Human Computer Interaction Employing Hand Gestures in Lieu of Mouse Movements

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Abstract : After the advent of computers, we have come to the stage where we can't imagine a day without interacting with the computers. When the computer interaction is playing such an important role, it would not be wise if we don't try to enhance the way we interact with the computer. So, the mechanism we propose helps to enhance the way we interact with the computer without any aid from any external device. The proposed system uses the webcam of the computer system to take the hand gestures as input and the cursor responds accordingly. Vision based approach is used for the skin detection. To reduce the effect of illumination on the image, HSV color space is used in the proposed design. The edge detection technique is used for the counter extraction process. Now a bounding rectangle is drawn so as to find the center of the hand. As the center of the hand moves, the cursor moves. To detect the gestures from the hand the fingers are to be recognized. This be done with the help of function like cvConvexityDefects() in openCV. Thus, with the help of two gestures right and left clicks can be preformed.

Keywords *: Gestures, Human Computer Interaction (HCI), Hue Saturation Value(HSV), Hand Gesture Recognition, track.*

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I. Introduction

Computers have a great impact either directly or indirectly in every walk of life. Without computers the advancements that we see today in various fields ranging from the space explorations to the nano-technology, from molecular biology to nuclear energy, might have confined to dreams. The way we intend to interact with the computer has a great role to play in the results that the computer provides us. So, there is great need for a better and enhanced way of interacting with the computer that efficiently overcomes the problems that existing systems have. The modern day mouse that we see today has been the medium of interaction with computer from early eighties. Though there have been changes in the technology that is used in the mouse, the performance, the level of ease and comfort in working with it has been the same. These devices are necessary but not sufficient in the world which is witnessing the exponential growth in various fields of computer science and technology. All these devices are helpful only when there is a physical contact between the user and the device. But, there are cases where the user is not in a position to touch the device. Now, in such cases, the user is deprived of using the computer as the user can't interact with the computer. When the world is heading towards the nano-technology and compact devices, these devices become obstacles in doing so. The mouse is not suitable for HCI in some real life situations, such as with human robot interaction (HRI). So, an alternative approach is needed that would overcome these problems. Though there has been many researches done in this area, the most dependable and instinctive one is the one which is based on the hand gestures. This will create a Natural User Interface(NUI) between the user and the computer that bridges the gap between man and the machine[1][2].

The Existing System

Human Computer Interaction can be done by various approaches, one among them is using hand gestures.
Hand Gesture recognition can be classified into two categories, they are:

i. Marker-less approach
ii. Marker-based approach

Many existing applications use marker-based approach which requires user to wear any external accessories such as any color marks on the hand or gloves. Programming is done in a way that it identifies colors of the markers or gloves using image processing techniques and performs the desired action. Some marker-based approach applications uses some sort of external hardware to track the motion of the hand which is same as using mouse.
This paper discusses an efficient methodology to implement the hand gesture based mouse control without the use of any external gadgets[3].

II. Proposed Architecture

The proposed architecture uses the marker less approach because it increases the ease of use and provides comfort to the user. In the proposed architecture, the webcam that is already present in the user's computer is used. It doesn't require any external gloves or any sort of external hardware. The webcam in the user's computer is meant for capturing the hand movements. Now, the hand

movement itself acts as the cursor movement. To detect the hand i.e. the skin, vision based approach is used. To reduce the effect of illumination on the image, HSV color space is used in the proposed design. The edge detection technique is used for the counter extraction process. This will help in detecting the fingers. Now a bounding rectangle is drawn so as to find the center of the hand. As the center of the hand moves, the cursor moves. To detect the gestures from the hand, the fingers are to be recognized. This be done with the help of function like cvConvexityDefects() in openCV. Thus, with the help of two gestures right and left clicks can be performed[4][5].

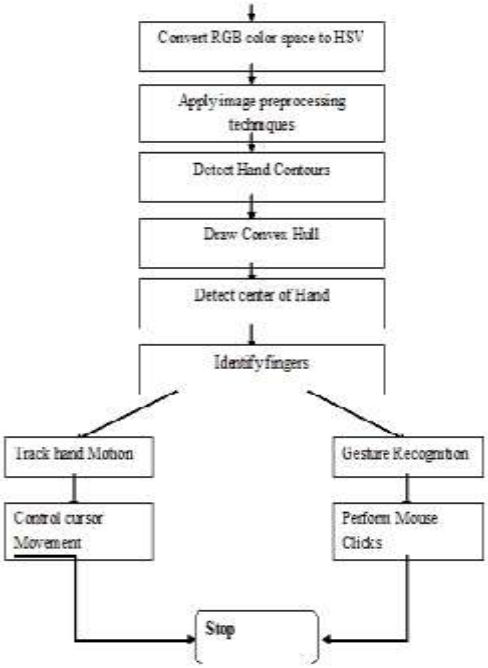

Figure 1 : Flow chart of the proposed system

III. System Implementation

Different steps that are involved in the implementation are[6]:

- Controlling the camera
- Creating Region of interest
- Converting image to HSV color space
- Image pre-processing stage
- Hand Recognition from the captured image
- Performing desired actions

Controlling the Camera

Opencv(Open Computer Vision) provides the functionality of handling the tasks pertaining to the camera. Every captured image will be in the form of matrix storing pixels in the rows and columns. A matrix object is used to handle the image and all the further operations can be performed on it.

