

Face Tracking and Robot Shoot using Adaboost Method

Priyanka Kulkarni¹, Vijay D. Chaudhari² and Kantilal P. Rane³

¹North Maharashtra University, Department Of E & TC,
GF's Godavari Collage of Engineering, Jalgaon, Maharashtra, INDIA.

^{2,3}North Maharashtra University, Department Of E & TC,
GF's Godavari Collage of Engineering, Jalgaon, Maharashtra, INDIA

ABSTRACT

Face detection & tracking is concerned with finding whether or not there are any faces in a given image and, if present, return the image location and content of each face. Recently, Adaboost has been widely used to improve the accuracy of any given learning algorithm. In this paper we focus on designing an algorithm of Adaboost. In this paper, we present a face detection and tracking algorithm in real time camera input environment. The entire face tracking algorithm is divided into two modules. The first module is face detection and second is face tracking. To detect the face in the image we use adaboost algorithm with classifier. Once face is detected and traced it is indicated by laser beam. The algorithm is applied on real time camera image.

Keywords: Face detection , Face tracking, adaboost, classifier.

1. INTRODUCTION

There are many existing systems to identify faces and recognized them. But the systems are not so efficient to have automated face detection, identification and recognition [1]. A lot of research work is going in this direction to increase the visual power of computer. But there are difficulties in the path such as development of efficient visual feature extracting algorithms and high processing power for retrieval from a huge image database. As image is a complex high dimension matrix and processing matrix operation is not so fast and perfect. Hence, this directs us to handle with a huge image database and focus on the new algorithms which are more real-time and more efficient with maximum percentage of accuracy. Efficient and effective recognition of human face from image databases is now a requirement. Applications of face recognition are widely spreading in areas such as criminal identification, security system, image and film processing [2]. From the sequence of image captured by the capturing device, in our case camera, the goal is to find the best match in the database. Using pre-storage database we can identify or verify one or more identities in the scene. In the proposed system we have used the face processing techniques including face tracking and detection for military application of spotting the person of interest. Here a given face is initialized and is considered as the image of interest. Then processing of the database images is done, tracking, scanning all the images each image is compared with the image of interest. Only one image matches with the database image. Basically, all the study can be simply divided into two categories. One is real time face detection, and the other is the combination of face detection and face tracking. Specifically, some face detection algorithms can get the faces in each frame timely, which can directly achieve the goal of face tracking; the other way to implement face tracking is to detect the face at the start frame first, and then adopt the object tracking algorithm to follow the face in the other frames. The second method of tracking face has been used in this project.

2. RELATED WORK

Face detection is the process of finding all possible faces in a given image. More precisely, we can say face detector has to determine the locations and sizes of all possible human faces in given image. It is a more complex case than face localization in which the number of faces is already known. On the other hand, face detection is the essential first step towards many advanced computer vision, biometrics recognition and multimedia applications, such as face tracking, face recognition, and video surveillance[4]. Face detection is one of the most popular topics of research in computer vision field. In recent years, face recognition has attracted much attention and its research has rapidly expanded by not only engineers but also neuroscientists[5,6], since it has many potential applications in computer vision communication and automatic access control system. However, face detection is not straight forward because it has lots of variations of image appearance, such as pose variation (front,non-front), image orientation, illuminating condition and facial expression.

a) The goal of face detection

The goal of the project is to create a face detector which will be able to find out face candidate present in a given input image and return the image location of each face. For doing that we have to come up with a good algorithm which will be able to give a good detection rate[7-9].

b) Problems closely related to face detection

Face localization

In face localization we have to determine the image position of single face [10]. This is simplified detection problem with assumption that an input image contains only one face.

Facial feature detection

The goal of facial feature detection is to detect the presence and location of features, such as eyes, nose, nostrils, eyebrow, mouth, lips, ears, etc, with the assumption that there is only one face in an image [10].

Face recognition or face identification

In face recognition or face identification it compares an input image against a database and reports a match, if any. The purpose of face authentication is to verify the claim of the identity of an individual in an input image [3].

