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Virtual Mouse And Keyboard For Computer Interaction

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ABSTRACT
Mouse and keyboard are the wonderful inventions of Human-Computer Interaction (HCI) technology. Currently, wireless mouse or a Bluetooth mouse still uses devices and is not free of devices completely since it uses a battery for power and a dongle to connect it to the PC. In the proposed virtual mouse and keyboard system, this limitation can be overcome by employing webcam or a built-in camera for capturing of hand gestures and coloured object. Method used for Hand gesture recognition is based on Convolutional Neural Networks (CNNs).The computer can be controlled virtually and can perform left click, right click, scrolling functions,volumecontrol,brightness control and other computer cursor function without the use of a physical mouse.A virtual keyboard is controlled by tracking a coloured object and it is based on image processing technique. The proposed system will mostly can use on the conference to present topics using projector and avoid COVID-19 spread by eliminating the human intervention and dependency of devices to control the computer.Main goal is to make the interaction between human and computer as natural as the interactionbetween humans.

Keywords-Virtual Mouse, Hand Gesture Recognition, Virtual Keyboard, Object Tracking, CNNs, Image Processing.

1. INTRODUCTION

In previously used wired technology, a user was unable to freely move as they are connected with the computer system with the wire and movement is limited to the length of wire. With the development technologies in the areas of augmented reality and devices that use in daily life, these devices are becoming compact in the form of Bluetooth or wirelesstechnologies[1].Always hear about new technology that improves lifestyle and makes lives easier these days. With the massive influx and advancement of technologies, a computer system has become a very powerful machinewhich has been designed to make the human beings' tasks easier. Due to which the HCI (Human Computer Interaction)has become an important part of our lives.While using a wireless or a Bluetooth mouse, some devices such as the mouse, the dongle to connect to the PC, and also, a battery to power the mouse to operate are used, but in this , the user uses his/her built-in camera or a webcam and uses his/her hand gestures to control the computer mouse operations. Humankind has been transformed by technological advancements. The invention of mouse and keyboards by the researchers and engineers has been a great progress, thereare still some situations where interaction with computer with the help of keyboard and mouse will not be enough.Mankind has made a great contribution.The main objective of the proposed system is to perform computer mouse cursor and keyboard functions using a web cam or a built-in camera in the computer instead of using a traditional mouse and keyboard.

This proposes a virtual mouse and keyboard system that makes use of the hand gestures detection for performing mouse functions and a coloured object is tracked to perform keyboard functions. In the proposed system, the web camera captures and then processes the frames that

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have been captured and then recognizes the various hand gestures and hand tip gestures and then performs the particular mouse function.This system typically performs all operations that could be performed by a traditional mouse pointer. Operations like left-click, right-click, double click ,multiple selection ,scrolling ,drag and drop. The main aim is to create a cost-free hand recognition software for laptops and PCs with external webcams.

The virtual keyboard system is based oncoloured objects that will be used for tracking should be identified. A range system has been initialized to set the HSV min, max values, and stored for use while tracking and performing operations. This is a significant part of the systemas it may fail to detect objects and perform tracking if the range is not set correctly. An image of a keyboard will be projected on the screen. Camera on the laptop will be turned on to capture live video images of the user's object movement . When the user points to or selects a particular letter on the keyboard, the computer will lock the colour of the user's fingers within the particular area allocated for the key which is being pressed, and the particular letter will be displayed on the output screen.

2. RELATED WORKS

The Object tracking method has been used to track the colored objects that help to operate on this system using the laptop webcam. By using the Object tracking system, the mouse and its basic operations like mouse pointing, selection, and deselection using left-clickcanbe controlled. In a computer system, colors are represented in different formats like HSV (Hue Saturation Value) and BGR (Blue, Green, Red). With the BGR format, a pixel is represented by blue, green, and red parameters with blue being most significant and red being less significant. Each parameter of BGR usually having 0 – 255 values where 0 for all parameters represents black and 255 represents white, and the combinations of values for BGR from 0 to 255 creates various colors.Table 1 shows the accuracy result of existing system.

Table 1: Accuracy Result of Existing System.

