



Computer Vision Based Mouse Control Using Object Detection Approach

Nirvika Rajendra^[1], Aishwarya R^[2], Roopa Shree N K^[3], Vibha C^[4], Bhaskar Rao^[5]

^{[1],[2],[3],[4]} – Final year Students, Department of CSE, DSATM, India

^[5] – Assoc. Professor, Dept. of CSE, DSATM, India

ABSTRACT

Today, there have been an enormous growth in the field of computer vision technology and have been a lot of developments. The project will be an approach for controlling the mouse movement using object detection. HCI is an interface where humans can virtually interact with computers easily. Here we use a similar approach to interact with computer by implementing virtual mouse that performs the cursor movements such as a real mouse can. The software for mouse functions is developed in Python Language, OpenCV and PyAutoGUI. We have used green colored object to perform actions such as cursor movement of mouse. This method mainly focuses on developing a human computer interaction device virtually that uses a Web Camera in a cost effective manner.

Keywords: Human Computer Interaction(HCI), Color Detection , PyAutoGUI, Webcam, Object Detection.

1. INTRODUCTION

The importance of computers is increasing constantly. Computers are being used for many purposes. Hardware devices such as mouse and keyboard are often used to interact with the computers. Technologies are evolving day by day in today's world. One of such example is the Human-Computer Interface (HCI). In a wired mouse , there is no scope to extend limit and should be carried everywhere where as in the wireless mouse, Bluetooth should be installed with Bluetooth dongle in the system.

As touch screen is little expensive for average users, an alternative way for touch screen can be creation of a virtual human computer interactive device. In recent years, a lot of interest has been growing towards providing more natural and human-centered means of interacting with computer. Computer Vision-Based Mouse is a system that does not use any physical device or mouse for controlling the cursor of computer. Our system basically uses image processing and object detection to control the mouse movement. The user will simply hold any green colored object, place it in the viewing area of the webcam , and thus controlling the mouse by object detection .

2. PRIOR AND RELATED WORK

Many of the researchers have tried to interact with computer through video devices and web camera and each of them used different approaches to make a mouse cursor move without any hardware.

* Corresponding author.

E-mail address: nirvikarajendra12@gmail.com

One of the method given by Onkar Yadav^[1] have control of mouse cursor using gesture recognition. In their work, hand gestures are used to control the mouse cursor. The system uses a real time camera to control the mouse pointer and implement its operation. The goal of this project is to form a system which will control the computer/laptop with hand gestures.

In this proposed work, various methods have been used which are referred from papers [5]-[13] and it can be classified as follows,

Skin Detection

Skin Detection is the process which detects the pixels which represents the skin color in an image. It is a fundamental step in gesture recognition, face detection, and hand tracking.

Hand Contour Extraction

Once the skin segmented binary image is obtained, edge detection is performed to get the hand contour present in an image. Border finding, Canny edge detection and Laplacian edge detection are some of the edge detection strategies.

Hand Tracking

Here in this step, the finger tip was used to control the movement of pointer .So to detect the finger tip the palm center should first be found.

Gesture Recognition

The proposed design uses the gesture recognition technique which is a combination of two methods, one method proposed by Yeo and another by Balazs. Using the OpenCV inbuilt function “cvConvexityDefects”, the convexity defect for the hand contour was calculated and after obtaining the convexity defects, finger tip identification and number of fingers are the two main steps for gesture recognition.

Cursor Control

After recognition of the hand gestures, the specific mouse functions are mapped to different hand gestures.

Nirmala Roy^[2] proposed a paper which controls the mouse cursor based on image segmentation and object detection. Here, in this paper, a real-time video using webcam is captured and individual input frame is processed. The object which is to be tracked is selected and object boundary is detected using condensation algorithm. Thus, a virtual mouse application has been developed by object tracking and implemented using a webcam. This has been implemented in Processing IDE using Boof CV library. Here, object boundary is detected by contour tracking which uses condensation algorithm.

Object Tracking

It is a process where the moving objects are located using a web camera over time. There are many applications of object tracking, some of them are traffic control, HCI, security, medical imaging, augmented reality. Target representation and localization, filtering and data association are the two components of visual tracking system.

