

Research Article

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Mobile Face Recognition Application Using Eigen Face Approaches for Android

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Abstract

Face recognition is one of current biometrics identification methods, that based on the measuring to one of human biological characteristics and utilize them to recognize individuals. These characteristics are called biometric they are hard to fake because they identify a person by measuring one of its biological characteristics such as (finger print, iris print and face print). With the rapid improvement of mobile technologies that happen in last decade face recognition process can make using mobile phone, this paper explains the building of mobile face recognition system using Eigen face approach, Experimental results have been tested on a local data-set that has been created to analyze the efficiency of the application in various cases including different illumination conditions, variation of view, and orientation, the recognition rate of the application when testing on Galaxy Grand Prime + was 78.4, while the recognition rate when testing on Galaxy Note 5 was 82.4. The accuracy of this application can reach to 100% if we use camera with high accuracy and on good light condition.

Keywords: Eigen face, Cascade classifier.

الخلاصة

تميز الوجه هي واحدة من طرق التعرف البايومترية الحالية، التي تعتمد على الحساب لآحد خواص الإنسان البيولوجية واستخدامها لتمييز الأفراد. هذه الخواص تسمى (biometric) من الصعب تزويرها لأنها تعرف الشخص بالاعتماد على حساب أحد خواصه البيولوجية مثل (بصمة اليد، بصمة العين، بصمة الوجه). مع التطور الحاصل في تقنية الموبايل في العقد الأخير، عملية تمييز الوجه ممكن ان تحدث باستخدام الموبايل، هذا البحث يوضح بناء تطبيق لتمييز الوجه ب استخدام الموبايل وباستخدام منهجية (Eigen face). تجارب النتائج طبقت على قاعدة بيانات محلية لغرض تحليل اداء التطبيق في حالات مختلفة تتضمن (شروط اضاءة مختلفة، اختلاف نقطة التصوير، التنوير). معدل تمييز التطبيق عند تجربته على موبايل (+ Galaxy Grand Prime) أظهرت نسبة ٧٨,٤، وعندما طبقت على (Galaxy Note 5) أظهرت دقة تمييز ٨٢,٤. دقة التطبيق ممكن ان تصل الى ١٠٠% اذا استخدمنا كامرة ذات دقة عالية وفي ظروف اضاءة جيدة.

Introduction

Face recognition is one of the applications of object identification designed for recognizing faces as objects. Face identification is primarily utilized for the identification or verification of individuals. Recognition is utilized for determining the identity of an unknown individual and is performed by matching of the facial data of a person to the face data of several people. Verification decides if an individual is actually who he claims he is. The verification procedure performs a comparison

of a person's face data to existing data on the claimed identity[1].

Face Detection

Face detection is a first step to identify any people, to build any recognition system the face must detected first. The application must ensure if there was any face in an image and localize it [2].

In this work, detection of faces is done using Open CV cascade classifier, which use a cascade classifier made up of Haar-like features and cascade of boosted classifiers.

The Eigen Face approach

Many previous researches concerning automated facial identification have bypassed the problem of which aspects of the facial stimulus are required for recognition, considering that predetermined measures were suitable and efficient [3]. This gave a suggestion that an information theory method of coding and decoding of facial images could provide insight concerning the information content of those images, focusing on the significant local and global “features”. Those features could or could not have a direct relation to the intuitive idea of facial properties like the hair, eyes, nose and lips. In the concept of information theory, the goal is to obtain some useful information in a facial image, and then encode it as sufficiently as possible, then compares one face encoding to a data-base of models that have been encoded in a similar way. A simple method of the extraction of information that is contained in a face image is to somehow detect the differentiations in a set of facial images, independent of any judgment of properties, and using this information for encoding and comparing distinct face images. Mathematically speaking, the goal is to find the main elements of the distribution of faces, or the Eigen vectors of the co-variance matrix of the group of facial images. These Eigen vectors might be considered as a group of properties that combined classify the difference between facial images. Every image index has some impact on every Eigen vector, therefore, the eigenvector is displayed as a type of ghostly face known as Eigen face. Every one of the face images in the training group could be represented precisely according to a linear combination of the Eigen faces. The number of potential Eigen faces is the same as the number of face images in the training set.

On the other hand, the faces may also be approximated with the use of only the “best” Eigen faces which have the largest Eigen values, and which therefore are responsible for the most variance in the group of facial images. The main cause to use less number of Eigen faces is the computational efficiency. The most optimal M' Eigen faces span an M' -dimensional sub-space “face space” of all

potential images. As sinusoids of different frequency and phase are the base functions of a Fourier decomposition (and are actually Eigen functions of linear systems), the Eigen faces are the base vectors of the Eigen face decomposition.

