Color Tracking Based Virtual Mouse Pointer

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***Abstract*—Virtual interface implements an easy and intelligent mode of interaction with computer/laptop. Hand gesture recognition is more efficient and easier than traditional devices like keyboards and mouse. Our method is to use a web-cam and image processing technology and processes, such as image segmentation, morphology, background subtraction and color tracking, to control mouse tasks left clicking, right clicking, double-clicking and dragging actions and we show how it can perform actions as current mouse devices can using centroid detection technique. A color pointer has been used for the object recognition and tracking, so as to implement without any physical contact with the computer/laptop. Mouse Click events of the mouse have been achieved by detecting the number of pointers on the images. The module has been created on MATLAB software with operating system as windows 8. This method mainly focuses on the use of a Web Camera to develop a virtual interaction between human and computer device in a cost effective manner.**

Keywords- Virtual mouse, Background Subtraction, Colour Detection, Web Camera, Computer Vision, Human Computer Interaction, colour pointer.

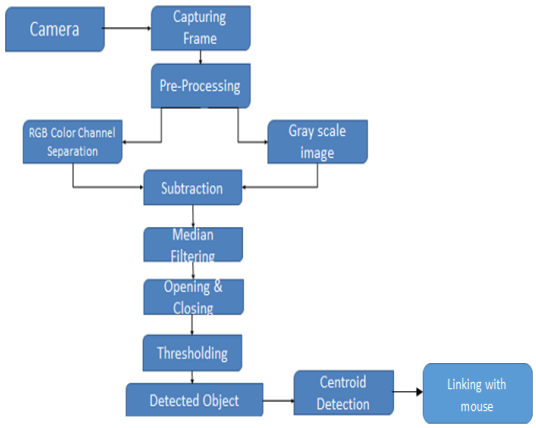
I. INTRODUCTION

A virtual mouse is similar to a conventional mouse but allows users to give mouse inputs to a system without using an actual mouse. It uses an ordinary web camera. A virtual mouse can be operated with multiple input devices, which may include an actual mouse or a computer keyboard. It uses web camera which works with the help of different image processing techniques using Matlab Software.

A color pointer has been used for the object (pointer) detection and its tracking. Left and the right click events of the mouse have been achieved by detecting the number of pointers on the images (frames of real time video). The colour finger pointers of a user are mapped into mouse inputs. A web camera is set to take images at 24 frames per second giving an illusion of real time tracking. The user must have a particular color on his fingers so that when the web camera takes image it must be visible in the detected image frame. This color is recognized after implementing many image processing techniques and the centroid position of the detected color pointer is mapped into mouse input. Depending upon the size of the image taken by webcam, a multiplying factor is multiplied which is obtained by scaling of the laptop resolution and image resolution because the position in the image will not have a correspondence with laptop screen resolution. The mouse cursor movement and click events are monitored using a camera based on color recognition technique. Here real time video or images at 24 frames per second has been captured using a Web- Camera. The user wears colored tapes on his fingers to provide information to the system. Individual frames of the real time video are separately processed. The processing techniques involve an image subtraction and image morphology algorithms to detect colors. Once the colors are detected, the MATLAB performs various image processing operations to track the cursor and performs control actions. No additional hardware is required by the computer/laptop other than the standard webcam which is provided in every laptop computer.

II. METHODOLOGY

A. Flowchart



Using Web camera images are taken in YCbCr format instead of the required RGB format as the resolution of the image in YCBCR format is lower reducing the processing time. Using Matlab software we convert this image in a matrix(640 columns and 480 rows) with size equivalent to its resolution i.e. 640X480.Then the image. is converted to RGB format using YCbCr to RGB conversion algorithm .The image is then flipped to synchronize our hand motion with the mouse movement as the image captured by webcam is mirror image.

The RGB image is split into 3 components red green and blue i.e. three 2 dimensional matrices are obtained .The RGB image is also converted to gray scale image by taking average of all pixels values of red green and blue components of RGB image.