Face tracking

Face tracking methods continuously estimate the location and possibly the orientation of a face in an image sequence in real time [8].

Facial expression recognition

Facial expression recognition concerns identifying the affective states of humans like happy, sad, disgusted etc.

c) Basic terms

Detection rate:

It is defined as the ratio between the number of faces correctly detected and the number of faces determined by a human [15].

False negative:

In which faces are missed resulting in low detection rates [15].

False positive:

In which an image region is declared to be face but it is not [15].

d) Challenges in face Detection

Due to scale, rotation, pose and illumination variation, face detection involves many research challenges. How to detect different scales of faces, how to be robust to illumination variation, how to achieve high detection rate with low false detection rates are only few of all issues a face detection algorithm needs to be consider.

For face detection following problems need to be considered:

Size: A face detector should be able to detect faces in different sizes. This we can achieved by scaling the input image. And small faces are more difficult to detect than the large face.

Expressions: The appearance of a face changes considerably for different facial expressions and, thus, makes the face detection more difficult. The simplest type of variability of images of a face can be expressed independently of the face itself, by rotating, translating, scaling and mirroring its image. Also changes in the overall brightness and contrast of the image and conclusion by other objects.

Pose variation: The images of face vary due to relative camera-face pose (frontal, 45 degree, profile), and some facial features such as an eye or the nose may become partially or wholly occluded. Another source of variation is the distance of the face from the camera, changes in which can result in perspective distortion [11-13].

Lighting and Texture Variation: Now we will describe how the variation caused by the object and its environment, specifically the object's surface properties and the light sources. Changes in the light source in particular can change a face's appearance.

Background Variation: When an object has predictable shape, it is possible to extract a window which contains only pixels within the object, and to ignore the background. However, for profile faces, the border of the face itself is the most important feature, and its shape varies from person to person. Thus the boundary is not predictable, so the background cannot be simply masked off and ignored.

Presence or absence of structural components: Facial features such as beards, moustaches and glasses may or may not be present. And also there may be variability among these components including shape, color and size [14].

Shape Variation: Shape variation includes facial expressions, either the mouth and eyes are open or closed, and the shape of the individual's face. The appearance of faces are directly affected by person's facial expression.

Occlusion: Faces may be partially occluded by other objects. In an image with a group of people some faces may partially occlude other faces. Partial occlusions of faces can be caused by objects within the environment (e.g, poles and people), objects worn by the person (glasses, scarf, mask), Other body parts of person (hands) and shadows. • **Image orientation:** Faces can appear in different orientation the image plane depending on the the angle of the camera and the face. Images directly vary for different rotations about the camera's optical axis.

3 RELATED WORK ON FACE DETECTION.

3.1 Detection methods

In this section we will discuss existing techniques to detect faces from a single intensity or color image. Single image detection methods can be classified into four categories:

Knowledge-based methods

Knowledge-based methods use human-coded rules to model facial features, such as two symmetric eyes, a nose in the middle and a mouth underneath the nose [9].

Feature invariant approaches

These algorithms aim to find structural features that exist even when the pose, viewpoint, or lighting conditions vary, and then use these to locate faces. Skin color, edges and shapes falls into this category [9].

Template matching methods

Template matching methods calculate the correlation between a test image and pre-selected facial templates. Several standard patterns of face are stored to describe the face as whole or the facial features separately [9].

Appearance-based methods

The last category, appearance-based, adopts machine learning techniques to extract discriminative features from a pre-labelled training set [9].

3.2 Problems Related to face detection and Tracking

3.2.1 Face Localization

In face localization we have to determine the image position of single face [10]. This is a simplified detection problem with the assumption that an input image contains only one face.

3.2.2 Facial Feature Detection

The goal of facial feature detection is to detect the presence and location of features, such as eyes, nose, nostrils, eyes, mouth, lips, ears, etc with the assumption that there is only one face in an image.

3.2.3 Face Recognition And Face Identification

In face recognition or face identification it compares an input image against a database and reports a match, if any. The purpose of face authentication is to verify the claim of the identity of an individual in an input image [3].

