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Face detection and recognition in smartphones

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ABSTRACT

In this paper, various algorithms have been referred for face detection and recognition for security purpose in smartphones. Different types of algorithms such as template matching, color code segmentation using K-mean clustering algorithm, etc. for face detection and KLT for face recognition have been used. In any of the face recognition system the first step is face detection. The mentioned algorithms have first been constructed in MATLAB and then later it is implemented in SMARTPHONES phones. After the implementation of the mentioned algorithms, we have recognized certain pros and cons while implementing the face recognition system on a mobile phone with limited hardware capabilities.

Keywords: *Security, Face detection, Face recognition, Mobile phones.*

1. INTRODUCTION

Face Recognition have become a new way for secure authentication for mobile phones. As mobile phones are becoming increasingly powerful, security of the data stored in mobile phones is a topic of concern; the data can be email addresses, sensitive and important documents, etc. Although, the current phones have password protection to provide security, a face recognition scheme is much more secure and flexible. In the face recognition feature, only by looking at the screen one can unlock their phone screen. Although figure print is the most used way of authentication in mobile phones, face detection is rapidly gaining popularity and acceptance.

In this paper, we will focus on few algorithms such as color segmentation combined with template matching for face detection and KLT algorithm for face recognition. As we know that, face detection and face recognition mechanism depends on Biometrics system. Biometric is a measurable and unique characteristic of human being. It can determine both Physiological and Behavioral characteristics of human being. A person's identity can be recognized and verified through this.

The Physiological biometric depends on the data obtained by the direct measurements of a part of human body whereas the behavioral biometrics is based on the action of human. Some of the physiological biometrics is facial recognition, finger-scan, retina-scan, iris-scan, hand-scan, etc. And the different technologies related to behavioral biometrics are voice-scan, signature-scan, keystroke-scan, etc.

2. STEPS IN FACE RECOGNITION

Face recognition is Computer/Mobile based digital technology and is been an active research area from the last few years. To detect faces in an image various techniques were proposed. Here we have referred to template matching algorithm and color code segmentation using k-mean algorithm for face detection and KLT algorithm and Viola-Jones algorithm for face recognition. The following block diagram which is referred from Face recognition in mobile phones by Guillaume Dave, Xing Chao, and Kishore Sriadibhatla shows the major steps in face recognition algorithm:

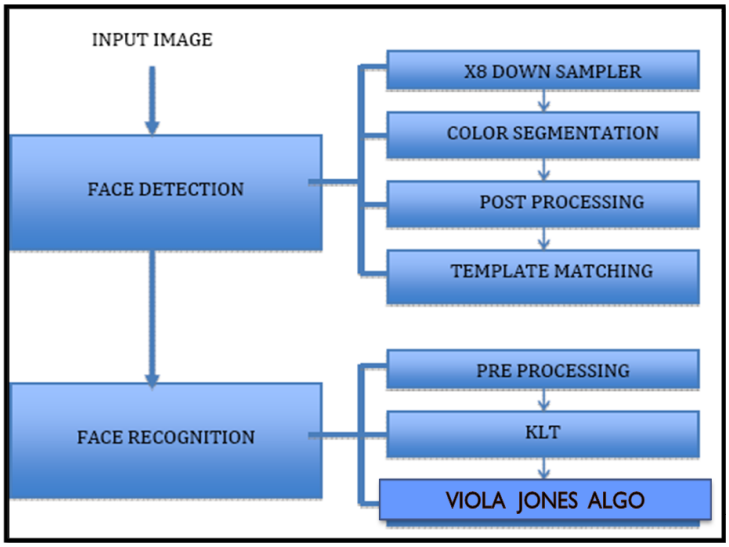

Figure 1: Block diagram of the Face Recognition system

Steps in face recognition algorithm are as follows:-

1) Input image: If the image is taken correctly, the few assumptions can be made-

- The face is centralized and takes a big part of the image, since the photo is shot closely.
- The lightning conditions are correct**.**
- The user should face the camera.

