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Development of an Efficient Hand Gesture Recognition system for human computer interaction

Umadevi N[1], Divyasree I.R[2]
[1]Department of computer science, Sri Jayendra Saraswathy Maha Vidyalaya College of Arts and Science,Coimbatore, India
umadevigayathri@gmail.com
[2]Department of computer science, Sri Jayendra Saraswathy Maha Vidyalaya College of Arts and Science,Coimbatore, India
divyasree.i.r@gmail.com

Abstract:

Human computer interaction technique has become a bottleneck in the effective utilization of the available information. The development of user interfaces influences the change in the human computer interaction (HCI). Dynamic hand posture recognition is one of the difficult tasks due to its complex background. The proposed method is implemented for hand postures taken in the natural environment. Challenges such as change of illumination and similar background are taken into consideration. Working system is based on two steps, namely hand detection and hand gesture recognition. In the hand detection process, normalized colour space skin locus is used to threshold the skin pixels from its varying background. Morphological filtering and canny edge detection is used efficaciously for removing object noise and obtain counter edges of hand gestures. Normalized cross correlation is used for pixel-wise comparison between the input image and the depository images and the best matching is considered as region of interest.

Keywords: Human computer interaction, hand detection, gesture recognition, normalized cross correlation**.**

1. Introduction

Gesture recognition is referred to as the tracking human gestures to represent and convey meaningful information. It has a variety of applications like surveillance, robotics, gaming technologies, virtual reality, augmented reality, sign language, medical environment etc. [2]. It is classified into following two states, glove based and vision based gesture recognition [7]. Contact based device or glove based devices employed for hand gesture recognition system are based on the physical interaction of user with the interfacing devices [9]. The user has to be connected with the system using some external devices like wires, sensors etc. It provides a promising result but it cannot be affordable due to its high cost and it also needs an external device to be worn, which reduces the natural way of communication with the system [4].

In vision based gesture recognition system a camera has been attached to the system and an algorithm is used for translating the human gestures into the system command. In vision based system a colour marker has been used for detection of human gestures [7]. Even though some external devices like colour markers has to be worn, it provides a considerable degree of freedom. The main challenge of vision based system is to cope with the large variety of gestures. [8] Used hand gestures for controlling media players. Vision based hand gesture has a variety of techniques [6]. Unless the hand gestures are detected it is impossible to recognize the shape of the gestures. Recognized gesture are considered for controlling applications.

2. Proposed method for gesture recognition

A contact based hand gesture method is presented. It is carried out step by step. It has the following states, video acquisition, frame separation, skin colour based background subtraction, hand detection, template matching and controlling desktop system as shown in the figure 1.

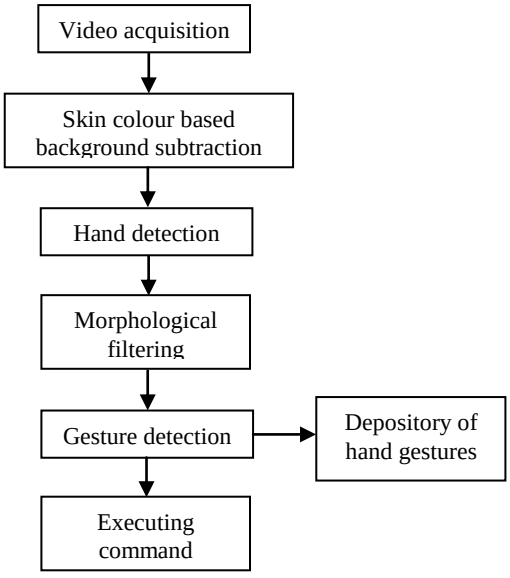

Figure 1: Hand gesture recognition system

2.1 Algorithm for gesture recognition

1. A noiseless video has been recorded using a standard camera.
2. Extract a frame (i.e. hand image) from recorded video stream.
3. Extracted frame is transformed from RGB colour space to HSV colour space model. Here we consider only H

and S part because H and S shows non-skin region. The threshold value of H and S for non-skin region is (H > 0.55 or S <= 0.20 or S > 0.95). Make zeros for all non-skin region in image I and obtained skin colour region in image (I) denoted as I1.