Inputs	Mouse events	Accuracy with a plain Background (in %)	Accuracy with a non-Plain background (in %)
Two-colour object (open Gesture)	Mouse Movement	95	40
Closer two colour object (Closed Gesture)	Left Button Click	89	41
Keep close for 5 seconds (Closed Gesture)	Double Click	87	42
Single color cap (open Gesture)	Right Button Click	96	80
Swipe up Down	Scrolling up or down	75	40

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3.PROPOSED METHODOLOGY

3.1 Virtual Mouse

The proposed virtual mouse system implemented using convolutional neural network (CNN) to predict hand gestures made by the users.This contain three modules.

Image Capturing:

Hand Gesture Recognition with Python is a system that can detect the gesture of hand in a real time video.Python OpenCV library can be used to capture gestures from computer's internal camera or web cam. Hand tracking and segmentation are the primary steps for any hand gesture recognition system. With the help of hand gesture tried to control the mouse actions.

Data set training:

CNN is a very popular approach in deep learning in which multiple layers are robustly trained. CNN can be applied to construct a computational form that operates on unorganized image inputs and transforms them into the correct output categories for classification. fig.1 shows the architecture of the proposed hand gesture recognition model using CNN.

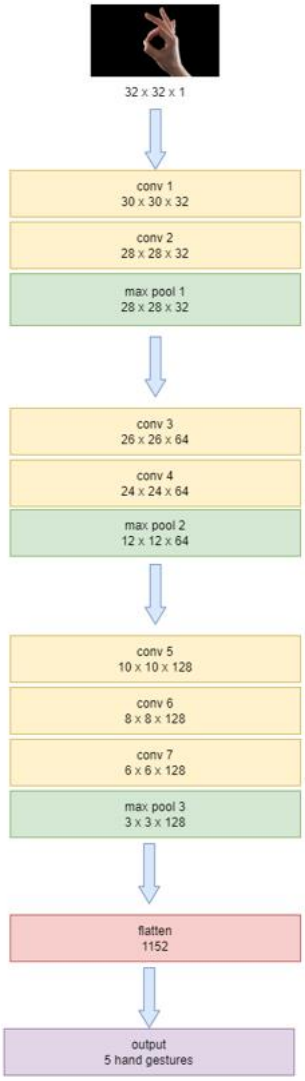

Fig 1: Architecture of the proposed hand gesture recognition model using CNN

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The model provides a method to add new gestures and train them accordingly.The data set consists of 5 gesture classes.Each class contain 1500 images.Each gesture controlling different mouse functions. The CNN that that has been considered in this research to recognize hand gesture is composed of seven convolution layers, three max pooling layers, two fully connected layers and output layer. There one dropout performance in the network to prevent over-fitting . The first convolution layer has 60 different filters with the kernel size 3x3. The activation function used in this layer is Rectified Linear Unit (ReLU). ReLU was applied to introduce non-linearity and it has been proved that ReLU performs better than other activation functions such as tanh or sigmoid. As it is input layer, have to specify the input size. The stride is set to default. The input shape is 32x32x1.This passes to first convolution layer and size become 30x30. Then passes again second convolution layer and size from 30x30 to 28x28 .This layer produces the feature maps and passes them to the next layer. Then the CNN has a max pooling layer with pool size 2x2 which takes the maximum value from a window of size 2x2. The spatial size of the representation is reduced progressively as the pooling layer takes only the maximum value and discards the rest. This layer helps the network to understand the images better because it only selects more important features. The next layer is another convolution layer and it has different filters with the kernel size 3x3 and default stride. Again, ReLU was used as the activation function in this layer. This layer is followed by another max pooling layer which has a pooling size 2x2.Also the next layer is convolution layer and in seventh convolution layer size become 6x6.Then followed by another max pool layer. In this layer, first dropout was added which randomly discards 25 percentage of the total neurons to prevent the model from over-fitting. Output from this layer is passed to the flatten layer.

Output from the previous layers are received by the flattening layer and they are flattened to a vector from two-dimensional matrix. This layer allows the fully connected layers to process the data achieved till now. The next layer is first fully connected layer which has 256 nodes and ReLU was used as the activation function. The layer is followed by a dropout layer which excludes 25 percentage of the neurons to prevent overfitting. The second fully connected layer again has 200 nodes to receive the vector produced by fully connected layer and uses ReLU as activation layer. The layer is followed by a dropout layer to exclude 25 percentage of the neurons to prevent overfitting. The output layer has 5 nodes corresponding to each classes of the hand gestures. This layer uses SoftMax function as activation function which outputs a probabilistic value for each of the classes.

