(Virtual Mouse Pointer)

Project report submitted in partial fulfillment of the requirement for the degree of Bachelor of Technology

in

Computer Science and Engineering/Information Technology

By

(Sanjay Kumar (171252))

Under the supervision

of(Dr. Rajni Mohana)

to

Department of Computer Science & Engineering and Information Technology

Jaypee University of Information Technology Waknaghat, Solan-173234,

Himachal Pradesh

Candidate’s Declaration

I hereby declare that the work presented in this report entitled **“ Virtual Mouse Pointer”** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Computer Science and Engineering/Information Technology** submitted in the department of Computer Science & Engineering and Information Technology**,** Jaypee University of Information Technology Waknaghat is an authentic record of my own work carried out over a period from December 2020 to May 2021 under the supervision of **(Dr.Rajni Mohana)** .

The matter embodied in the report has not been submitted for the award of any other degree ordiploma.

(Sanjay Kumar) Sanjaykumar.

171252

This is to certify that the above statement made by the candidate is true to the best of myknowledge.

(Supervisor Signature)Dr. Rajni Mohana Rm

(Associate Professor)

CSE & IT

Dated: 17th May 2021

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I should express my most huge gratitude to every last one of the general populations who gaveme the likelihood to finish this report. A unique gratefulness I oblige to our fourth-year meandermanage **Dr.Rajni Mohana,** whose devotion in empowering recommendation and support, helped me to energize my meander particularly in framing this report and besides have put hisfull exertion in controlling the social occasion in accomplishing the objective. I need to regard the heading given by other officials and furthermore the sheets particularly in our undertaking introduction that has enhanced our introduction aptitudes because of their remark and advice.

Other than that, we may in like way need to see with much appreciation the fundamental bit ofthe staff of the Computer Science department. Who gave the consent to utilize all required hardware and the essential materials to finish the undertaking.

LIST OF ABBREVIATIONS

ACRONYM	DEFINITIONS
1. RGB	Red Green Blue
2. HCI	Human-Computer Interaction
3. UML	Unified modeling language
4. HSV	Hue, saturation, lightness
5. MHI	Motion History Images
6. FPS	Frames Per Second

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ABSTRACT

In this paper, we are presenting an approach for Human-Computer Interaction, where we have tried to control our mouse cursor movements and functionalities like clicking, dragging, and afew more using hand gestures with the help of either colored tapes or hand gloves. Our one and the only sensor is the webcam that is present in our laptops. Hand gestures were acquired usinga camera-based color detection technique. In this project, our main focus is on how to use our Web Camera to develop a virtual interaction between humans and machines in the most cost- effective manner

Chapter -1 INTRODUCTION

Introduction

The most efficient way of human communication is through hand gestures, which is a universally accepted language. It is expressive such that the dumb and deaf people could understand it. In it a real time gesture system is proposed. Experimental setup of the system uses fixed position with a web camera recording feature mounted on a monitor or a fixed camera on a laptop, which captures a snapshot using RGB colour space from a fixed distance.

This work is divided into several stages: image pre-processing, region extraction, feature extraction, feature matching. Recognition, interpretation of sign language is one of the issues for communication with dump-deaf people. In this project a hand gesture segmentation technique has been proposed based on the pre-processing, background subtraction and edge detections.

In work, the pre-processing techniques are created on the basis of different types of combinations from hand gesture image processing operations such as capturing image, removing noise, and edge detection and these image pre-processing methods are discussed as follows.

Initially, the hand gesture images are captured from the vision camera, the hand gestures can be observed with interfaces that accurately record every abduction angle. The interfaces need the user to be hitched to the laptop, all minimizing time to user comfort interface, vision-basedinterfaces provide unencumbered interactions with humans.

The project covers a recognition tool which could be used to move the mouse pointer, performoperations like clicking and gesture operations like moving files from computer to computer performing simple but fascinating operations that could be covered with hand recognition.

Problem Statement

The system consists of the mouse and trackpad system of monitor controlling and the non-availability of a gesture system. The remote access to the screen using a hand gesture is unavailable. Though it is trying to implement the scope restricted in the field of virtual mouse.The existing virtual mouse control system consists of the simple mouse operations, where we could perform mouse operations like mouse pointer control, right click, drag etc.

Objectives

To focus on helping patients who don’t have control on limbs and to improvise the interaction between the machine & humans. Greater recognition can be used for applications like sign language recognition for deaf and dumb people etc.

Our motive was to create the technology in the cheapest possible way.

This system is mainly aimed to reduce use of hardware attached to computers.

Methodology

In the Methodology, the method used in systems will be explained as:

Camera Settings

The runtime operations are managed by the webcam. To capture given video, we need to create a Video Capture object. Its arguments can be device index or name of video file. Device indexis a number given to specify which camera. Since we are only using a single camera, we pass it as ‘0’. We can add additional cameras to the system and pass it as 1 so on. Then you capture frame-by-frame. But at the end release the capture. We could also apply colour detection techniques to any image.

Capturing Frames

We use an infinite loop so that the web camera captures frames in every instance and is opened during the entire program. We capture live streams, frame by frame. Then we process every frame which is in RGB colour space to HSV colour space. There are about 150 colour- space conversion methods provided in OpenCV. But we will be using BGR to Gray and BGR to HSV.

Masking Technique

The mask is creating a specific region of the image following certain rules. We create a mask that consists of an object in red colour. Then perform bitwise 'AND' operation on the input image and the Threshold image, which highlight only red coloured objects. This result of the 'AND' operation is stored in the result variable. We display frames, resend masks on separatewindows using imshow() function.

Display the frame

The imshow() function of HighGui and it is to call the waitKey(). The processing of the loop of the imshow() function by calling waitKey(). The function waitKey() waits for a delay. Windows events like redrawing, input, resizing etc. are processed by HighGui. So, we call thewaitKey with min. delay.

Mouse Movement

First calculate the centre of both detected objects which we do by taking the average of the bounding boxes max and min points. Now we get two co - ordinates from the centre of the objects. We then find the average of those and we get the red point. We convert detected co- ordinate from camera to actual screen resolution. Then we set the location as the mouse pointer to move the pointer. It will take time. So, we wait till the pointer reaches a given point. We started a loop where we stand idle. We are waiting to check if the current mouse location is thesame as the assigned mouse location. Thus, performing open gesture.

Clicking

Next is to implement the close gesture. The operation is performed by clicking on an object and then dragging it. Here we have one object so we need to calculate the centre of it. And thatthen be placed on the location where we position the mouse pointer. We will be performing a mouse press operation.

Drag

To implement dragging we use a variable 'pinch_flag'. It will be set to '1' if, was clicked earlier. So after clicking we find the open gesture and check if the pinch_flag is set to 1. If, setto '1' then Drag operation is performed else the mouse operation is performed.

DnD

First create a MyFileDropTarget class. Inside that we implement an overridden method, OnDropFiles which accepts the x/y position of the mouse with the file paths which are dropped.

Organisation

Chapter 1: Highlights and Underlines novel camera vision-based cursor control system, usinghand gestures captured through a colour detection technique.

Chapter 2: The nitty gritty writing audit from the exploration paper, books and gatherings are finished. In this part, the concentrates from grouped research papers on Virtual Mouse, Hand Gestures, Image Capture and Processing.

Chapter 3: Cover frameworks improvement which is the key part of the work. In this part, theproposed demonstration, UML charts and related parameters are accentuated.

Chapter 4: The usage comes about with the relative execution investigation that appears in thispart. The re-enactment results and screen captures are uncovered to protect the proposed work. Chapter 5: Detailed conclusion about work which directs the forthcoming understudies and research researchers to improve the flow work with higher proficiency and adequacy by usinghand gestures through a colour detection technique.

Chapter -2 LITERATURE SURVEY

Literature Survey

We can perform Cursor control using many methods, but in general most of the time we make use of Data Gloves. In our project we are using coloured tapes for gesture identification and our only sensor is our laptop webcam. A Data Glove is an input device with many sensors attached to it and used to sense hand movements and gestures. This leads to reduction in the efficiency of performance between the user and our system. Due to continuous and complex calculations that are being performed the system it was observed that system complexity also became an issue in this process.

