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Interactive Projector Screen with Hand Detection Using Gestures

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***Abstract*—There are very few interfacing technologies to manipulate real-time behavior for operating computer systems. During a presentation, it is inconvenient to control the computer and simultaneously explain the topic. There are several alternatives like speech recognition, laser based gloves but these techniques are less portable and have less accuracy. Our system, interactive wall display, allows you to use hand gestures to control OS on the projected screen. We have developed an effective human-computer interface for a virtual mouse system in a projector-camera configuration without any hardware requirement. To experience our project only one camera source is required to detect the user's hand.**

***Keywords*—Hand Detection,Region Detection,Hand Gesture, & Fingertip detection**

I. Introduction

There has been a considerable growth in development of technologies for human machine interface over the years. The interaction with the computer is done with the standard devices such as keyboard and mouse. For manipulating the OS, certain instruction were used over the different software such as to interact virtually with the system. Basically our project is making an interactive wall for presentation purpose. Wall size can be varied according to different projector. In our project we have developed an effective interface system without any use of external hardware for virtual mouse interaction with projected screen. Our proposed work interacts with the system (i.e computer and projector) making it work like a touch screen wall. Certain gesture are used to interact with system which are predefined via our program. Gesture detection makes it easier for the user to control the OS .[7]

II. Technologies Used

A. OpenCV

Open Source computer vision library (open CV) is a real time computer vision systems library. Open-source BSD license are provided to use open CV for free. These library are basically independent of the working platforms like Windows, Linux and Mac OS. Open CV library is created by Intel. Real time image processing are done with the help of open CV library to extract the relevant information of the input images. Basic C language are used to develop the open CV library and provides primary interfacing with C language. C++ is the new primary language for Open CV where all new development and algorithms are done. Open CV is compatible with various other languages such as Python , Java , MATLAB and Octave. Matrix operations are with its help. Complex real time image processing and computer vision applications are done in an efficient way by using its data structures and algorithm.

B. C++

C++ is middle level general purpose and multi paradigm language. C++ inherits most of the basic C language's syntax as well as memory management techniques. C++ implements many object Oriented Programming (OOP) features to C language like classes. C++ language is used with openCV library over different software like visual studio to implement real time image processing. Data structures like Matrix(short form Mat) which is multi-channel and multi-dimensional array and used for storing images, intermediate image transformations values in the array form.

III. Proposed System

A. Methodology

The system mainly focuses on two parts, Input and Interface / Output.

1) Input: Input comprises of the images fed by web camera from the projector screen at the defined rate. Images which are fed to the OS are of fixed size which is predefined as well. Hand (i.e glove) detected by program is traced according to its movements showing their X-Y co-ordinates. Fingertips are also detected to perform the gesture. Gesture are predefined ,if the gesture matches, it interprets the gesture and sends the respective commands to the system.

2) Interface / Output: Processing of input data has to be fast for real time operation. All the sub-modules works in integration and depends on each other to implement this system's application. After implementing each sub-modules , the collected data is given to interface unit which basically the main program with some particular and fixed instruction to avail the feature of virtual mouse.

IV. System Architecture

A. Valid Region Detection

Firstly, for the system to be real time , it is initialized to recognize a certain portion of the camera feed only. It is important for the application to detect only in the working area and discard all other data in its surrounding. The working

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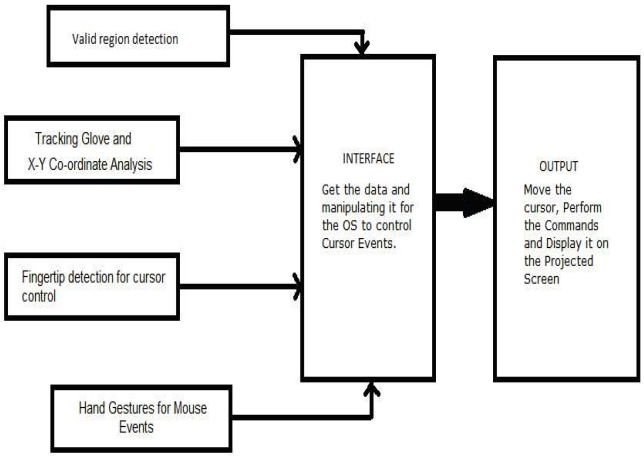

Fig. 1. Block Diagram [7]

Fig. 2. Projector Screen

area includes the projected panel on a white screen on which our virtual mouse is required to work. Generally the projector screen is rectangular , by using the contour finding function (i.e cv Find Contour) from open CV , the four corner of the projected rectangular area can be detected. The actual position of the projected area on the screen can be captured by the web camera. This is covered in the valid region detection module. Refer figure 2

B. Tracking Glove

Tracking glove module comprises detection of the user's hand (i.e gloves) and tracing its location. The user has to point the back of his palm in front the camera with erecting the index and middle finger only for detection the centroid and fingertips. Tracking of hand takes place with the help of contour finding function. A threshold is set to remove the noise (i.e background substraction). The object with largest area to be detected, so we safe a reference area . A draw object