Condensation Algorithm

Condensation refers to Conditional Density Propagation. It is based on computer vision algorithm. Its application is to track the boundary of moving objects by detecting them. It is the probabilistic algorithm that identifies the pixels in an image that makes the boundary of the object. Rafiqul Zaman Khan^[3] has proposed a paper where various methods for gesture recognition were discussed, they were neural network, fuzzy c- means clustering, HMM, besides using orientation histogram for features representation. HMM tools are best for dynamic gestures and have been showing its efficiency in robot control.

Feature Extraction

It is a process in which interesting parts of the image are obtained by dimensionally reducing and representing the large number of pixels in a image efficiently. Kabid Hassan Shibly^[4]. This system used technologies like motion detection, image comparison to perform selection of icons and mouse indicator movements. Here a camera is used to develop a virtual mouse by gesture control. Mouse operations like selection of icons navigations and task like right, left click, scroll up and down.

Color Detection and Masking

Color detection is a process which identifies the color pixels of the color caps on the fingertips. For masking, rectangular boundary such as boxes are made around the color caps to detect and track them.

3. PROBLEM STATEMENT

Computer Vision-Based Mouse is a system which uses no physical device for controlling of mouse cursor of the computer. Here we will essentially have a green colored object in our hand. The video of the motion of green colored object has been captured by the web-camera which acts as a sensor. The green colored object is tracked and using its motion, the cursor of the mouse is controlled.

In order for the object to work, we will use green color within the viewing area of the camera. The green color object should be placed in the Region of Interest(ROI).

The video generated by the camera is detected and analyzed using image processing and the computer cursor moves or displays its click events according to green color object movements.

4. TECHNIQUES USED

The proposed system is a computer vision based application which is an example of real time application system. It makes use of OpenCV for image processing and image acquisition and PyAutoGUI for handling mouse control in order to replace the actual mouse with the green colored object.

A. Image Acquisition

Here an image sensor or web-cam can be used for detecting and capturing the information that is required to make an image. The digital representation of the visual characteristics of the physical world is acquired by the image or the frame which was detected by the web-cam.

B. Image Processing

Image acquired are processed in this step. To remove the noise or any irrelevant frequencies, the signals in the acquired images are filtered. If necessary, images will be padded and transformed into a different space, to make them ready for the actual analysis.

C. Image Analysis

In this step the processed image is analyzed to extract useful information. It involves many important image properties like color recognition, pattern identification, feature extraction, object recognition, image segmentation and motion tracking.

D. Morphologic Processing

Here, some set of simple basic operations are performed on the image shape. The operations are performed on binary images and it takes two inputs, one is the original image, and another is the kernel or structuring element which decides the operations to be performed. Erosion and Dilation are the two basic operators in the morphology process.

E. Image Segmentation

It is a process that partitions the digital image into group of pixels for multiple segments to represent the image in a simpler way so that it can be used to analyze in an easier way.

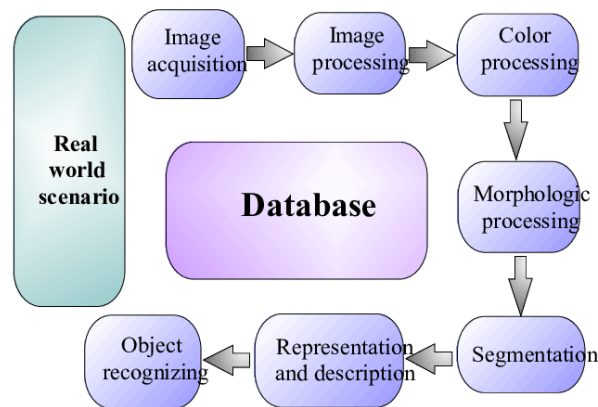


Fig.1.Block Diagram.

5. METHODOLOGY

A. Capture Video

In the proposed architecture, the input is the green colored object which is given to the web-camera. The camera reads the frame of the video. Here, the web-camera which is used as a sensor will help to detect and track the object. Video is a collection of multiple visual images and is divided into Frame Rate which ranges from 6 or 8 per second for the old mechanical camera and 120 or more frames per second for professional camera.