The concept of utilizing Eigen faces was inspired by an approach that was developed by Sirovich and Kirby for the efficient representation of face images with the use of principal component analysis. Sirovich and Kirby insisted that a group of face images might be approximately reconstructed via storing a small set of weights for every one of the faces and a small group of standard images. It occurred that in the case where a multitude of facial images may be reconstructed by weighted summations of a small set of feature images, then a sufficient manner of learning and recognizing faces can construct the characteristic properties from known facial images and for the recognition of specific faces via the comparison of the property weights required for (approximately) reconstructing them with the weights associated to the known persons. [4].

Materials and Methods

Data set

The image dataset that used by the application were collected from 25 persons, for each person 8 different sample image has been taken with different expressions (look up and down, smiling and non-smiling), orientation (30 degrees in two directions right and left). in training application the distance between the person and the camera of the application is 125 CM.

For testing application the distance between the person and the camera of the application were 1 meter.

The complete number of faces image samples in the dataset is 200 (25×8).

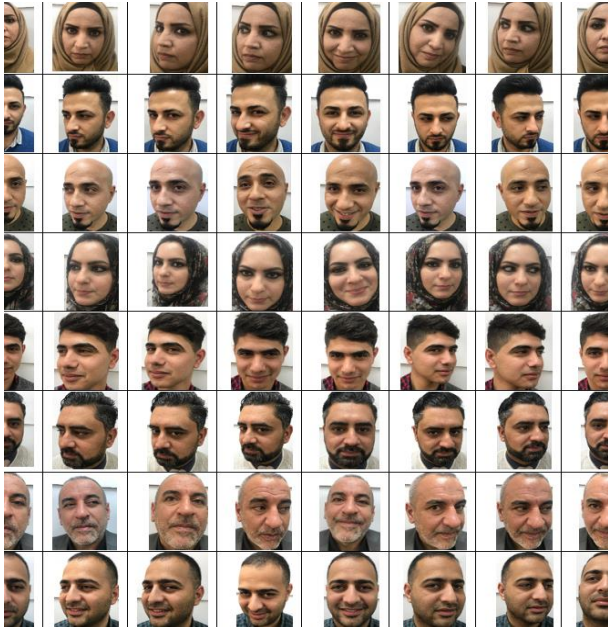


Figure 1: Data Set Some Person's Images with their Samples Chosen from the Dataset.

Recognition Faces Using Eigen Face Approach

The responsibility of recognition system was to finding the features vector that is nearest and most similar to the features vector of training set.

The recognition system responsibility it's identify person's identity using the information that store in database about the feature vector of persons, if any match was found then the input image belonging to one of person's that the data base was training on their images. If not then the image is for no one of these persons, or the image is not a face. The recognition program uses Eigen face algorithm that made to accomplish recognition.

Algorithm 1: face recognition using Eigen face approach.

Input: face images I1, I2,..., IM (testing faces)
Output: distance within face space (er), recognized image.

Start

represent test face image Ii as one-dimension vector Γ_i .
normalize image vector by subtracting it from mean (average face).

$$\Phi = \Gamma - \Psi$$

project on the Eigen space

$$w_i u_i (w_i = u_i^T \Phi)$$

represent Φ as: Ω (Longitudinal expansion coefficient)

$$\Omega = \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_K \end{bmatrix}$$

search for the nearest face on training set (Φ_i) to face that we want to recognize (Φ).

$$e_r = \min_i \|\Omega - \Omega_i\|$$

e_r : distance within face space

it has been reported that the Mahalanobis distance performs better so it's used to find e_r

$$\|\Omega - \Omega^k\| = \sum_{i=1}^K \frac{1}{\lambda_i} (w_i - w_i^k)^2$$

if $e_r < T_r$, then Γ (test image) is recognized as face L from the training set

T_r : threshold

Otherwise the image is not a face.