Mouse Functions

Operations are performed by capturing the movements in a frame.
Mouse Cursor Movement : Keep the index finger and middle finger together and move.
Left Click : Keep the index finger up and down.
Right Click : Keep the middle finger up and down.
Double Click : Keep the index finger and middle finger closer or Close using mouse movement .
Scrolling :Keep all fingers closed and move up and down
Drag and Drop:Keep all fingers open and close then move .
Volume Control :Use ok hand gesture to move left and right.
Brightness Control : Use ok hand gesture to move up and down.
Stop mouse action : Using palm of the hand.

3.2 Virtual Keyboard

In the proposed system, the Object tracking method has been used to track the colored objects that help to operate on this system using the laptop webcam. By using the Object tracking system, the keyboard and its basic operations space,enter, backspace etc. canbe controlled. In a

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computer system, colors are represented in different formats like HSV (Hue Saturation Value) and BGR (Blue, Green, Red). With the BGR format, a pixel is represented by blue, green, and red parameters with blue being most significant and red being less significant. And each parameter of BGR usually having 0 – 255 values where 0 for all parameters represents black and 255 represents white, and the combinations of values for BGR from 0 to 255 creates various colors.

For example, a red pixel on your computer would have an R-value of 255, a B value of 0, and a G-value of 0. Your computer would interpret this as, "The pixel is 0 parts blue, 0parts green, and 255 parts red." HSV also represents pixels by 3 parameters but uses Hue, Saturation, and Value as parameters. HSV makes use of hue, which is the shade or color. The saturation is the intensity of the color. A value of255 is the max intensity for saturation and 0 for saturation represents white. Saturation can also be known as how colorful a pixel is. How bright or dark a color is, is represented by its value. Since the HSV is used, it has been necessary to convert BGR to HSV which is done by OpenCV using the cv2.cvtColor( ) function and passing image and the flag as parameters that determines the image type of conversion to be done. Here using green colour object to track keyboard.

The proposed system uses Computer Vision libraries and algorithms to determine the object, its movements, andact as the movement using Real-time tracking. But primary focus is on pointing the keyboard and different actions by hand tracking and output is written in to text file.Virtual keyboard contain 5 modules and fig2 shows the flow chart of keyboard.

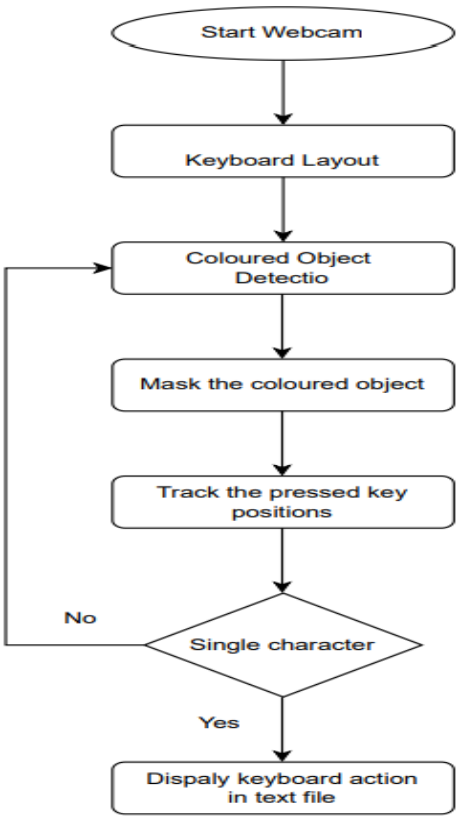

Fig:2 shows the flow chart of keyboard.

Camera Settings

In order to perform runtime operations, the device's web-camera is used. To capture a video, need to create a VideoCapture object. Its argument can be either the device index or the

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name of a video file. The device index is just the number to specify which camera. Normally one camera will be connected, so simply pass 0. You can select the second camera by passing 1 and so on. After that, you can capture frame-by-frame.

