Different Techniques of Hand Segmentation in the Real Time

Manel BEN ABDALLAH*, AMENI Sessi*,
Unité de Recherche SETIT ISBS Sfax,
(ISBS), Sfax University
BP 1175, 3038 Sfax
Tunisie

MOHAMED Kallel *, M.S.BOUHLEL*
Unité de Recherche SETIT ISBS Sfax,
(ISBS),Sfax University
BP 1175, 3038 Sfax
Tunisie

ABSTRACT
In this paper, we present a part of vision based hand gesture recognition system of natural human computer. The segmentation is the primary step for any hand gesture recognition system. So our objective is not only to detect the hand but also to segment so that we can extract the information about shape and position. In our case, we used both HSV and YCbCr color spaces to segment and compare the results obtained. Then, we have chosen the best method of segmentation, so as to determine the following steps of treatment for the hand gesture recognition.

Keywords
hand gesture recognition, human computer, segmentation, HSV, YCbCr .

1. INTRODUCTION
The Human Computer Interface (HCI) is defined as a discipline concerned with the means and tools implemented so that humans can control and communicate with computer system. Many tools exist for connecting with computer (screen, keyboard, and mouse). These tools are the three basic, devices of the interface of our computers. Currently you can interact with a computer more naturally and intuitively than with conventional devices. Over the past few years, there has been a growing interest in hand gesture recognition, thanks to the use of computer vision technique. Therefore, the gesture recognition systems first used electronic gloves with sensors providing the hand position and angles of finger joints. But these gloves are very costly and cumbersome, hence the growing interest in methods for computer vision. Indeed, with technological advances and the advent of cameras, it is now possible to develop systems for gesture recognition based on computer vision. . To solve the problem of visual interpretation of gestures, a lot of approaches studied it. Many of these approaches have been developed by concentrating on one particular aspect of the gesture such as the hand tracking, the estimation of posture or gesture classification. These studies may lead us to a particular application like remoting the recognition of sign language [1], augmented reality, virtual reality and multimodal.

The gesture is the most signification and richest channel of communication that can be used to replace the speech [2]. More precisely, the gesture was structured to three parts. The first part is the beginning of movement; the second gesture is the path action and the third is the end of gesture. The recognition of hand gestures is a problem processing sequence that can be resolved in different ways. Different works using gestures are proposed. We present in this section some systems. Three-dimensional hand tracking and gesture recognition for human-computer interaction [3]. This work consists of replacing the operation of a touch screen with a stereo vision system used two cameras, using the appearance model to recognize a gesture from a predefined set of gestures. The system for the recognition of 3D hand gestures [4]. This system is based on a database prepared through a limited number of hand gestures to follow and reproduce the movement of the hand. The principle of the recognition of an act according to [5] is based on comparing the signatures of the current action and the signatures of the training sequences corresponding to an alphabet of known gestures. The gesture recognition is associated with the smallest distance.

2. System Overview
Our gesture recognition pepline consists of the following steps:

1-Segmentation: the segmentation is crucial part of the gesture recognition because if we do not properly segment the image, further gesture recognition may be impossible. You just need to explicitly set the bounds of the interval in the region representing the color of the skin in the suitable color space. Methods based on thresholding are commonly used to deal with the particular case of segmentation into two classes. In our case we have skin and non-skin classes. To discriminate between skin pixels from those of non-skin must therefore specify the appropriate upper and lower bounds of each component of the model adopted for the color segmentation.

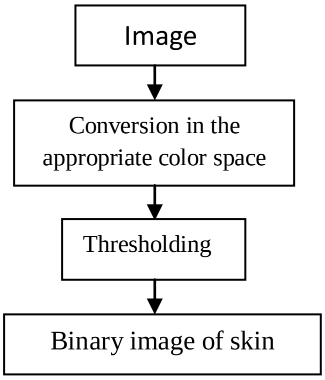

Fig 1: steps of a segmentation hand

2-Extraction Characteristics: This extraction is the analysis stage. The characteristics are a set of measures to determining the hand configuration and its position, aiming at two analytical techniques. The technique based on the gloves provides accurate measurements of the position of the fingers but this technique suffers from the link of the user with a cable. The visual recognition of gesture is the most natural technique solution; it frees the user from the use of devices such as digital gloves. There are three categories in the gesture recognition.