3.2.4 Face Tracking

Face Tracking Methods Continuously Estimate The Location And Possibly The Orientation Of A Face In An Image Sequence In Real Time [8].

4. PROPOSED SYSTEM

To overcome all these closely related problems in face detection and face tracking we have used the algorithm of Adaboost. The algorithm results in high accuracy results overcoming various occlusions. AdaBoost is used as a short form for Adaptive Boosting, which is a widely used machine learning algorithm and it is a meta-algorithm used in conjunction with other learning algorithms to improve their performance of that algorithm. AdaBoost algorithm is an adaptive algorithm in the sense that the subsequent classifiers built is weakened in favour of instances of those misclassified by the previous classifiers. But it is very sensitive to noise data and the outliers. The basic idea of boosting is actually to use the weak learner of the features calculated to form a highly correct prediction rules by calling the weak learner repeatedly processed on the different-different distributions over the training examples. Also human-robot interaction is involved in the system. In our project we address one of the computer vision tasks, involved in developing of such an interactive system. The goal of the current project is to implement a system, having the following specifications:

- Track all the faces in an image of multiple faces.
- Match each face with the face image in database.
- When the image is matched and detected or recognized, spot the image with laser gun.

4.1 Flowchart For System

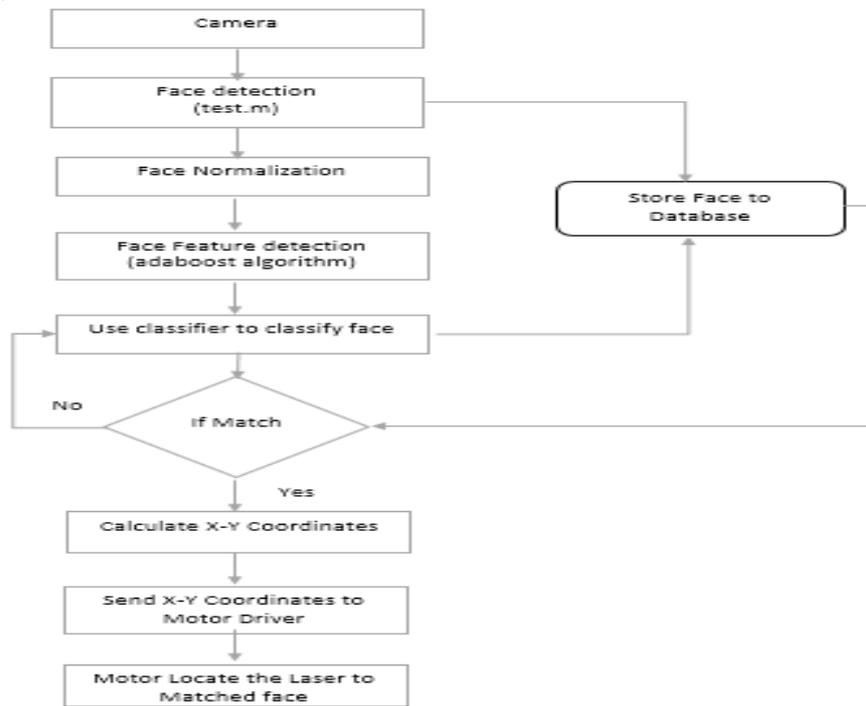


Figure 1: System Flow Chart

4.2 Algorithm for system

1. Read the Image Using Camera
2. Locate the face
3. Detect face using (Test.m)
4. Store the face in database
5. Normalise the detected face
6. Extract the feature using adaboost method
7. Use classify.m to classify detected face
8. Check detected face with face exist in database
9. If face is matched with database face then go to step 11
10. If not then go to step 7
11. Calculate the X-Y Coordinates of detected face
12. Send X-Y Coordinates to Motor driver circuit connected to serial port of PC
13. Motor Start & Locate laser to Particular X-Y coordinates to track the face.