Capturing Frames

The infinite loop is used so that the web camera captures the frames in every instance and is open during the entire course of the program. After capturing the live stream frame by frame are converting each frame in BGR colour space(the default one) to HSV colour space. There are more than 150 colour-space conversion methods available in OpenCV. But will look into only two which are most widely used ones, BGR to Gray and BGR to HSV. In specifying the range, have specified the range of green colour. Whereas you can enter the range of any colour you wish.

Masking Technique

The mask is basically creating some specific region of the image following certain rules. Here are creating a mask that comprises of an object in green colour. After that, I have used a bitwise and on the input image and the threshold image so that only the green coloured objects are highlighted . Then display the frame, res, and mask on 3 separate windows using imshow function.

Keyboard Data

An image of a keyboard will be projected on the screen and Fig.3 shows the virtual keyboard layout. Next the, user is asked to wear the coloured gloves or stickers on his hands, and the camera on the laptop will be turned on to capture live video images of the user's finger movements. When the user points to or selects a particular letter on the keyboard, the computer will lock the colour of the user's fingers within the particular area allocated for the key which is being pressed, and the particular letter will be displayed on the output screen. Colour conversion from RGB to HSV colour codes, are used for this purpose.

Display The Frame

As imshow() is a function of pyautogui. it is required to call waitKey regularly, in order to process its event loop. The function waitKey() waits for key event for a "delay" (here, 5 milliseconds). If you don't call waitKey, HighGui cannot process windows events .like redraw, resizing, input event, etc. So just call it, even with a 1ms delay.

3. RESULTS AND DISCUSSION

Replacement of the mouse with hand ,so that they can use mouse function for what they desire from anywhere concerning be in the frame of web camera. The use of this project in real-time is vast. The system performance is very wellin good lighting conditions and also this overcome the problem with the background that is gesture can recognize with any background. Nevertheless the system is little bit fast responsive as compared to the other systemwhich have been developed earlier as it does not require any training phase for gesture recognition and the training accuracy of the system is 96.37 wich shows in fig 3. and fig 4 shows the accuracy of mouse over epochs.

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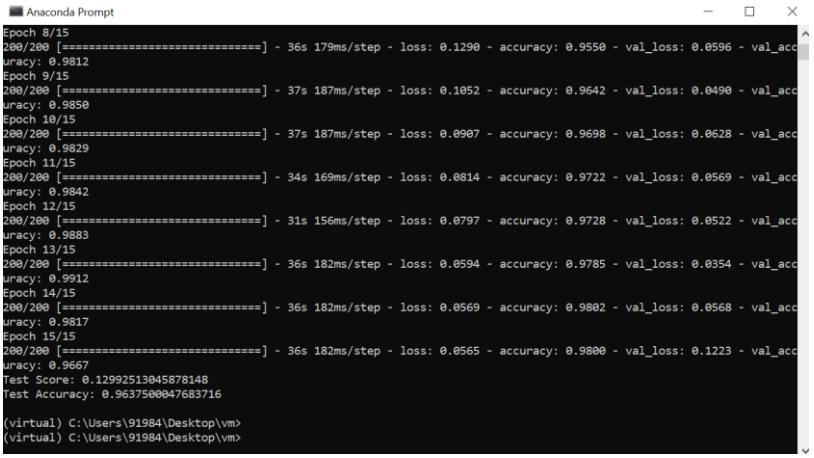


