Controlling Computer with Hand Gestures

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Abstract: Gesture is one of the most efficient and vivid way of communication between a human and computer. This study investigates to access the method of human interaction with digital world by performing gestures with hand movement that will control computer mouse pointer with hand gestures in a cost-effective manner that is by using the built-in computer webcam. The basic aim of this work is to develop easier ways for human to interact with computers which is possible by hand gesture recognition. Controlling computer wirelessly by only our hand movements will introduce a new feature for future enhancements.

Keywords: *Color Recognition, Human Computer Interaction, Mouse Events, Hand Gesture, Cursor Control*

1. Introduction

Recently, there has been a lot of research on human interaction with digital world. Human Computer Interaction is basically the interaction between human(user) and computers. Human Computer Interaction aims to duplicate vision [1]. The basic aim of human computer interaction is to develop easier ways for humans to interact with computers which is possible by hand gesture recognition. Over the past decades there have been significant advancements in HCI technologies for gaming purposes. These gaming technologies provide a more natural and interactive means of playing videogames.

Color recognition has received a significant interest computer vision due to the wide range of applications including video surveillance, biometric identification, and face indexing in multimedia contents. This paper proposes new real time color recognition features, i.e., extracting primary colors for the purpose of vision-based human–computer interaction. Vision-based human–computer interaction could be achieved by analyzing segmented primary color regions. However, one of the challenges of color-based target tracking is that color distributions would change in different lighting conditions. This paper presents our investigation of color-based image segmentation, non-stationary color-based target tracking, color based mouse pointer, color based virtual music instruments, and color based virtual calculator. Our experiments show that Red, green and blue are the default color used for recognition process. Live video is captured from camera and the video is converted into number of frame images. This algorithm should monitor and process the every frame from the live video. Due to a real time process, it gets an input as a number of frames and processing it simultaneously. In this color recognition process primary colors are segmented from the input RGB frame.

Gesture Recognition enables humans to be able to communicate with the machine directly without using any mechanical devices. By implementing the concept of gesture recognition using color detection technique color bands wrapped on fingers are used and the mouse cursor moves according to the movement of color bands. [2,8] Based on image processing, we have used built-in laptop camera which will detect colors through color detection technique and with the help of those colors it will recognize gestures [7] and will convert them into digital data by using algorithms which are implemented using MATLAB programming. Each segmented colors are identified by its own pixel. Five basic operations of mouse like Cursor move, Right Click, Left Click, Drag and Double Click were performed using this technique and their results for accuracy are compared.

2. Related Work

A lot of research has been going on in Gesture recognition and interpretation through mouse pointer. In 2014, D. Senthamaraikannan [6] has investigated on segmentation of image on the basis of color and tracking the target with continuously moving object having required color. Yuvraj V. Parkale [5] in 2012,has designed a system that works in very poor lightening conditions, with inexpensive cameras and even works well in conditions where there is fluctuation in light. In 2016, Pooja kumari et al. in[2] proposes a novel vision based cursor control system, using hand gestures captured from a webcam through a color detection technique. The system allows the user to navigate the computer cursor using their hand bearing color caps or tapes and cursor functions, such as right and left clicks, double clicks, scroll up and down will be performed using different hand gestures [8]. Kaoru Yamagishi [9] collects acceleration values of a gesture and transmits the

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value to a PC wirelessly for further processing. Sidharth S. Rautaray et al. [4] Image processing techniques have been used in this gesture recognition system for segmentation, detection of camera and recognizing gestures of hand for performing required operation from stored database. According to Benedetti [12], motion controls is the future of gaming and it have tremendously boosted the sales of video games, such as the Nintendo Wii which sold over 50 million consoles within a year of its release. Besides HCI, hand gesture recognition are also used in sign language recognition, which makes hand gesture recognition even more significant. [13]

3. Methodology

3.1 Accessing Camera

The built-in computer Web-Camera is used using core i3 processor, that is first accessed in MATLAB and then image is captured from real time video [3].For the system to work we need a sensor to detect the hand movements of the user. The webcam of the computer is used as a sensor. The webcam captures the real time video at a fixed frame rate and resolution which is determined by the hardware of the camera.

