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Review Article

HAND MOTION BASED MOUSE CURSOR CONTROL USING IMAGE PROCESSING TECHNIQUE

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Abstract

The various devices are used for communications between the human and the machine. These devices are keyboard, mouse, etc. for performing tasks. While the workstation technologies are developing up, the roll of Person Workstation Interaction (HCI) is also increasing rapidly. Most of the devices uses touch screen technology which cannot be affordable to all the applications. For the traditional touch screen, virtual mouse can be used as substitute way in virtual person interactive module. Motion based interaction systems are very popular at workplace and at home. This paper proposes to develop a method and model that identifies hand motions which can be used as an input command to work together with the workstation system. The motion is recognized and the action specific is performed. While developing the system using image processing, one key area is looking for the system. The method is created to recognize the motions and built in task for every motion. PyAutoGUI is providing coding system in Python and uses the OpenCV library. The purpose of real-time hand motion recognition in the real world are numerous, since it can be used almost anywhere. The technique is focused on the use of a webcam. Then it is used to develop a virtual Person Workstation Interaction Device in a cost-effective manner.

Keywords: Motion Recognition, Person Workstation Interaction, Image Processing, NumPy, OpenCV, PyAutoGUI module.

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INTRODUCTION

Workstation technologies have developed tremendously over the past years and it has become a necessary part of day-to-day life. Traditionally it uses the hardware devices interact with the system. The evaluations of user interface are witnessed for growing up the development from keyboard to graphical UI mouse. In current virtual environment applications, keyboards, pests and other input devices are still the most dominant and popular devices. The main workstation accessory for Person Workstation Interaction (HCI) is the mouse and keyboard. However, here some real-life situations, like Person-Robot Interaction (HRI), the mouse is not suitable for HCI. Research in HCI primarily deals with the design and implementation of new interfaces for improving the interactions between persons and machines so that it becomes natural without the use of any mechanical devices. The techniques and methods for HCI is the use of hand motions. Today, Most of the laptops are attached with webcam. Such devices are used in security applications utilizing facial recognition. In order to utilize the full potential of a webcam, it can be used for vision-based Workstation Control (CC). The effectiveness of a webcam can also be extended to other HCI's applications such as mark language and movement controller. An implicit mouse using hand motion recognition is a system that allows users to give mouse key for workstation without using the actual mouse hardware.

Over the long periods, there have been tremendous advancements in HCI technologies such as the Microsoft Kinect, Nintendo Wii and Leap Motion. These gaming technologies provide a more natural and interactive way of playing video games. Motion control is advanced for gaming and also it has significantly enhanced the sales of video games like the Nintendo Wii, which sold over 50 million consoles within a year of its release. The technology of Leap Motion device which supports hand and finger motions as input, analogous to a mouse, but it requires no hand contact or touching. It was designed for hand tracking in implicit Reality (IR) which is a simulated experience that can be similar to or completely different from a real world.

In this work, novel devices and technologies are used for cursor control using hand motions. The hand motion recognition is used in sign language even though it is more significant. The challenge of this proposed work deals with is the implementation of mouse cursor control. Mouse control cursor is not used in some application like Person-Robotic Interaction (HRI). But the same is must in some other important applications like gaming or functioning a device with a complex GUI. Mouse cursor can be functioned using hand motions for smooth with acceptable sensitivity. The mouse is more proficient for all kind of people but it is not sufficient for the bodily affected people to use the mouse for interaction. In this work, the webcam is used for providing motions which is processed for further process. The image processing techniques like Image acquisition, image pre-processing, feature extraction and motion recognition are used for this system. A webcam is used for capturing the images frame using image classification techniques. The captured images are taken for going through the image pre-processing process. This involves color filtering, smoothing and thresholding. For extracting features of the hand images, feature extraction is involved. Motion identification absorbs recognizing hand motions by extracted features.

RELATED WORK

Hand Motion Recognition System is a branch of Person Workstation Interaction in which person hand motions are recognized by the workstation system and then perform pre-defined tasks as per the application for controlling the software as well as the hardware.

The authors in [1] have used MATLAB to develop the system completely. The system consists of three units: static, dynamic and virtual mouse. The static hand motion recognition system uses K-curvature algorithm which is used to find fingertips. The technique will collect every vector point to its near points at a distance of K. The value of K thus found is tested several times for different hand sizes. The angle between the vector lines is

calculated and the threshold values are considered based the angle calculation. The vector point would be identified for a fingertip. The angle is smaller or equal to the threshold value. The other two systems use the centroid measuring and tracking.