Fig:Training Result

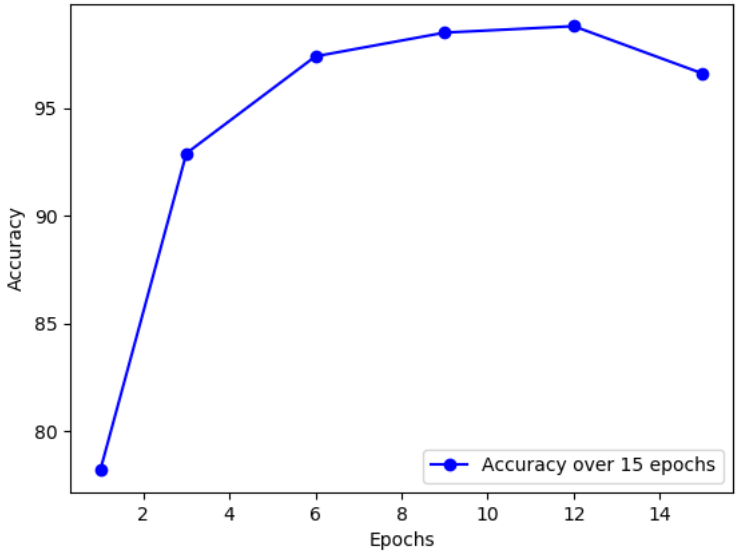
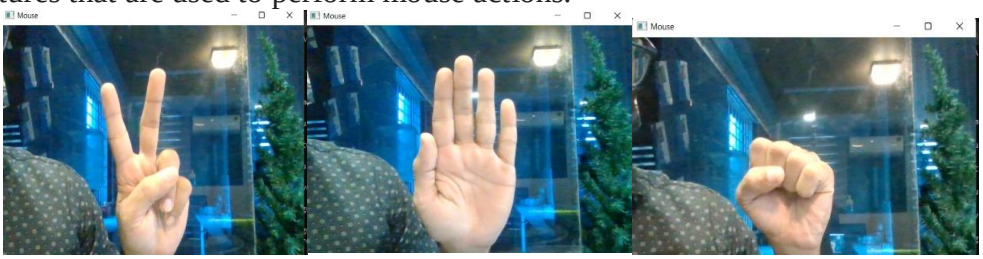


Fig 4:Accuracy Over Epochs

Different mouse functions are performed using five hand gestures.Fig5 shows the hand gestures that are used to perform mouse actions.



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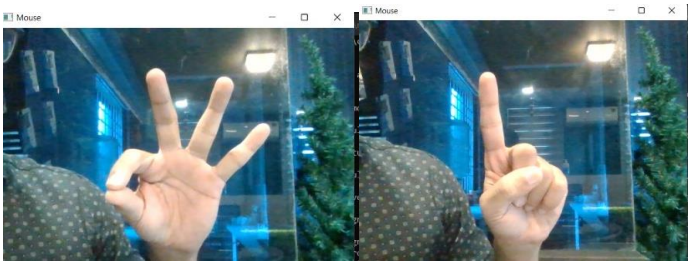

Fig 5: Different Hand Gestures Used For Virtual Mouse

The overall recognition rate of the proposed virtual keyboard is 94.62 percentage.The results indicate that the recognition rate is related to both the accuracy of each typing position and the type of light source.Fig 6 shows the output of the keyboard.

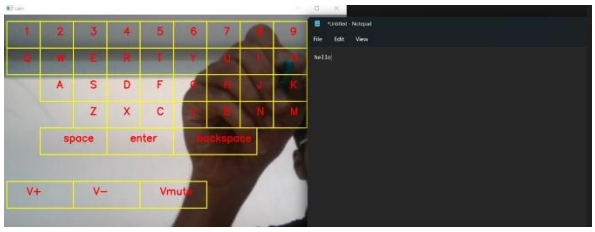

Fig:Output of Keyboard Shows in Notepad.

CONCLUSION

The main objective of the virtual mouse system is to control the mouse cursor functions by using the hand gestures instead of using a physical mouse and the virtual keyboard is controlled by tracking coloured object. The proposed system can be achieved by using a webcam or a built-in camera which detects the hand gestures processes frames to perform the particular mouse functions and detect coloured object and perform keyboard function accordingly ,then display to text file. From the results of the model, can come to a conclusion at the proposed virtual mouse and keyboard system has performed very well and has a greater accuracy compared to the existing models and also the model overcomes most of the limitations of existing systems.

Since the proposed model has greater accuracy, the virtual mouse and keyboard can be used for real-world applications, and also, it can be used to reduce the spread of COVID-19, since the proposed mouse system can be used virtually using hand gestures and object without using the traditional device.Virtual mouse can perform right click,leftclick,doubleclick,scrolling and drag and drop.Virtual keyboard can configure according to needs.So it has vast applications such as virtual can use for conference or presentations and keyboard can use gaming.Also can use for handicapped persons if they can only move hands,so they can communicate through this proposed system. For the future work, swipe keypads which detect the gestures in air view can also be implemented. This would improve the results when the typing speed is quick. Also, this technique can be further improvised to be use on a smart TV.

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