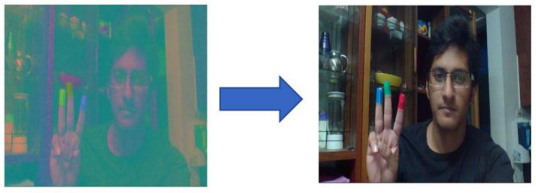
The image on which all image processing techniques is done is obtained by subtracting gray image from individual red green and blue components

.Thus we get only red green and blue objects separately in 3 different matrixes or images. Using median filtering and opening and closing we smoothen the irregular shapes and by image filling we fill them also. Then using thresholding only the red green and blue colored objects are left in the respective images. Three bounding boxes of specified dimension and maximum count is then used to eliminate all the other unnecessary objects and get more precise detection of colors red green and blue. Then we find the centroid of the bounding box of red color which is used for mouse movement or scrolling of mouse. The location of the centroid i.e. the coordinates are then used in a java command which is used to link the mouse position with the the red detected colour in the image. The coordinates are multiplied by the multiplying factor so that mouse movement is possible across the entire laptop screen otherwise the mouse movement will be in an area limited to the image resolution. The whole process of capturing and processing is done at rate of 24 frames per second to get real time tracking of mouse by synchronization of motion of our finger with red tape and movement of mouse. Other detected colors are used to perform other mouse action in a similar way The detection process of green and blue colors are same except the processing is done on the blue and green images obtained after subtraction from gray. For example one detected green color can perform left clicking action and if two are detected then right clicking action. And similarly blue color can be used to perform double clicking. After detection java commands are used to perform clicking actions. Matlab software is used for its ease in image processing and the ability to use java commands which can communicate with operating system and enable controlling of mouse.

B. Pre-Processing

Here we take a YCBCR image of low resolution instead of a high resolution RGB image to lower our computational time. As processing is done on all pixels of an image, higher the resolution higher the pixels and more the processing time. Instead YCbCr image is converted to RGB format.

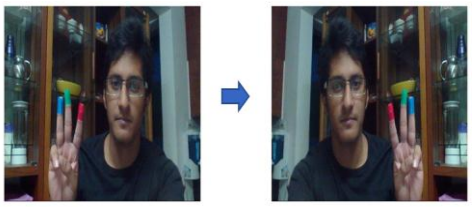
Conversion of YCBCR to RGB



YCbCr Image **RGB Image**

C. Flipping of Image

When the camera captures an image, it is inverted. This means that if we move the colour 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 .



Captured image **Flipped Image**

D. Color Channel Separation

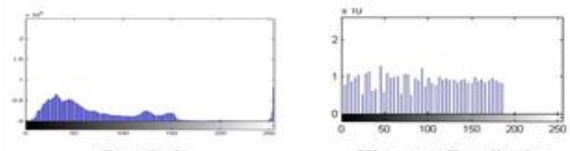
These are the three red, green, blue planes of RGBimage.

E. Gray Scale of Flipped image

Gray Scale Image is the average of red , green and blue colours. Each pixel is the average value of RGB

F. Histogram Equalization

Histogram equalization is an image enhancing technique it forms the basis for numerous spatial domain processing techniques. It uniformly distributes black and white pixels giving an enhanced image Histogram equalization automatically determines a transformation function that seeks to produce an output image that has a uniform histogram. It is done to enhance the image to get a better output .Histogram equalization is done on above gray scale image. We can compare the pixel distribution in both gray scale and the image obtained by histogram equalization.



Gray Scale **Histogram Equalization**

Scale X-axis: Gray scale intensity Y-axis: Number of Pixels

G. Subtraction of Images

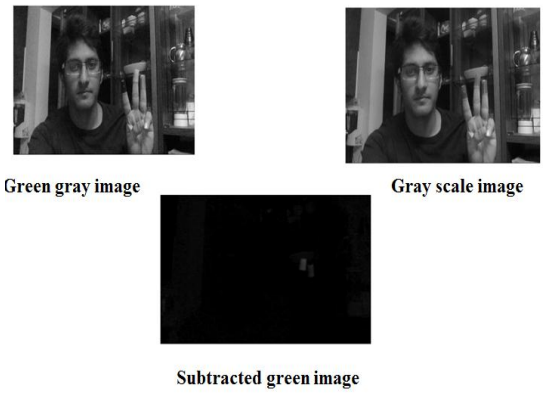
In order to obtain only red colored objects from an image we subtract the gray channel image from the red channel image by eliminating all other colored objects except red colored objects. Similarly, to get blue colored objects we subtract the gray channel image from the blue channel image and also to get green colored objects we subtract the gray channel image from green channel image and thus eliminating gray color from the respective red, green and blue images. Thus we get the following three images.