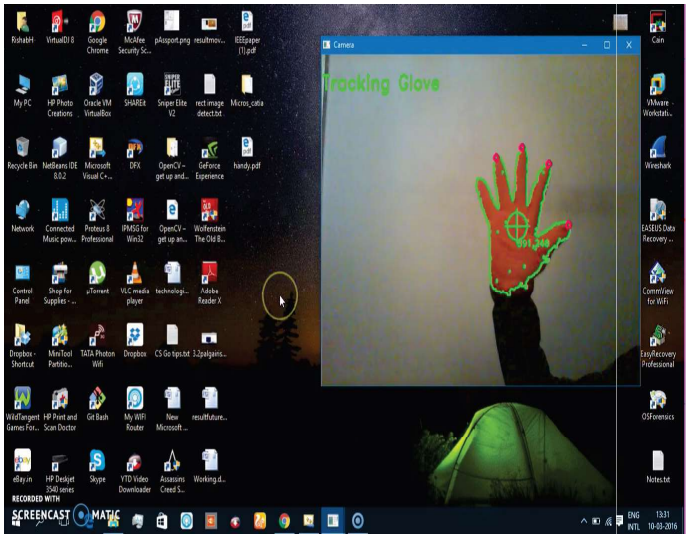

Fig. 3. Tracking Glove

function is used to indicate the location which appears at the centroid of the palm. It also shows the X-Y co-ordinates of the tracking glove. In this way, system tracks the hand which is to be used for moving the cursor of virtual mouse.
Refer figure 3.

C. Fingertip Detection

Various contour appears across the glove representing the boundary of the glove. These contours outline hand for marking the tracked portion. It also detects finger tips on hand. These finger tips are recognized by detecting defects in the large contour. Users can use their fingertip as a mouse on the virtual panel to simulate a cursor for the remote display. Finger tip detector detects position and orientation of finger tip. These finger tips are detected automatically when they appear on the screen.

D. Hand Gestures for Mouse Events

Our system implements mouse events by using certain gesture which are recognised by the gesture detection module, the position and orientation of the fingertips are recognised by the fingertip detector. User clicks with his index or middle finger to implement a right or left click. Mouse events occur using windows API's in our system. This module takes care of manipulating users movements and clicks into respective mouse events. Clicking event are simulated by a V shape gesture and a certain orientation and angle between the fingertips. Angle between two points of the fingertips with respect to centroid point on the hand is given by the equation

$$\theta = atan(\frac{P_1y - P_2y}{P_2x - P_1x}) \times \frac{180}{3.14} \quad (1)$$

where,
P_1 and P_2 are points of index and middle finger.
(x,y) are the co-ordinates of centroid