3-Regnition: We have seen that the hand can produce a wide variety of gestures. However, it is extremely difficult to identify all possible configurations of the hand from its projection in an image. Indeed, according to the orientation of the hand over the camera, parts of the hand may be hidden. To facilitate the recognition of gestures, it is necessary to define a vocabulary of gesture. The gestures of a vocabulary are simple and intuitive to the user. The elements of the base of gestures can be represented in different forms such as images, contours or silhouettes. The objective is then to explore the basic gesture to find a correspondence to an image provided by the camera. We can cite a basic example of gestures that can be used for gesture recognition.

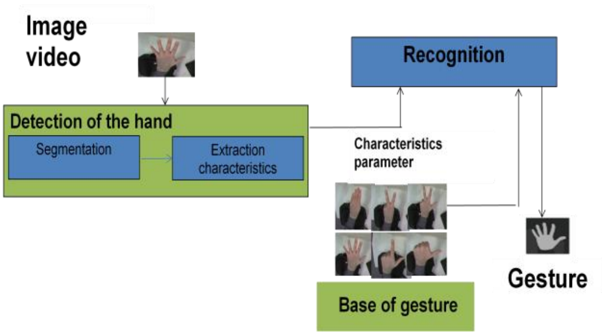

Fig 2: Steps of a gestures recognition

3. SEGMENTATION

The detection of the hand in the images is an important common problem to most systems of gesture recognition. This first step is essential because it determines the following treatment. So our objective is not only to detect the hand but also to segment so that we can extract the information about shape and position.

We present three approaches to segmentation of the hand:

3.1 Thresholding Otsu

Thresholding a grayscale image is to associate the value 0 (black) to all pixels whose value is below the threshold α, and 1(white) to all others. This gives an image thresholded S, also known as mask binary or silhouette. The method of Otsu threshold is determined from the histogram of the grayscale image.

Original image	Result with the method of Otsu	Histogram

Fig 3: Example of segmentation by thresholding

3.2 Image difference

The technique of image difference is well known in computer vision; it is to perform a pixel by pixel difference between two images. This approach is at the pixel level, which means it does not take into account the relationships between adjacent pixels. The value of the pixels is assumed stable in time.

However, changes in scene brightness can change this value. These methods are very sensitive to changes in brightness, shadows, and change of the background. It should also take into account the acquisition noise of the camera.

There are two types of methods for the image difference. The difference of successive images, which detects moving objects, and the background subtraction, which detects objects outside the background.

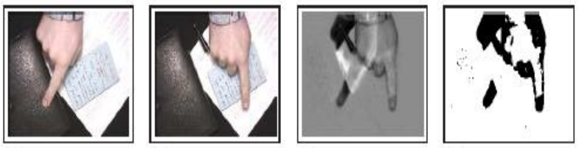

Fig 4:Difference between two successive images (extract from Martin[6])

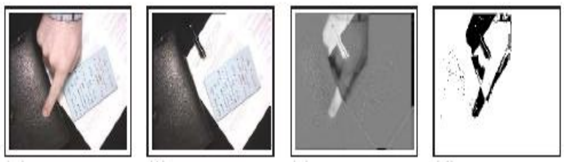

Fig5: Difference image with a background image (extract from Martin[6])

3.3 Detection of skin color

An analysis of skin color is very used to segment the regions of skin color such as the hand or the face. In this type of segmentation, there are two important aspects; the choice of a color space and the choice of the method to classify the pixels of the skin.