4.3 Block Diagram of Proposed System

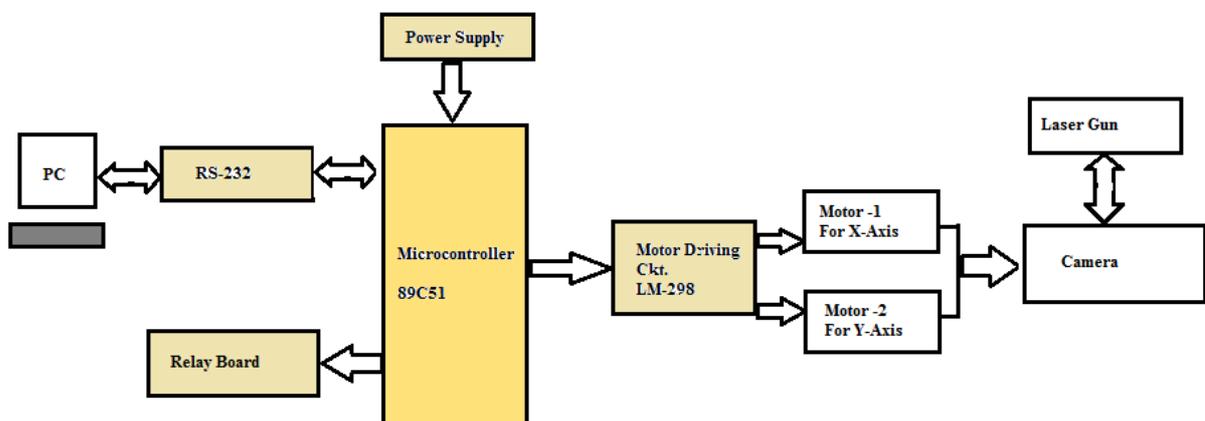


Figure 2: Basic Block diagram

4.4 Software Design

4.4.1 Adaboost algorithm

1. Read the Face Image
2. Normalize face Image
3. Process the Image to detect features like Face ,eyes, nose,
4. Store the features in array
5. Validate the Image by comparing with database
6. Match the face.

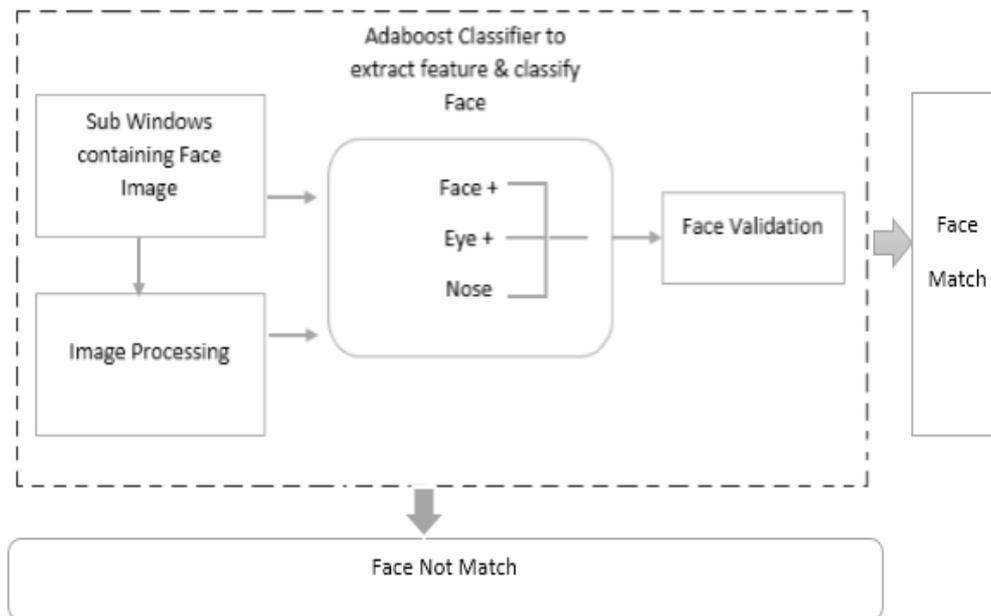


Figure 3 Adaboost design

From the figure above adaboost can be explained in detail. The Adaboost algorithm applied to a face, a particular region in the face being considered and parameters like colour, feature, etc. is extracted. The extracted features are given to trained adaboost classifiers. These classifiers will separate the face and non-face part of an image and a joint decision is taken by the final classifier which has the correct face at the output only. Key ideas for face detection are Integral Images for fast feature evaluation, boosting for feature extraction, attentional cascade for fast rejection of non-face windows.

