Face Detection and Recognition Using Ada Boost-ICA Algorithm

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***Abstract*— Face recognition mainly involves recognizing personal identity, based on statistical as well as geometrical features which are derived from face images .This paper presents an automated system for human face recognition in a real time background world for a large homemade dataset of persons face. The task is very difficult as the real time background subtraction in an image is still a challenge. Addition to this there is a huge variation in human face image in terms of size, pose and expression. To detect real time human face AdaBoost algorithm is used and a simple fast ICA is used to recognize the faces detected. Our method basically consists of two main parts: firstly we detect faces and then recognize the detected faces. Even every one can detect and identify faces in respective data with little or no effort, but building an automated system that will accomplishes such objectives is, however, very challenging. These challenges are even more profound when one considers the large variations in the visual stimulus due to illumination conditions, directions of viewing or poses, facial expression or changes, aging, and disguises such as facial hair, as well as glasses also. Face perceptions are very complex as the recognition of facial expressions involves extensive and diverse areas in the Face recognition research provides the cutting edge technologies in commercial, law enforcement, and military applications. So that an automated vision system that will performs the functions of face detection, verification and as well as recognition will find countless unobtrusive applications, such as airport security and access control, building (embassy) surveillance and monitoring, human-computer intelligent interaction and perceptual interfaces, and smart environments at home, office, and cars.**

***Keywords*— ADA, Face Detection, ICA , Recognition,PCA**

1. INTRODUCTION

Face detection is an essential application of visual object detection and it is one of the main components of face analysis and understanding with face localization and face recognition. It becomes a more and more complete domain used in a large number of applications, among which we find security, new communication interfaces, biometrics and many others. The goal of face detection is to detect human faces in still images or videos, in different situations. In the past several years, lots of methods have been developed with different goals and for different contexts. We will make a global overview of the main of them and then focus on a detector which processes images very quickly while achieving high detection rates. This detection is based on a boosting algorithm called AdaBoost and the response of simple Haar-based features used by Viola and Jones [1].The motivation for using Viola's face detection framework is to gain experience with boosting and to explore issues and obstacles concerning the application of machine learning to object detection

Basically face detection is a computer technology that determines the locations and sizes of human faces in arbitrary (digital) images. It detects facial features and ignores anything else, such as buildings, trees and bodies. Face detection systems identify faces in images and video sequences using computers. An ideal face detection system should be able to identify and locate all faces regardless of their positions, scale, orientation, lightning conditions, and expressions and so on. Due to the large intra-class variations in facial appearances, face detection has been a challenging problem in the field of computer vision. Face detection can be regarded as a specific case of object-class detection. In object-class detection, the task is to find the locations and sizes of all objects in an image that belong to a given class. Examples include upper torsos, pedestrians, and cars. Face detection can be regarded as a more general case of face localization. In face localization, the task is to find the locations and sizes of a known number of faces (usually one). In face detection, one does not have this additional information.

The most familiar application is in the security industry. Popular movies and television series have already shown many examples of high security systems which base admittance on identification by face matching. Although the accuracy required for high security applications may not be available, lower security applications or identification verification systems can be implemented. Other application areas include the field of communications, specifically adaptive image compression for teleconferencing, and the field of advanced human

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interface, which seeks to use information about the facial expression or identity of the user to adapt interaction paradigms. It is typically used in security systems and can be compared to other biometrics

Early face-detection algorithms focused on the detection [2] of frontal human faces, whereas newer algorithms attempt to solve the more general and difficult problem of multi-view face detection. That is, the detection of faces that are either rotated along the axis from the face to the observer (in-plane rotation), or rotated along the vertical or left-right axis (out-of-plane rotation), or both. The newer algorithms take into account variations in the image or video by factors such as face appearance, lighting, and pose.

Many algorithms implement the face-detection [4] task as a binary pattern-classification task. That is, the content of a given part of an image is transformed into features, after which a classifier trained on example faces decides whether that particular region of the image is a face, or not. The classifier is used to classify the (usually square or rectangular) portions of an image, at all locations and scales, as either faces or non-faces (background pattern).Images with a plain or a static background are easy to process. Remove the background and only the faces will be left, assuming the image only contains a frontal face.

