing of an object and detection and recognition is generally a challenging task. In this review,an attempt has been made to do research on existing algorithms and schemes is defined the limitation of different method and system in place has been discussed.

## Keywords

Haar Based Cascade Classifier, Histogram of Oriented Gradient, Face Landmark Detection, AdaBoost Algorithm

## I. Introduction

In this era of hi-tech automatic machines and gadgets the authentication and security becomes major problem to get worried about. Many home people becomes the victim of robbery and crimes.to prevent crimes people has started using various security related systems which are only workable in certain extents.By those security systems people feels more safe and secure. The system like CCTV camera can only guard up to the certain area and with less functions and facilities. So the real time face detection and recognition becomes the major problem when it comes to security camera. The security system must be able to detect the presence of an object and recognize the object .as per the literature survey the algorithms like Voila john algorithm, Histogram of face oriented gradient are more useful in detection and recognition of an object.

## A. Voila John algorithm

The main focus of Voila John algorithm is to solve the problem of face detection. For computer to detect face needs precise instruction and constraints to make the task manageable the Voila John needs the full frontal control upright facial view. In order to detect the face must be faced toward the camera and should not be tilted. The Voila John algorithm poses four stages for face detection [6].

1. Haar feature selection
2. Creating an integral image
3. AdaBoost training
4. Cascading classifiers

For each feature calculation, it need to find sum of pixels under white and black rectangles. To solve this, Voila and john introduced the integral images. It simplifies calculation of sum of pixels which classify how large may be the number of pixels, to an operation involving just four pixels. It makes detection super-fast [1]. AdaBoost is used to select the best feature of a pixel. For each new images it will apply AdaBoost features and each features it finds the best threshold which will classify the faces to positive and negative. Classifier is a mathematical approach for machine

learning. In terms of machine learning classifier is a supervised learning process. The Voila John object detection frame work is the first step for object recognition, it can be trained to detect various object classes.

## 1. Haar Features Selection

The algorithm needs a lot of positive image (image of face) and negative image (image without faces) to trained the classifier. It uses three methods:

- Edge features
- Line features
- Four rectangle features

## 2. Creating an Integral Image

The integral image simplifies the calculation of sum of pixels, how large may be the number of pixels, to an operation involving just four pixels which makes things super-fast. the integral image is define as two deminisional look up table which is in form of matrix with the exact size of the original images.this computes the rectangular area of the image at certauin position scale. The point A, B, C, D is a point of integral images I, as in the fig.

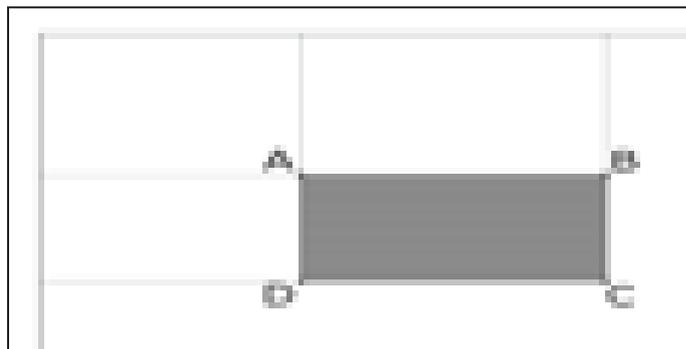


Fig. 1: Finding the Sum of the Shades Rectangular Area (Image Source Wikipedia)

$$\text{Sum} = I(C) + I(A) - I(B) - I(D).$$

## 3. AdaBoost training

AdaBoost is a learning classification function which when given a set of features and a training set of positive and negative Images, to learn a classification function any number of machine learning approaches could be used. AdaBoost is used to train the classifiers as well as to select a small set of features when used in its real form, AdaBoost learning function boosts the performance of a simple learning algorithm (sometimes called weak). AdaBoost has capability to achieve large margins rapidly which is one of the key features of this algorithm.

## 4. Cascading Classifiers

The cascading of classifiers and their training whose training functions were Increase the performance detection while reducing the detection time are the key features of this algorithm. Simpler Classifiers separate the positive and the negative from the image, hence are called weak classifiers or initial classifiers. Then

additional features are added to other classifiers and hence are called complex or strong classifiers.

Face landmark detection: facial landmark detection is a computer vision topic and it deals with the problem of detection distinctive features in human faces automatically. It also referred to as “facial feature detection” “facial key point detection” and “face alignment”.

