Gesture Based Efficient Cursor Controller Using Human Computer Interaction Technique

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ABSTRACT: In the proposed project, an approach for Human computer Interaction (HCI) is presented, where an attempt is made to control the mouse cursor movement and click events of the mouse using hand gestures. Hand gestures were acquired using a camera based on colour detection technique. This method mainly focuses on the use of a Web Camera to develop a virtual human computer interaction device in a cost effective manner.
The system is interacting with humans for performing mouse operations. The system serves as a block between Users and computer. It will capture the required feature with a webcam and it will monitor all its action in order to translate it to some events that will try to communicate or interact with the computer. In this proposed work a webcam is used that affords an average resolution and frame rate as the capturing device in order to make the ability of using the program affordable for all individuals.. The geometrical operation and integral image processes are performed on the input. It will check the file when there is movement detected. System will compare both coordinates and perform the action i.e. it will allow the user to control the mouse operations using webcam based on which colour tape is used in front of the web camera.

KEYWORDS: Human computer Interaction, Web Camera, Mouse, image processes.

I. INTRODUCTION

Human beings are primarily visual creatures who depend solely on sense of vision. Vision allows humans to perceive and understand the world surrounding them in a better manner. For our purpose, an image is a single picture which represents some information. It may be a picture of a person, of people or animals, or of an outdoor scene, or a microphotograph of an electronic component, or the result of medical imaging. Pixels are tiny sections of colour or tone that together form a photograph. Each pixel is made up of 3 values; red, green, and blue, or RGB. This RGB information is used to determine the colour of each pixel. Vision-based hand tracking is an important problem in the field of human-computer interaction, since hand motions and gestures could potentially be used to interact with computers in more natural ways. For example, video cameras and computer vision techniques may be used to capture many details of human shape and movement. The shape of the hand may be analysed over time to manipulate an onscreen object in a way analogous to the hand's manipulation of paper on a desk. Such an approach may lead to a faster, more natural, and more fluid style of interaction for certain tasks.

Ubiquitous computing is devoted to changing the relationship between humans and the computers with which we interact, towards allowing computers to become invisible and recede into the periphery of people's lives. Here three colours are used to move the cursor and to click. In this study, finger tracking based a virtual mouse application has been designed and implemented using a regular webcam. A click of the mouse button is implemented by defining a screen such that a click occurred when a user's hand passed over the region. Another approach was developed where only the RGB objects were used to control the mouse cursor and click. The clicking method was based on colour detected, and required the user to hold the mouse cursor on the desired spot for a short period of time. Movement of the red object while making a special hand sign moved the mouse pointer. In this study, a colour pointer has been used for the object recognition and tracking. Left and the right click events of the mouse have been achieved by detecting the number of blue colour objects on the image. In first case red colour is used for mouse operation. In second case red plain is used to cursor pointing, one blue finger is used for right click, and two blue colour finger for left click, and three blue colour finger is used for double click, and green finger is used for scrolling.

II. SYSTEM DESIGN

In the proposed work a method is implemented to control mouse cursor movement and click events using a camera based on colour detection technique. Here real time video has been captured using a Web Camera. The user wears coloured tapes to provide information to the system. Individual frames of the video are separately processed. The processing techniques involve an image subtraction algorithm to detect colours. Once the colours are detected the system performs various operations to track the cursor and performs control actions.

A. Block Diagram: Figure 1 shows the block diagram of the proposed work. The first step of the system is to separate the potential hand pixels from the non-hand pixels. This can be done by background subtraction scheme which segments any potential foreground hand information from the non-changing background scene. At the system start-up, a pair of background images is captured to represent the static workspace from camera view. Subsequent frames then use the appropriate background image to segment out moving foreground data. In the object tracking application one of the main problems is object detection. Instead of finger tips, a colour pointer has been used to make the object detection easy and fast. A circle red sticker is used as a colour pointer in this study.
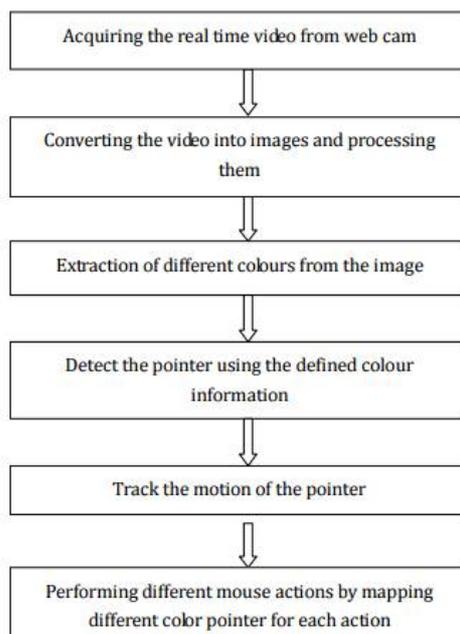