- Computer Webcam is used to capture the Real Time Video
- Video is divided into Image frames based on the FPS (Frames per second) of the camera
- Processing of individual Frames

After capturing the initial image, the images from each video frame is processed and compared with the initial image where the initial color could be refer as a reference color as shown in the Fig .1.
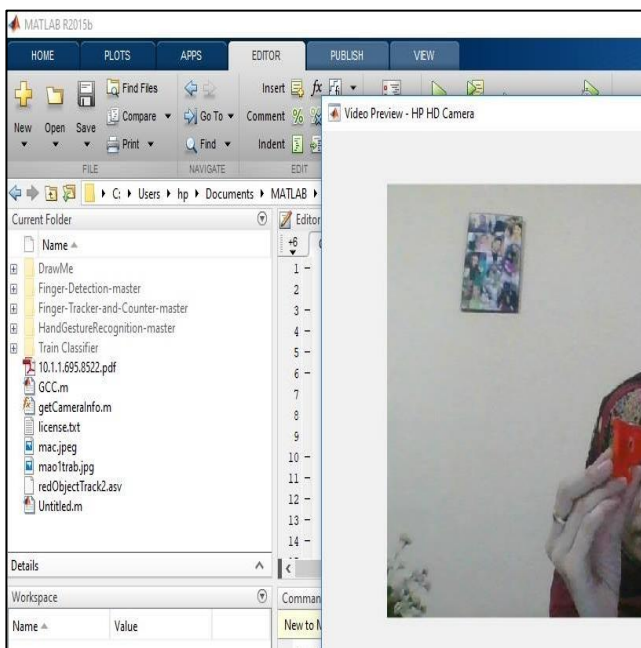

Figure.1. Accessing mouse pointer with red color

3.2 Detection of Colors

Color recognition is the process of segmenting the colors and identifying the segmented colors. It is the one of the human to computer interaction. Here the colors are acting as interface between human and computer. At initial primary color modal is used for a recognition process, it only recognizing primary colors. In every color image, primary colors are segmented and segmented colors are recognized to identify its name like red, green, blue.

Initially, the color from basic colors i-e Red, Blue or Green is shown which means it can work on any color. Then the primary color that is already saved in the program is recognized, segmented and identified [6].

The pixels from the RGB color space are converted into chrominance component that is YCbCr color space and then segmented. However, the other colors are neglected by comparing each pixel in Cb and Cr component as described in the Fig .2.
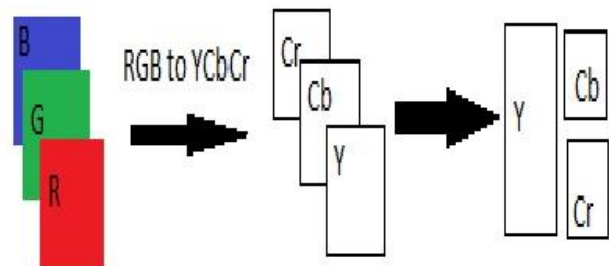

Figure. 2.   Conversion or RGB image to YCbCr Component

If Cb and Cr lie in the specified range then the values are matched by comparing each pixel with the captured image frame. Then all the pixels of the next frames are compared and scanned. For the user to control the mouse pointer it is necessary to determine a point whose coordinates can be sent to the cursor. With these coordinates, the system can control the cursor movement. However, if the values do not lie in the specified range the loop is run and all the pixels are scanned again unless the desired color is obtained. This is the core process of color recognition.

After the color is recognized and detected, the ROI value is extracted and the ROI location is set in a way that it stays entirely in the boundaries of the video frame. Depending on the elative position and ROI value, the mouse event is triggered. The ROI is converted into single pixel value by finding the mid pixel of the shaded region. This single pixel value facilitates the smooth movement of mouse pointer and performs operations equally well. The mouse event's such as cursor movement, left click, right click and drag are performed according to the number of region of interests and their relative position in each captured frame.
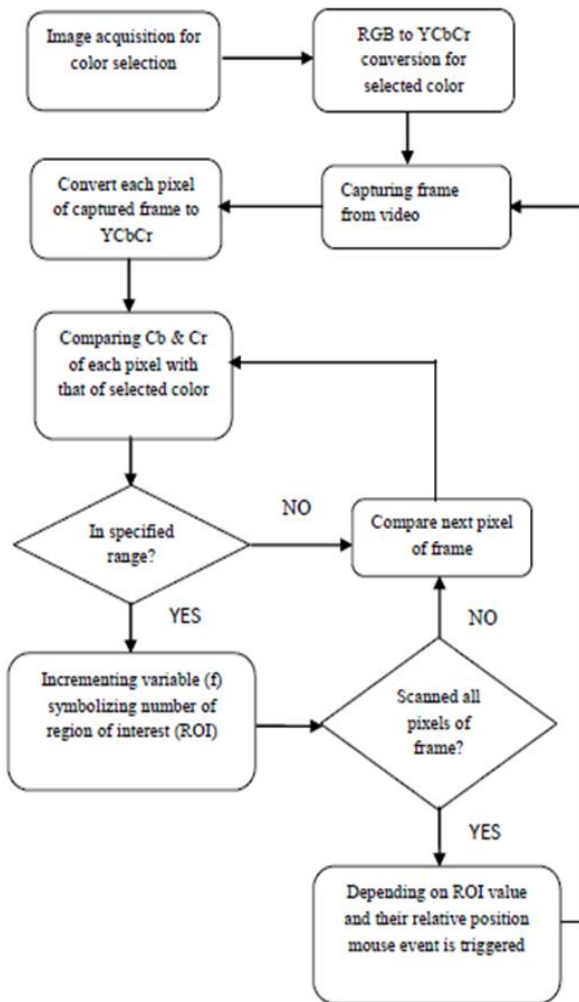
Figure.3. Block Diagram for accessing mouse pointer by color recognition