2) Face detection: For an input image the very first Phase is the Face detection phase. So, this phase has four steps which are as follows:

-X8 Down Sampler or Sampling process.
-Color Segmentation.
-Post processing or Morphological processing.
-Template matching.

In sampling process stage, the image sensor produces output as analog signal, it is impossible to do digital image processing on that signal .So it is necessary to convert analog signal to digital signal .For this purpose sampling process is done on the input image. In color segmentation stage, we use color segmentation process to find skin pixels of image using k-mean algorithm which solves clustering problem. The following data provided below depicts the concept of the K-mean algorithm which is being referred from A Review of K-mean Algorithm by Jyoti Yadav, Monika Sharma which was published in International Journal of Engineering Trends and Technology (IJETT) – Volume 4 on 7- July 2013.

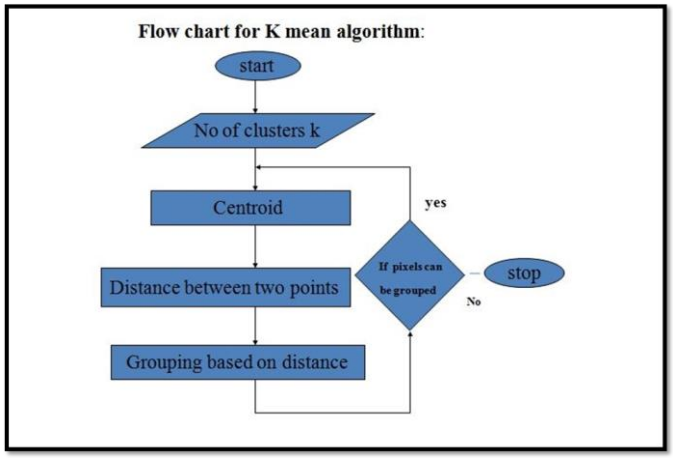

Figure2: Flowchart Diagram of k-mean algorithm

K-mean Algorithm

Input

K: number of desired cluster

D: {d1, d2...dn} a data set containing n objects.

Output

A set of k cluster as specified in input Method

1) Arbitrarily choose k data item from D dataset as initial cluster centroid;

2) Repeat

3) Now, assign each data item di to the cluster to which object is most similar based on the mean value of the object in cluster;

4) Calculate the new mean value of the data items for each cluster and update the mean value;

5) Until no change.

The third stage of face detection is morphological processing or post processing which is used to eliminate non skin visible pixels and regroup the skin pixels. This stage usually comes after color segmentation where we get a mask of non skin pixels. However the mask we get is not perfect as it has some non skin pixels which are still visible and some part of face can be masked. In morphological process removal of the non-skin pixels deterioration is performed and after that distension is performed to reorganize the skin regions and smooth them. The following below image shows the output of color code segmentation and morphological process

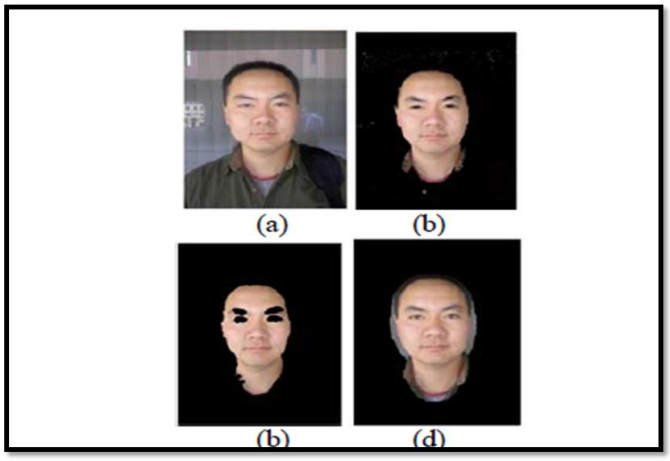

Figure3: Output images of face detection stages (a) color segmentation image, (b)erosion image, (c)dilation image, (d)detected image.