Fig. 1 Block Diagram

B. Algorithm: To simulate the click events of the mouse finger with red colour pointers has been used. Algorithm of the proposed work is shown in Figure 2. The cursor can be controlled by using the various colours. In the proposed work red colour is used. In the R plane, initially video capturing is done. Here the real time video is captured by using the built in web cam and then from the real time video, individual image frames are obtained .Then the red plane is obtained from the images. To obtain the red plane for the image a threshold is applied.

The image is then converted into a binary image. The output image replaces all pixels in the input image with luminance greater than level with the value 1 (white) and replaces all other pixels with the value 0 (black). Specify level in the range [0,1]. This range is relative to the signal levels possible for the image's class. Therefore, a level value of 0.5 is midway between black and white, regardless of class. In this study, the threshold 0.15 gave the best result for the large range of illumination change as shown in Figure 3.
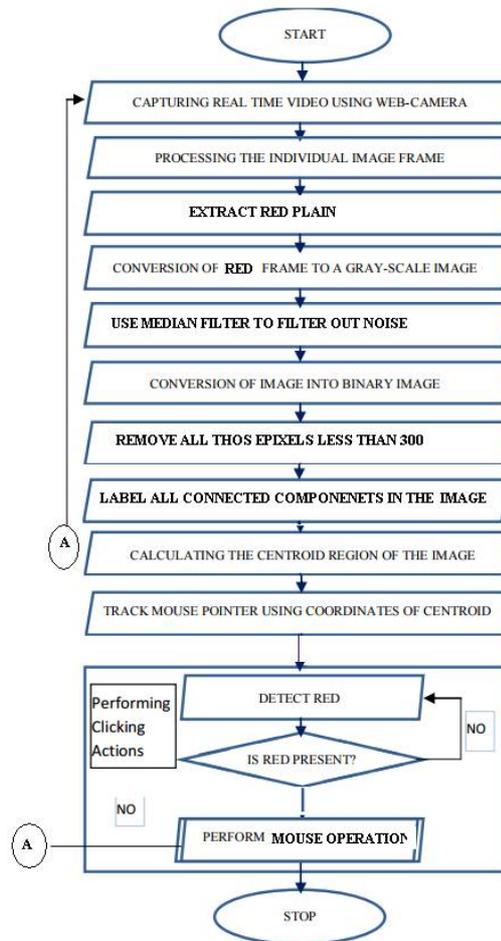
Fig. 2 Algorithm

The cursor can be controlled by using the various colours. In this work red colour is used. Using R plane, initially video capturing is done. here the real time video is captured by using the built in web cam and then from the real time video ,individual image frames are obtained. To obtain the red plane for the image the threshold is applied.

C. filtering: Noise is defined as any degradation in the image signal, caused by external disturbance. If an image is being sent electronically from one place to another, via satellite or wireless transmission, or through networked cable, may cause errors in the image signal. These errors will appear on the image output in different ways depending on the type of disturbance in the signal. It cannot be predicted accurately because of its random nature, and cannot even be measured accurately from a noisy image, since the contribution to the grey levels of the noise can't be distinguished from the pixel data.

Filtering the Noise After detecting the red colour in the input image, a median filter has been used to filter out the noise. A median filter is more effective than convolution when the goal is to simultaneously reduce noise and preserve edges.

Fig. 3: (a) Before median filtering (b) After median filtering

To detect the red colour of the pointer, image subtraction operation is performed which returns the difference in the corresponding element of the output array. The array returned has the same size and class as original image. Later the image is converted to binary so that processing speed increases and the computation becomes easy as shown in figure 4 and then the centroid calculation is carried out so as to get X and Y co-ordinates ,so that whenever pointer moves actual co-ordinates at that position can be obtained. The next step involves interfacing the virtual mouse to the computer to carry out the operations of the actual mouse, by importing java package.