4. Then hand is detected in the image using skin colour based detection techniques.

$$h = \begin{cases} \emptyset, & if\ B \le G \\ 360 - \emptyset, & if\ B > G \end{cases} \quad (1)$$

Finally, the intensity components is given by

$$I = \frac{1}{3}(R + G + B) \quad (2)$$

5. After detection of hand we have converted the image into black & white i.e. marked the skin pixels as white and non-skin pixels (i.e. background) as black and then we have applied some pre-processing techniques like image filling, morphological erosion using 15 × 15 structuring elements etc. to increase the quality of image and to remove some noise.
6. Then apply median filter of window size [3,3] to remove noise from the image.
7. Calculating the area of each binary region, first we have to label them and then calculate area of each region.
8. Gesture is recognized by counting the number of white objects in the image and orientation of image. Finally a command is passed to the applications running on the computer corresponding to the recognized gestures as shown below.

Pre-process each segmented image I with morphological filter.

```
For I=1 to k do
For J=1 to k do
Comparing segmented image with template image
K = I -> J
End for
End for
Where I= index.
If index=1
Open Microsoft Office word document
Elseif index=2
Open Text document
Elseif index=3
Open video player
Elseif index=4
Open audio player
Elseif index=5
Open web browser.
End if
```

Video acquisition is the first step. It is the process of acquiring the video using a digital camera. For acquiring the video, a video acquisition toolbox has to be installed [1]. A video input object is created for temporarily storing the video. The captured video should be of good quality and free of noises. It is followed by the frame separation which converts the video into a continuous sequence of frames. Background subtraction is a prominent method for separating foreground image from its background. Here skin colour segmentation has been utilized by the background subtraction method for the detection of hand objects. Each frame consists of either a skin colour objects or non-skin colour objects [5, 3]. The hand object is detected by separating the skin colour pixels from the non-skin colour pixels. If the background consists of colours similar skin colour pixels then hand detection becomes a difficult process. Hand detection is an important phase where the hand has to be segmentation from other foreground objects which are moving. In general, the selection of an appropriate segmentation algorithm depends largely on the type of images and the application areas. An HSV (Hue, Saturation and View) colour space has been used for the detection of hand gestures. Even after the segmentation process there may consists of some 1s in the background which is known as background noise and some 0s in hand gesture which is considered as gesture noise [10]. These errors to be removed before detecting the contour of hand gestures. Morphological operations are applied to obtain complete and smooth gestures. Segmented hand region from the original image is shown in the figure 2.

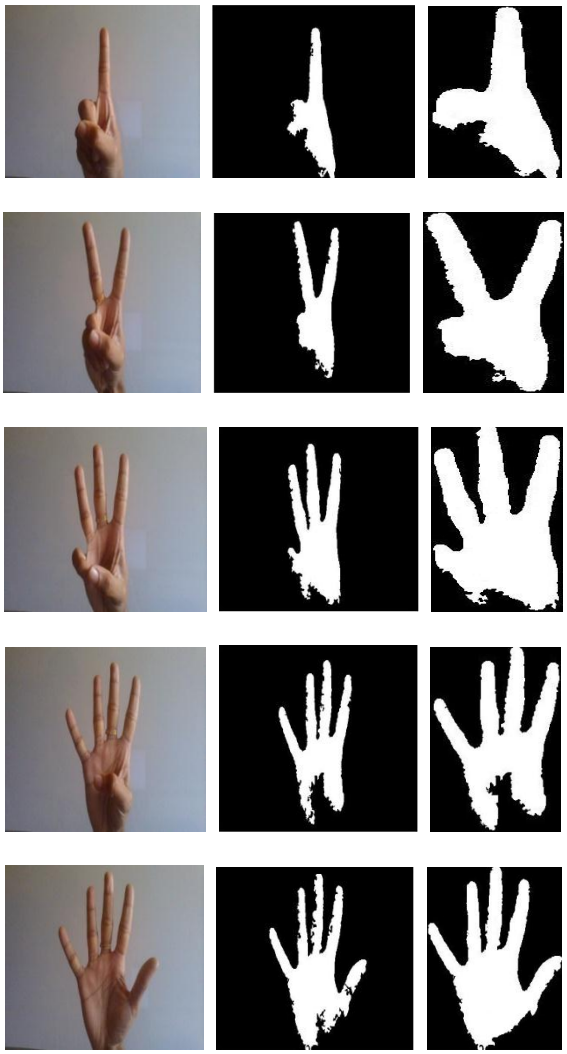

Figure 2: Segmentation of hand gestures

3. Result and Discussion

The recognised hand gestures are considered for controlling desktop system. When the user interacts with the system by hand gestures, the system detects the shape of the hand gestures based on its skin colour and compare it with the depository images using cross correlation method. A skeleton of the hand gestures are obtained for better identification of hand shapes as shown in the figure 3.