There could be two possible gesture recognitions for HCI. Gesture recognition could be hardware based and another one could be computer vision.

One of the earliest hardware-based systems was proposed by Quam in 1990. In the study proposed by Quam users needed to wear a heavy and uncomfortable Data Glove to use the system. Even though this method gives a high accuracy control, it was observed that it was very difficult to use as some of the gestures are not meant for every individual and also very impractical for a large number of users in everyday life in the world.

The vision-based hand gesture recognition is also of two types. They can be categorized into marker-based and non-marker based. In case of non-marker-based recognition, accuracy is in general is not as good as in the case of a marker-based recognition. Marker based recognition has better accuracy as compared to the other gesture recognition systems, even though the number of coloured caps used is only one. This way is lighter in comparison to the Data Gloveof the hardware-based system.

Gesture recognition might be a very advanced way for the computers to understand human gesture and body Language. Using Data Gloves will build a greater and better interaction between human and computer machines rather than old and primitive text-based interaction. Generally, in case of a marker-based gesture recognition mouse uses at least two-colour markers to track the movements and gestures.

As we are making use of multiple colours, the system is comparatively slow and some laggingsappear on the system during the time of execution. In 2010, ChenChiung Hsieh and Dung-Hua

Liou proposed a paper “A Real-Time Hand Gesture Recognition System Using Motion History Image" which was based on an adaptive skin colour model and motion history image. In their paper they used an adaptive skin colour model and a motion history image to detect the direction of motion as well as amount of movement. The Main limitation of their system wasa problem that was associated with increasing complexity of gestures and movements.

In 2011, Chang-Yi Kao and Chin-Shyurng published a paper titled “A Human-Machine Interaction Technique: Hand Gesture Recognition Based on Hidden Markov Models with Trajectory of Hand Motion" that is a learning-based interaction between human and machine. Their work is highly accurate but it worked well only in high configuration computers.

In 2013, Angel, Neethu. P.S proposed a paper named "Real Time Static and Dynamic Hand Gesture Recognition" which is based on designing, developing and studying practical gesture recognition that can work when it comes to various and complex human and computer interactions which are applicable in real time. Even though it was practical on many levels, it was unable to work with a complex background. It was computable when a proper outer environment like proper lighting was provided.

In 2013 another paper titled “Cursor Control System Using Hand Gesture Recognition “was released by Ashwini M. Patil, Sneha U. Dudhane, and Monika B. Gandhi. In their work they designed and developed a machine-user interface which implemented hand gesture recognitionusing computer vision and multimedia algorithms. But a major limitation was recognized whileworking with algorithms dealing with comparison of different hand gestures. Major changes like skin pixel detection and hand segmentation from stored frames needed to be done before implementing these algorithms for detecting gestures.

Another paper titled “Mouse Control using a Web Camera based on Colour Detection” was proposed. Methodology in case of this work involved acquiring hand gestures using a webcam.The limitations that were observed with their system was one that was related to the operatingenvironment that has to be lighted enough with no bright coloured objects. It works well only on certain computers with high configuration. In 2016, Yimin Zhou, Guolai Jiang & Yaorong Lin published their work titled “A novel finger and hand pose estimation technique for real- time hand gesture recognition” which was based on direct extraction of fingers from hand by detecting edges. If we consider the hand’s geometrical characteristics, the hand postures become segmented and defined by characteristics such as finger positions, palm (which will be our centre) location and position of wrist. It was observed that this method was only compatiblewith high configuration computer machines.

In 2016, Saurabh Singh, Pooja Kumari, and Vinay Kumar Pasi designed and developed "Cursor Control using Hand Gestures" which is a system based on multiple colour bands or tapes where different colours were used to perform different actions. The variety of colours used is a key variable that determines the number of functions that can be performed. Multiple colours were used to control the system. Their system relied on the number of colours to perform a function instead of different gestures.

A system in 2017 was developed titled "Hand Gesture Recognition for Human-Computer Interaction" by Aashni Haria, Archanasri Subramanian, Nivedhitha Asokkumar, and Shristi Poddar, Jyothi S Nayak.

In the study held by Erden et al and Hojoon Park, Erden et al had used a camera and computervision technology. Computer vision technology such as gesture recognition and image segmentation were used to control mouse functions.

Our project was inspired by a paper of Hojoon Park and Erden et al where they used Computervision technology and webcam to control mouse functions and activities. In case of their project, they used finger-tips to control the mouse cursor and the angle between the thumb andindex finger determined the type of clicking actions. The work by chu-Feng Lien made use ofan intuitive method to detect hand motion. They used Motion History Images to determine thedirection of movement. In this approach only the fingertip was used to control both the cursorand mouse click. In his approach the user needs to hold the mouse cursor on the desired spot for a specific period of time for performing clicking operations. Kamran Niyazi used a webcamfor detecting-coloured tapes and then calculated the centroid at run time and tracked that centroid to perform cursor movements. Again, here the clicking actions were performed by calculating the distance between two coloured tapes in the fingers.

In a paper published by K N Shah et al, he used some of the innovative methods for finger tracking that are used to interact with a computer system using computer vision. They dividedthe approaches used in Human Computer Interaction into two main factors: first HCI without using interface and second HCI along with interface. They have mentioned some useful applications using finger tracking through computer vision techniques.

OpenCV

Computer Vision is programming a computer to process and understand images or simply saying making a computer see. Solving small parts of Computer Vision challenges, creates new possibilities in technology, engineering. To advance vision research and disseminate vision knowledge which is critical to have a library of programming functions with optimizing and portable code. An original goal of the Intel team when OpenCV (Open-Source Computer Vision Library) was launched.

A number of programmers contributed to recent library developments. The latest change in OpenCV 2 was to include main changes to the C++ interface.

Nowadays the library has more than two thousand five hundred optimized algorithms. Extensively being used around the world, having 2.5M downloads and more than 40K people in the user group. OpenCV can be used in academic and commercial applications. To master OpenCV library it is necessary to consult books available on the topic of OpenCV. Although reading more comprehensive material after comprehending a basic idea about OpenCV from this paper.

Some of the main engine features used in OpenCV implemented processing techniques and methods. Several OpenCV image processing techniques and algorithms are known to be widelyused too. Concept of image histograms is explored for image analysis. A histogram which is a table shows a number of pixels having values in an image. Entries in a histogram are called bins. Calchist() an OpenCV function computes histogram . For enhancing image contrast the first idea would be to spread an original narrow range of intensities on a full available range which is a linear stretch. Although, the real problem is that some intensities are used more frequently, which is easily visible from the histogram intensities distribution.

On the idea that a good quality image should have equal use of all available intensities, it brings the concept of histogram equalization, which tries to make image histogram flat. EqualizeHist() function performs this task of OpenCV. Intensity distribution can also be understood as the probabilities that few pixels will have a specific value. Using a histogram back projection we constitute a base to detect specific image content.

The back projection replaces pixel value in an input image by finding its corresponding probability which was read in the histogram, thus yields a probability map. Further, the probability map is used to detect objects on the image which uses a mean shift algorithm. Which is an iterative procedure of locating local maxima of probability function by finding the weighted centroid of the respective data point inside a predefined window. The respective algorithm moves the window centre to the centroid location repeating the same procedure until the window centre converges to a stable point. Visual tracking is one of extensive use of mean shift. Addition to that, a more advanced version could be used where the size and the window orientation can change and is implemented under CamShift algorithm.

Chapter -3 SYSTEM DEVELOPMENT

System Requirements

The structure and programming necessities for making hand gesture-based applications using webcam mounted on laptop are according to the accompanying:

Supported Operating Systems

Windows XP (32-bit), Vista (32-or 64-bit), or Windows 7 (32-or 64-bit) Mac OS X 10.5.8GNU C Library (glibc) 2.7 or later is required.