Now the last n final stage is Template matching. It is a process of locating an image represented by template T(x, y) in an input I(x, y) by cross-correlating the input with the template. Normalized 2D cross-correlation is performed with the given input image to obtain the position of the face. The output image which we get from colour segmentation and morphological process is used as input to a template matching block where both images are cross correlated with each other.

3. FACE RECOGNITION

Face Recognition has become a new method of secure authentication for mobile phones. One can unlock their Smartphone by simply looking at it.

Figure 4

For recognition process few algorithms are used such as VIOLA JONES ALORITHM and KLT algorithm. The reference for both this algorithm has been taken from Comparison between viola-jones and klt algorithms and error correction of viola-jones algorithm by Mohammad Ashraful Islam md. Anin Naeem, md. Nazmul Hasan which was published in International Journal of Computer Engineering and Applications, Volume XI, issued on 5th May 17.

A. VIOLA JONES ALGORITHM

This is a first object detection framework which was developed by Michael Jones and Paul Viola and this algorithm is already been implemented in OpenCV in the act of cvHaarDetectObjects() which is used for basically face detection as per the Comparison between viola-jones and klt algorithms and error correction of viola-jones algorithm by Mohammad Ashraful Islam md. Anin Naeem, md. Nazmul Hasan published in International Journal of Computer Engineering and Applications.

Here, the main motive is to detect face from a picture or image. A human can do this task easily but for a device like computer or a robot always needs some information's. In the case of Viola-Jones, to do this task it needs appropriate front view against the camera and the face should not be bending to any other sideways.

Although it detects the front view of the face properly, this algorithm seems to be vulnerable when the face is bend at least 45 degree or more. This is the main defect with this algorithm as per the research done by Mohammad Ashraful Islam, Md. Anin Naeem and Md. Nazmul Hasan in their paper.

STEPS IN VIOLA JONES ALGORITHM

Viola-Jones algorithm uses Haar components. This is the first step which follows some basic similarities such as dark and bright region, eye region and nose region. Here nose region is supposed to produce more light than the eyes and eyes are supposed to produce less light than the cheeks. The size and location of nose, eyes and mouth and pixel volume of individual component is calculated. Haar uses square box to find the pixel volume.

There are three types of Haar components. They are as follows:

a) Two square
b) Three square
c) Four square

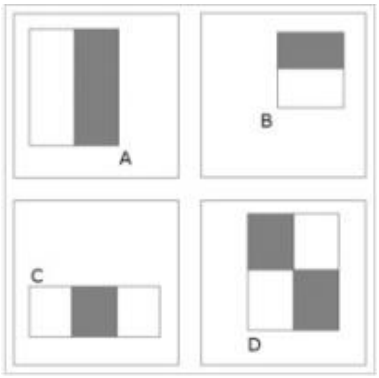

Figure: 5. 1Haar Components

How the components are applied to a face is given below:

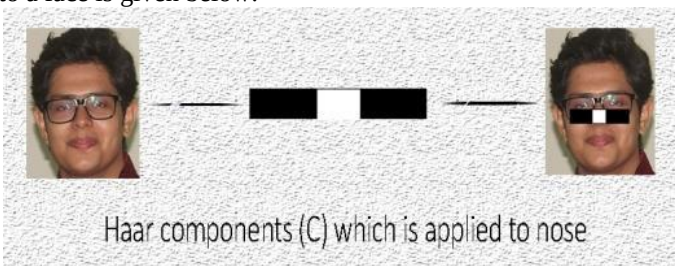

Figure 5.2

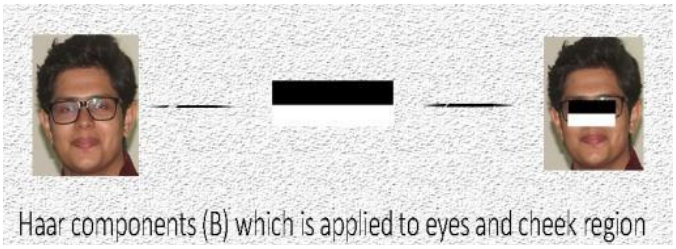

Figure 5.3

Example of Viola-Jones algorithm:

