Mobile Devices Application: Alive Face Detection Using Skin Color Segmentation and Gabor Filter

Hanaa M.Ahmmed* Ph.D. (Asst. Prof.) Salma H. Abdullah*,M.Sc.(Asst.Lect.)

Abstract: Interest in mobile phone applications is increasing. The circulation of mobile phones with digital cameras led to a number of applications being generated. Face detection techniques are the first process in many applications and it is not an easy process. The proposed application method locates a human face by obtaining a capture frame from a camera in live video. To start processing this image, the application searches for important features and then uses these features to decide the face location. A popular technique based on skin color is a robust and faster approach than many other techniques for face detection because color has more information processing than other facial feature extraction. This paper recommends a method for mobile device application to detect the human face by using a skin color model based on YCbCr chrominance space. Only the frontal face use, segment all skin that detects include all object, and then using an erosions function to delete additional objects that are not skin. Subsequently, a Gabor filter is used to classify skin color (face or no face). Our method achieves 96% accuracy and can locate a single face closer to the camera. It can detect a face in different light conditions in addition to those based on light control in an intricate image background.

Keywords: Face Detection, Skin Color Detection, Gabor Filter, YCbCr mode, live color segmentation.

* University of Technology

1. Introduction

In many applications face-detection techniques play important roles in biometric identity, video conferencing, and human computer intelligent interface, database face image management, face recognition. The face detection techniques is not straightforward because there are numerous face image in appearance variations, for example variation pose (front, non-front); therefore, facial expression includes occlusion, orientation image, and lighting conditions [1]. Many applications in computer vision contain face detection. Identifying and locating the faces in an unknown image is usually the first and foremost significant stage of an automatic human face recognition system [2]. Face detection involves locating and determining a human face and separating it from the background [3]. Processing and searching for an image in the system requires important features to discover the location of the face. Several approaches are used to detect the face. The most famous method of skin color uses only color space information to produce a wrong classification of skin in the presence of objects similar to skin-like color and non-skin pixels [4]. Mobile phones use skin color to detect faces for fast processing and implementation, although they have limited mobile CPU and memory capabilities [5]. For perfect classification process, it is required to combine this segmentation scheme with other techniques (e.g., Gabor filter), using only color space model leads to partially detect faces [1]. Detecting and locating human faces in an image or a sequence of images with presence features such as beards and glasses is another source of variation that we have to take into account when detecting faces with this approach [6]. Common approaches use Haar-cascades and image scanning with a coevolution window and segmentation skin color, template matching and morphological processing algorithms [7]. A face-detection achievement is efficient at the frame rate.

The aim of this paper is to verify whether the image input contains the face of a human. To detect it, we introduced a fast algorithm for face detection in live sequences video, by model of skin color, the YCbCr color space [8]. The contribution of this algorithm is the use of the erosion function to delete any additional object, as well as to use a Gabor filter for detecting feature extraction to classify skin regions in binary mode if it is a face or not.

These methods are fast, robust, and reliable and permit the segmentation and tracking of multiple instances of facial images. This algorithm is designed and implemented to work well with color images under varying lighting conditions and in a homogeneous background. Details follow: 2) face detection methods, 3) proposed algorithm, 4) extracting the face area, 5) results and discussion, and 6) conclusions.

2. Modern Face Detection Methods

2.1 Gabor Feature Face Method

A Gabor filter is a band-pass linear filter [9]. That regularly obtains localized frequencies and is recognized as the one of the best choices. Gabor filtered images could be robust to variations of facial expression and illumination [10]. The response is a Gaussian function characterized via harmonic function. Within image processing field, for edge detection methods can use Gabor filter [11]. Like the human visual system, frequency and orientation can represent Gabor filters, and it was observed to be particularly appropriate representation for texture and differentiation. With spatial domain, a Gaussian kernel function in 2D Gabor filter is controlled based on sinusoidal plane wave [12].