- On Ubuntu Linux, adjustment 8 or later is required.
- 64-bit scatterings must be prepared for 32-bit applications

Supported Development Environments

Anaconda open-source distribution of Python programming languages for computing purposes.Include data science packages for Windows, macOs and Linux.
Matlab a multi-paradigm programming language, Numerical computing environment allowingmatrix manipulations, plotting data and functions and creation of user interfaces.

Hardware requirement

Webcam and Coloured Caps: For this project we need a webcam for capturing frames of imagesfor gesture recognition. Here it is important that we know about the frame capturing rate of ourwebcam for getting proper frames. Here instead of Hand Gloves we are using coloured caps of red and blue colour to perform functions like left click, right click, dragging and a few more.

EXISTING SYSTEM

The existing system consists of the mouse, trackpad system of monitor; controlling the nonavailability of a hand gesture system. The remote access of the monitor screen by hand gestures are unavailable. Though we are trying to implement the scope in a simple restricted field of virtual mouse.

The existing virtual mouse control system comprises mouse operations using the hand recognition system, where we perform basic operations like mouse pointer control, left click etc. Also, the hand recognition has not been made use of. Even when there are a number of systems which are used for recognition, the system they made is the static hand recognition which recognizes the shape made by hand and by defining actions for each shape, limited to anumber of defined actions; a large amount of confusion.

PROPOSED SYSTEM

Using the current system where there are number of access methods available for the hand andmouse gesture for laptops, using our project we could make use of the web-cam and by recognizing the gestures we could control mouse and perform various operations like mouse pointer controlling, selecting deselecting using left or right click and a quick access feature forfile transfer between systems via network LAN cable. The project is a Zero Cost hand recognition system, which uses algorithms to determine the hand and its movements and by assigning action to each and every movement.

Although we have mainly concentrated on the mouse positioning, its pointing, clicking actionsalong with action for the file transfer between systems by hand action with specific movements.The system we are implementing which has been written in python code and is responsive andis implemented using python which is platform independent with flexibility and is portable which is desirable in creating programs focused with an aim for creating a Virtual Mouse and Hand Recognition system. The system is extendable by defining actions for the hand movement for doing specific actions. It could be further modified to implement actions for the set of handgestures.

Usability

To develop and implement an alternative system to control mouse cursor. The alternative method to it is hand gesture recognition using a webcam and color detection method.

Tracking fingertips as movable objects and utilizing it for mouse functions, the camera being positioned in a way that it can see the user's hands in the right positions. This can be used where we need space, for patients who don't have control over their limbs and for people withsimilar cases. A virtual mouse which will work only based on webcam captured frames & tracking fingertips.

SYSTEM DESCRIPTION

Following are the steps followed in our approach:

(i) Capturing real time video using a web camera mounted on a laptop.

(ii) Processing every individual image frame.

(iii) Flipping image frames.

(iv) Converting each individual frame to a grayscale image.

(v) Colour detection to extraction of different colours from each flipped grayscale image

(vi) Converting detected image into a binary image.

(vii) Finding regions of image and thus calculating its centroid.

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

(ix) Simulate left click and right click events of the mouse by assigning differentcolour pointers.

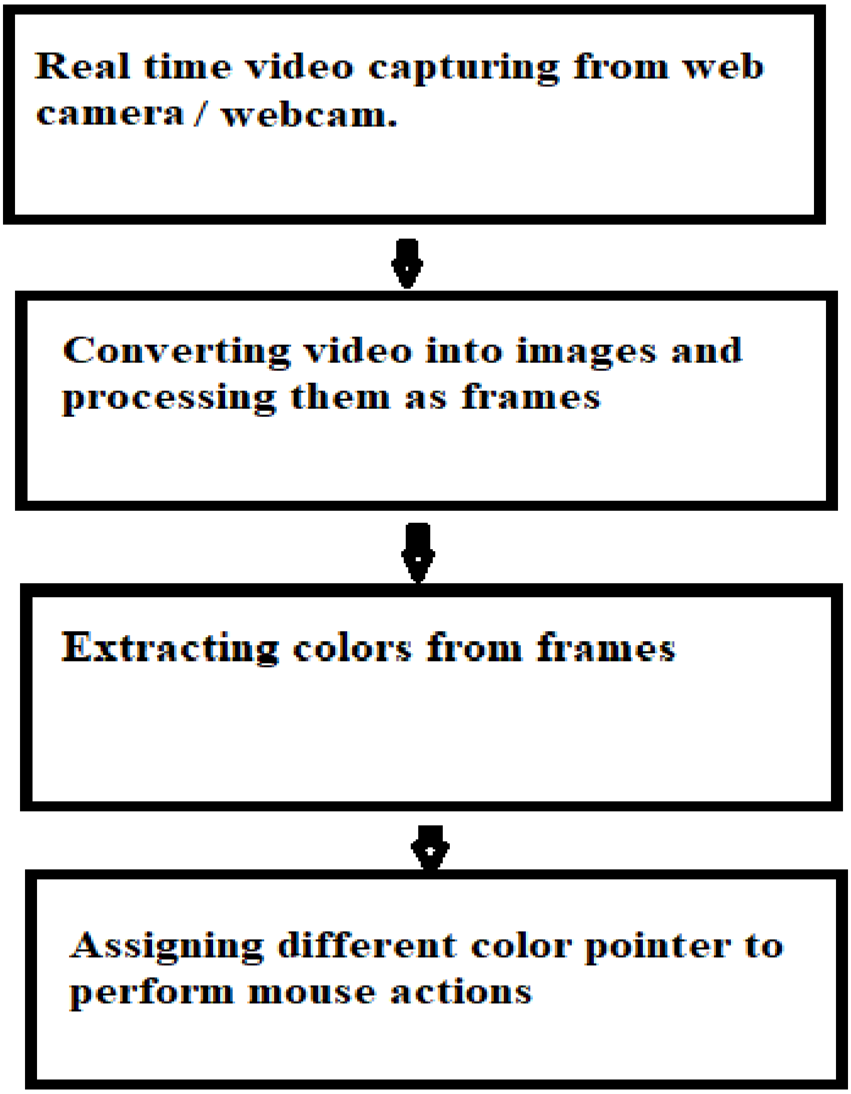

Real time video capturing from web camera / webcam.
Converting video into images and processing them as frames
Extracting colors from frames
Assigning different color pointer to perform mouse actions

Figure 1: Diagram of the System

For the system to work we need sensors to detect the hand movements. The webcam of a computer acts as a sensor. The webcam captures video with fixed frame rate with resolution which is determined by the hardware of the camera. The frame rate with resolution can be changed in the system. Computer Webcam captures the Real Time Video.Video is divided intoframes based on their FPS. Processing every frame.

