Virtual Mouse Control using a Web Camera based on Color Detection

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1. ABSTRACT:

In this project we present an approach for Human Computer Interaction (HCI), where we have tried to control the mouse cursor movement and click events of the mouse using hand gestures. Hand gestures were acquired using a camera based on color 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.

2. INTRODUCTION:

Human Computer Interaction today greatly emphasizes on developing more spontaneous and natural interfaces. The Graphical User Interface (GUI) on Personal Computers (PCs) is quiet developed, well defined and provides an efficient interface for a user to interact with the computer and access the various applications effortlessly with the help of mice, track pad, etc. In the present day scenario most of the mobile phones are using touch screen technology to interact with the user. But this technology is still not cheap to be used in desktops and laptops. Our objective was to create a virtual mouse system using Web camera to interact with the computer in a more user friendly manner that can be an alternative approach for the touch screen.

3. INTRODUCTION TO THE SYSTEM:

In our work, we have tried to control mouse cursor movement and click events using a camera based on color detection technique. Here real time video has been captured using a Web Camera. The user wears colored 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 colors. Once the colors are detected the system performs various operations to track the cursor and performs control actions, the details of which are provided below.

No additional hardware is required by the system other than the standard webcam which is provided in every laptop computer.

4. SYSTEM DESCRIPTION

Following are the steps in our approach:

(i) Capturing real time video using Web-Camera.

(ii) Processing the individual image frame.

(iii) Flipping of each image frame.

(iv) Conversion of each frame to a grey scale image.

(v) Color detection and extraction of the different colors (RGB) from flipped gray scale image

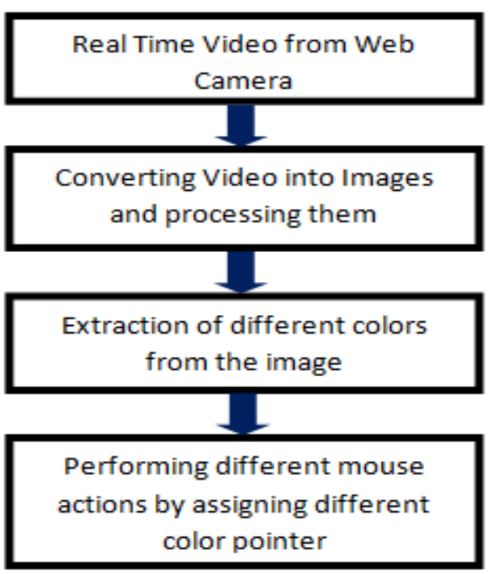
(vi) Conversion of the detected image into a binary image.

(vii) Finding the region of the image and calculating its centroid.

(viii) Tracking the mouse pointer using the coordinates obtained from the centroid.

(ix) Simulating the left click and the right click events of the mouse by assigning different colour pointers.

4.1 Block Diagram:



4.2 Capturing the Real Time Video

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. The frame rate and resolution can be changed in the system if required.

- 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

Figure 1: Capturing the video

4.3 Flipping of Images

When the camera captures an image, it is inverted. This means that if we move the color pointer towards the left, the image of the pointer moves towards the right and vice-versa. It's similar to an image obtained when we stand in front of a mirror (Left is detected as right and right is detected as left).

To avoid this problem, we need to vertically flip the image. The image captured is an RGB image and flipping actions cannot be directly

performed on it. So the individual color channels of the image are separated and then they are flipped individually. After flipping the red, blue and green colored channels individually, they are concatenated and a flipped RGB image is obtained.