2.2 Face Skin Segmentation Color Models

Firstly, a color-based approach in mobile phones for face detection has limited resources presented. Surely, an important feature is that it can be implemented in an easy and efficient way to extract objects locating since color is a low-level [1] way to distinguish regions in the image of skin or non-skin. Face detection based on skin color algorithm consists of two steps: 1) segmentation of expected face regions and 2) region merging. The first step includes choosing the suitable color spaces in the skin color detection [3]. Partitioning an image into regions is called the segmentation process. The problem with face detection, probable regions identifying skin segmentation that contain the faces helps regions all skin-segmented that are not face regions reducing search space . Skin region may be detected by various color spaces, like RGB, YCbCr, and HSV, to simply detect the skin color and non-skin color [13].

The proposed method uses the YCbCr color model for skin detection. The YCbCr color model has three components: two color-difference components for chrominance and color information stored as Cb and Cr and Y for luminance [13]. This color space has become widely used in digital videos and defined to meet the increasing requirement video information of digital processing algorithms. It has been developed to permit the color information on televisions to transmission, with consideration the existing black and white television as yet images displays in shades of gray [14].

$$Y = 0.299R+0.587G+0.114B \tag{1}$$

$$Cb = -0.169R-0.331G+0.500B+128 \tag{2}$$

$$Cr = 0.500R-0.419G-0.082B +128 \tag{3}$$

2.3 Morphological Image Processing

The most basic morphology theory is that a binary gray image can only have two possible values. To process and analyze an image, morphological image processing uses a certain form of structural elements to measure and extract the corresponding shape of the image. The base of math morphology involves an opening and closing technique operation: the dilation and erosion techniques operation [15]. Skin color detection morphological operations like erosion are widely used in image processing for eliminating the non-skin visible pixels. This process helps regroup the skin pixels. By execution, erosion can remove scattered non-skin pixels. Via dilation regrouping, the skin region is attained to smooth the contours. The binary image results in removing noise [16].

The steps of dilation are:

1. If the origin of the structuring element coincides with a ’0’ pixel in the image, there is no change; move to the next pixel.

2. If the origin of the structuring element coincides with a ’1’ in the image, make black all pixels from the image covered by the structuring element.

The Notation is as under [15]:

$$I \oplus H = \{(p + q) \mid p \in I, q \in H\} \tag{4}$$

Where

I: Resource Image

H: Structuring Element

And the steps of erosion are [17]:

1. If the origin of the structuring element coincides with a ’0’ pixel in the image, there is no change; move to the next pixel.

2. If the origin of the structuring element coincides with a ’1’ pixel in the image, and any of the’1’pixels in the in the structuring element extend beyond the object (‘1’ pixels) in the image, then change the ’1’ pixel in the image to ‘0’.

The Notation is as under [15]:

$$I \ominus H = \{p \mid H_{\underline{p}} \subseteq I\} \quad (5)$$

3. Proposed Algorithm

Framework face detection in this paper describes a digitized video signal that can input an arbitrary image from a mobile device camera and then return its location if there are any human faces in the image. The proposed face detection method shown in Figure 1 provides a low false-detection rate in order to realize high face-detection accuracy. The approach combines three methods.