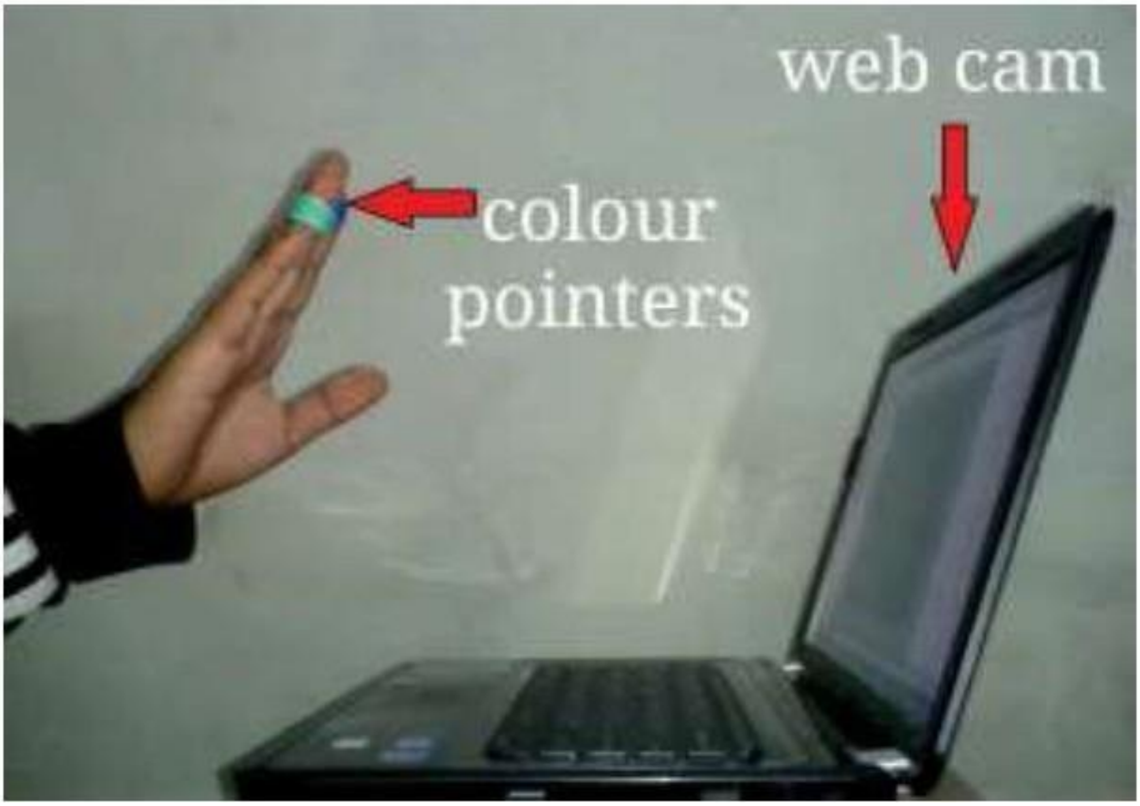


Figure 2: Capturing Real Time Video

Flipping of Images:

When the camera captures an inverted image. It means that we move the pointer towards the left, then the pointer moves towards the right & vice-versa. The image obtained standing in front of a mirror. To avoid the given problem we need to vertically flip every image. The imagecaptured, thus an RGB image flipping actions cannot be performed on it. Individual colour channels image separated and then flipped individually. Flipping the red and blue coloured channels, they are concatenated also flipped obtaining RGB image.

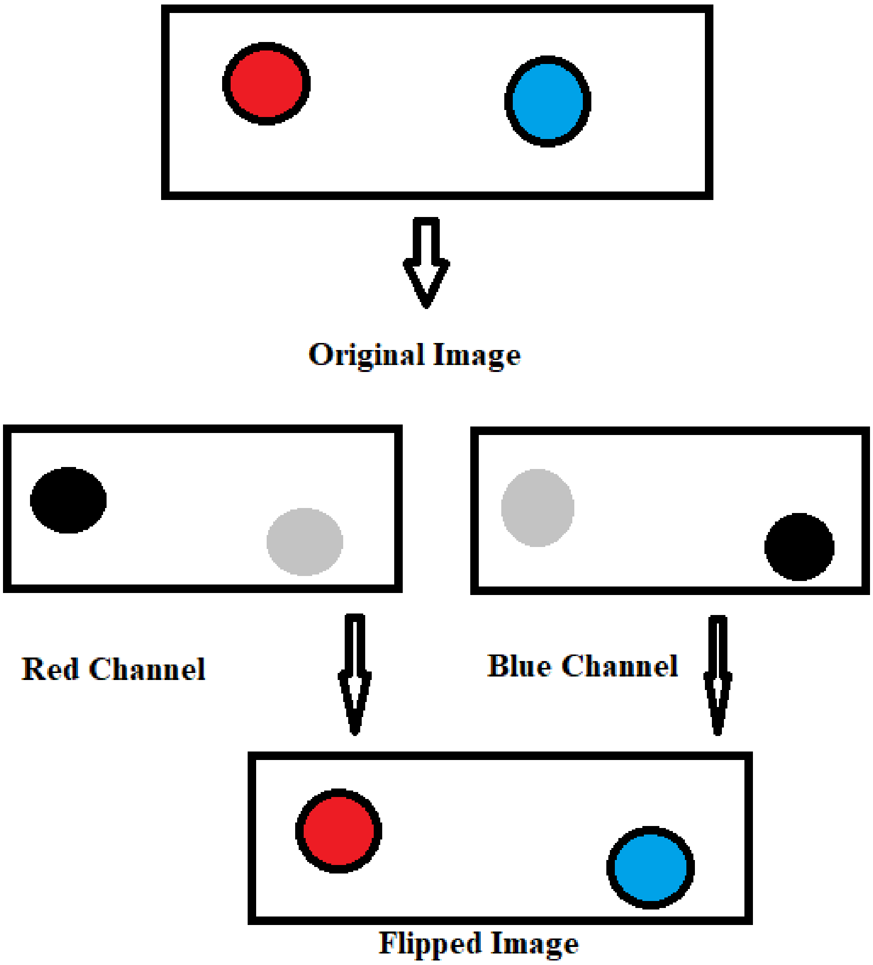


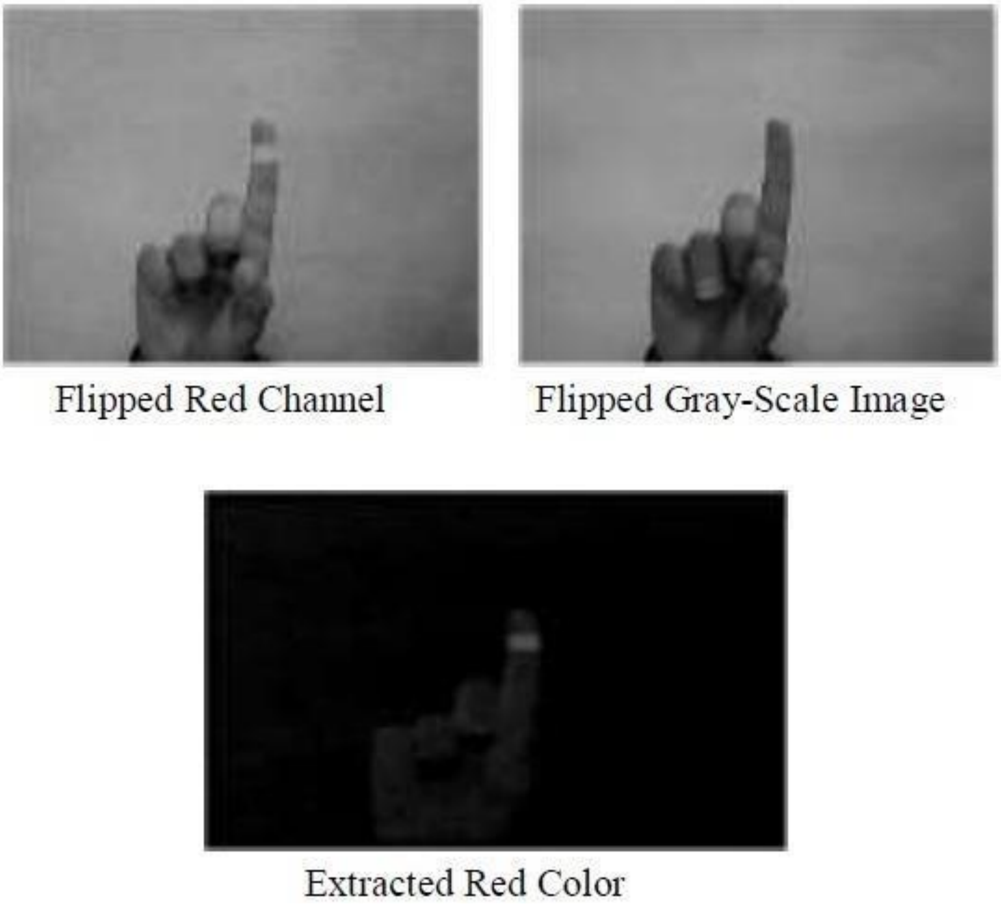
Figure 3: Flipping of an image

Converting Flipped Image into Grayscale Image:

Computational complexity gets reduced in gray scale image as compared to coloured image. Flipping image is converted into a grayscale. All operations are performed after conversion ofthe image into grayscale.