RED Channel

Red gray image Gray scale image

Subtracted red image

GREEN Channel



Green gray image Gray scale image

Subtracted green image

BLUE Channel

Blue gray image Gray scale image

Subtracted Blue image

H. Median Filtering

The median filter is a nonlinear digital filtering technique, often used to remove noise. Such pixel noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries.

RED Tape median filtering

GREEN Tape median filtering

BLUE Tape median filtering

I. Opening & closing

For Edge correction requires a structuring element.In opening we are rotating this disc from inside of detected object. In closing we repeat this process from outside. We are going to highlight the detected object in the main RGB image and going to capture the next image and repeat this process again. Here we have done removal of noise using opening and closing method with structural element as disk.

Red Tape Close disk Filtering

Green Tape Close disk Filtering

Blue Tape Close disk Filtering

J. Thresholding

Thresholding is conversion of image into only black white image, it is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images. The simplest thresholding methods replace each pixel in an image with a black pixel if the image intensity is less than some fixed constant, or a white pixel if the image intensity is greater than that constant. This technique can be used to track only the required color which is linked with mouse pointer.

Red Tape Thresholding

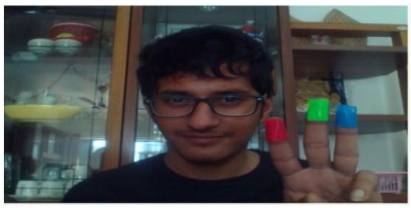
Green Tape Thresholding

Blue Tape Thresholding

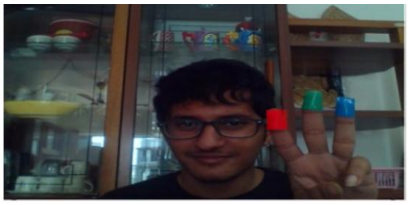
K. Detection of Object pointer using color patch

Detection of Blue Object

Detection of Green Object



Detection of Red Object



L. Centroid Detection and Bounding Box Detection of Object

To control the movement of mouse pointer it is necessary to determine a point whose coordinates can be sent to the cursor. With these co-ordinates, the laptop can control the cursor movement. An inbuilt function in MATLAB is used to find the centroid of the detected region. The output of matlab 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.

Bounding Box of Red Tape

Bounding Box of Blue Tape

Bounding Box of Green Tape

Centroid Detection of Blue Tape

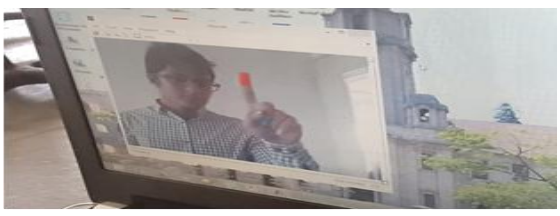
Centroid Detection of Red Tape

Centroid Detection of GreenTape

RESULTS

A. *Linking with Mouse*

Once the colour pointer 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 desired by the user. It is assumed that the finger pointer 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. A java object is coded in matlab program and it is linked with the mouse drivers. Based on the detection of other colours along with red the laptop performs the clicking events of the mouse.



Red pointer movement is mapped with mouse movement

One green pointer indicates left click and two green Pointers indicates right click which will pop up the window as shown in the fig above. A blue pointer can be used for double click. There is a constant need to change the threshold value every time the location is changed

CONCLUSION .

In this paper, a colour pointer tracking based virtual mouse application has been developed and implemented using a webcam. The system has been implemented in MATLAB software using MATLAB Image Processing Toolbox. However, this virtual mouse has some disadvantages such as: being variant to illumination up to some scale and movement of the cursor is very sensitive to motion. In the near future, a robust virtual mouse interface which will automatically adjust the threshold values of colour pointer that will overcoming the above said challenges can be developed with little modifications to the existing . 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 objective was to create this technology in the cheapest possible user friendly way. This system could be useful in presentations and to reduce work space.

In the future, our focus would be to develop a virtual mouse interface GUI(graphic user interface) to make it more user friendly along with this by coding it globally such that after making its exe file it can be used in other laptops which does not have MATLAB software. Also more features such as enlarging (zooming in) and shrinking (zooming out) windows, direct scrolling, etc can be added there by making it an integrated version of touch screen and traditional mouse. Users would also be able to save profiles which include threshold values for a particular location which the users uses frequently. The user can set and save threshold values for all different locations and load the required profile as necessary.Also as a security feature, face recognition can be added.This will allow only a recognized person to control the mouse using color pointers.

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