End

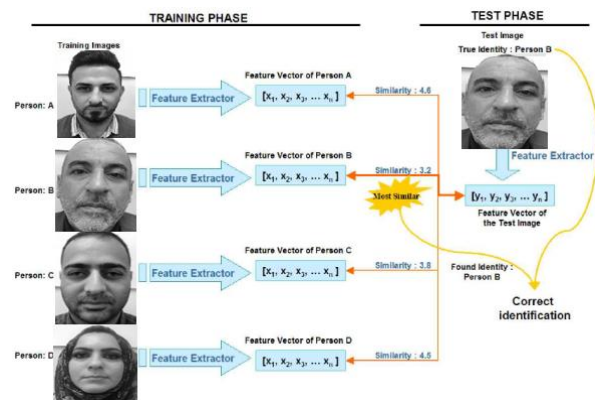


Figure 2: Recognition Process.

Results and Discussion

The Result and Accuracy of Face Detection Using Cascade Classifier

Because of the detection of the application done through the use of opencv cascade classifier, so that the accuracy of application on face detection is the same accuracy of open cv cascade classifier which show accuracy rate up to 93% in a good light condition.

The experiment show that when the person looks to the camera with natural view and looks in his/her front view, this record the better accuracy rate, while when he/she look to camera at slight angles and the face has different facial expressions the accuracy of detection will decrease.

The Result and Accuracy of Face Recognition Using Eigen-face Approach

The result of face recognition application can be obtained by input the result of face detection process to face recognition application. We must have said that the result of face recognition application can be shown only if the face detection work and detect any face this required that the image of a face have been taken in good light condition so that this will enable to extracted the face feature vector and use it for recognition.

The experiment of this project done one two different mobile devices (Galaxy Grand Prime +) and its camera is 8 mega pixels, and on (galaxy note 5) and its camera 16 mega pixels. The number of training image were 3 for all experiments and the number of testing image were 5 for all experiments.

The tested result on the first mobile (Galaxy Grand Prime +) shown on the table below:

Table 1: some of test Results of recognition experiments on galaxy grand prime +.

On artificial light		
Person	Correct recognition	Incorrect recognition
1	5	0
2	4	1
3	2	3
4	3	2
On day light		
Person	Correct recognition	Incorrect recognition
1	5	0
2	5	0
3	4	1
4	3	2

The tested result on the second mobile (Galaxy note 5) shown on Table 2.

When comparing between the results of the experiments of the two device the result show when using the camera of galaxy note 5 the accuracy was increase respect to galaxy grand prime +.

All result of experiments on day light show higher accuracy than on artificial light.

The recognition rate of the application when testing on galaxy grand prime+ was 78.4. while The recognition rate when testing on galaxy note 5 was 82.4.

The accuracy of this application could reach to 100% if we using camera with high accuracy and on good light condition.

Table 2: some of test Results of recognition experiments on galaxy note 5.

On artificial light		
Person	Correct recognition	Incorrect recognition
1	5	0
2	4	1
3	4	1
4	3	2
On day light		
Person	Correct recognition	Incorrect recognition
1	5	0
2	5	0
3	4	1
4	4	1

Mobile Device Application Testing

When ruining the mobile face recognition application many component of mobile device has been used, at start of the application the camera was opened and when the user takes an image frame has been taken by the application this will continually dined the energy of mobile.

After capturing frame, the application processing the input frame for detect and recognize faces, this processes need high computation to be done, which also used the mobile energy.

At the end after the application recognize a face, or obtained that the image is not a face, message and audio feedback must provide by the application to user about the result, this process consume energy too.

The next component of mobile device which also used by the application is processing power, which mean the use of processor when the application running and perform detect, recognize and giving the result.

The last component of mobile device which also used by the application is memory which must compute when the application running and perform detect, recognize and giving the result.

The used of all mention component were done using Android Debug Bridge.

Android have many built-in function one of them was an application named (Android Debug Bridge) used to compute power consumption of the battery, memory, and processing power by any application.

The discuss result of the effect of using application on battery, data usage and Processing Power and Memory is shown below:

Battery: the energy consuming by the application is very important thing for real time computer vision, the battery live over a time were shown in table (3)

The experiment shown that constant energy was consuming by a device when running the application and these value may be differing from one mobile device to another and from one user to another, because the user may be running another application at the same time with this application.

Table 3: Battery life of the device over time

Time Elapsed	Battery Life (%)
10 minutes	94
20 minutes	91
30 minutes	89
45 minutes	83
1 hr 10 minutes	76
1 hr 25 minutes	71
1 hr 30 minutes	68

Data Usage: the data that used by the application consist of small size image and sent and received text and audio message, this considered as small amount of data, the application size is 27.55 MB before training any image, after training the application on 25 persons the use of memory and CPU shown below Figure 3.