Colour Detection:

An important step in the whole process. The red, blue colour objects are detected by subtracting the flipped coloured suppressed channel from flipped gray-scale image. Creating an image containing the detected object as a patch of grey surrounded by black space.



Flipped Red Channel

Flipped Gray-Scale Image

Extracted Red Color

Figure 4: Detection of Red Color

CANNY EDGE DETECTION using OPENCV

Using Canny edge detection, follow several steps:

Step 1: Denoise image before detecting edge in image, usually use Gauss smoothing filter toreduce noise; eq(1)

G(x,y) = e(pow(x2 + y2)/ 2(sig)) * ½(pi)(sig)sq. eq(1)

Step 2: On Calculating the gradient amplitude and direction, the gradient direction takes fourangles which are - 0, 45, 90, and 135 degrees; eq(2),

G = sqrt(Gx2 + Gy2) eq(2)

Theta = arc = tan(Gx/Gy) eq(3)

Gy, Gx is a pair of convolution arrays.

Step 3: Non maximum suppression leaves only a few fine lines by eliminating non edge pixels.

Step 4: Selection of the hysteresis threshold requires two thresholds which either retain or exclude pixels for selection of the edge.

The pixel is reserved as an edge pixel, if the amplitude of the pixel position is higher than its threshold. The pixel is excluded, if the amplitude of the pixel position is less than threshold value. The pixel is reserved if the amplitude of the pixel position is between the two thresholdvalues, only condition is that it is then connected to a pixel higher than the threshold value.

Canny () function in OPENCV

void Canny which includes respective parameters: Input Array image, Output Array edges, double threshold one, double threshold two, int aperture Size of three, bool L2gradient defaultfalse.

This function includes six parameters, the first parameter is the input image, second parameter is the output image, third and fourth parameters are for the first hysteresis threshold and for thesecond hysteresis threshold, the fifth parameter is a sobel parameter which gives identificationof the image gradient magnitude calculation.

Conversion of Grayscale into Binary scale Image:

That gray region of the image obtained after subtraction, needs to be converted into a binary image for finding regions for the detected object. Grayscale image consists of a matrix, whichcontains the values for every pixel. The pixel values lay between range 0 - 255; where 0 represents black and 255 represents white colour. Using a threshold value of twenty percent toconvert the image into binary image. Which means that pixel values lying below twenty percentof the maximum pixel value are converted to black colour which is 0 and the rest image is converted to white which is 1. Resulting into obtaining a monochromatic image consisting of black and white colours. Conversion to binary requires Python, because it can find properties of monochromatic Image.

Finding Centroid of object and plotting it:

For users to have control on the mouse pointer it’s necessary to determine points whose coordinates are sent to the cursor. These coordinates control the cursor movement.

Inbuilt function in Python is used to find the centroid of the detected region. The output ofthe function is a matrix consisting of the horizontal, vertical coordinates of centroid. These coordinates change as the object moves across the screen. Detecting the centroid of the image.The coordinates are located, then stored in a variable.

Mouse Pointer Tracking:

When coordinates are known, the mouse driver is accessed and the coordinates are sent to the cursor. Then the cursor places itself in the required position, with these coordinates. We assumethat the object moves continuously and each time a new centroid is determined and for each frame a new position is obtained for the cursor, creating the effect of tracking. Our user moves hands across the provided field of view of webcam, mouse moves proportionally across the screen.

There is no such inbuilt function provided in Python which can directly access mouse drivers. Since python is a machine independent language so it is preferred over the others. A python object is created, linked with mouse drivers. Based on detection of colours the systemperforms the clicking events of the mouse.

Based on requirements, colour codes can be made to be customized.

3.4.8 Performing Clicking Actions:

The control actions of the mouse are performed on controlling flags which we associated withmouse buttons. PYTHON is used to access flags. The user performs hand gestures, to create control actions. Computation time required is reduced, since we are using colour pointers.

Further making system resistant to background noise and low illumination. Detection of two colours can simultaneously be performed on clicking. If Red along with blue colour is detected,we perform left clicking action else if red along with red colour is detected, right click action is performed

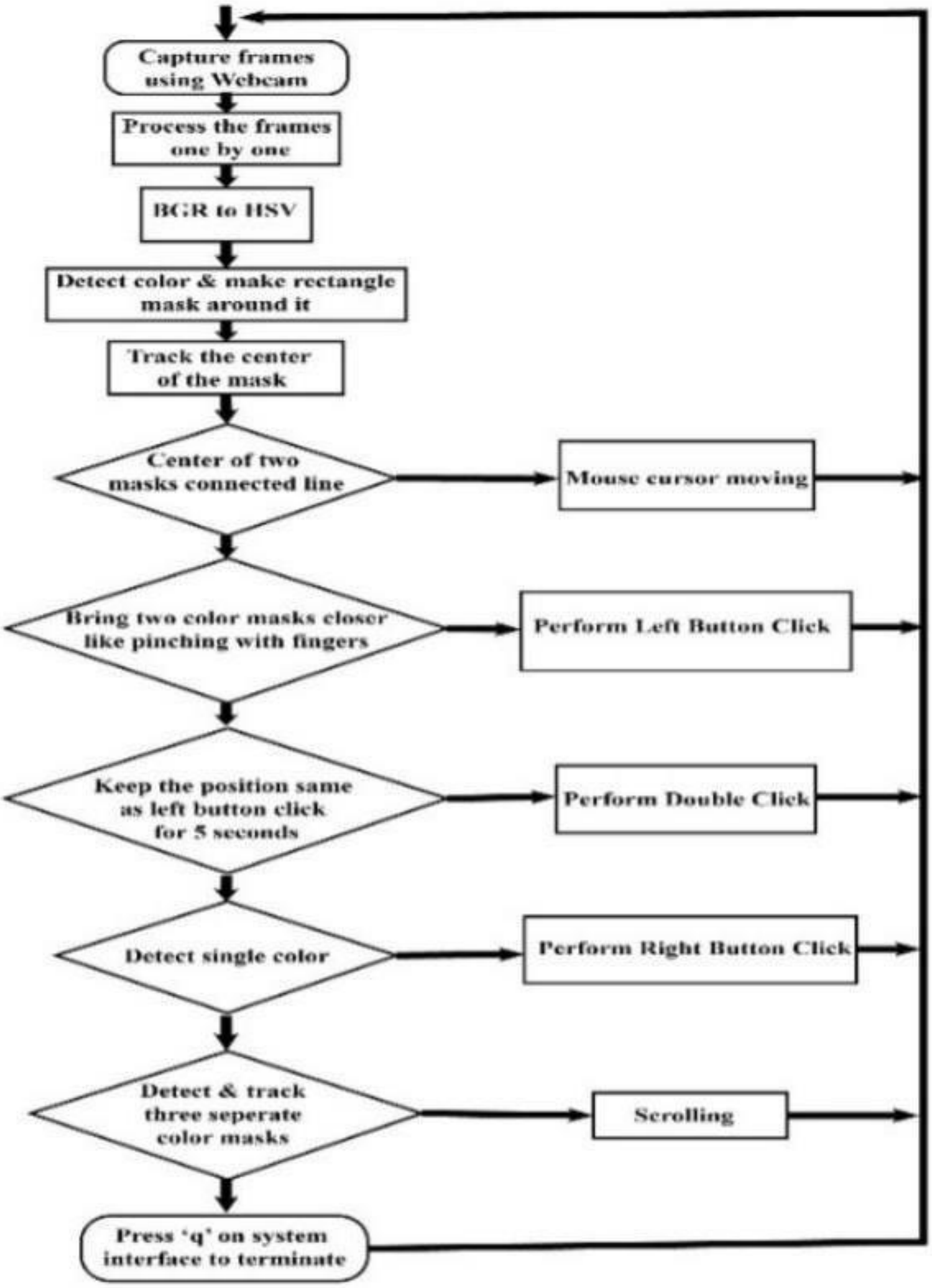

Capture frames using Webcam
Process the frames one by one
BGR to HSV
Detect color & make rectangle mask around it
Track the center of the mask
Center of two masks connected line
Mouse cursor moving
Bring two color masks closer like pinching with fingers
Perform Left Button Click
Keep the position same as left button click for 5 seconds
Perform Double Click
Detect single color
Perform Right Button Click
Detect & track three seperate color masks
Scrolling
Press 'q' on system interface to terminate

