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Investigation Study about Multi-Biometric System for Identification and Verification

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Abstract

In the last decenniums, Crime and terror have been noticed at a very high rate, it became substantial to attain a smart and developed biometric security system harmonious with the progression of the information technology (IT) services, Therefore human have a continuous research in the field of face detection, Artificial intelligence added many of the scientific approach to the notion of face recognition and data gathering, As well as the sophisticated in the field of a fingerprint have reached a great degree in verification. This paper will investigate which algorithm and scenario is the best to the future proposed system requirements.

Keywords Facial Detection and Recognition; OpenCV; Figure print ; HAAR; Adaboost; cascade; eigenvalue; Eigen face; Principle Component Analysis(PCA); local binary patterns(LBP);

1. INTRODUCTION

One of the perfect keys to unlock the individual's identity on the personal and perceptive level is the human face, which is the most significant source of identity and verifies person by visual system, Chiara Turati.et [1], have stated that babies from one to three day old can recognize between familiar faces. On another hand it was shown by David Hubel and Torsten Wiesel that our brain has a specific and specialized nerve cells react to particular local features of a scene, such as a line, edges, angle or movement. So how it could be arduous for a computer? It turns out we know little about human recognition to date [2], are inward features (eyes, nose, and mouth) or outer features (head shape, and hairline) used for effective face recognition. However with the appearance of newfangled technology, computers are running faster and faster. New facial detection and recognition mechanism techniques are also being developed that are quicker and more credible. For example, a revolutionary change to object detection came in 2001 by Viola and Jones when they invented the Haar-based cascade classifier. Still, an even faster technique was the LBP(feature detector developed by Ahonen, Hadid and Pietikainen in 2006 [1] [3] . LBP stand for local binary patterns and is potentially several times faster than Haar-based detectors albeit 10-20% less accurate.

Once an object (or face) is discerned an image is preprocessed, there still needs to be a way to trace and distinguish a new object when presented to the facial recognition system. In 1901 Karl Pearson suggested the technique of Principle Component Analysis (PCA), which transforms a set of possibly connected alterable (raw pixels of trained faces) into a smaller set of unconnected alterable (eigenvectors and eigenvalues). The theory is that in a higher dimensional dataset, most of the information can be characterized by a few ingredients. These ingredients are called the principal ingredients and are responsible for the most variance in the data [4].The Eigen faces representation of faces uses this PCA method to train and store the model used for recognition.

However the PCA method has a shortcoming in that it does not consider any of the classes (different people) and organizes the principle ingredients purely based on the highest variance the component generates. In the case that an external source (such as light) is generating the variance, the principle ingredients may not include much peculiar information at all. To find solution for this case, another class-specific reduction algorithm was developed by Sir R. A. Fisher and uses Linear Discriminant Analysis (LDA). The method was successfully used to classify flowers in his 1936 paper entitled “The use of multiple measurements in taxonomic problems”. In this way, features are found to maximize the rate of between-classes variation to within-classes variation as opposed to just maximizing overall variation [5]. Therefore the recognition algorithm is more active to external sources such as light. This method is called the Fisherfaces algorithm and is the same algorithm used by the FRJ system, for real time face recognition the input is often an image or video stream, and the output is identification or verification of the object or subjects that appear in the image or video [6].

A fingerprint can be defined as a pattern of ridges and valleys on the surface of a fingertip, the formation of which is determined during the first seven months of germinal development [7], Fingerprints of identical twins are different and thus are the prints on each finger of the same person.

2. THEORY OF FACE DETECTION

A computer program that determined whether an image is a positive image (face image) or negative image (non-face image) is known a **classifier**. A classifier is trained on hundreds of thousands of face and non-face images to figure out how to classify a new image accurately. Open CV equips us with two pre-trained and ready to be used for face detection classifiers [2][3] to Haar Classifier and LBP Classifier. Both of these classifiers procedure images in gray (dark) scales, essentially because we don't need color information to decide if a picture has a face or not .As these are pre-trained in

OpenCV, each Pre-trained file start with the name of the classifier it belongs to. For instance, a Haar cascade classifier starts off as haarcascade_frontalface_alt.xml.

2.1 Haar classifier

The Haar Classifier is an instrument learning based process, an algorithm formed by Paul Viola and Michael Jones [8], are trained from many positive images (with faces) and negatives images (without faces), to accomplishing high recognition rates Paul-Jones proposes three key contributions:

a) Haaar features: Essentially highly contrasting (black and white) square shapes that can be envisioned, Each component is a single worth gotten by subtracting sum of pixels under the white square shape from sum of pixels under the black rectangle, all possible sizes and locations of each window are used to calculate lots of componet (24x24 window results over 160000 features).