A face model [7] can contain the appearance, shape, and motion of faces. There are several shapes of faces. Some common ones are oval, rectangle, round, square, heart, and triangle. Motions include, but not limited to, blinking, raised eyebrows, flared nostrils, wrinkled forehead, and opened mouth. The face models will not be able to represent any person making any expression, but the technique does result in an acceptable degree of accuracy. The models are passed over the image to find faces, however this technique works better with face tracking. Once the face is detected, the model is laid over the face and the system is able to track face movements. Face detection can be performed based on several different clues: skin colour (for faces in colour images), motion (for faces in videos), facial/head shape and facial appearances, or a combination of them. However, detecting faces in black and white, still images with unconstrained, complex backgrounds is a complicated task. Viola and Jones [1] introduced an impressive face detection system capable of detecting frontal-view faces in real time. AdaBoost, from adaptive boosting, was rapidly made popular in the machine learning community when it was presented by Freund and Schapire. The AdaBoost algorithm sequentially constructs a classifier as a linear combination of weak classifiers. This detection is based on a boosting algorithm called AdaBoost and the response of simple Haar based features.

A face detection method is presented here. It is a difficult task in image analysis which has each day more and more applications. The main idea in the building of the detector is a learning algorithm based on Ada-boost[5]. The family of simple classifiers contains simple rectangular wavelets which are reminiscent of the Haar[3] basis. Their simplicity and a new image representation called Integral Image allow a very quick computing of these Haar-like features. Then a structure in cascade is introduced in order to reject quickly the easy to classify background regions and focus on the harder to classify windows. The structure of the final classifier allows a real-time implementation of the detector. Some results on real world examples are presented. Our detector yields good detection rates with frontal faces and the method can be easily adapted to other object detection tasks by changing the contents of the training dataset.

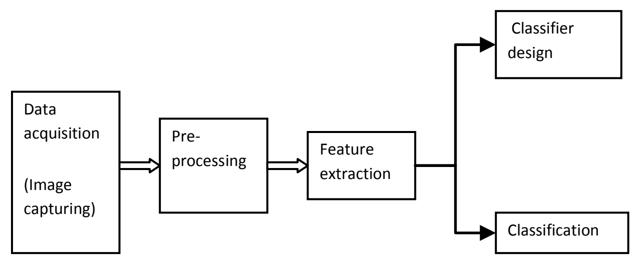

Fig 1: Data process diagram

Fig 1 shows that Data processing methodology for face recognition and as well as detection. The major steps followed in Face detection and recognition methods are

- Face recognition consists in identifying the people present in images, in other words, we want to assign one name to one detected face. It is used in security systems for example.
- Face localization is the problem of finding precisely the position of one face, whose presence is already known in a single image.
- Face tracking has for goal to follow a detected face in a sequence of images in a real world context in most of the cases.
- Facial expression recognition will try to estimate the affective state of detected people (happiness sadness etc...).

2. Flow of ada boost algorithm

Let h1; h2; ::::; hT be a set of simple hypothesis and consider the composite ensemble of hypothesis:

$$f(x) = \sum_{t=1}^{T} \alpha_t h_t(x) \qquad (1)$$

Where α_t denotes the coefficient with which the ensemble member h_t is combined. Both α_t and h_t have to be learned during the boosting process.

AdaBoost is an aggressive algorithm which selects one weak classifier at each step.

A weight d(t) = (d(t)=1 ; :::; d(t)N) is assigned to the data at step t and a weak learner ht is constructed based on d(t). This weight is updated at each iteration. The weight is increased for the examples which have been misclassified in the last iteration. The weights are initialized uniformly: d(1) n = 1=N for the general version of AdaBoost[5]

To estimate if an example is correctly or badly classified, the weak learner produces a weighted empirical error defined by:

$$\varepsilon_t\left(h_t, d^{(t)}\right) = \sum_{n=1}^{N} d_n^t I(y_n \neq h_t(x)_n) \qquad (2)$$

The steps involved in ADA Boost algorithm is as follows :

1. Input $S = \{(x_1, y_1), \ldots.., (x_n, y_n)\}$ Number of iterations T

2. Initialize: $d_n^1 = 1/N$, for all $n = 1, \ldots\ldots., N$

3. Do for $t = 1, \ldots\ldots., T$

(a) Train classifier w.r.t. the weighted sample set $\{S, d^{(t)}\}$ and obtain hypothesis $h_t : x \mapsto \{-1, +1\}$ i.e $h_t = L(S, d^{(t)})$.