Figure .4. Simulation results of the designed system

4. Results and Discussion

Various mouse events (for example; 1-4 described in Section 3) are obtained by using color recognition and by performing different hand gestures mouse cursor moves.

Fig.2. shows the hand gestures used for controlling the cursor's movement. The cursor movement is controlled with the tip of the index finger. This gesture is relatively easy to perform and shows better accuracy. The Right Click function is performed when two green colors are detected having an angle less than 90 degrees whereas the Left Click function is performed at 90 degree angle. Similarly, the drag function is operated when three green pointers are detected in one frame and the Double Click is performed when four green color tips are detected in a frame.

The green color is taken as reference color and here the cursor move function is performed as it is detecting single color in the video frame. This cursor will move in accordance with the fingertip having green color. The results are shown in the Fig .5.

3.3 Interpreting mouse events

There is no built-in feature in MATLAB which can directly access the mouse drivers of the computer so everything is programmed manually. Next step after the color is recognized is to find the region of interest by calculating its centroid [8]. The distance that is already saved in the data base is implemented by comparing the image with the images already stored in the database. The fingertip is then given a finger name depending on the range the measured angle falls within. This process is then repeated for the other fingertips. The hand gestures are then distinguished based on the fingers identified.

Clicking action is based on the following conditions:

1. If single color is detected the cursor moves.

2. If two single colors are detected in one frame then right and left click is performed depending on the distance.

3. If three single colors are detected in one frame then drag function is performed.

4. If four single colors are detected in one frame then double click function is performed.
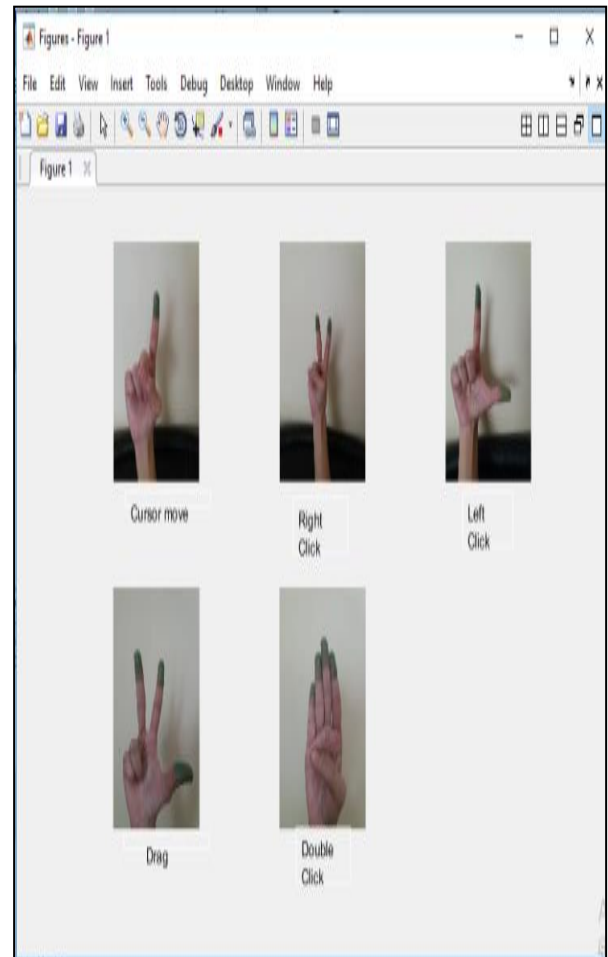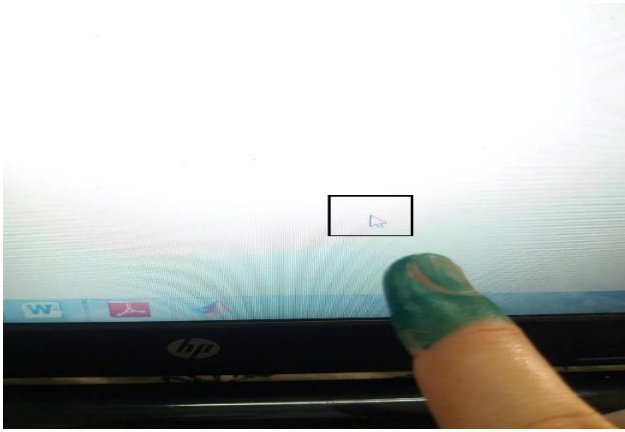
Figure .5. Result showing initial position of the mouse pointer