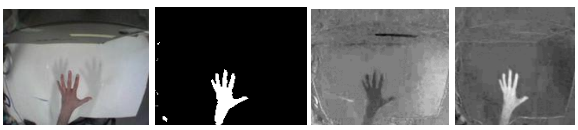

Fig 6: Example of segmentation of the hand with the thresholded cbcr

In the segmentation by Otsu thresholding method, there are false detections, which are manifested by isolated white pixels, and the pixels of the object undetected are manifested by "holes". It is necessary to filter the binary image to keep only the region corresponding to the hand. The image difference segmentation approach is very used for the detection and tracking of objects, but it is not adapted to our problem. Indeed, in our configuration, the hand causing shadows are segmented by hand. For this purpose, in our case we have chosen the method of color detection. In addition, the skin color information is robust against rotation, scale changes, and partial occlusions. This low-cost method of calculation gives good results in real time by the testimony of several former work.

4. Color Models

Skin color is often used for the detection of faces and gestures. However, it is known that color is unreliable in dark areas and sensitive to ambient light. In most cases, the skin can be viewed as an image portion of a determined color. Using the frontiers of this area as a threshold for an image, it is possible to extract the pixels whose color can resemble that of the skin. Studies have shown that the variability of skin color gives more importance to the difference intensity rather than the chrominance. However, the color can be presented in different color spaces such as RGB, HSV, CIE LUV, YCbCr...

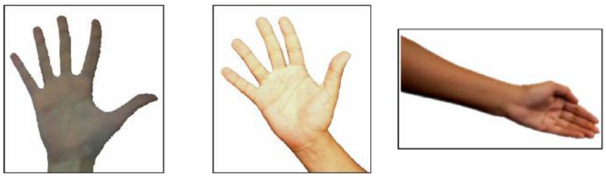

Fig 7 : Presentation of different skin color

4.1 HSV color space

It is a natural model for the representation that is close to the physiological perception of color by the human eye.

-Hue: corresponding to the color perception
-Saturation: describing the purity of the color; that is to say, its lively or dull character.
-Value : indicating the amount of light of the color; that is to say, its light or dark aspect.

In HSV space, it is considered that the channels H and S represent the color information and the channel V is neglected since it represents the intensity information in the detection of the color of the skin. This model with the segmentation requires the conversion of RGB color space of the original image to HSV space.

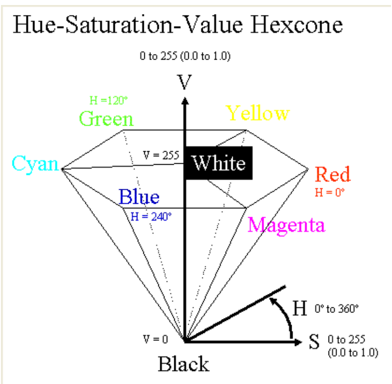

Fig 8 : HSV color space

4.2 RGB Color space

The model presents three primary color: red (R), green (G) and blue (B). This color space is simple it does not separate luminance and chrominance and, the R,G and B components. RGB coding is based on three components offering the same range of values. It is generally represented graphically by a cube are highly corrected.

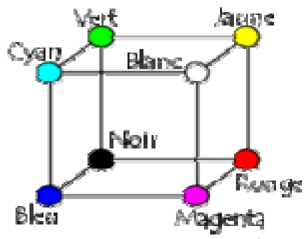

Fig 9: RGB color space

Detecting skin color using RGB space requires no skin model and no transformation of color, it verifies a series of constraints to determine whether a triplet of color (R, G, B) represents a color skin or not, these constraints are divided into two according to the state of the light, strong (day) or low (night) [7]