Sixth Sense Technology

The sixth sense is a wearable gestural interface. It augments the physical world with digital data. It can use natural hand motions to work together with digital data. Mobile wearable and some other hardware devices are used in a pendant. Mobile computing device use the projector and camera in user's packets. Visual data enabling exterior, walls and physical objects are used as interface in this work. Meanwhile the camera recognizes and tracks user's hand motions and physical objects using workstation vision-based techniques. The user requires colored caps on fingers while operating the system. There is the problem in the current technique. If any object of same color is identified for recognizing colors, then the system will not work properly.

Mouse Free

The primitive Person Workstation Interaction (HCI) is replaced with use of touch pad and mouse. This appealing option is the Vision-Based creature Workstation Interaction. It is possible only through real time hand tracking and motion identification vision based interactive. The webcam is used for identifying the users hand and for recognizing the motion for the purpose of interaction with the system.

Many researchers in the field of robotics and HCI comprise to manage the mouse movement using video devices. But, different methods are used to make a click on events. One method is also used to control the motion of the mouse. A click on the push button is evolved supported defining a screen. So, click is occurred when a user passed his fork over the surface [5,6].

Vision Based Method

The extra devices are not required in the visualization based approach. The system needs only camera to take the image required for a natural person workstation interaction.

Data Glove Approach

Instrumented data glove approach, which is shown in figure1, involves the use of sensor devices to recognize the hand motions. This easily provides precise match up of palm and finger's location and orientation, and helps in hand recognition [6].

Fig. 1: Instrumented/Data Glove

Colored Markers Approach

The colored markers, which used to trace the hand part and locating the palm and fingers, gloves which are worm by the person hand that is shown in figure 2.

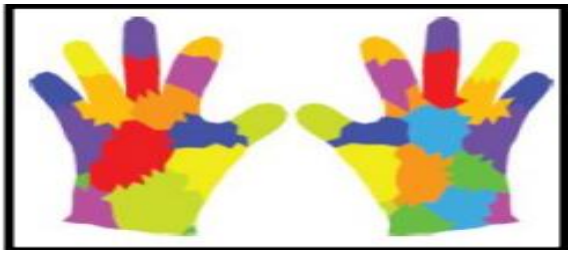

Fig. 2: Colored Markers Glove

PROPOSED WORK

The proposed system is done with respect of real time video processing and a real time application system. The mouse is replaced in order to introduce new system using the hand motions. Then the user interacts naturally with workstation. The basic diagram of the general proposed system is as shown in figure 3.

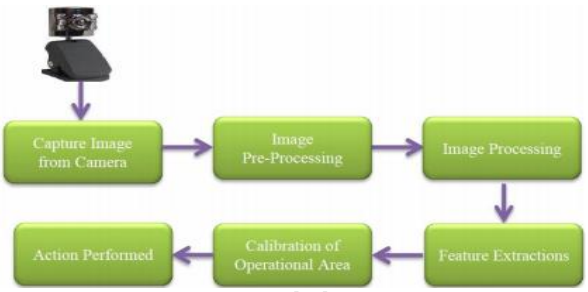

Fig. 3: Basic Block Diagram

Once the palm is detected by the camera, the process of capturing image will be stored. The processed images will be taken as input for further process. Then the detecting process will be based on the centers and edges. The detecting hand motions the extracted features, which are used for the further process. The work flow diagram is shown in figure 3 for the only frame which is captured. The system may be a real time system therefore the flowchart, which is shown in figure 3, may be a regular process for every and each frame that's captured by the online camera.