(b) Calculate the weighted training error ε_t of h_t :

$$\varepsilon_t = \sum_{n=1}^{N} d_n^t I(y_n \neq h_t(x)_n)$$

(c) Set : $\alpha_t = \frac{1}{2} \log \frac{1 - \varepsilon_t}{\varepsilon_t}$

(d) Update the weights :

$$d_n^{(t+1)} = d_n^t \exp\{-\alpha_t y_n h_t(x_n)\} / Z_t,$$ where Z_t is a normalization constant, such that $\sum_{n=1}^{N} d_n^{(t+1)} = 1$.

4. Break if $\varepsilon_t = 0$ or $\varepsilon_t \geq \frac{1}{2}$ and set $T = t - 1$

5.Output : $f_T(x) = \sum_{t=1}^{T} \frac{\alpha_t}{\sum_{r=1}^{T} \alpha_r} h_t(x)$

3. Learning and testing through DATASETS Style

These Datasets are represents the images that we use for our face detection task. It is really important to notice that the choice of the datasets is crucial for the learning and the tests on the detectors. We can separate the Datasets as follows:

Learning Data

Training Data

Testing Data

Learning Data: It clusters all the examples that have been used to train and test the different classifiers. There are some positive and negative examples. On one side there are positive examples which are faces extracted from different sources: The faces are thus pictures from different acquisition conditions and lightning conditions. Concerning the Negative examples (non faces), they have to represent the best the backgrounds that can be found in real situations. Thus we just extract them randomly from the web in images without faces. It is hard to know a priori which images are the most representative of the non face class and the number of non faces that we need to train the classifier. However a bootstrap method will select non face images that are the hardest to classify and so to find more precisely the boundary between the face and non face classes. The images from the various Databases are of different sizes and the faces are more or less cropped while our learning set has to be homogeneous in term of size and face repartition. As most of the faces are higher than larger, we have chosen a rectangular window of 20x15 pixels. All the faces have been cropped and rescaled if necessary in order to respect this basic detector size.(We notice that the examples are effectively low resolution ones as imposed in the context of the detection.)

Training Set: It is the input of AdaBoost for the mono-stage classifier (to train some 500 features) and for the first sage of learning in cascade. Recall that one of the limitations of AdaBoost is the large influence of the input data on the boosting results, the choice of the training set needs particular careful. The use of diverse databases is well adapted because images from a single database are often taken from similar conditions.

Testing Set: Once a classifier has been trained using AdaBoost, we have to train it on another set of images (both positive and negative images).Thus we can obtain the test error of the classifier.

In the case of the cascade, this set is used during the learning to test the current cascade. The misclassified examples become the train examples of the next stage. Thus each stage is directly adapted to the efficiency of the previous ones, in the sense that it is trained from the examples that have been badly classified by the previous Stages.

4. Results & analysis

Fig 2 and 6 shows that input which is considering, and Fig 3 and 7 shows that detected data and fig 4 and 8 shows that data which is added to the database, this is the data which we consider to recognize, then fig 5 and 9 the face which we recognised through the data base and using from face number.