B. Read Frame from the video

Once the video is captured by the webcam, with the help of `cam.read()` function frames can be read from video, where the `cam` is the output where the video is captured. The image that we get is inverted after the frames are obtained by the OpenCV function. That means if we move the tracked object in the right direction, the image of the pointer will move towards the left, so we need to flip the image frame.

C. Conversion to HSV Color space

HSV is a model which represents a color that remaps the `rgb` color into dimensions that makes humans easier to understand. The `opencv` inbuilt function `cv2.cvtColor(img,cv2.COLOR_BGR2HSV)` is used for conversion of BGR to HSV color space.

D. Creating Mask

Masking may be also known as filtering, where we recalculate each pixel in an image based on given mask matrix.

E. Morphologic Operations

Morphological opening and closing operations are performed on the image. Opening is used for noise removal and is also known as erosion followed by dilation. Closing is used in foreground objects for closing the holes present.

F. Contour Extraction

It is simply a process where all the continuous points along the boundary which have same color or intensity are joined as a curve. It is helpful in detection of contours, also helps to analyse the shapes.

G. Cursor Control

Here it is used to control the cursor movement by tracking the object without the use of physical mouse. The movement of the object that is the direction of motion of object determines the movement of the cursor.

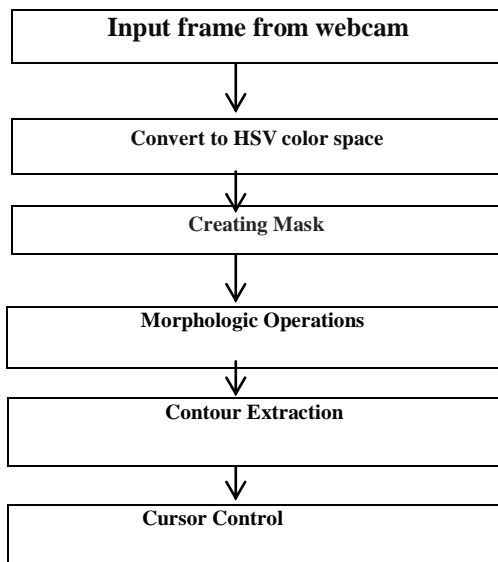


Fig.2. Flowchart

6. MODULES

Module 1: Image Acquisition

In image acquisition, frames from webcam are captured using Python OpenCV module. Image or the frame that is detected by the web-cam is acquired as the digital representation of the visual characteristics of the physical world. An image sensor or the web-cam is used to detect and capture the information required to make an image. Conversion of BGR to HSV colorspace is done using built in `open cv` functions.

Module 2: Image Processing

In image processing, images acquired are then processed in this step.

The signals in the acquired images are filtered to remove the noise or any irreverent frequencies. Masking Image is a process to hide some portions of an image and to reveal some portions. Then, a collection of non-linear operations related to the shape or morphology of features in an image are performed which is known as Morphological Operation in Image Processing.

Module 3: Object Tracking

After cleaning all the noise now we know exactly where the object is so we can draw a contours from this mask. By using `cv2.findContours()` function we can find the contours which is helpful for shape analysis. After finding contours we can get the boundary point, width and height to draw rectangle over the detected object using the function `cv2.boundingRect()`. Then using these input we draw the rectangle using `cv2.Rectangle()`.

If there is 1 object we will find the center of object and draw the circle using `cv2.circle()`, if there are multiple objects detected we will find center of those objects and find average of them to get a single point.

Module 4: Cursor Movement

Now we need to position our mouse cursor according to the calculated coordinate. First we are doing a mouse release to ensure the mouse left button is not pressed. Then we are converting the detected coordinate from camera resolution to the actual screen resolution. After that we set the location as the mouse position.

7. RESULT AND EVALUATION

In this paper, HCI and Computer Vision technologies contribute to vision based interaction between human and machine. Here we have used green color object to control the mouse movements.

The results obtained by performing masking operations and object detection.