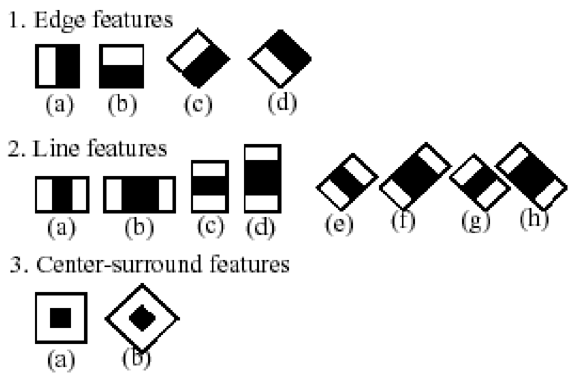

Fig 1. These Haar- like features

b) Integral image: which allow the features used by our detector to be computed very quickly, in an integral image the value at pixel (x,y) is the sum of pixels above an to the left of (x,y).

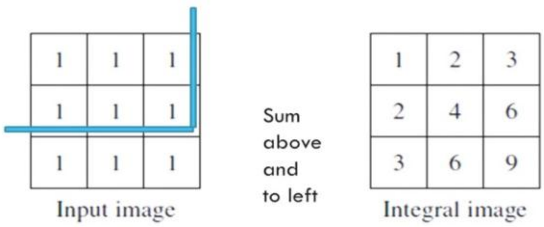

Fig 2. Integral image computation process

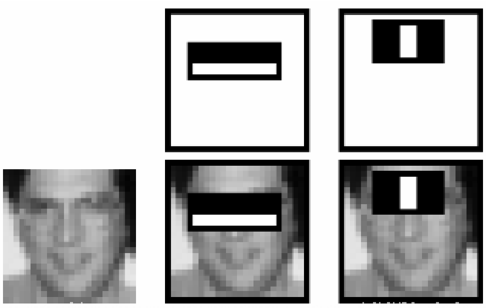

Fig 3. Different stages in visualization.

For instance, in the above image, we are extracting two features. The first one concentrate on the property that the area of the eyes is usually darker than the region of the nose and cheeks. While the second feature depends on the property that the eyes are darker than the bridge of the nose.

c) Adaboost: which chooses a small number of critical visual features from large set and yields extremely efficient classifiers (select the best features out of 160000+ features), each image is given an equal weight in the beginning After every order, weight of misclassified iamge are expanded, Then a similar procedure is finished, New error rates are calculated, Also new weights, The last classifier is a weighted sum of these weak classifiers, It is named weak because it alone can't classify the image, but together with others forms a strong classifier. (this reduction features from 160000+ to 6000).

d) Cascade: which allows background regions of the image to be quickly discarded while spending more computation on promising object-like regions, Instead of applying all 6000 features on a window, the features are grouped into different stages of classifiers and applied one-by-one, If a window fails the first stage, discard it, We don't consider the remaining features on it. If it passes, apply the second stage of features and continue the process, the window which passes all stages is a face region.

2.1 LBP Cascade Classifier

LBP is stands for Local binary patterns, which is need hundreds of images to be trained then divided each training image into some blocks as shown in the picture below.

Fig 5. Image 4*4.

For each block, LBP looks at 9 pixels (3×3 window) at a time, it compares the central pixel value with every neighbor's pixel value under the 3×3 window, For each neighbor pixel that is greater than or equal to the center pixel, it sets its value to 1, and for the others, it sets them to 0,it reads the updated pixel values (which can be either 0 or 1) in a clockwise order and forms a binary number, then, it converts the binary number into a decimal number, and that decimal number is the new estimation of the center pixel. We do this for each pixel in a block.

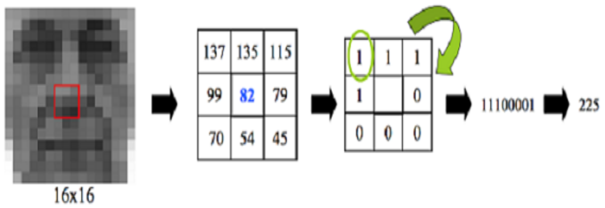

Fig 6. How to find new value of the center.

3. COMPARATIVE BETWEEN HAAR VS. LBP

After applying the two algorithm on raspberry Pi3 and using Raspberry Pi Cam to found the best algorithm to detection and recognition the face, founded the following results (divided into advantages and disadvantages for best compere)

3.1 Advantages for haar.

1. High accuracy can be up to 95% for detecting frontal faces.
2. Low false positive rate.

3.2 Advantages for LBP.

1. Computationally Simple and fast.
2. Shorter training time.
3. Better accurate on black face than Haar.
4. Robust to local illumination change.
5. Robust to occlusion.

3.3 Disdvantages for haar.

1. Computationally complex and slow.
2. Longer training time.
3. Less accurate on black face.
4. Limitations in difficult lightening conditions.
5. Less robust to occlusion.

3.3 Disdvantages for LBP.

1. Less accuracy about 77.8% for face localization.
2. High false positive rate.

4. FINGERPRINT

People have utilized fingerprints for individual recognizable proof for a long time and the coordinating exactness utilizing fingerprints has been demonstrated to be extremely high [7]. The exactness of the as of now accessible unique finger impression acknowledgment frameworks is satisfactory for confirmation frameworks and little to medium-scale distinguishing proof frameworks including a couple of hundred clients, different fingerprints of an individual give extra data to permit to huge scale acknowledgment including millions of identities, One issue with the current fingerprint recognition systems is that they require a large amount of computational resources [9], At long last, fingerprints of a little division of the populace might be unacceptable for programmed distinguishing proof due to hereditary components, maturing, natural, or word related reasons (e.g., manual laborers may have countless cuts and wounds on their fingerprints that continue evolving).

