

# DETECTION OF HUMAN FACIAL BEHAVIORAL EXPRESSION USING IMAGE PROCESSING

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## Abstract

*The paper presents Haar feature extraction classifier based image processing technique for the analysis of human facial behavioral expressions. As an improvisation, some of instances misclassified by Haar classifier are further detected by subsequent classifier adaptive algorithm (Adaboost). Careful attention is paid while generating the templates of various facial behavioral expressions including eye open, close, drowsy and smile. The obtained results create the possibilities of adapting an embedded image processor with the developed algorithms for the real time applications. The image processing algorithm is implemented by using Matlab.*

## Keywords:

*Human Facial Expression Identification, HAAR Classifier, Adaboost, Image Processing*

## 1. INTRODUCTION

The necessity to have an algorithm to analysis as well as automatically recognize human facial behavioral expression from an online image has been understood inevitable. It is also one of the most researched areas and all differs either by various usage of techniques or by rate of accuracy. As face detection is the first step of any face processing system, it has numerous applications in face recognition, face tracking, facial expression recognition, facial feature extraction, gender classification, clustering, attentive user interfaces, digital cosmetics, biometric systems. While most of the face detection algorithms can be extended to recognize other objects such as cars, humans, pedestrians, and signs, etc [1]. This can be adapted to differentiate and also to recognize the distinct parts and facial features like eyes, nose, mouth, eye brow and then skin. It is well understood that human emotions also have acoustic characteristics. Although the combination of acoustic and visual characteristics promises improved recognition accuracy, the development of effective combination techniques is a challenge, which has not been addressed by many researchers. In this study, real time facial feature tracker has been considered to deal with the problems of face localization and feature extraction in spontaneous expressions.

The main objective of this study is to generate a set of facial features eventually adapt feature extraction classifiers for tracking and recognizing face in an image eventually much facial expression with minimal error rate. The algorithms are preliminarily applied to discriminate the images with face and images without face.

The technique equally utilizing webcam with IR light as it has an advantage of being invisible to the naked eye, removing a distraction from the user. The classifiers HAAR and adaboost work together to give more accurate resultant features. The image and feature based methods have been well used by

researchers for face recognition. The former one uses trained classifiers with an example set while latter will detect face features like eyes, nose, eye brow and mouth. The combination of two methods simultaneously utilize on the image which contains face. The image in which eye is cropped for analyzing whether it is in closed or opened state and then mouth is cropped for analyzing it is in yawning, closed or smiling state.

This paper is organized as follows: In Section 2, rectangle feature based Haar classifiers with Adaboost is described. Section 3 introduces the flow chart model of the developed algorithm. Experimental results are discussed in Section 4.

## 2. ALGORITHM DEVELOPMENT: HAAR LIKE FEATURE WITH ADABOOST

Most of the detection systems are based on extracting certain properties from the set of training images acquired at a fixed pose in an off-line setting. As faces are often detected across scale, the raw detected faces are further processed to combine overlapped results. Removal of false positives with Haar-like features gives impressive empirical results in detecting faces under any occasion.

Haar Like features consists of two or three jointed black and white rectangles. The integral image is defined as the summation of the pixel values of the original image. The value at any location  $(x, y)$  of the integral image is the sum of the image's pixels above and to the left of location  $(x, y)$  [9]. The integral image value is calculated by finding out the difference between the sums of pixel gray level values within the black and white rectangular regions compared with raw pixel values. Haar-like feature can increase or decrease the in-class/out of class variability and thus makes classifier easier.

A large training set of face images is essential for the success of learning-based facial features detectors. Face detection system needs to be trained with several iterations. One common method to further improve the system is to bootstrap a trained face detector with sets, and re-train the system with the false positive and negatives. This process is repeated to further improve the performance of a face detector several times till the facial features are recognized.

The Adaboost-based face detection can be reliably detected in real-time under any occasion. Haar features are used for representing faces and they are proposed to compute efficiently with that integral image while most other algorithms use one single strong classifier (e.g., Support Vector Machines and Neural Networks). While HAAR classifier is used as an ensemble of weak classifiers where each one is constructed by thresholding of one Haar-like feature.