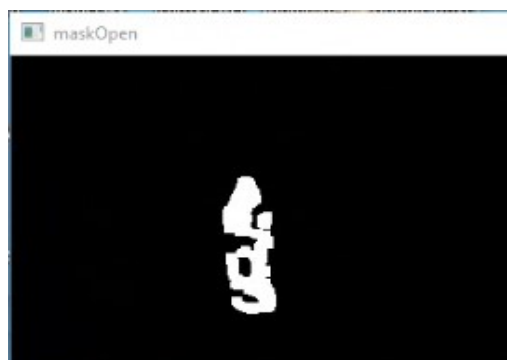


Fig.3. Mask Open



Fig.4. Mask Close



Fig.5 SINGLE OBJECT DETECTION



Fig.6. MULTIPLE OBJECT DETECTION

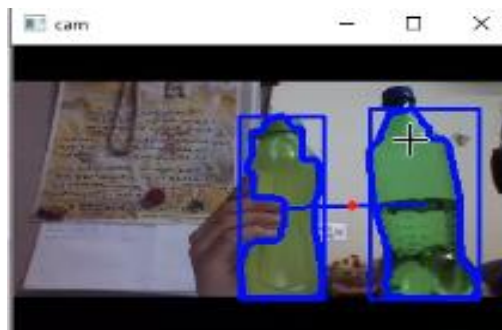


Fig.7.CENTROID CALCULATION OF OBJECTS

The tests are done with a plain background. 70-90 percent accuracy is present with fast working. Complex background are also used for testing such as colorful home background, complex background with variable light environment, colorful clothes etc. But with complex background the system does not perform much in an efficient manner. By using High Definition Camera we can improve the accuracy.

8. APPLICATION

To reduce workspace and lots of hardware devices, this project can be useful. It brings the workspace and user more closer by removing the burdens of devices.

Major applications are

Robot Control:

It is possible to control robot by object movement. We can assign different objects to robot to perform particular task such as one object specifies move forward , two objects means stop and so on.

Sign Language Recognition:

This mouse system can be used for sign language recognition which is useful for dumb and deaf people and also for humans with physical disabilities such as no limb control, this system is useful and effective for them.

Further Works

We can improve the performance of software in the future. It could be, to reduce the software response time for cursor movement, therefore it can be used to replace the conventional mouse completely. The hardware implementation of the project could be improved in accuracy and extend its functionality in domain such as sign language recognition, robot control etc. The proposed work can also be extended by adding various other mouse functions such as zoom in, zoom out, scroll up, scroll down etc.

Table.1.Comparison Table

Comparison				
TITLE	OBJECTIVE	TECHNOLOGIES USED	ADVANTAGES	DISADVANTAGES
[1]Cursor Movement By Hand Gesture	Proposes a Virtual mouse application based on hand tracking which is implemented by web cam. Mouse events left clicking right clicking and scrolling are managed by gesture recognitions.	Skin Detection, Hand contour Extraction, Hand tracking, Gesture recognition.	Usage of pointing devices such as mouse will be tougher in the case of mobile systems, so this project benefits the mobile systems without usage of physical mouse.	Gestures needs to be properly learnt and remembered by the user for accuracy.
[2]Controlling Mouse Cursor Based on Image processing and Object Detection	Controlling the mouse and its operations by detecting the object.	Contour Tracking, Condensation algorithm	Calculation of the center of object adds for precision. It is useful in drone technology and medical imaging.	Detection of similar objects in the background.
[3]Hand gesture recognition :A Literature review	Management of mouse movements and its tasks by gesture recognition	Extraction method, Feature extraction, gesture classification	It helps in 3d modeling, numbers recognition, robot control.	Application of neural network classifier for gesture classification is time consuming and increment in the number of training data also increases the time for classification.
[4]Design and development of hand gesture based virtual mouse	Development of virtual mouse system that is based on HCI which uses hand gestures and computer vision, cursor movements and functions are controlled by the hands with colored caps present on finger tips.	Gesture recognition, Color detection, Computer vision technology and Human Computer Interaction.	Workspace is reduced and usage of extra devices such as mouse. This system helps for people with no limb control. Sign language for deaf and dumb people.	Interaction with multiple window is not possible, shrinking and enlarging window is also not possible.