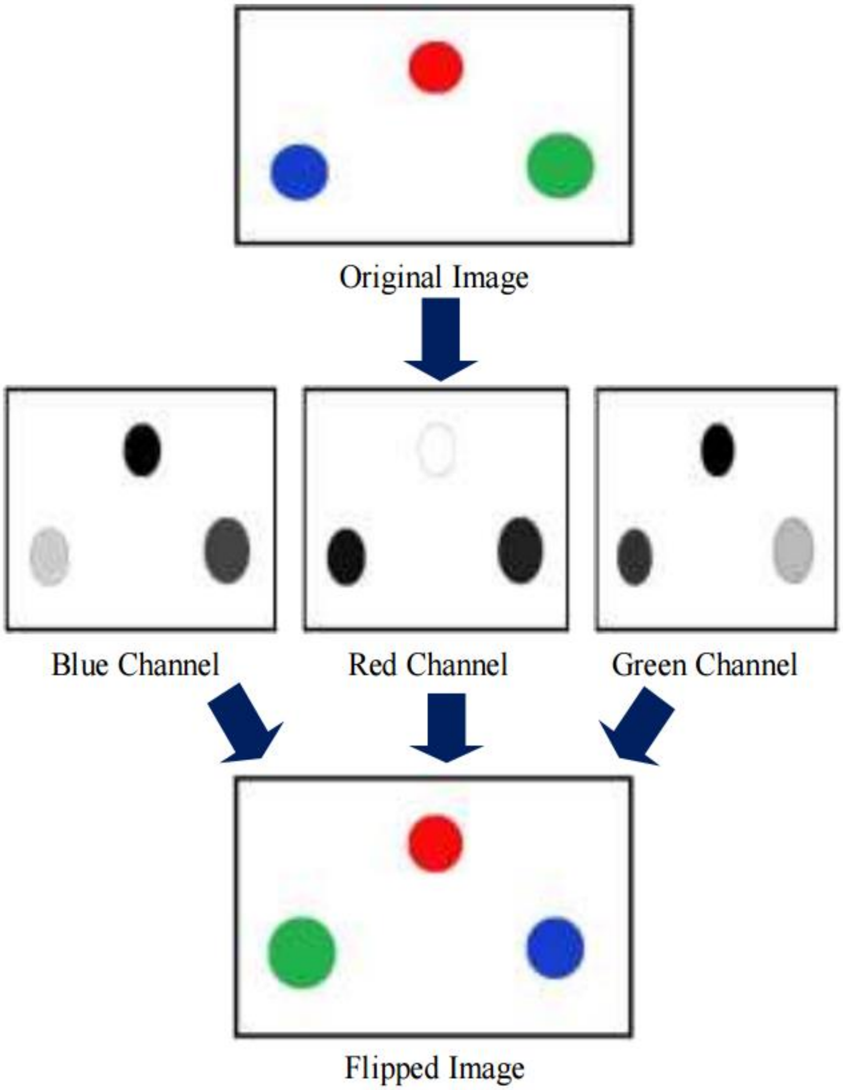

Original Image
Blue Channel
Red Channel
Green Channel
Flipped Image

Figure 2: Flipping of an image

The following images show the entire flipping process in real time.

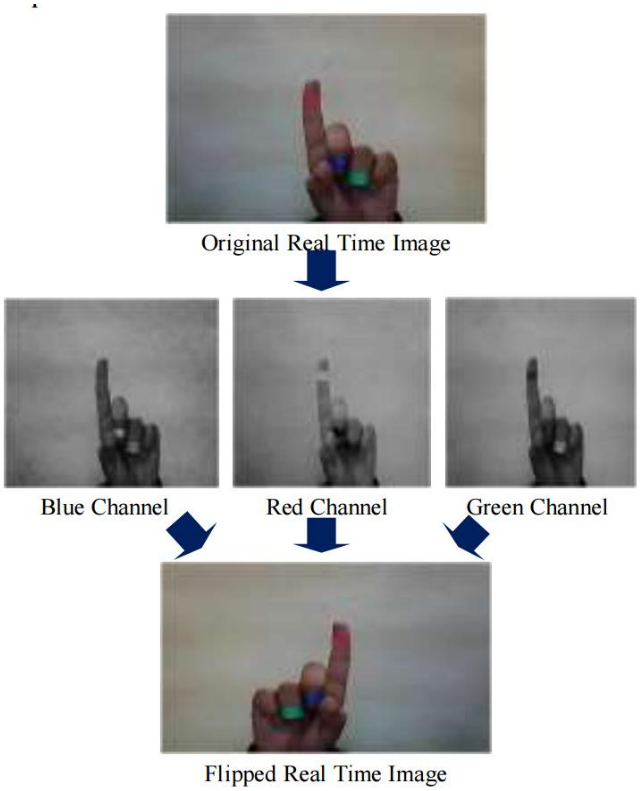


Figure 3: Flipping of Real Time Image

4.4 Conversion of Flipped Image into Grayscale Image:

As compared to a colored image, computational complexity is reduced in a gray scale image. Thus the flipped image is converted into a gray scale image. All the necessary operations were performed after converting the image into gray scale.