4.3 YCbCr Color space

YCbCr is a family of color spaces used as a part of the color image pipeline in video and digital photography systems. This color space is most useful in compression application and most importantly it separates RGB into luminance and chrominance information. Y is the luminance component and CB and CR are the blue-difference and red difference chrominance components. RGB values can be transformed to YCbCr color space using the following equation:

$$Y = 0{,}299 * R + 0{,}587 * G + 0{,}114 * B$$

$$Cb = -\,0{,}1687 * R - 0{,}3313 * G + 0{,}5 * B + 128$$

$$Cr = 0{,}5 * R - 0{,}4187 * G - 0{,}0813 * B + 128$$

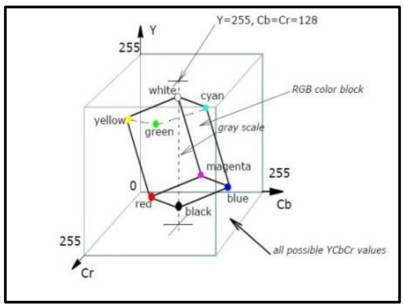

Fig 10 : Cube RGB color space YCbCr

5. Adapted approach to segmentation

Segmentation by the RGB color space is not used in the field of detection of the hand. The tristimulus value of a color stimulus is related to its luminance. Two color stimuli can well have the same chrominance but have different components R, G and B because of their luminance. In our case we used both HSV and YCbCr color space to the segmentation and compare the results obtained. The segmentation procedure starts scanning the pixels of the image to be processed in accordance with the searching of those selected thresholds. The pixel belongs to the interval thresholding takes the value "1". Otherwise, it takes the value "0". Segmentation produces a binary image in which the skin regions are represented by white and others are black.

5.1 Segmentation HSV color space

For the HSV color space, the luminance component is represented by the channel V (Value) and the chrominance component is represented by the two channels H (Hue) and S (saturation). The distribution of skin color in the HSV space is compact and imitated in space. This distribution is presented in Figure 11. Spatial representation shows that the cluster of skin color, represented by the red dots is less compact for low saturation values. Using the boundaries of this cluster as thresholding values, it is possible to extract the pixels whose color can be likened to that of the skin in the HSV color space [8].

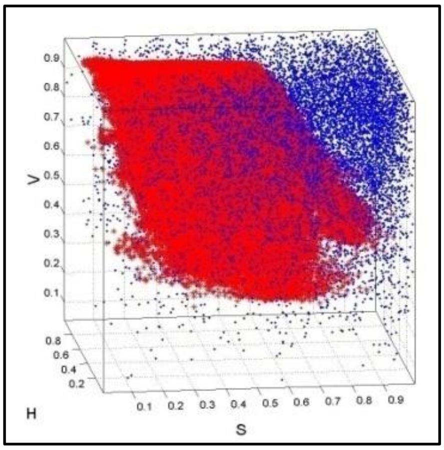

Fig 11: Skin color distribution in HSV space

Thresholding values chosen are presented by the following inequalities:

$$0 \leq H \leq 20$$

$$45 \leq S \leq 255$$

These values are extracted from the scientific literature of the ancient works of detecting the color of the skin.

Fig 12 : Segmentation of skin color according to the color space HSV color light

Fig 12 shows an example of hand segmentation. This segmentation step is applied to a light shade of skin and HSV color space.

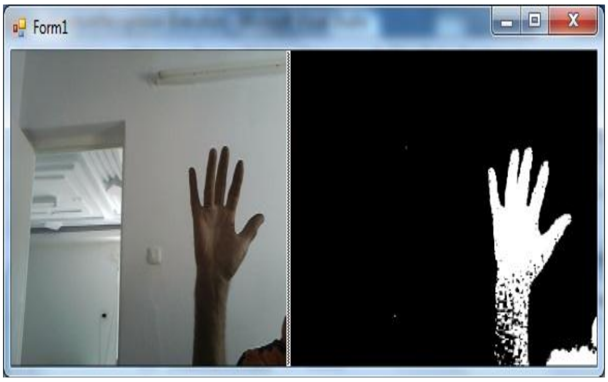

Fig 13 : Segmentation of skin color according to the color space HSV color dark

Fig 13 shows an example of hand segmentation. This segmentation step is applied to a shade of skin and HSV color space. These two figures show some holes in the segmented hands.