- Tip of the nose
- Corners of the eyes
- Corners of the eyebrows
- Corners of the mouth
- Eye pupils

The color the texture or the motion is used in object detection. The HOG descriptor techniques calculates the occurrence of gradient orientation in localize area of an image or region of interest (ROI).

### B. The Histogram of Oriented Gradient (HOG)

Image (or a region of interest in the image) as opposed to only the local neighborhood of key points like SIFT. Intuitively it tries to capture the shape of structures in the region by capturing information about gradients. It does so by dividing the image into small (usually 8x8 pixels) cells and blocks of 4x4 cells. Each cell has a fixed number of gradient orientation bins. Each pixel in the cell votes for a gradient orientation bin with a vote proportional to the gradient magnitude at that pixel.

To reduce aliasing, the pixels votes are linearly interpolated. This interpolation happens in both the orientation as position. This statement is important - it means that a pixel will not only vote for its orientation bin, but also for the two neighboring orientation bins (e.g. if the gradient orientation at a pixel is 45 degrees, it will vote with a weight of 0.5 for the 35 to 45 degree bin and a weight of 0.5 for the 45 to 55 degree bin). Similarly, it will vote for these two orientation bins not only in its cell, but also in the 4 neighboring cells of its cell. The weights here are decided by the distance of the pixel from the cell centers.

Histograms are also normalized based on their energy (regularized L2 norm) across blocks. Since the blocks have a step size of 1 cell, a cell will be part of 4 blocks. This defines four differently normalized versions of the cell's histogram. These 4 histograms are catenated to get the descriptor for the cell. Typically, the elements of histograms are also capped at some value.

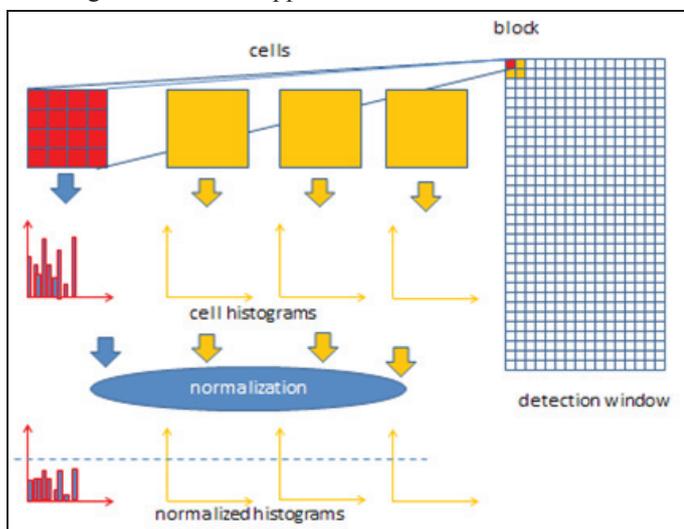


Fig. 2: Image Process in HOG (Image Source Google)

## II. Literature Review

The technique for real time human face detection and tracking using a modified version of the algorithm suggested by Paul Viola and Michael Jones [1]. This developed algorithm computes data and produce results in just a fraction of seconds. Using the technique like integral image and AdaBoost learning classification function which when given a set of features and a training set of positive and negative images, to learn a classification function any number of machine learning approaches could be used. AdaBoost is used to train the classifiers as well as to select a small set of features and integral image simplifies the calculation of sum of pixels involving just four pixels which makes thing super-fast.

The system also describes the localizing and extracting the face region from the background. It also has several application in areas such as content based image retrieval video coding, video conferencing, crowd surveillance and intelligent human computer interfaces [2]. A wide variety of techniques have been proposed, ranging from simple edge-based algorithms to composite high level approaches utilizing advanced pattern recognition methods.

The various author aims for an automatic face recognition or facial expression recognition using the three proposed method which has the three stages: (a) face detection, (b) feature extraction and (c) facial expression recognition. Skin color is used as a feature for detecting human faces and the output of the first phase is used for extracting the facial features like eyes, nose, and mouth using Active Appearance Method (AAM) [3]. The automatic facial expression recognition involves simple Euclidean Distance method.

For real time detection of face in sequential frames containing face and complex object in background with less processing time for detection and recognition process. To reduce human intervention and increase overall system efficiency the system is segregated into three stages-motion detection, face detection and recognition [4]. Motion detection reduces the search area and processing complexity of system. Video processing is used to detect movement of multiple object in static and dynamic background in a near real time change or motion detection is accomplished with background. Motion detection is done using background subtraction model [4] to localized moving object.