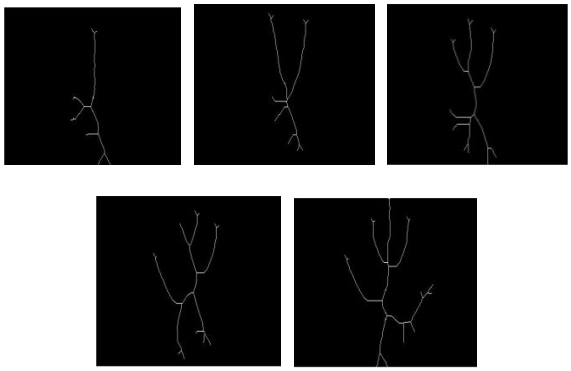

Figure 3: Skeleton of gestures 1 to 5

After detecting the shape of the hand gestures it is necessary to manipulate the detected hand shapes with the system control. Whenever the user shown a forefinger in front of the camera which is attached to the system, the gesture recognition algorithm process the data and compare it with the template images and once it is identified as one, an Microsoft word document has been opened. Likewise, when the system identifies the hand gesture as two a new windows explorer panel is opened. For the recognised hand gestures of three a video file is played irrespective of the format. If the detected hand shape is identified as four an audio file has been played. The user if want to access internet through the web browser, user can simply open his hand and show all the fingers in front of the camera. The system detects the shape and opens a web browser.

Performance evaluation is done to prove the efficiency of the proposed methodology in terms of the average time and precision rate.

Table 1: Success rate of proposed system and traditional system

Number of pixels	Precision comparison	
	Existing system	Proposed system
50	40	47
100	52	59
150	67	71
200	72	77
250	79	86
300	84	92

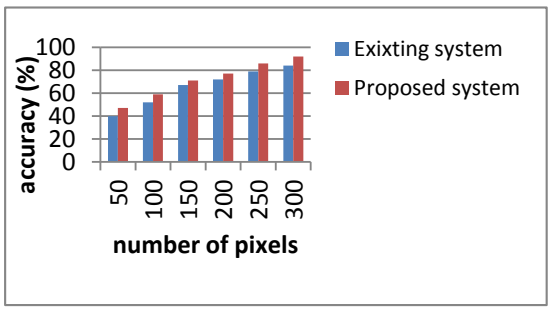

Figure 4: Success rate of proposed system and traditional system

From the above findings it is clear that project completion success rate of proposed system is more than that of the traditional system.

4. Conclusion

Gesture based interface allow human computer interaction to be in a natural and intuitive manner. This research work focuses implementation of tracking and extraction using hand postures. Models for interactive system using skin colour based hand gesture recognition system have been implemented. Normalized cross correlation and absolute difference have been used for hand posture based recognition system. The proposed system is user friendly and it is robust in detection and recognition of hand gestures. Still more robust algorithm for detection of hand gestures in cluttered background and lighting condition is required. We also need to extend the system for more gesture as we implemented it for only 5 gestures. However this system can be used to control most of the applications like media player, web browser, Microsoft word etc.

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Author Profile

Dr.N.Umadevi working as Head and Associate Professor in the Department of Computer Science and Information Technology, Sri Jayendra Saraswathy Maha Vidyalaya College of Arts and Science. She has 3 years of industrial experience and 13 years of teaching experience. Her area of interest are image processing and Data mining. Her publications include 8 international journals. She has presented papers in 6 international conferences and 4 national conferences

I.R.Divyasree pursuing her M.Phil in Computer Science, Sri Jayendra Saraswathy Maha Vidhyalaya College of Arts and Science, Singanallur, Coimbatore under the guidance of Dr.N.Umadevi working as Head and Associate Professor, Department of Computer Science and Information Technology, Sri Jayendra Saraswathy Maha Vidyalaya College of Arts and Science, Singanallur, Coimbatore. Her area of interest is Image processing.