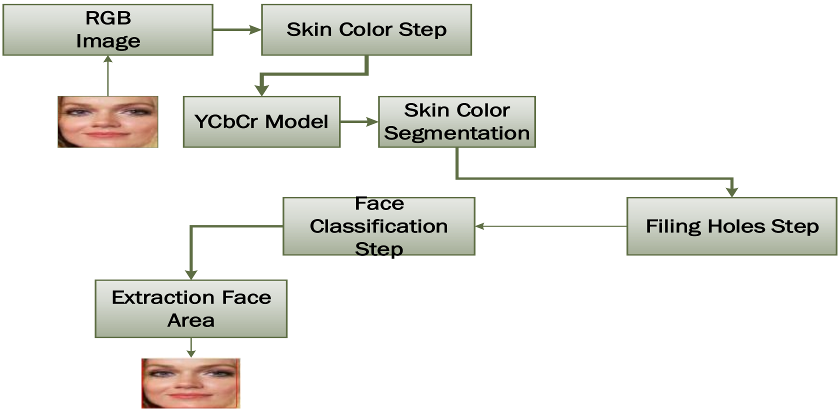


Figure 1. Flowchart for Proposed Algorithm

3.1. Capturing Image

To implement the proposed algorithm, an image is captured from a camera input sequence video or database images From Makeup Datasets are used for faster admission to a large number of images, making the debugging process faster.

3.2. Image Preprocessing

To detect faces in different sizes, a face detector should be masterful. First, the input image should be resized to 160 x 160, we will re-size the image to a fixed width and height image to Compatible with mobile devises screen, so that the scaling factor between the reference and the face image under test is efforts correct consideration. That done by replace (newWidth)and (new Height)with the dimensions of the specified image. The Figure 2 illustrate resize image.

Figure 2. Resize Image

3.3 Three Main Modules Contain:

1- Skin Segmentation Step: Using YCbCr Color Space.
2- Filling Hole Step: Using Morphological erosion and dilation
3- Face Classification Step : Classify skin regions into two classes, face or non-face, by using Gabor filter

3.3.1 Skin Segmentation: Using YCbCr Color Space

1) Skin segmentation of the color image retrieves connected and important regions representing objects of interest, consisting of skin pixels. The four-step segmentation modules for allowing us to locate candidates' faces are as follows:

Step 1: using a skin detector to get a binary image for classifying pixels color image into two groups (skin/ non-skin) classes by the YCbCr color model. The processing converts from RGB to YCbCr color space, shown in the following equations:

$$40 < Cb < 240 \text{ and } 10 < Cr < 100 \quad (1)$$

$$Y > 80 \quad (2)$$

These result in a binary image depend to the range Ranges:

R/G/B [0….255]

Y [16……235]

Cb /Cr [16….240]

After experimenting with various threshold the best result were found by using the following rule for detecting the skin pixel in(1 ,2)equations ; having 1 value means they belong to skin regions a having 0 value means they are non-skin regions.

Step 2: This segments the binary image that results from the previous step.

Step 3: Important skin areas are located.

a) b)

Figure 3. a) input image b) Skin color Segmentation Output

3.4 Filling Hole

This removes and filling non-important regions by using the erosion and dilation process as shown in figure 4.

a) b)

Figure 4. a) input image b) Morphological Operations output

3.5 Extraction Face Feature Approach

The classification of skin regions into two classes: face or non-face by using a Gabor filter. The second part of the face identification process represents extraction of face features. This section proposes the use of a Gabor filter, a commonly used image processing tool, for feature extraction to obtain feature vectors of the visual content of facial images. Choose the two-distension Gabor filtering that provide optimal characterizations:

3.6 Gabor Filter

After segmenting face regions by using skin color, the regions of interest applied a 2D Gabor filter to find the real face area. Since a 2D Gabor filter is similar to the receptive fields of neurons in the visual cortex, the Gabor filter has been applied in various computer vision applications like live face detection .

A sinusoidal signal modulated a Gaussian function as shown in Eq. [1] having the following form:

$$G(x,y) = e^{-(x^2m^2+y^2n^2)} \cos(ux+vy) \qquad (1)$$

Where $u = f cos\theta, v = f sin\theta;$

Where f is: is: sinusoid radial frequency; $\theta(\theta \in [0,\pi])$ specifies the orientation; m and n are the filter parameters scaling and effective determine size of the pixel neighborhood in which the weighted summation takes place. Via varying θ, orientations can be detected corresponding with the edges. Gabor filter horizontally ($\theta = \pi / 2$) only used in this paper for features facial extract. The facial features are extracted from the output of the Gabor filter. Example in the following shown in Figure 5 (a), (b):