Figure 5: Flowchart of Gesture System

Screenshots:

Open gesture for mouse movement:

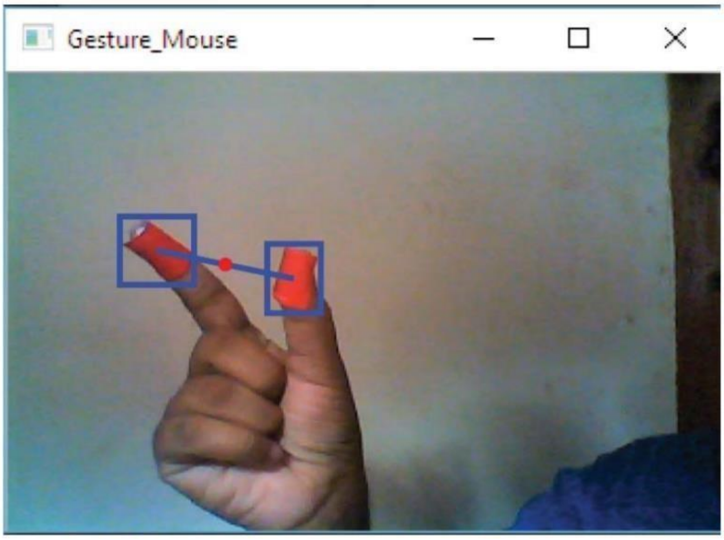


Figure 6: Open gesture

Left click a close gesture :

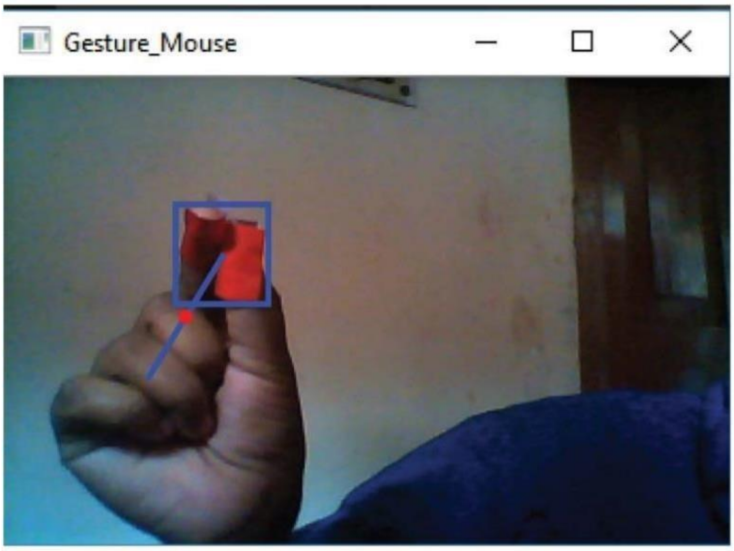


Figure 7: Close gesture

For Drag & Drop:

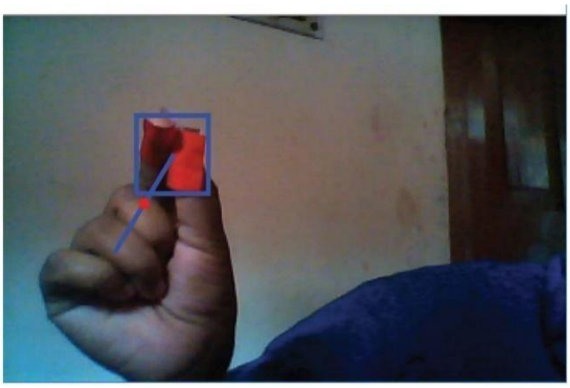


Figure 8: Drag & Drop

Use Case Diagram of the following application:

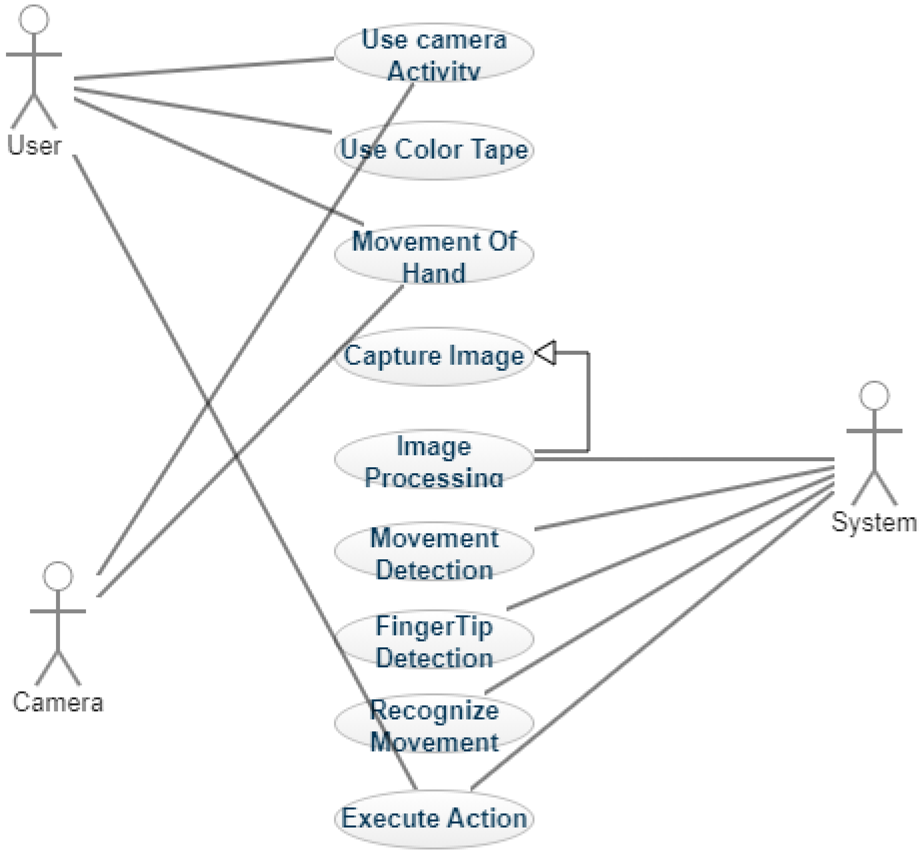


Figure 9: Use Case of the Diagram

EVALUATION

We have used HCI and computer vision which contributes in vision-based interaction between machines and humans. It is about controlling mouse functions using hand gestures. The main functions are mouse movements, left, right button clicks and dragging files up or down. The users can pick any colour from multiple colours. There is a defined colour and the user can pick any colour according to the background and the lighting conditions. Which vary in different backgrounds.

Example, when a user starts the system, he will be provided with choices to pick colour bandsfrom multiple colours. The user would choose one colour, which doesn't match with the background. The colour then be highlighted in the current background.

Testing are done on plain background. Works very fast with accuracy of seventy-eight to ninety percent. Testing was also performed on complex backgrounds, such as wearing printed dress, colourful dress, complex wall backgrounds, indoor daylights & also indoor home light etc.

The system is not very efficient in the complex backgrounds. But it is faster than other gesture-based mouse systems. A high-definition camera or a webcam can increase accuracy value. Thesystem is developed in Windows OS, the accuracy rate might be better in Linux base or Macintosh.

Chapter-4 PERFORMANCE ANALYSIS

Performance Analysis

It is defined as a specialised discipline of study that provides the authority monitoring or inthis case developers with objective information and gives them insight into understanding efficiency, redundancy, mistakes and better solutions. This process is underpinned by systematic observation and later provides reliable, valid and detailed information regardingour system and its performance.