5.2 Segmentation YCbCr color space

In the majority of color spaces, the skin is represented by a particular portion of the space. Segmentation of skin color as this space can be limited to a segmentation of the chrominance components Cb and Cr. The plans of delimitation of skin color in YCbCr space chosen in our work are described as follows:

$$131 \leq Cr \leq 185$$

$$80 \leq Cb \leq 135$$

We have to set these limits through previous work in the field of skin color detection with some corrections to be more appropriate to our stage of work, the amount of light and camera quality image acquisition.

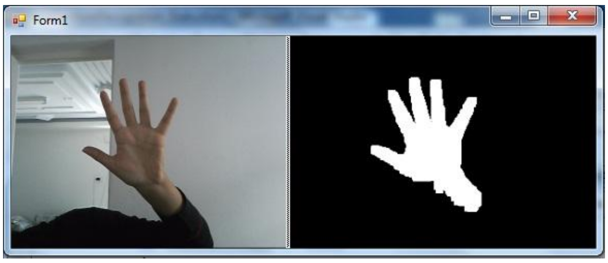

Fig 14 : Segmentation of skin color according to the color space YCbCr color light

Fig 14 shows an example of hand segmentation. This segmentation step is applied to a light shade of skin and YCbCr color space.

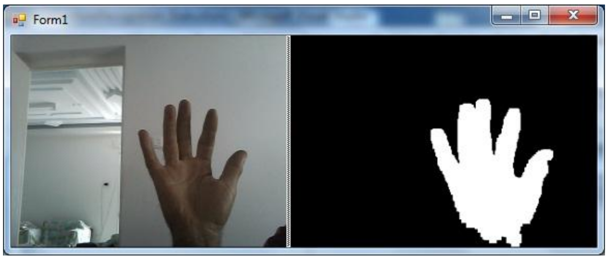

Fig 15 : Segmentation of skin color according to the color space YCbCr color dark

Fig 15 shows an example of hand segmentation. This segmentation step is applied to a light shade of skin and HSV color space.

In our case, the segmentation by YCbCr color space gives better results than the segmentation HSV color space. Segmentation by the YCbCr color space is used to determine the result of the treatment in order to have a good recognition of hand gesture.

6. Conclusion

Detection of skin color in color images is a very delicate operation mainly because it is considered as a preliminary step in most systems of human computer interaction; and the performance of these systems are closely related with the results in this step. The study we propose in this paper is a comparative one, demonstrating the detection of skin color according to different color spaces where we adopt, based on each space, a segmentation threshold of skin color drawn from the scientific literature.

7. REFERENCE

[1] A. Braffort " Reconnaissance et compréhension de gestes, application à la langue des signes" Thése de doctorant , Université Paris X-I, 1996.

[2] C. Cadoz, le geste canal de communication home-machine/la communication instrimentale. *Technique et sience informatique*, 13 : 31-61, 1994.

[3] S. Conseil suivi tridimensionnel de la main et de reconnaissance de gestes pour les interfaces Homme-Machine, Mai 2008.

[4] R. Ionescu, " Reconnaissance de geste dynamique de la main". 19 colloque sur le traitement du signal et des images, 2003 ; p670-673.

[5] O. Ben-Henia, S. Bouakaz, Utilisation de l'ACP pour la reconnaissance de geste 3D de la main, ORASIS-Congré des jeunes chercheurs en vision par ordinateur, Mai 2011.

[6] J. Martin, "Reconnaissance de geste en vision par ordinateur". Thése de doctorat, iInstitut National Polytechnique de Grenoble, 2000.

[7] C.Garcia, G.Tziriatas, "Face Detection using quntizied skin color skin color regions merging and wavelet packat analysis" *IEEE Transaction on multimedia*, 1(3), september 1999 p264-277

[8] R.L. Hsu, M. Abdel-Mottaleb, A.K. Jain, Face detection in color images, IEEE Trans. Pattern Anal. Machine Intell. 24 (5) 696–706, 2002.