Fig. 4: (a) Before removing small areas (b) After removing small areas

Removing all the small areas to get the best accurate number of the object detected in the image, all the areas other than the pointer need to be removed. A threshold of 300 pixels is set for this study.
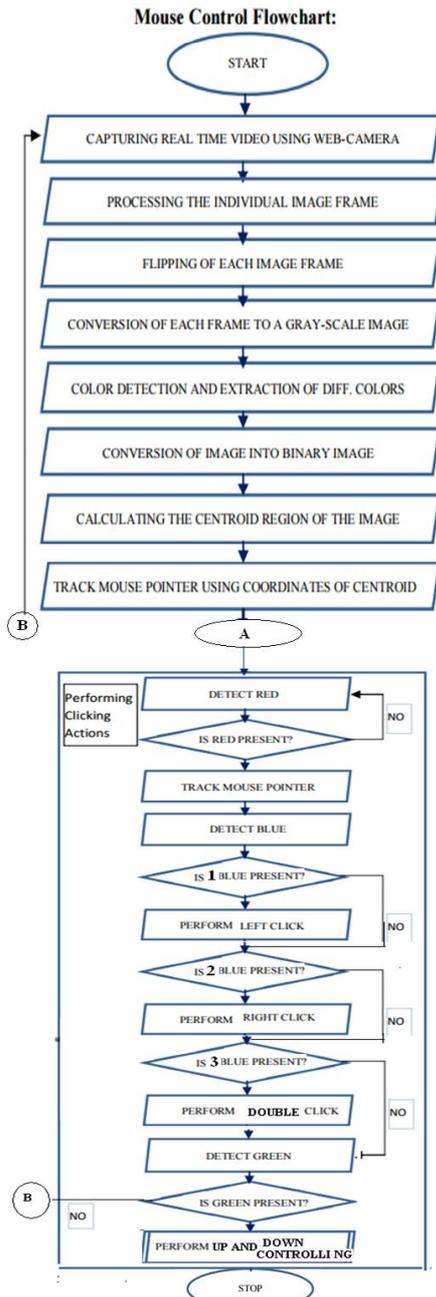
D. Mouse Control: Figure 5 shows the sequence of operations that are carried out in order to perform all the mouse events viz. click and scroll.

Mouse Control Flowchart:

Fig. 5: Sequence of mouse operations

Initially the real time video is captured using web camera, after that the individual frames out of the captured video will be processed then flipping of the image will be done. Flipping is done to remove the red region which has arrived out of the bounding region. Immediately after this the colour detection and extraction of different colours is done and converted to gray scale image after that is converted to binary image so that computation becomes easy and processing becomes faster. Once the image is converted to binary calculate the centroid of the image so that the pointer can be located. Accordingly as the red plane is moved the pointer can be tracked. Further it will detect if any red object is present if present then it will perform the tracking of pointer as the red object is moved, accordingly there will be movement of the pointer, otherwise it will be scanning for red coloured objects. Further it checks for blue objects, if blue object is present it will search for number of blue objects. If one blue object is present it will perform left click, if two blue objects are present it will perform right click and if three blue objects are present it will perform the double click operation. Finally it will check for green coloured objects, if present it will perform up and down scrolling based on the movement of the green object.

The index finger with red colour tape as a cursor controller is used to control mouse cursor movement. Two different approaches for moving the mouse cursor can be used. The first method is position mapping the index finger on a camera screen to a desktop screen position. But this method incurs a problem. If the resolution of the desktop window is greater than the camera resolution, then the cursor position cannot be accurate because while converting camera resolution to the desktop window resolution, intermediate values are lost. The expected ratio of jumping pixel is up to 4 pixels. The second method is known as weighted speed cursor control. Here the difference of the finger of the current image and the previous image is found and the distance between the two is computed. Next, the mouse cursor is moves fast if the gap between the two finger images (current and previous frame) is far or, if the gap is close then the cursor moves slow. There is a problem associated with this algorithm also. Some machines which cannot achieve image processing more than 15 fps do not work smoothly because computing the image centre and the hand shape takes time. In this work first method is used, which uses absolute position of finger tips because it is more accurate than the second method.