(a)

(b)

Figure 5. (a) Facial image, (b) Gabor filter output

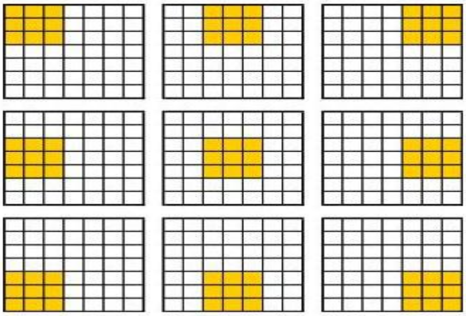


Figure 6. Windows in each sub-image for feature extraction

The output image is split into 9 sub-images as shown in figure 6, moving the window over each sub image to extracted features. The summation averaged values pixel that result from moving the window are feature used. Therefore, get a feature vector, where

$d'_i = ('d_1, 'd_2, \ldots\ldots, 'd_9)^T$, Stands the $i-th$ Sub-image feature. For use a normalized feature vector at face detection to eliminate lighting effects and camera distance, the element

$d_i = (d_1, d_2, \ldots d_9)^T$ $A = \pi r^2$ Can be estimated as

$$d_i = d'_i / \sqrt{\sum_{j=1}^{9} {d'_j}^2} \quad (2)$$

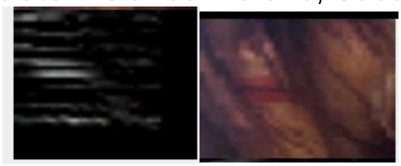
The face area is detected or determined by use of a Euclid distance between the feature vector of the potential face area and that of a template facial image, which is shown in in Eq. [3].

$$d = (d_P^T . d_T)^{1/2} \quad (3)$$

Where d_P and d_T are feature vectors of the potential face image and the template image, in Figure 6: a),b),c) are shown (face images and non-face images) and their distances. The first and second one. The distances that can be seen for face images and output of Gabor filter are ordinarily small, for non-face images are large. By tests, for face detection the threshold is set as 0.075.

a) Template Distance = 0, Successes Face

b) Template Distance = 0.046, Successes Face



c) Template Distance = 0.125, Failure Not Face

Figure 7. a)- b)- c)- Illustration Output of Gabor filter, Successes and Failure Face Detect

The face is illustrated with coefficients expressed. They possess Gabor at the credence points: eyes, nose, and mouth. This confirms existence faces in the image.

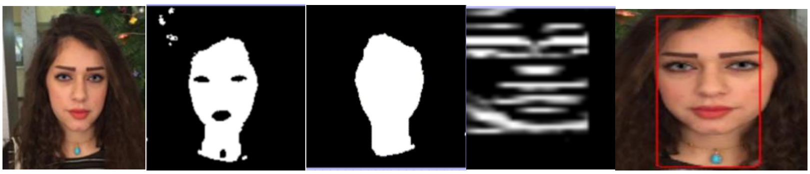
4. Extracting Face Area

To extract regions of human non-face morphological operations, one must draw a bounding box around the human facial region. Generally, the oval shape is similar to the shape of the human face. This method does not reject the region that has a shape possibly likely an olive. For finding the specific shape of skin regions rejected shapes are not olive, the function gives its abnormality value. Finally, a box is drawn around every human face, drew images with a square-shaped boundary. As shown in figure 7.