Adaboost algorithm is used to weight the selected weak classifier. All the weak classifiers are ranked to several cascades with the use of optimization process [2]. Within each stage, an ensemble of several weak classifiers is trained using the Adaboost algorithm. The impulse behind the cascade of classifier is that simple classifiers at early stage can filter out most negative features efficiently, and stronger classifiers at later stage are only necessary to deal with occurrence that look like faces.

Haar-like features impulses a real-time performance with fairly high detection and low false positive rates. It demonstrates the excellent run-time performance of boosted cascade classifier [5]. Despite training time of such a system is rather lengthy. So that Adaboost algorithm is used to select a specified number of weak classifiers with lowest error rates for each cascade and the process is repeated until a set of optimization is satisfied.

### 3. IMAGE PRE-PROCESSING

An image is taken as an input and tokens are produced as output. The output may contain face or non face feature. In this sequence, the unwanted pixels are removed. It is then followed by the edge detection process. Edge detection is a basic term in image processing and computer vision, particularly in the areas of feature detection and feature extraction, which aim at identifying points in a digital image at which the image brightness changes sharply or more formally has discontinuities [3].

In this study, the edge detection is done by using Sobel algorithm [10]. Sobel method edge detection produces an image where higher grey-level values indicate the presence of an edge between two objects. It returns edges at those points where the gradient of a grayscale or a binary image is in maximum.

The algorithm is illustrated as flow chart model and shown in Fig. 1. Each box shown in flow chart is treated as one module. The first module captures the image using the web camera. Second module is for face detection which can detect the human face from the captured image using Haar Classifier.

The Adaboost is an iterative algorithm to improve the accuracy as stage by stage based on a series of weak classifiers. The next module is the edge detection modules from the detected face region. And the last module is the decision making called recognition module which produces the final result with detected pattern. It is analyzed whether the captured image belongs to face or non-face pattern. At this stage, the non-face image is rejected. If it belongs to face database eventually the face is recognized and marked in a rectangle.

From the recognized image the location of eyes and mouth are identified which then used to find facial behavioral features.

The detection of eyes involves two states: open and closed position. In general, open eye state is defined as i.e., if a man can see something, it is considered that his eyes are in open state. But computer criterion is different from our criteria. If the iris and the white of eye are visible, the eye is in open state. Otherwise, the eye is in closed state.

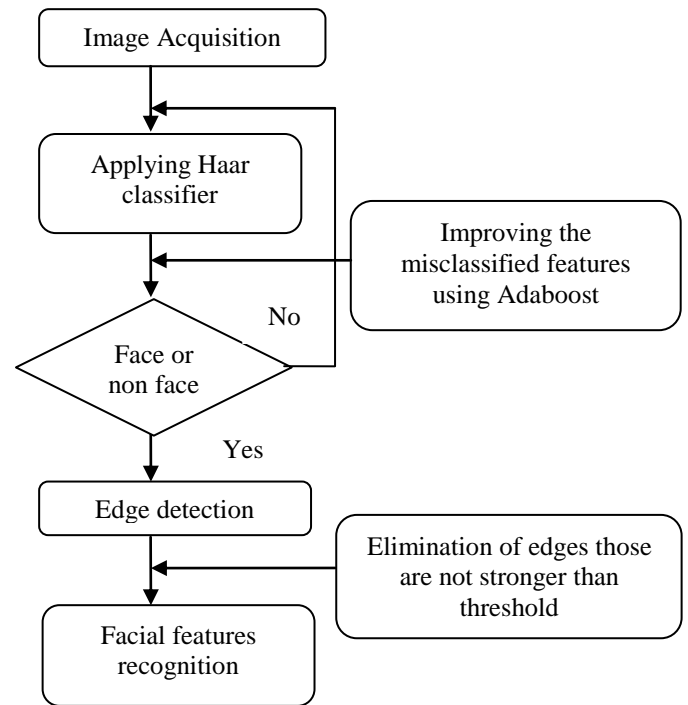


Fig.1. Flow chart model of facial behavioral recognition

### 4. RESULTS AND DISCUSSIONS

The Fig. 2 illustrates the sequence of operations performed in recognition of face, eye and mouth. The captured image is converted to grayscale.