4.4.2 Detection and Tracking

Face recognition is one of the nonintrusive biometric techniques commonly used for verification and authentication. Local and global features based extraction techniques are available for face recognition. Global features extraction technique calculates co-variance matrix of inter- images whereas auto-correlation matrix is computed in local features technique. PCA is a mathematical procedure that transforms a number of possibly correlated variables into a smaller number of uncorrelated variables called principal components. PCA can be expressed in general as a linear transformation of the image vector to the projection feature vector as given below:

$Y = WTX$, where, W is the transformation matrix having dimension $K \times 1$, Y is the $K \times N$ feature vector matrix and X is the higher dimension face vector obtained by representing all the face images into a single vector $X = \{x_1, x_2, x_3, x_4, \dots, x_n\}$.

4.4.3 System Algorithm Steps

- The image having a group of 8 faces is trained and all the 8 faces are detected and stored in database.
- The matrix size of this image is 415×415 .
- This is the size of the image is the face image size.
- The face is segmented into sub-patterns, the matrix of size 8×8 of each sub-pattern is formed depending upon the features extracted.
- The value of this matrix is compared with predefined PCA value.
- The changes in the image are made until PCA value is equal to bunch value.
- Thus using PCA the accuracy of the face detection or recognition increases tremendously.

4.4.4. System Operation

In the project entitled ‘_Face Tracking and Robot shoot’ Adaboost algorithm is used for obtaining the results with great accuracy. Here face tracking and detection is done using the above mentioned algorithms in Matlab. The concept is identifying the face of interest among ‘n’ number of faces in a sequence or group. The face to be identified is available as face of interest along with the entire group image in the database. All the faces in the group image are scanned. Face Tracking and detection takes place. Once this face is detected in matlab, then dimensions of the detected face in the group are taken. These dimensions are converted into equal steps of angle and the robot shoot module including camera and laser gun are moved according to these dimensions. The camera and laser gun assembly is brought in front of the detected face and a feedback signal is given to the relay via the microcontroller to turn on thereby switching ON the laser gun.

5. RESULT AND DISCUSSION

1) Labeling the faces

The input for software is image having a group of 8 faces. All the faces in the image are labeled as shown below for face identification in order to test all faces in the image and store them properly in the database. Also individual identification of each face in the image becomes easier with such labeling.



Figure 4: Input Image

2) Training of the face Images

In this we sort out each image separately & find its coordinates. Store this data to database. Training of all the faces is performed to detect these images accurately and store them in the database with 100% accuracy using Adaboost algorithm.



Figure 5: Face Identification with its coordinates

3) Matching of the images with visualized vector image

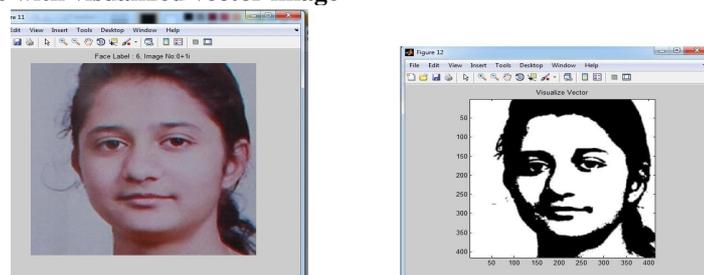


Figure 6: Image 11 matching with its visualized vector image 13

Similarly each face is matched with its visualized vector image with accuracy of 100% using Adaboost algorithms. The face of interest in the database is matched with the its database face in the group image. This concludes the faces are detected, tracked and matched to point out the face of interest. Once we select Image from database to match with Input Image, microcontroller read the coordinate from database and turn ON the Motor for X and Y Axis. Once motor rotate according to coordinates, Laser is ON & Point out the face.