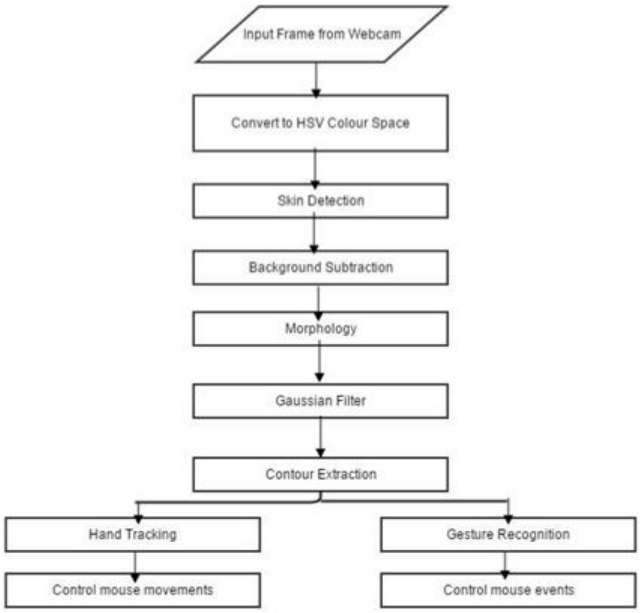

Fig. 4: Proposed System Flowchart

The hand motion is captured through webcam. According to the special effects of illumination, the captured image can be converted to chrominance color space which is less sensitive to illumination changes. The HSV color space was chosen since it was found to be the best color for covering recognition. In next step, there will distinguish skin pixels from non-skin pixels in the skin detection images Background subtraction is then performed to remove the face and other skin color objects in the background. Morphology Opening operation (erosion followed by dilation) is applied to efficiently remove noise. A Gaussian filter is applied to smooth the image and give better edge detection. Edge detection which is performed to get the hand contour in the frame. Using the hand contour, the tip of the index finger is found and used for hand tracking and controlling the mouse movements. The contour of the hand is also used for motion recognition.

METHODOLOGY

In this section some component of the system are going to be explained separately. They're following subsections:

Camera Settings

The runtime operations are managed using the webcam of the connected laptop or desktop. To capture a video, it needs to create a Video Capture object. Since this system uses a single camera, so it can pass the argument as 'zero'. It uses additional camera to the system and pass it as 1, 2 then on. Then, it can capture frame-by-frame.

Capturing Frames

It captures the image stream for classification and extracting the pixels. Then it processes each frame which is in RGB (default) color space to HSV color space. OpenCV has more than 150 color-space conversion methods. But it will use only two which are most widely used ones, BGR to Gray and BGR to HSV.

Image Processing

Images are stored as a collection of pixels in the database. Color images consist of a red, green and blue value which is combined to allow colors to be represented. Grayscale images are represented from 0 to 255. In the range, 0 is extremely black and 255 is extremely white. For performing some specific tasks, from images, the processing techniques are used. The three basic steps are used for segmentation. Image Segmentation, which involves image conversion between different color spaces to attenuate the complexity of image. Skin Detection which gets obviate any unwanted background noises and objects related to the image. Contour Detection is employed to locate an object within the image.

Skin Detection

Skin detection may be a technique which is employed for detecting the colour pixels in images. It's a essential step in wide selection of image processing applications like face detection, hand tracking and hand motion recognition. Skin detection using color information has recently gained tons of attention, since it's computationally effective and provides robust information against scaling, rotation and partial occlusion. Skin detection using color information are often a challenging task, since skin appearance in images is suffering from illumination, camera characteristics, background and ethnicity. So as to scale back the consequences of illumination, the image are often converted to a chrominance color space, which is a smaller amount sensitive to illumination changes. A chrominance color space is one where the intensity information (luminance), is separated from the colour information (chromaticity). Within the proposed method, the HSV color space is employed with the Histogram based skin detection method. The HSV color space has three channels, Hue (H), Saturation(S) and Value (V). The H and S channels hold the colour information, while the V channel holds the intensity information. The input images from the webcam would be within the RGB color space, thus it might need to be converted to the HSV color space using the conversion Formulae.