In order to aim at security and surveillance using raspberry pi kit making the system cost effective and easy to use with high performance. This paper aims at taking face recognition to a level in which the system can replace the use of passwords and RFI cards for access to high security system and building. Object Detection [5] using Haar feature-based cascade classifiers was also used which is an effective method which was proposed by Paul Viola and Michael Jones.

It is an adaptive machine learning based approach in which a cascade function is trained from several positive and negative images. This is then used to detect objects in other images. Initially, this algorithm requires plenty of positive images (images of faces) and negative images (images without faces) to train the classifier. Then Features are extracted from the images.

## III. Limitations

After going through papers of different authors the limitations which need to be consider in further implementation of Face detection and recognition system is, it can only track up to fifty faces. No comprehensive comparative evaluation has been done and need to be implemented new algorithm. The system can detect only six universal expression, the method has less computational complexity and it is not popularly used due to unreliability and

inability to handle minute variations in the features. Add feature like recording time and date for a person whose image has been recognized and also keep it on a database for making system more useable. Cost factor can be reduce by implementing the cheaper system like face detection and recognition for making more authentic and comprehensive system for the users.

Table 1: (Comparative of various system on Face Detection and Recognition)

SL No	Author and publication house	Title of the paper	Techniques used	Limitation
1.	Jatin chatrath, Et.al 2014 International Conference on Signal Processing and Integrated Networks (SPIN)	Real time human face detection and tracking	Human face detection, Integral Image, AdaBoost.	This system can detected and track up to 50 human faces
2.	Ishita Gupta, Varsha Patil, Chaitali Kadam, Shreya Dumbre. 2016 IEEE International WIE Conference on Electrical and Computer Engineering (WIECON-ECE) 19-21 December 2016, AISSMS, Pune, India	Face Detection and Recognition using Raspberry Pi	- Face recognition, face detection, Haar Detection, PCA, and Raspberry Pi.	We can add feature like recording time and date for a person whose image has be recognized and also keep it on a database
3.	Nawaf Yousef Almodhahka , Mark S. Nixon, Jonathon S. Hare	Automatic Semantic Face Recognition	Soft biometrics labeled face in wild dataset	Add some gesture movements for automatic reorganization of face
4.	Erik Hjelmas , Boon Kee Low Received October 23, 2000; accepted April 17, 2001	Face Detection: A Survey	face detection; face localization; facial feature detection; featurebased approaches; image-based approaches.	No comprehensive comparative evaluation.
5.	Md. Syadus Sefat, Abdullah Al Mamun Khan, Md. Shahjahan ,3rd international conference on informatics, electronics and vision 2014	Implementation of vision based intelligent home automation and security system	Autonomous system, Counting mechanism, Image processing, OpenCV. I	The system can also count the number of people in the room by using image processing algorithm and will automatically turns off the entire load in the room when no one is present
6.	S. V. Tathe, A. S. Narote , S. P. Narote 2016 Intl. Conference on Advances in Computing, Communications and Informatics (ICACCI), Sept. 21-24, 2016, Jaipur, India	Human Face Detection and Recognition in Videos	Video Processing, Motion Detection, Face detection, Face Recognition	The method has less computational complexity .it is not popularly used due to unreliability and inability to handle minute variations in the features
7.	Tian Xuehong School of Education Science Hangzhou Normal University Hangzhou, China	Face Recognition System and It's Application	Face recognition; Image Processing; Discriminant Analysis	There must be adequate test image to do feature extraction
8.	Qianqian Zhao, Hualong Cai, 2010 2nd International Conference on Future Computer and Communication	The Research and Implementation of Face Detection and Recognition Based on Video Sequences	Kalman filter; face detection and recognition	The input sequences used for this researched in this paper is the video sequences with static background.
9.	Markus mathis, Radrigo Benenson, Marco Pedersoli, Lue Van Gool	Face detection without bells and whistles	Integral channel features detector ,FDDB dataset	This research they did not focused on face quality and high performance which remain un explained
10.	AnaghaS. Dhavalikar, Dr.R.K. Kullarni, 2014 International Conference on Electronics and Communication System (ICECS -2014)	Face Detection and Facial Expression Recognition System	Face detection, Feature extraction, AAM, Expression recognition, Euclidean Distance, ANFIS	It can detect only six universal expression

#### IV. Conclusion

The table above has exclusive list of various methodologies that imply on finding out various features of face and facial extraction that can be of use for detection and recognition. The studies shows that the researchers implemented algorithm for detection.

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