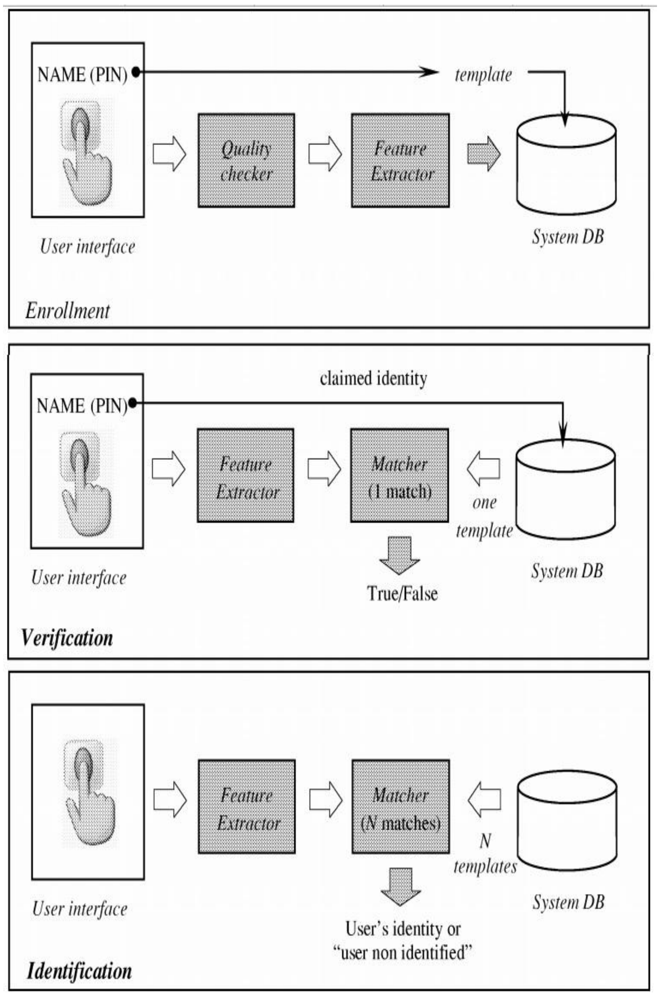

Fig 6. Block diagrams of enrollment, verification, and identification tasks are shown using the four main modules of a biometric system, i.e., sensor, feature extraction, matcher, and system database.

5. LIMITATION OF BIOMETRIC SYSTEM

Biometric system like any other system have limitations, the following are the most obvious related issues:

5.1 Noise in sensed data

The detected information may be noisy or distorted. A fingerprint with a scar are examples of noisy data. Noisy data could also be the result of defective or improperly maintained sensors (e.g., accumulation of dirt on a fingerprint sensor) or unfavorable ambient conditions (e.g., poor illumination of a user's face in a face recognition system). Noisy biometric data may be incorrectly matched with templates in the database (see Fig. 7) resulting in a user being incorrectly rejected.

Fig 7. Effect of noisy images on a biometric system. (a) Fingerprint obtained from a user during enrollment. (b) Fingerprint obtained from the same user during verification after three months. The development of scars or cuts can result in erroneous fingerprint matching results

5.2 Non universality

While every user is expected to possess the biometric trait being acquired, in reality it is possible for a subset of the users to not possess a particular biometric. A fingerprint biometric system, for instance, might be not able to extract features from the fingerprints of specific people, because of the poor (low) quality of the edges (see Fig. 8)

Fig 8. An example of "failure to enroll" for fingerprints (with respect to a given fingerprint recognition system): four different impressions of a subject's finger exhibiting poor quality ridges due to extreme finger dryness. A given fingerprint system (using a certain sensor and matching algorithm) might not be able to enroll this subject since minutiae and ridge information cannot be reliably extracted.

5.3 Intra-class variations

The biometric data acquired from an individual during authentication might be very different from the data that was used to generate the template during enrollment, thereby affecting the matching process. This variation is typically caused by a user who is incorrectly interacting with the sensor (see Fig. 8) or when sensor characteristics are changed (e.g., by modify sensors—the sensor interoperability problem) during the verification phase. As another example, the varying psychological makeup of an individual might result in vastly different behavioral traits at various time instances.

CONCLUSION

Various strategies and algorithms of face detection have been reviewed in this paper. The choice of a face detection method in any study ought to be based on the specific requests of the application, None of the current methods is the universal best for all applications and according to previous information and comparative the major differences are in accuracy and speed, as the result HAAR Cascade have the best results relevant with the proposed system and in the field of fingerprint it have been concluded at the end to use fingerprint sensor ZFM-20 modules that provide a good accuracy and speed to the proposed system requirements for identification and verification.

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