6.CONCLUSION

The Adaboost algorithm used for face tracking and detection provide highest accuracy. Adaboost algorithm achieves a higher detection performance. We introduced an approach to enhance the training classifiers for boosting data for face detection to achieve a higher detection performance The trained classifier achieves a lower classification error being more selective in detection. Our experiments on face detection showed that our method decreases the false positive rate of the boosted classifier. Our approach managed to significantly lower the amount of false alarms without reducing the detection rate. Our method decreases the amount of false positives while maintaining a high detection rate The main advantage of their approach is uncompetitive detection speed while relatively high detection precision, comparable to much slower algorithms. Thus the face of interest can be detected from the database and pointed out.

REFERENCES

- [1] Schapire, R. E., Freund, Y., October 1998, Boosting the margin: a new explanation for the effectiveness of voting methods. *The Annals of Statistics*, 26(5):1651–1686.
- [2] Freund, Y., Schapire, R., Aug 1997 —A decision theoretic generalization of on-line learning and an application to boosting. *Journal of Computer and System Sciences*, 55(1):119–139.
- [3] Schapire R. E., Y. Singer, Dec 1999 —Improved boosting algorithms using confidence-rated predictions. *Machine Learning*, 37(3):297–336.
- [4] Friedman, J., Hastie, T., and R. Tibshirani, July 1998. —Additive logistic regression: a statistical view of boosting Technical report, Department of Statistics, Sequoia Hall, Stanford University
- [5] Dietterich, T. G., Aug 2000 —An experimental comparison of three methods for constructing ensembles of decision trees: Bagging, boosting, and randomization, *Machine Learning*, vol. 40, no. 2, pp. 139–157.
- [6] Papageorgiou, C., Oren, M., Poggio, T. , 1998, A general framework for object detection. In *International Conference on Computer Vision*.
- [7] Viola, P., Jones, M., Dec. 2001, —Rapid Object Detection Using a Boosted Cascade of Simple Features, *Proc. IEEE CS Conf. Computer Vision and Pattern Recognition*.
- [8] Rowley, H., Baluja, S., Kanade, T., 1998, Neural network-based face detection. In *IEEE Patt. Anal. Mach. Intell.*, volume 20, pages 22–38,.
- [9] Li, S. Z., Zhang, Z. Q. , sept. 2004 —FloatBoost Learning and Statistical Face Detection *In IEEE Patt. Anal. Mach. Intell.*, vol. 26, no. 9.
- [10] Haykin, S., July 1998 ,*Neural networks : A comprehensive foundation*. Prentice Hall.
- [11] R. Caves, *Multinational Enterprise and Economic Analysis*, Cambridge University Press, Cambridge, 1982. (book style)
- [12] M. Clerc, “The Swarm and the Queen: Towards a Deterministic and Adaptive Particle Swarm Optimization,” In *Proceedings of the IEEE Congress on Evolutionary Computation (CEC)*, pp. 1951-1957, 1999. (conference style)
- [13] H.H. Crockell, “Specialization and International Competitiveness,” in *Managing the Multinational Subsidiary*, H. Etemad and L. S, Sulude (eds.), Croom-Helm, London, 1986. (book chapter style)
- [14] K. Deb, S. Agrawal, A. Pratab, T. Meyarivan, “A Fast Elitist Non-dominated Sorting Genetic Algorithms for Multiobjective Optimization: NSGA II,” *KanGAL report 200001*, Indian Institute of Technology, Kanpur, India, 2000. (technical report style)
- [15] J.Geralds, "Sega Ends Production of Dreamcast," *vnunet.com*, para. 2, Jan. 31, 2001. [Online]. Available: <http://nl1.vnunet.com/news/1116995>. [Accessed: Sept. 12, 2004]. (General Internet site)

AUTHOR



Priyanka Kulkarni received the B.E. degree in E&TC Engineering from Pune University in 2008 and Appear for M.E Degree In E&TC Engineering. , Currently work as Asst. Professor In Sapakal Collage of Engineering in Nashik, Maharashtra, INDIA. Shee has published different research papers in International Journals and participated in various International Conferences.