4.5 Color Detection:

This is the most important step in the whole process. The red, green and blue color object is detected by subtracting the flipped color suppressed channel from the flipped Gray-Scale Image. This creates an image which contains the

detected object as a patch of grey surrounded by black space.

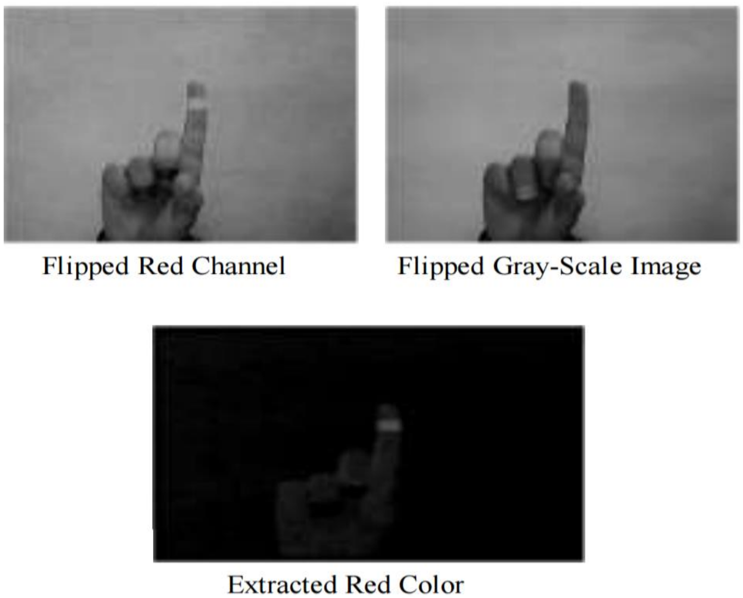


Figure 4: Detection of Red Color

4.6 Conversion of gray scale Image into Binary Image:

The grey region of the image obtained after subtraction needs to be converted to a binary image for finding the region of the detected object. A grayscale image consists of a matrix containing the values of each pixel. The pixel values lay between the ranges 0 to 255 where 0 represents pure black and 255 represents pure white color. We use a threshold value of 20% to convert the image to a binary image.

This means that all the pixel values lying below 20% of the maximum pixel value is converted to pure black that is 0 and the rest is converted to white that is 1. Thus the resultant image obtained is a monochromatic image consisting of only black and white colors. The conversion to binary is required because MATLAB can only find the properties of a monochromatic image.

4.7 Finding 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.

An inbuilt function in MATLAB is used to find 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

4.8 Tracking the Mouse pointer:

Once the coordinates have 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.

There is no inbuilt function in MATLAB which can directly access the mouse drivers of the computer. But MATLAB code supports integration with other languages like C, C++, and JAVA. 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 colors along with red the system performs the clicking events of the mouse.

These color codes can be customized based on the requirements.

4.9 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. Due to the use of color pointers, the computation time required is reduced.