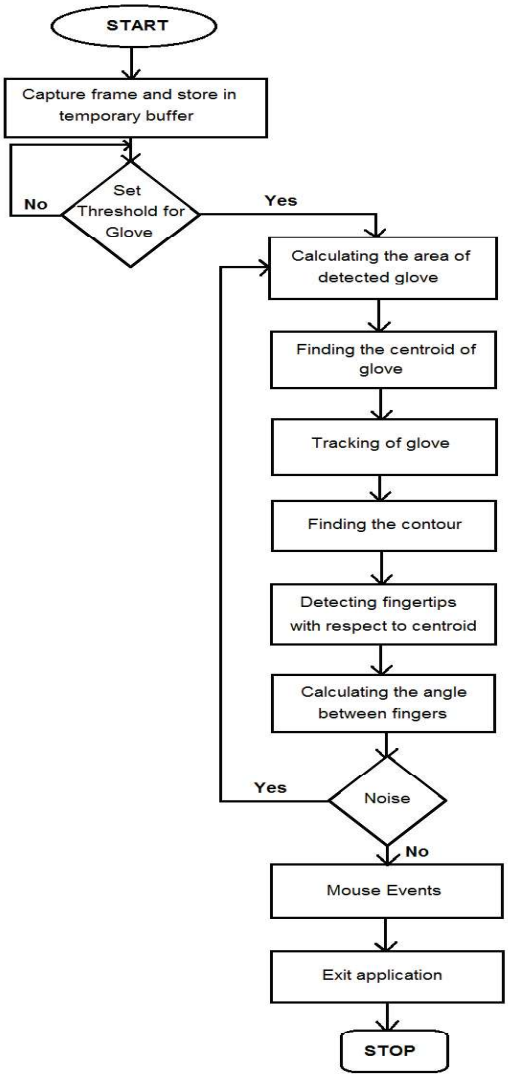

Fig. 4. Flowchart

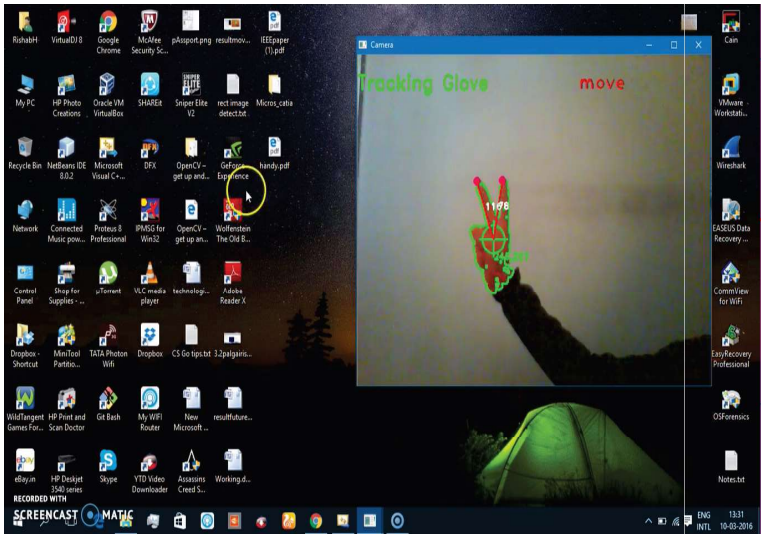

Fig. 5. Cursor Movement

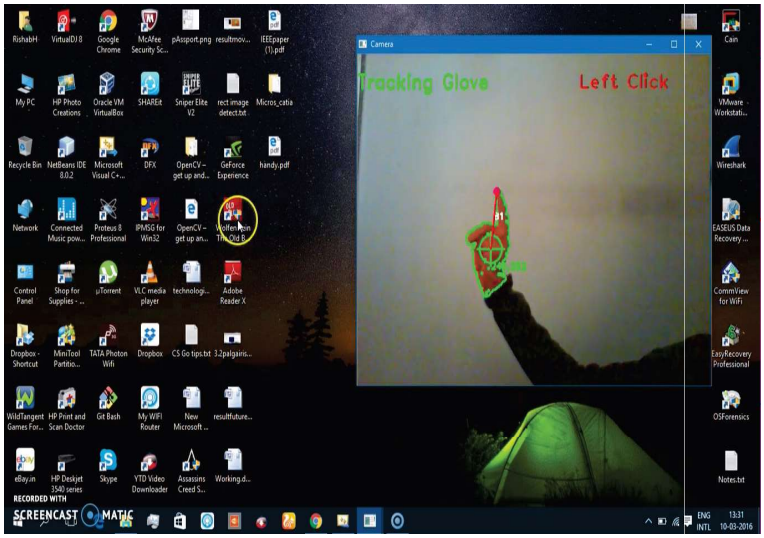

Fig. 6. Left Click

V. Flowchart

VI. Result

First the user has to initialise a particular range of Hue, Saturation and Values. These values are set for a given colour of user's glove. Erode, Dilate, Blur and Threshold functions are adjusted to alter noise present in the background. Thus the resulting panel detects only the user's glove. As shown in the figure, Hand is detected and tracked by the system. A large contour is developed across the palm and area is calculated. Centroid is determined from this calculated area. It is used to track hand by giving its X-Y co-ordinates.
Refer figure 5

Now, depending upon the position and orientation of fingers, cursor events occur. If both fingers are tracked then cursor moves on the screen. And, if either of index finger or middle finger is detected then right click or left click is implemented respectively.
Refer figure 6 for left click and figure 7 for right click.

VII. Application

1) Classroom Purpose.
2) Gaming.

A. Advantages

- Our project being a real time project can be used for commercial purpose.
- It makes presentation easier as it offers you an interactive display to perform a particular operation.
- It is cost efficient.
- No need of external hardware and installation process is simple.

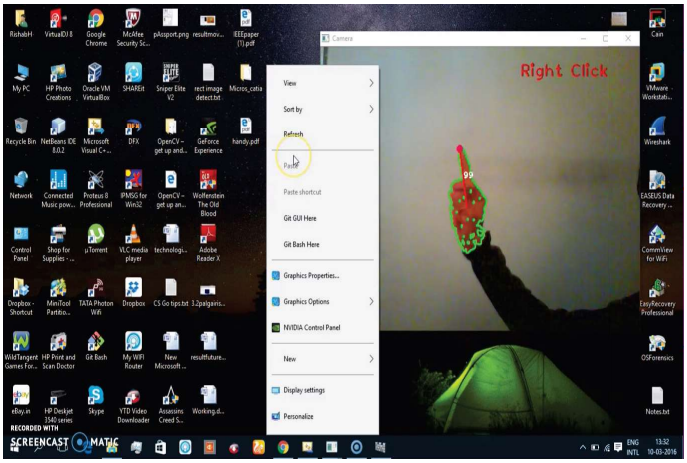

Fig. 7. Right Click

B. Disadvantages

- There are many constrain related such as it only works in a particular region.
- The processing may be a bit slower than the actual touch screen.
- The user's glove must be perfectly distinguished from the background.

VIII. Future Scope

1) It can integrated with laptop, desktop's and other personal computer so hardware cost can be cut-off.
2) Gaming consoles can also use this technology.
3) Voice recognition can be combined with it to provide a highly interactive system.

IX. Conclusion

There are four different sub modules in our system. Tracking of hand from video and determining its X-Y co-ordinates which is further used for movement of the cursor along with the hand movement. After glove tracking , the fingertips are detected with respect to centroid of the hand (i.e glove) which with some predefined gestures is used for mouse events. In this way the projected screen can be made interactive.

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