To find the centre of the object and draw a bounding box after removing all the connected components (objects) other than the pointer such as centre point or bounding box etc a function can be used where it measures a set of properties for each connected component (object) in the binary image. In this application only center of the object and the bounding box is needed, only these two properties are used.

E. Centroid of an object and plotting: 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. To perform this task a function can be used which finds the centroid of the detected region. The output of function is a

matrix consisting of the X (horizontal) and Y (vertical) coordinates of the centroid. These coordinates change with time as the object moves across the screen. Centroid of the image is detected. Its co-ordinates are located and stored in a variable

F: Tracking the Mouse pointer: Once the coordinates has been determined, the mouse driver is accessed and the coordinates are sent to the cursor. With these coordinates, the cursor places itself in the required position. It is assumed that the object moves continuously, each time a new centroid is determined and for each frame the cursor obtains a new position, thus creating an effect of tracking. So as the user moves his hands across the field of view of the camera, the mouse moves proportionally across the screen. Since java is a machine independent language so it is preferred over the others. A java object is created and it is linked with the mouse drivers. Based on the detection of other colours along with red the system performs the clicking events of the mouse. These colour codes can be customized based on the requirements.

 The control actions of the mouse are performed by controlling the flags associated with the mouse buttons. JAVA is used to access these flags. The user has to perform hand gestures in order to create the control actions. Due to the use of colour pointers, the computation time required is reduced. Furthermore the system becomes resistant to background noise and low illumination conditions. The detection of green and blue colours follows the same procedure discussed above. Clicking action is based on simultaneous detection of two colours. If Red along with Green colour is detected, Left clicking action is performed. If Red along with Blue colour is detected, Right clicking action is performed.

Move the Cursor According to the Position of the Pointer To move the cursor desired (X,Y) coordinates. To move the mouse and to simulate the mouse click event "Java class java.awt.Robot" which has all these abilities can be used. Since the resolution of the camera is smaller than the resolution of the computer monitor, the (X,Y) coordinates are needed to be scaled. In this application the resolution of the input image is 640x480 and the resolution of the computer monitor is 1280x800. Figure 6 shows use of one and two pointers.

Fig. 6: (a) Use of one pointer (b) Use of two pointers

G. Performing Clicking Actions: The control actions of the mouse are performed by controlling the flags associated with the mouse buttons. JAVA is used to access these flags. The user has to perform hand gestures in order to create the control actions.. The detection of green and blue colours follows the same procedure discussed above. Clicking action is based on simultaneous detection of two colours.

H. Use of colour fingers: To perform the mouse events the following colours are used in the proposed project.
- ❖ Move the RED finger everywhere to control the POINTER POSITION
- ❖ Show ONE BLUE finger to LEFT CLICK
- ❖ Show TWO BLUE finger to RIGHT CLICK
- ❖ Show THREE BLUE finger to DOUBLE CLICK
- ❖ MOVE the GREEN finger up and down to control the MOUSE SCROLL.

Mouse Click Events Mouse click is one of the most challenging parts for the virtual mouse application. As all we know, the left button of the mouse has a different task for a single or double clicks. When the second pointer is detected in the image, left mouse click event has been executed. Depending on the time that the second pointer is being detected

single and the double clicks have been simulated, and the third pointer is being used to simulate the right click of the mouse.

CLICK OPTION
java.awt
Class Robot
java.lang.Object
java.awt.Robot

public class Robot
extends Object

This class is used to generate native system input events for the purposes of test automation, self-running demos, and other applications where control of the mouse and keyboard is needed. The primary purpose of Robot is to facilitate automated testing of Java platform implementations. Using the class to generate input events differs from posting events to the AWT event queue or AWT components in that the events are generated in the platform's native input queue.
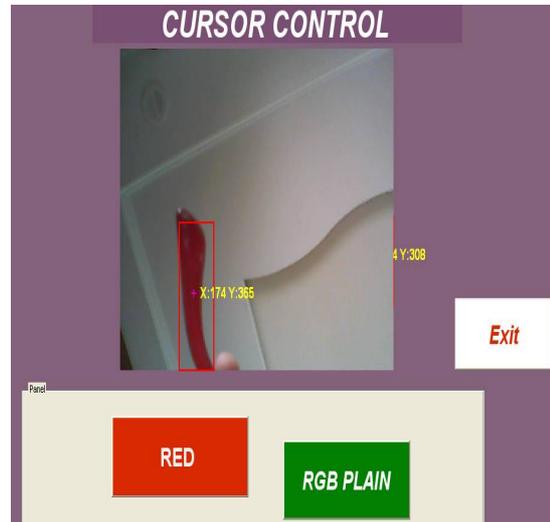