Fig.2. Face detection process

The choice of a good database plays vital role for the learning step. Especially to detect significant eye detection those are robust under changing conditions. Non-frontal images can introduce noise in the data, because some eye detection has different appearances in different poses [7].

- In this study, the algorithm is tested for both face and non-face images. The four different face patterns are tested, such as,
- Pattern 1: Normal human face i.e. eyes are in opened position
  - Pattern 2: Face differs from common faces i.e. eyes are in closed position
  - Pattern 3: Face differs from common faces i.e. eyes are in lightly opened position
  - Pattern 4: Eyes are with glasses

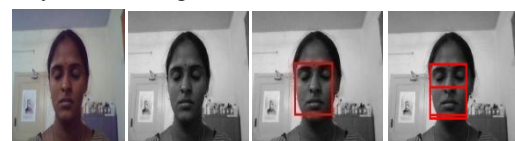


Fig.3. Detection of eye in closed position



Fig.4. Detection of eye in lightly opened position

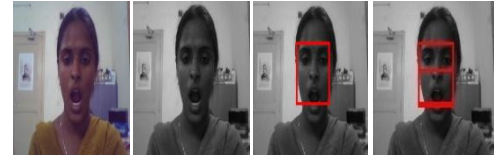


Fig.7. Detection of mouth in yawning position

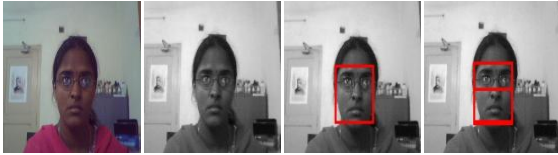


Fig.5. Detection of eye with glasses in opened position



Fig.8. Detection while smiling

For each pattern, the technique is applied for 37 numbers of images. The detection rate is shown in Table 1. In this study, the difficulty is encountered when adapting the algorithm to the eyes in half opened and/or closed state as shown in Fig. 4. The reason for the difficulty come from that the eye is actually in opened condition but the iris is not visible. The nearly closed eye is regarded as closed and it seems to be adoptable in many practical applications. It is well understood that identification of facial features using positions relative to the face image is difficult because of multiple variations of features possible at different occasions. These variations are due to changing orientation, emotion and especially identity. A Haar classifier should be used to identify these regions.

Table.1. Eye detection rate

Eye State	Correct Rate (%)	Misses Rate (%)
Opened	99.19	0.81
Closed	98.89	1.11
Lightly Opened	97.14	2.86
With Glasses	89.12	10.88

The misses rate is significantly higher for pattern 4 i.e. eyes are with glasses as it encounters with glaring phenomenon. Further study is under way to improve the detection accuracy for the faces with spectacles by reducing the effect of reflection.

The technique is also tested to classify the face images with facial expressions. In this operation, the mouth detection is under taken. The face images are collected in three patterns such as,

Pattern 1: Normal human face i.e. mouth in closed position

Pattern 2: Face differs from common faces i.e. mouth in opened or in yawning position

Pattern 3: Face differs from common faces i.e. smiling position



Fig.6. Detection of mouth in closed position

The developed algorithm is applied for 30 numbers of images and rate of detection is given in Table 2. The results create the possibility of adapting this technique for real time both face and facial expression analysis. It is understood, each pixel in the face image is associated to an appearance of cluster. The cluster stands for robust face features which are: eyes, mouth.

Table.2. Mouth detection rate

Mouth State	Correct Rate %	Misses Rate %
Closed(24)	98.70	1.30
Opened(30)	93.72	6.28
Smile(25)	91.24	8.76

It is tried to extract and utilize the maximum of information contained on a single image of a face. These regions can be enclosed with rectangles in the image. The embedded image processor with this algorithm is being studied.

#### 4. CONCLUSION

In this paper, Haar like features with Adaboost is successfully applied for the detection of local face features which are robust to pose. The obtained results prove that this technique is well suited for both face and facial expression detection. The technique yields poor results for the faces with spectacles. Experimental results show that the false detection is mainly due to the reflection of spectacles.

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