As shown in Fig .6. the cursor has moved from its previous position to its new position.
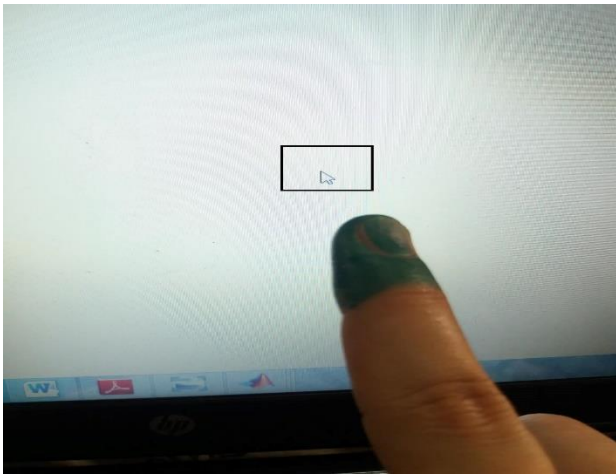

Figure .6. Result showing change in position

In Fig.7 the results obtained by various mouse events such as cursor movement, left click, right click, double click and drag have been compared.
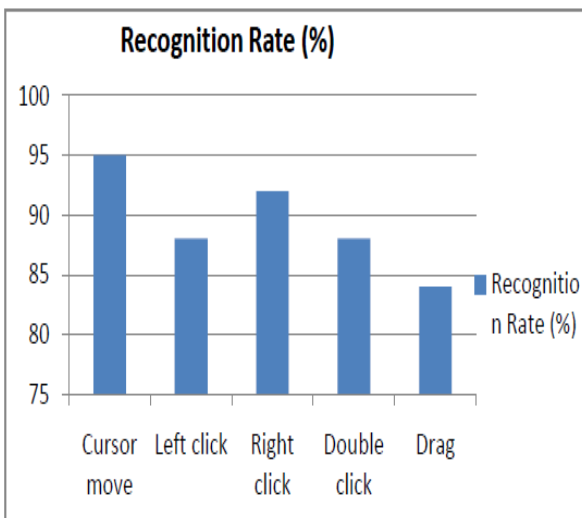

Figure. 7. Recognition rate v/s Mouse events

The accuracy for the performing Cursor move function is significantly higher than the accuracy of other functions like Left Click, Right Click, Double Click and Drag. The drag function shows lowest accuracy. This can be attributed to the fact that the threshold values for moving cursor is well defined (i.e., 90º angle), and it can be seen that the results for this function are better than the rest of the computer mouse operations.

5. Conclusion

In this paper, image processing in MATLAB proves to be successful in the movement of mouse cursor with gestures. Also this would lead to a new era of Human Computer Interaction (HCI) where no physical contact with the device is required. This project provides an easier access to computer and uses more efficient algorithms.

Computer vision techniques provide promising ways to human–computer interaction through understanding primary colors from visual data. An important step to achieve this goal is the robust and accurate segmentation of primary colors.

Different applications can be implemented with this technique to create a several applications with these inexpensive resources. This technology is very useful for disabled people who cannot control their limbs or with people who have hand tremors. Moreover, it can not only be useful for people with diseases it is also a new feature for future enhancements.

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