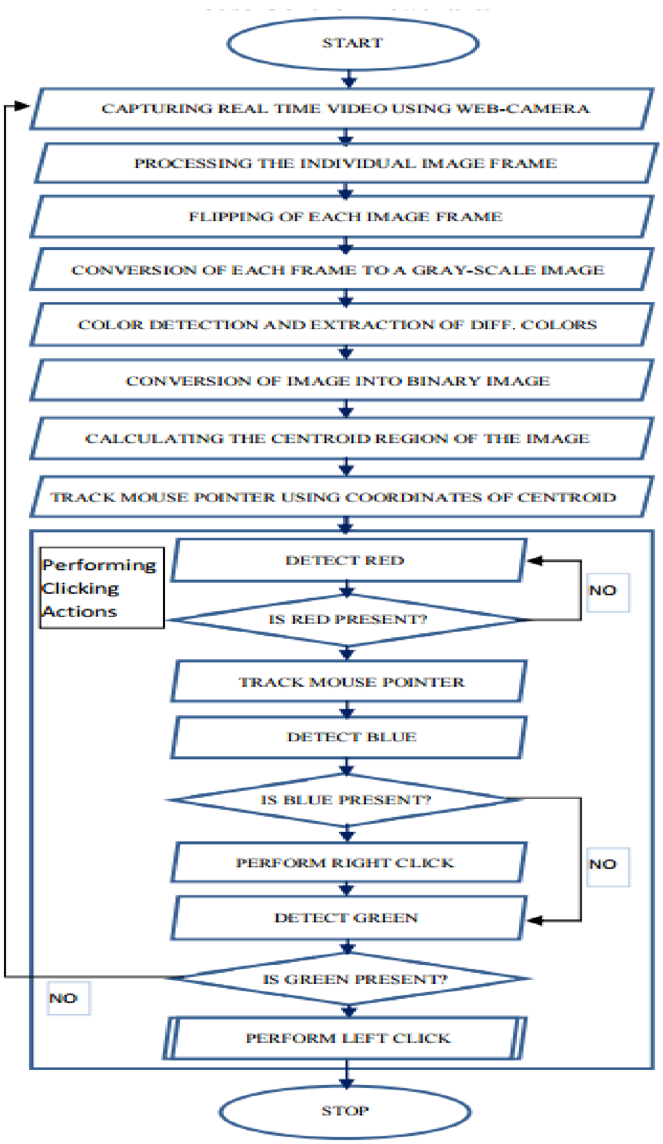
Furthermore, the system becomes resistant to background noise and low illumination conditions. The detection of green and blue colors follows the

same procedure discussed above.

Clicking action is based on simultaneous detection of two colors.

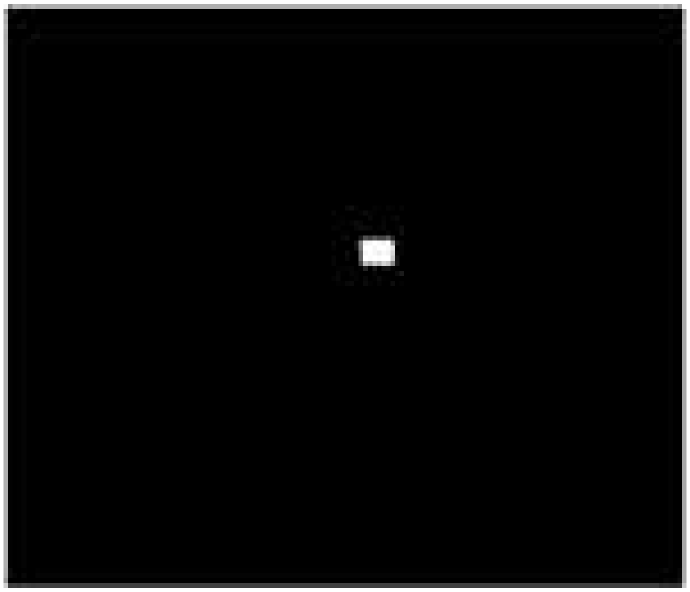
- If Red along with blue color placed on right is detected, right clicking action is performed
- If Red along with Blue color placed on left is detected, left clicking action is performed

5. MOUSE CONTROL FLOW CHART



6. RESULTS:

Detected region:



7. CONCLUSION:

In this paper, an object tracking based virtual mouse application has been developed and implemented using a webcam. The system has been implemented in MATLAB environment using MATLAB Image Processing Toolbox. 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.

Most of the applications require additional hardware which is often very costly. Our motive was to create this technology in the cheapest possible way and also to create it under a standardized operating system. Various application programs can be written exclusively for this technology to create a wide range of applications with the minimum requirement of resources.

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