Processing Power and Memory: from the first mili-second at which the application start it used the CPU and memory. The use of the CPU reach to 15.54 % at the 50.2 MS, while the use of memory reach to 37.11 MB at the same time (this result shown for the device galaxy grand prime +, this is shown on Figure 4.

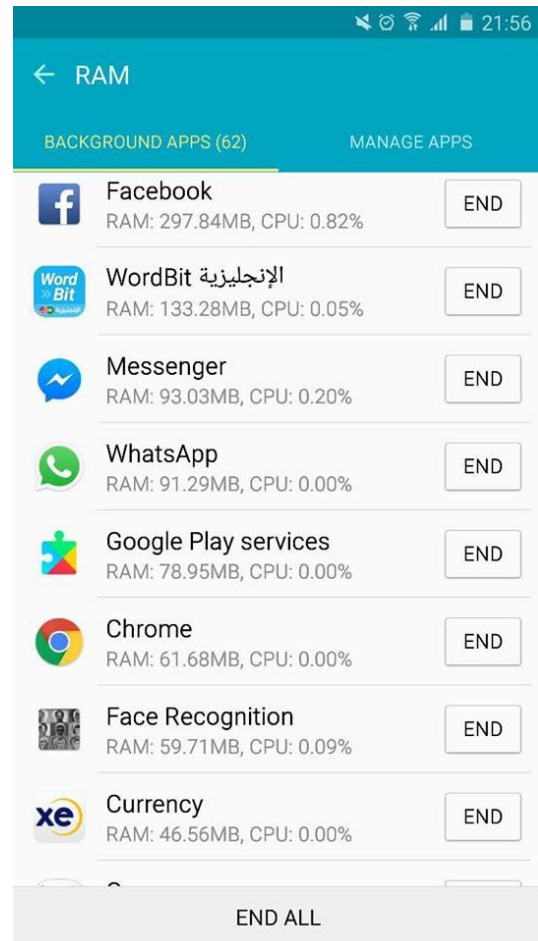


Figure 3: The Use of Data of the Application after Training.



Figure 4: processing power and memory statistics for galaxy grand +.

When using galaxy note 5 the result of memory at a 7 second and 42 MS reach to 195.31MB, which are greater than the use of memory on galaxy grand prime +, this is shown on Figure 5.

When capturing frame, the use of memory of device reach to 273.28 MB, this test on galaxy note 5, this shown on Figure 6, these statistics differs from one device to another.

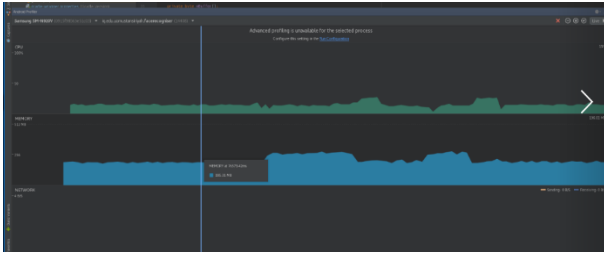


Figure 5: processing power and memory statistics for galaxy note 5.

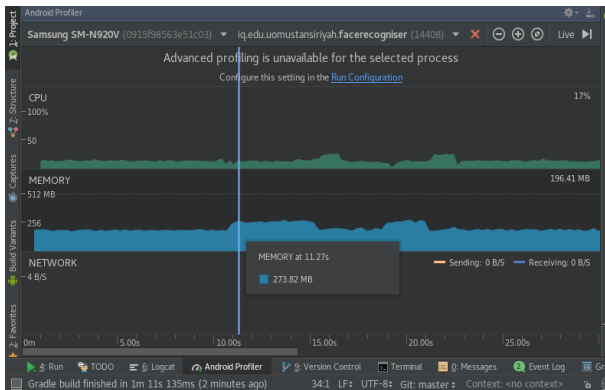


Figure 6: Processing Power and Memory Statistics for Galaxy Note 5 when Capturing Frame.

Conclusions

From testing the result of the application, there are several conclusions appeared, which have summarized in some points below:

First that the mobile face recognition system benefits from the portability of mobiles and offers a simplified interface which benefits from the system which is easy to use for people. Also the lighting has to be under control, due to the fact that in case where there are shadows on the face, it will make detecting the face a difficult procedure.

The recognition rate of the application when testing on Galaxy Grand Prime + was 78.4, while the recognition rate when testing on Galaxy Note 5 was 82.4.

The accuracy of this application could reach to 100% if we using camera with high accuracy and on good light condition.

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