Figure 7:Red object detection

III. RESULT

GUIs (also known as graphical user interfaces or UIs) provide point-and-click control of software applications, eliminating the need to learn a language or type commands in order to run the application. MATLAB apps are self-contained MATLAB programs with GUI front ends that automate a task or calculation. The GUI typically contains controls such as menus, toolbars, buttons, and sliders. Many MATLAB products, such as Curve Fitting Toolbox, Signal Processing Toolbox, and Control System Toolbox, include apps with custom user interfaces. Anyone can create their own custom apps, including their corresponding UIs, for others to use. GUI used in this work is shown in figure 7.

1) *RED OBJECT DETECTION:* Red object detection image is as shown in figure 7. When the red object is moved in front of the webcam , it is detected and processed. Later the centroid is calculated which is indicated in the figure as X and Y co-ordinates .This is required to the track the mouse.

2) *RGB PLANE (RED OBJECT):* In the RGB plane red colour object is used to control the pointer position. Here the red colour tapes are used as shown in figure 8.
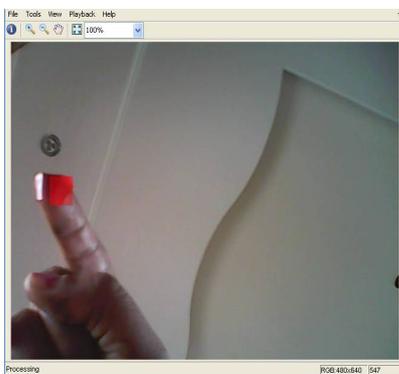

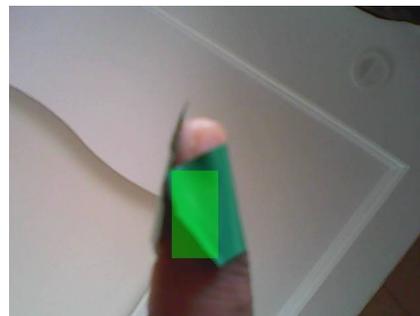Fig. 8: The red tapes used during the control of pointer

Fig 9: Green tapes used during the scrolling of pointer

3) *GREEN PLANE DETECTION:* In the RGB plane green colour object is used to control the mouse scroll .Here the green colour tapes are used as shown in figure 9.

4) *BLUE PLANE DETECTION:* In the RGB plane blue colour object is used to perform the clicking operation .Here the blue colour tapes are used as shown in figure 10.

5) *RGB PLANE TOGETHER USED DURING THE OPERATION:* This image i.e. figure 11 indicate that all the three colours are stick to three different finger ,so that the operation becomes more flexible.

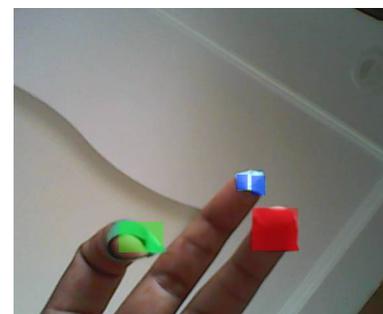Figure 10: The blue tapes used during the clicking operation

Figure 11: All the three color stick to same hand

IV. CONCLUSION AND FUTUREWORK

In the proposed work, an object tracking based virtual mouse application has been developed and implemented using a webcam. The system has been implemented using image processing techniques. As an object a blue colour sticker is used to make the detection easy and fast. Object detection and motion tracking worked very well. Using the pointer moving the cursor and the simulating the mouse click events also worked well. However, system has some disadvantages such as; being invariant to illumination up to some scale, and movement of the cursor is very sensitive to motion. Because of this reason, to control the cursor, pointer cannot be used on the air efficiently. This technology has wide applications in the fields of augmented reality, computer graphics, computer gaming, prosthetics, and biomedical instrumentation. Furthermore a similar technology can be applied to create applications like a digital canvas which is gaining popularity among artists. This technology can be used to help patients who don't have control of their limbs. In case of computer graphics and gaming this technology has been applied in modern gaming consoles to create interactive games where a person's motions are tracked and interpreted as commands.

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