Efficiency of finger tracking In different outside environmentconditions

OpenCV has been used in many research scenarios and it’s efficiency can be effected by factors like improper frames of pictures (can be due to improper lighting or distance of the user being great due to which colours are either not detected or interpreted as another colourand therefore the algorithm is not able to perform efficient edge detection or centroid calculation). Even if we get a clear image to the hand of the user our system might fail to perform its task if the background is coloured.

Since we use red and blue for different gesture recognitions, background colours can distortour process of colour detection and conversion to grayscale.

We also observed that if multiple people use this tracking system together at a time the accuracy gets lowered and results might not come out as we want them to. We observed ifwe use our method then we use a common metric called precision.

Precision matrix is widely used in case of image segmentation evaluations. Using the notationof true positive, false positive, and false negative, this metric is expressed as:

Precision=True positive/(True positive + False positive)

Comparison of performance of a system using Data Gloves and aSystem using only Computer Vision

Data Glove is an input device that uses various sensors to take various movements of hand asinput values that are further used in virtual mouse, even though this device makes it easier for developer as well as user but since this is costly means we use tapes and computer vision.

In the case of Even a Data Glove some features can be confused with others but generally asystem with Data Gloves gives more accurate results. Using Data Gloves also reduces the chances of False positives as mentioned above.

This system that we have used only gives accurate results for a single individual in an isolated environment. The system can only be practical in case of personal PCs or laptops. Incase of systems used in mass systems like ticketing systems this method is not so practical.

Practical Runtime Performance

The efficiency of not only this system but any other system produced till date is not goodenough when it comes to any practical runtime setup.

In the practical setup as we discussed before problems like environment setup which varies ina real runtime condition plays a very vital role. Problems like inappropriate lighting, multiplepeople trying to interact from a single screen, inappropriate distance from the webcam (too far away or too close) and many more makes such systems less reliable when it comes to using these systems in real time.

Mouse Events and their Accuracy

If we use our system where movement is an open gesture with two colour caps the action performed will be mouse movement and it’s accuracy with a plane background is 91 percentand that with a complex background is only 41 percent.

If the movement is a closed gesture with two coloured caps then the action that will be performed is a left click and its accuracy with a plane background is 88 percent and that witha complex background comes out to be 40 percent only.

If the movement that is used is a closed gesture with keeping two fingers together for any defined t seconds the movement that will be performed is a double click with an accuracy of87 percent with a plane background and 42 percent with a complex background.

If the movement is an open gesture with a single-coloured cap then the action that will be performed is a right click and its accuracy with a plane background is 95 percent and thatwith a complex background comes out to be 79 percent.

If the movement is a swipe movement with all three coloured caps then the action that will beperformed is a scrolling action and its accuracy with a plane background is 78 percent and that with a complex background comes out to be 40 percent at maximum.

Comparison with existing systems

Clearly, our system is not very efficient in case of complex and rough background. Still our system is comparatively faster than other gesture-based mouse control systems. The accuracyof the system can be increased by using a high definition (HD) camera. The readings mentioned above are taken from a built-in laptop VGA (Video Graphics Array) camera.

Though our system is developed in Windows Operating system. In some cases, the accuracyrate might be better in a Linux based operating system or Macintosh operating system computer rather than Windows operating system computer.

Testing Fundamentals

Software Testing is the process of evaluating the software against various requirements gathered from the users and the system specifications. Testing is conducted at the phase level in software development life cycle (SDLC) or at module level in program code. Software testing comprises Verification and Validation.

The process of examining whether or not the software satisfies the user requirements and system specifications is called validation. It is carried out at the end of the software development life cycle. If the software should match requirements for which it was made to bevalidated.

The process of confirming if the software is meeting our needed business requirements, and is developed following the proper specifications and methodologies is termed as verification. Target of testing is to discover:

a. Errors : These are actual mistakes in the code that are made by developers or designers.If there is a difference in output of software and desired output then it is considered asan error.

b. Fault : Faults are accommodated along with errors. A fault is also known as a bug thatis a result of an error which can cause a system to fail.

c. Failure : failure is the inability of the system to perform the task in a way that we desired. Failure occurs when there is an existing fault in our system.
Testing can either be manual or can be automatic.

Manual - This testing is performed without taking help of automated testing tools. The software tester prepares test cases for different sections and levels of the code, executes the tests and reports the result to the manager.
Manual testing is time and resource consuming. The tester needs to confirm whether or not right test cases are used. Major portion of testing involves manual testing.
Automated This testing is a testing procedure done with aid of automated testing tools. The limitations with manual testing can be overcome using automated test tools.

Testing Concepts

Software testing is defined as a process where we execute our program or application under conditions like positive or negative (can be manual or automated as mentioned above).
The main conditions on which a system is to be tested are:

Specification

This step of testing code is not required to start our testing. It helps in saving money and managing resources throughout the process with minimal wastage and appropriate monitoring.It describes the functional and non-functional aspects of the software.

Focuses on what not how (how part is related to design part in SDLC). Here we need to define standardized tests and then use them to measure our requirements. All the requirements will bepassed through the tests one by one and then with those results we can evaluate and freeze thefunctional requirements.

Many times, the designers fail to get the idea on how to make a specific module and they simplyassume some of the requirements in the design phase (which should not happen as requirementsshould be complete and cover each and every aspect of the system under development).

Functionality

Functional testing is a kind of software testing that validates software system against our functional requirements or specifications. The main purpose of Functional testing is to test each and every function present in our software application. We need to provide appropriate input and verify the output against our functional requirements.

Functionality testing involves black box testing. It is not concerned with the source code of oursystem or our application, it checks our user interface, our database, security and other important functionalities of our system which is being tested.

The testing can be either manual or automatic. The main objective of Functionality testing is to check the proper working of all the functions in our software system.

It concentrates on concepts of mainline functions (testing main functions), basic usability (basicusability testing of the system), accessibility (checking accessibility of the system), error conditions (check for errors).

Performance

Performance testing is a type of software testing that is used for testing the speed, response time, reliability, scalability, resource usage and stability of a software under particular workload.

The main use of performance testing is to find and eliminate all the performance bottlenecksin our system. It comes under performance engineering and known as “Perf Testing”.

Performance testing checks:

a. Speed: Performance testing determines the responding time of the application fordifferent functions.

b. Stability: Performance testing also determines the application’s ability to handledifferent varying loads.

c. Scalability: Performance testing also determines if our system or application’smaximum used load capacity.

d. Load Testing: It is a non-functional testing which is performed in order to understandthe behaviour of the application under unexpected or sudden loads. It is used to understand performance of a system under its peak and as well as normal conditions.

e. Stress Testing: It is a type of testing where you verify stability and reliability of the software. The main purpose of stress testing is measuring software considering it’s error handling capabilities and robustness under heavy load conditions and to ensurethat software does not crash under crunch situations. It tests in conditions beyond normal points and checks and monitors how our system is working under these conditions.

f. Spike Testing: It is a non-functional testing under performance testing. Which evaluates the performance and handling of our systems in conditions in cases ofsudden increase or decrease in the load on the system.

g. Volume Testing: It is a type of performance testing where our systems come in subjection to large volumes of dataset. Therefore, it is also termed as flood testing. Here we analyse our system in this new condition of huge volume or flooding of data.

h. Endurance Testing: It is also termed as soak testing or longevity testing or capacitytesting and it is done in order to understand sustainability under huge load (comes under load testing).