Fig 2 : Input Data 1

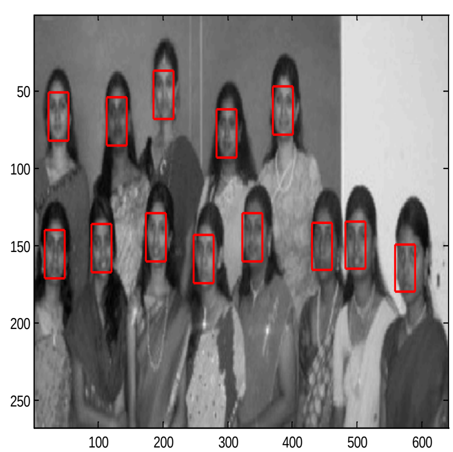

Fig 3:Detected Data

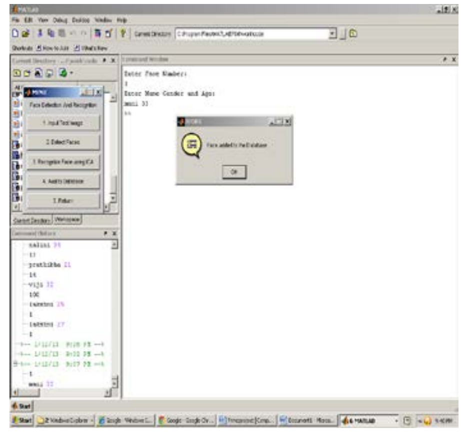

Fig 4:Data added toDatabase

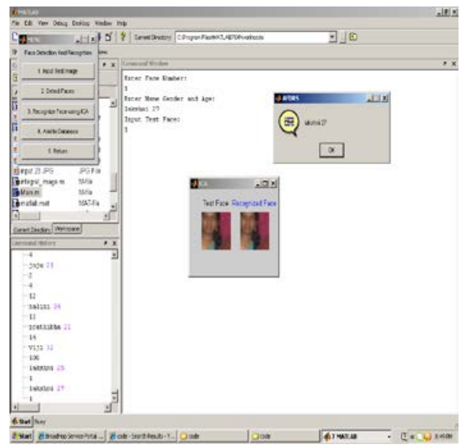

Fig 5: Face Recognized Data

Fig 6 : Input Data 2

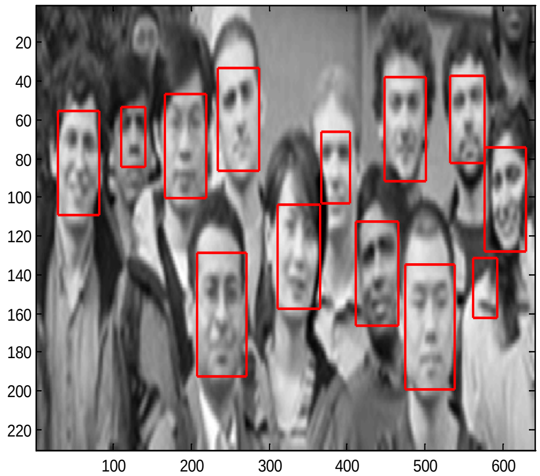

Fig 7: Detected Data

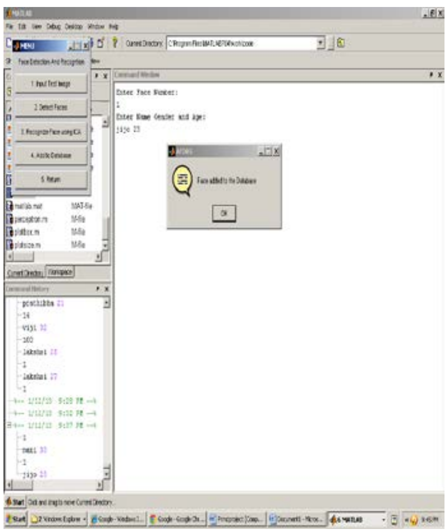

Fig 8: Data added toDatabase

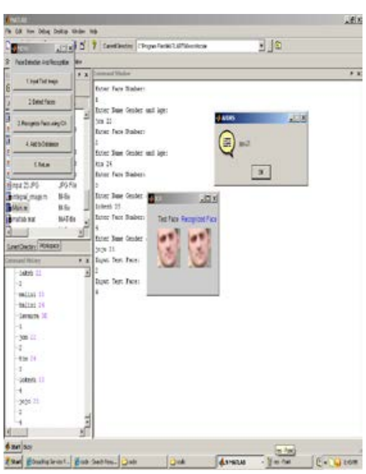

Fig 9: Face Recognized Data

Conclusions

In this paper, we have introduced Adaboost and ICA algorithms to the face detection and recognition purposes. We have briefly described the main characteristics and observations of Face recognition and detection process, and also discussed about several similar algorithms. Advantages of these characteristics and observations is been used to improve the quality of the data. The advantage of the adaboost is that it can used for recognising and as well as detecting the respective faces, because it can be applicable for both PCA and ICA algorithms.

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