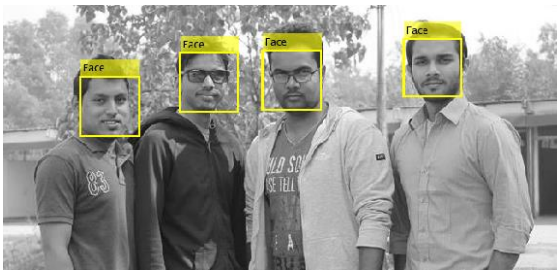

Figure 6

B. KLT ALGORITHM

Kanade-Lucas-Tomasi or KLT algorithm measures the components or points of a frame and also detects the same points in another frame and then measures the movement of the points from previous frame to the present frame. This technique is planned because the other techniques are expensive and KLT is so much speedy than other techniques.
KLT is basically used for face tracking rather than face detection. Moving objects can be tracked by tracking the particular points in a frame and finding the points in another frame. KLT algorithm is simply used for tracking the faces sequentially from frame to frame.

Detailing of KLT algorithm is provided in the research paper of Mohammad Ashraful Islam, Md. Anin Naeem and Md. Nazmul Hasan.

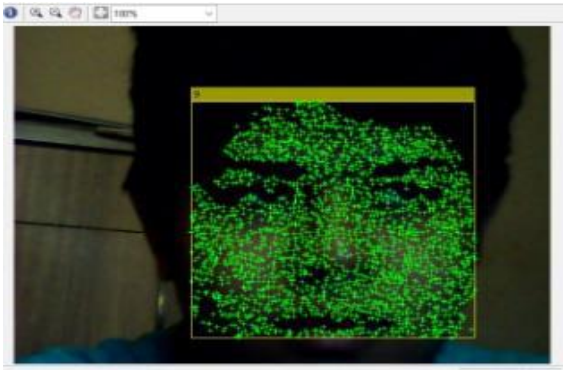

Figure 7. LT algorithm (point tracking)

A. Comparison between VIOLA JONES and KLT:

	Viola-Jones	Kanade-Lucas-Tomasi
Looking front	97%	90%
Looking left	90%	85%
Looking right	88%	83%
Looking up	80%	80%
Looking down	80%	80%
Total	87%	84%

The data has been taken from research done by Kamath Aashish and A. Vijayalakshmi in their paper.

B. Facial Recognition in Smartphones

Facial recognition is becoming the de-facto standard for unlocking phones and gradual elimination of fingerprint sensors in smartphones.

The steps it includes are as follows:

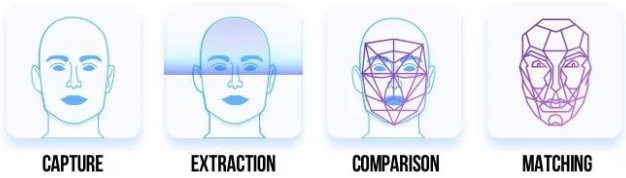

Figure 8

All identification or authentication technologies operate using the following four stages:

a. CAPTURE:
   A behavioral or physical sample is captured by the system during enrollment.
b. EXTRACTION:
   A template is created by extracting the unique data from the sample that is being captured and stored within the phones database.
c. COMPARISON:
   Now, a new sample is compared with the template.
d. MATCH/NON-MATCH:
   Here, the system decides if the features which are extracted from the new samples are a match or non-match.

4. FUTURE SCOPE

The face recognition concept has a wide scope in the future of technology. It can be majorly used in security as well as in advertising sector. This app makes it possible to improve quality of searching in numerous ways. For example, searching a picture by a person's name or the name of the place. Tagging a picture at the time it is taken only once, and then from next time when the picture of same person or thing is taken, tagging will be done automatically. It helps in saving time and gives an easier access for searching pictures.

5. CONCLUSION

Face recognition has been considered as a secured though costly application. Today as the core technologies are evolving day by day, the cost of the equipment's are also getting decreased dramatically due to integration and increasing processing power. Certain applications of face recognition technology are now reliable, cost effective and highly accurate..

6. REFERENCES

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