Creating Region of Interest

The main task of this paper is to design an effective application to control mouse with hand, instead of processing the whole image if we limit it to a specific region we can achieve better results. Region of interest is a region in the image obtained from the camera and all the image processing is confined to that region itself.

A rectangle is created and drawn on the screen to specify the region where the user needs to place his hand. All the further steps are confined only to this region as shown in figure 2.

Figure 2 : Region of interest

Converting to HSV color space

Every image is formed with some combination of red, blue and green colors. Skin pixels can be identified easily if the image is in HSV (Hue Saturation Value) color space. Hence, we need to convert the image from RGB to HSV as show in figure 3. Skin range pixels can be identified either by manually taking the range of minimum and maximum possibilities of hue, saturation and value for human skin or creating and using a slide bar which dynamically assigns range values. It is better to use a slide bar which makes the application useful under different light conditions[7][8].

Figure 3: HSV image of human hand

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175 – 178

Image pre-processing stage

This stage separates the background and the main object from the hand. Firstly, the image is blurred using image processing functions. Noise in the obtained image will be more hence smoothing of the blurred image is done as shown in figure 4a and 4b. The output image obtained from this will be used in the further steps.

Figure 4 a: Blurred image Figure 4 b: image obtained after smoothing

Hand recognition from the captured image : To recognize a hand from the processed image following steps are needed (see figure 5)[9]:

a. Draw Contours
b. Draw Convex Hull and find convexity defects
c. Find the center of hand
d. Detect and differentiate fingers of hand

a. Drawing Contours: Contours are the borders drawn across the identified hand region.

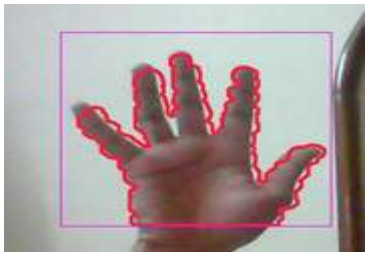

Figure 5. Contours drawn for hand

b. Drawing Convex Hull and finding Convexity Defects: Convex Hull is a polygon which encloses the hand region and has all the contours found earlier inside it. Convexity defects are the gaps between the contours and sides of convex hull, the three points internally start point of defect, end point and a point which is at the middle of this two points (see figure 6). These points are used for the calculations in the further steps.

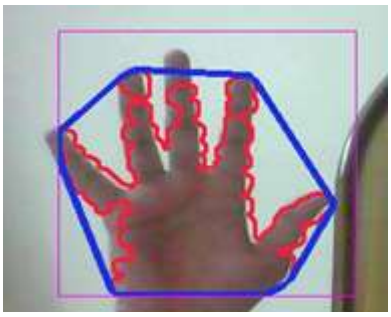

Figure 6. Convex Hull

c. Finding the center of Hand: A bounding rectangle (blue in color) is drawn around the hand and the coordinates (width/2, height/2) gives the center of hand approximately as shown in figure 7.

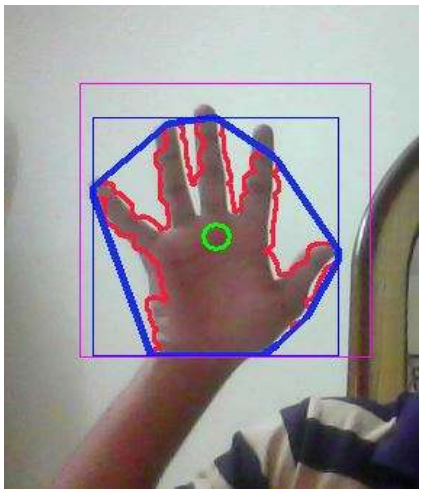

Figure 7. Finding the center of hand

d. Detecting and differentiating fingers: Hand fingers are identified by using the points obtained from the defects and center of the hand[9][10]. Always a start point of the convexity defect has the probability of becoming a finger tip in order to find whether it is a finger or not and it must satisfy following 3 conditions as given in table I:

i) Consider the inner angle between the two lines of the defect region i.e. to be between a certain interval.

ii) Consider the angle between the start point and the center of the hand i.e. to be between a certain interval.

iii) Consider the length of the line from the initial point to the center point i.e. to be above a certain threshold.

If the above three conditions are satisfied a point can be identified as a finger. Now it is easy to distinguish among the fingers based on the angle from the center where the finger tip is identified. Below are the values for right hand gestures.

Table 1 : Finger position and angular ranges.

Finger	**Fingers Angular Range(degrees)**
Thumb	200-120
Index	120-60
Pinkie	60-0

IV. Performing desired actions and Evaluation

Consider the Region of Interest (ROI) whenever user places his hand such that the center of hand is towards the left of the bounding rectangle the mouse must tend to move towards the left side. Similarly mouse must be moved according to the movement of hand. This can be achieved by finding the current position of the mouse by the virtue of decreasing or increasing the coordinates of the axis as necessary. Based on the identified fingers a gesture can be recognized and corresponding clicks can be performed.

V. Conclusion

Human-Computer Interaction through Real-Time Hand Tracking and Gesture Recognition Vision-based interaction is an appealing option for replacing primitive human computer interaction (HCI) using a mouse or touchpad. As the camera is used as an alternative to the mouse, the mouse operations are controlled by the hand movement that is captured by the camera. This provides a natural user interface and helps interaction with computer easier and is also convenient for the user. The user finds it more interesting to work on the computer thereby producing better results.

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