9. CONCLUSION

This project eliminated the need for a mouse or any physical device cursor control. The use of object detection, PyAutoGUI for the implementation of our proposed work proved to be successful and the movement of the mouse is achieved with the high precision accuracy. This also led to better Humans - Computer Interaction(HCI). It also has wide applications in the Augmented Reality ,modern Gaming and Computer Graphics. In the 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. The main aim is to eliminate the use of any physical device that is mouse and make use of only web cam for controlling computer which is readily available with the laptop. Though this project has many advantages, it has some drawbacks also. It can give an erroneous response and may not work properly if the background image is clashed with the specified image. So it is advisable to use this technology where the background light and the object color does not mix .System may run slower on certain computers of low resolution and computational capabilities. The system might run slow if the camera is high on resolution, but this problem can be solved by reducing the resolution of the image.

REFERENCES

-
- [1] Achmad Onkar Yadav, Sagar Makwana, Pandhari Yadav, Prof. Leena Raut, Cursor Movement By Hand Gesture, International Journal of Engineering Sciences and Research Technology, Doi:10.5281/zenodo.400838.
- [2] Nirmalya Roy, Controlling Mouse Cursor Based on Image Processing and Object Detection, Department of School of Electronics Engineering KIIT University, Bhubaneswar, Odisha, India, 2017
- [3] Rafiqul Z. Khan, Noor A. Ibraheem, (2012). "Survey on Gesture Recognition for Hand Image Postures", International Journal of Computer And Information Science, Vol. 5(3), Doi: 10.5539/cis.v5n3p110
- [4] Kabid Hassan Shibly, Samrat Kumar Dey, Design and Development of Hand Gesture Based Virtual Mouse, 1st International Conference on Advances in Science, Engineering and Robotics Technology 2019 (ICASERT 2019)
- [5] A. Yadav, A. Pandey, A. Singh, A. Kumar, "Computer Mouse Implementation Using Object Detection and Image Processing", International Journal of Computer Applications. (IJCA), Volume 69-Number 21, 2013.
- [6] D. Verma, et al., "Vision Based Computer Mouse Controlling Using Hand Gestures", International Journal of Engineering Sciences & Research Technology.(IJESRT), 7(6): June, 2018.
- [7] Hojoon Park, "A Method for Controlling the Mouse Movement using a Real Time Camera", Brown University, Providence, RI, USA, Department of computer science, 2013.
- [8] Chu-Feng Lien, "Portable Vision-Based HCI – A Realtime Hand Mouse System on Handheld Devices", National Taiwan University, Computer Science and Information Engineering Department.
- [9] Kamran Niyazi, Vikram Kumar, Swapnil Mahe, Swapnil Vyawahare, "Mouse Simulation Using Two Coloured Tapes", Department of Computer Science, University of Pune, India, International Journal of Information Sciences and Techniques (IJIST) Vol.2, No.2, March 2012.
- [10] Y. Zhou, G. Jiang & Y. Lin, "A novel finger and hand pose estimation technique for real-time hand gesture recognition," in Pattern Recognition vol. 49, pp. 102-114, January 2016.
- [11] P. Kumari, S. Singh & V. Kr. Pasi, "Cursor Control using Hand Gestures," Recent Trends in Future Prospective in Engineering & Management Technology 2016, International Journal of Computer Applications (0975 – 8887), 2016.
- [12] S. S. Abhilash, L. Thomas, N. Wilson & C. Chaithanya, "VIRTUAL MOUSE USING HAND GESTURE," International Research Journal of Engineering and Technology (IRJET), vol. 05 issue: 4, April 2018.
- [13] A. Haria, A. Subramanian, N. Asokkumar, S. Poddar & J. S. Nayak, "Hand Gesture Recognition for Human Computer Interaction," 7th International Conference on Advances in Computing & Communications, ICACC-2017, Cochin, India, Procedia Computer Science 115 (2017), pp.367–374, 22-24 August 2017.