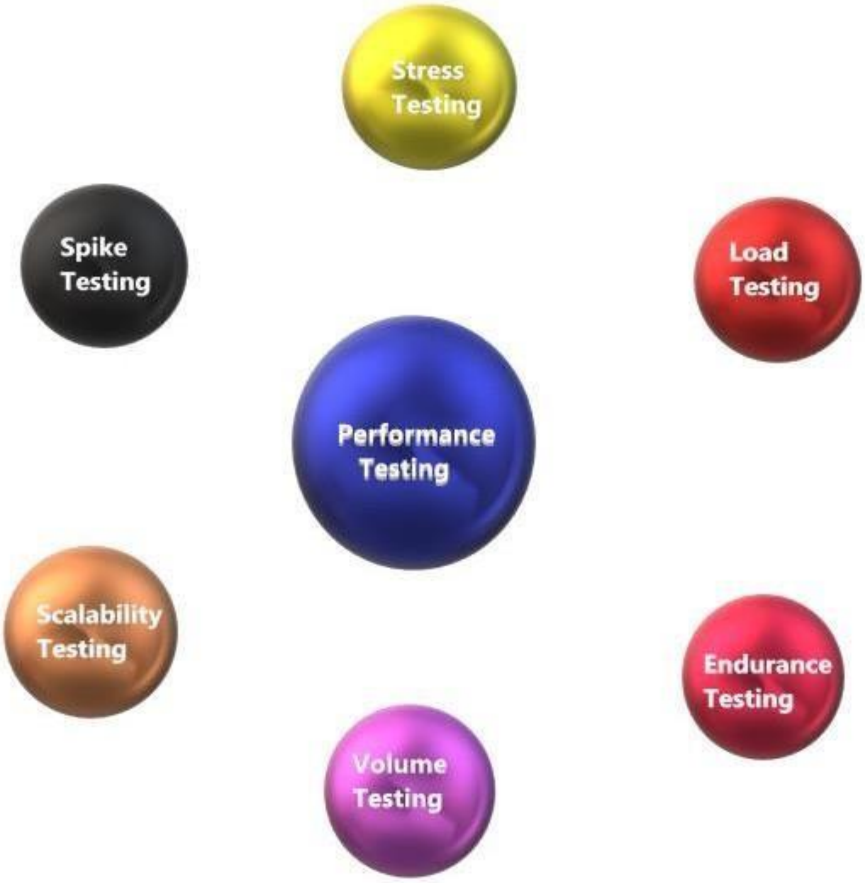


Figure 10: Types of Testing Under Performance Testing

Step to Performance Testing

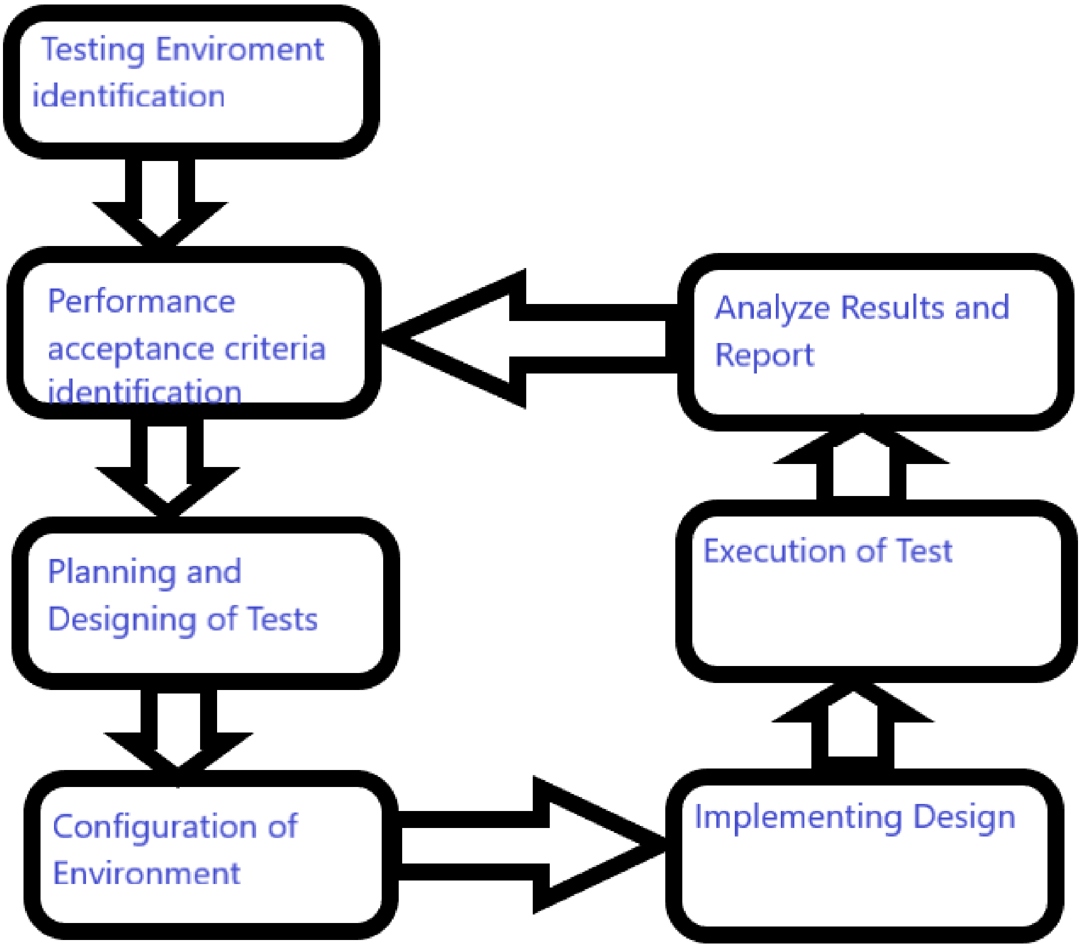

Testing Enviroment identification
Performance acceptance criteria identification
Planning and Designing of Tests
Configuration of Environment
Implementing Design
Execution of Test
Analyze Results and Report

Figure 11: Steps of Performance Analysis

Performance Difference Considering Platform

We have used OpenCV as our platform for the given project. OpenCV is an open-source software for Machine Learning and Computer Vision which offers general structure for fast-track machine perceptions used in commercially available applications.

It has minimum restriction on library usage and it has a product quality score for features as 8.9 out of 10 and ease of use as 9 out of 10.

Chapter-5 CONCLUSION

CONCLUSION

Virtual gesture control mouse is a system that is profound to guide cursor and execute its taskusing a webcam. We implemented mouse navigation, drag and dropping of files etc. This system is based on image capturing and motion detection technology, to do mouse indicator movements using hand gestures. Analysing results, it can be anticipated that the clarity of the image plays a very important role therefore the environment in which the image is obtained should be well illuminated and also there should be no colours in the background to confuse our object identifying the algorithms at any domain.

Making our system more systematized. The clarity of the image plays a very important role therefore the environment in the system might run slower on certain computers with low computational capabilities. If their solution of the captured image is low then computation might take more time and hence the system will run extremely slow.

The main advantage that we gain by using this system is that we do not necessarily have to touch surfaces to interact with the machine. In today's world, this might be a lifesaving action.For example, a similar system can be used at ticket counters in the current COVID 19 scenariosto avoid the spread of the virus.

FUTURE SCOPE

In the future we would merge more features such as interaction in multiple windows, enlargingand shrinking of window, closing window etc. by using palm and multiple finger gestures The major extension to this project will be to make the system able to work at complex backgrounds and making it compatible with different light conditions. To make it an effectiveuser interface which can include all mouse functionalities.

Making it ideal to research advanced mathematical materials for image processing andinvestigate different hardware solutions resulting in more accurate hand detections.

It also demonstrates the potential in simplifying user interactions with computers and hardwaredevices and systems.

Applications

This project can be useful for reducing workspace and burden of extra hardware. Since it removes the burdens of devices, it will bring users and the workspace closer than before. Majorapplications:

- Robot controlling is one of the major applications. Controlling them without machines canbe an excellent addition to this technology.
- Digital artists can draw images using gesture-based mouse on digital canvases. It will allowmore freedom and more dynamic space to artists to create their art.
- Critical events like a battleground, operation theatre can be controlled by gesture mouse.
- Virtual Reality based games can be played without any extended devices with bare handscomfortably.
- For patients with no limb control, this system can be proved very useful
- This mouse controlling gesture can be applicable for sign language for the dumb and deafpeople. It can help them to interact with computing machines in an easy manner.

This technology has wide applications in various fields of augmented reality, computer graphics, prosthetics, and biomedical instrumentation, thus making its contribution impactful.

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