Figure 8. Final face detect with square boundary

5. Results and Discussion

The proposed method identifies human faces in images from background for frontal face by using the YCbCr skin color model. It decreases the area in this method because it selects only the skin regions. To separate among faces and further objects, body, or other objects (similar hands or wood) region segmentation, it is lucid that the usage of only skin color is not sufficient. For this reason, use of erosion on photography results. To detect faces precisely, the Gabor filter was evaluated for binary images to extract features. Our proposed approach was implemented with databases named mockup on face image, which contains different conditions. It also used images taken with a digital mobile camera to represent the real word. This dataset was built from face images for different conditions, including frontal faces and of many different origins (Asians, Middle-Eastern, Hispanic and African). The test images also consist of different lighting conditions: daylight, fluorescent light, flashlight (from cameras), or a combination using different scenes, indoor and outdoor. Under various illumination conditions, faces appear completely different. Not only do different persons have different-sized faces, but faces that are far away from the camera look smaller than the faces nearer to the camera. The face detection system was implemented using the Android studio. Figure 8 show another Experimental Result examples.



(a) (b) (c) (d) (e)

Figure (9-a).Shows the experimental result of face detection from real word camera

(a) (b) (c) (d) (e)

Figure (9-b). Shows the experimental result of face detection from makeup dataset

The result in mobile phone for face detection :(a) Original image (b) Skin Segmentation (c) Morphological operations (c) Result of Gabor Filter (e) Face detect.

Comparison of the Proposed Method that Using Hybrid Methods with Each Methods Alone as shown in table 1.

Table 1: Comparison of the Proposed Method that Using Hybrid Methods with Each Methods Alone

Detection Method	Total Faces	False face detection	Detection result (%)
Proposed method	100	4%	96%
YCbCr	100	8.256	92.69%
Gabor Filter	100	6.35	93.65

6. Conclusion and Future Work

In this work, we have presented an efficient face-detection method application on mobile devices based on skin color and a Gabor filter. This method are testing with muckup dataset that Contain 500 images belong to 108 women from Asian region and. The test were successful at a rate of 99%. In future work, we will improving this algorithm by considering the face-detection algorithm as the first step to achieving eye-gaze detection. Using this method can improve the eye-gaze system by detecting faces and sending this method to detect eye gaze in a mobile device.

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تطبيق للأجهزة النقالة: اكتشاف الوجه بشكل مباشر باستخدام لون البشرة ومرشح كابور

أ.م.د. هناء محسن م.م. سلمى حميدي عبدالله

المستخلص: الاهتمام بتطبيقات الهاتف المحمول آخذ في الازدياد. أدى انتشار الهواتف المحمولة مع الكاميرات الرقمية إلى عدد من التطبيقات التي يتم إنشاؤها. تعد تقنيات الكشف عن الوجه أول عملية في العديد من التطبيقات وليست عملية سهلة. تحدد طريقة التطبيق المقترحة الوجه الإنساني من خلال الحصول على إطار الالتقاط من كاميرا في فيديو مباشر. لبدء معالجة هذه الصورة، يبحث التطبيق عن ميزات مهمة ثم يستخدم هذه الميزات لتحديد موقع الوجوه.تم استخدام أسلوب شائع يعتمد على لون البشرة وهو نهج قوي وأسرع من العديد من التقنيات الأخرى لكشف الوجه لأن اللون يحتوي على معالجة معلومات أكثر من غيرها من ميزات استخراج الوجه. توصى هذه الورقة بطريقة الكشف عن الوجه البشري لتطبيقات في الأجهزة المحمولة يستخدم الوجة من الجهه الاماميه فقط. باستخدام (YCbCr) ثم يستخدم وظيفة التآكل لحذف كائنات إضافية في الجلد. وبعد ذلك، يتم استخدام فلتر كابور لتصنيف الجلد اذا (وجد وجة أو عدم وجود وجه). تحقق طريقتنا دقة بنسبة 96٪ ويمكنها تحديد موقع وجه واحد أقرب إلى الكاميرا. يمكنه الكشف عن وجه في ظروف إضاءة مختلفة بالإضافة إلى تلك القائمة على التحكم في الضوءوبخلفية صورة معقدة.

الكلمات المفتاحية: كشف الوجه، كشف لون البشرة، مرشح غابور، وضع YCbCr، تجزئة اللون الحية.

*الجامعــة التكنولوجيــة