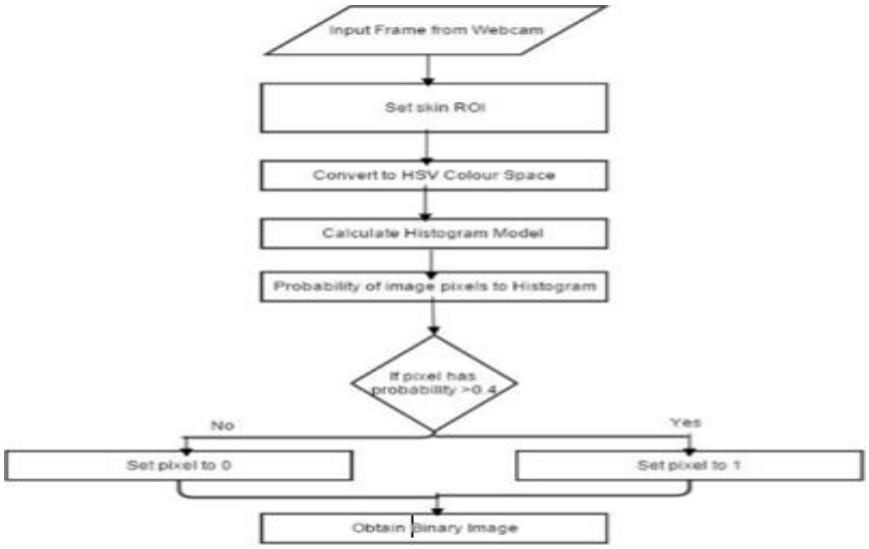

Fig. 5: Skin Detection Flowchart

Thresholding

Here, the matter is straight forward. If pixel value is high than defined threshold value, that is assigned to white color, otherwise it is assigned to black color. The function used is "cv.threshold". In this there are three arguments as follows: 1. A grayscale image which is used as source image. 2. Classifying the pixel value which is used as threshold value. 3. If the pixel value is more than threshold, maxVal is considered. The hand, which is captured through the webcam, is then extracted from the surroundings using the sampled color profile. Each color, which is available in the profile procedures, is summed all. A nonlinear median filter which is used for getting a smooth and noise free binary representation of the hand. Thresholding and hand extraction is shown in figure 6.

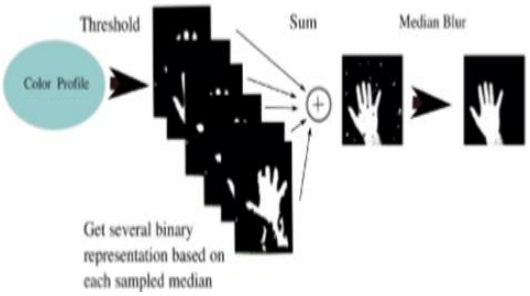

Fig. 6: Thresholding and Hand Extraction

Hand Contour Extraction

An outline is the curvature for two variables function along with the function has a constant value. A contour map illustrates the contour using contour lines which shows the steepness of slopes and valleys and hills. The edge detection has to be performed to obtain the hand contour after skin segmentation is over. The shape is drawn around the white blob of the image of hand that is identified by thresholding the input image. Due to noise or some other problem, more than one blob will be formed. The edge detection, Canny edge detection and border finding are used in this work. The OpenCV role "cvFindContours()" an order finding edge detection method to find the contours in the image. The major advantage of the border finding edge detection method is that all the contours found in the image are stored in an array. This means that we can analyze each contour in the image independently, to regulate the hand outline. Even though there will be a lot of outline in the picture, the small contours considered as noise and ignored them.

Fig. 7: Hand Contour

Fingertip Identification

After the hand segmentation, the hand is used only mark. Therefore, it will start by finding the largest contour which is assumed to be the hand. After finding the largest contour, it will find its convex hull. The convex hull which is shown in figure 8, is simply a curve covering the finger contour. The convexity defects are found from the convex hull.

Fig. 8: Convex Hull

Convexity defects which is shown in figure 9 are the places where the curve is bulged inside. These are assumed to be the spaces between the fingers. It includes index of the depth point in the contour and its depth value from the line. While counting the convexity defects, we must impose some limitations. The limitations include the depth of the defects must be larger than a certain value. Besides, it excludes the defects if it is wider than 90 degrees.

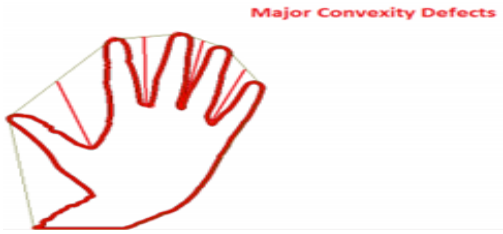

Fig. 9: Convexity Faults

Number of Fingers

While finding the convexity defects, we will use Cosine rule (1):

$$a^2=b^2+c^2+2bccosA \quad (1)$$

Using the "convexityDefects" function, it gets all the defects of the contour and we save them in array. These are the lowest points between one finger and the other. It can use the two arrays to make assumptions about the number of lifted fingers in the image.For example, if the number of convexity faults is two, then the number of fingers raised is three.

Pointer Control

The different hand motions are used to specific mouse function after motions are recognized. It also prospects controlling the workstation cursor, in the Python language with OpenCV is relatively easy. Positions on screen are referred to by X and Y Cartesian coordinates. While the X coordinate starts at zero on the left side and increases going right. While the Y coordinate starts at zero on the top and increases going down. These co-ordinates change with time based on hand moves across the screen. Once the co-ordinates have been strong minded, the mouse driver the mouse driver is accessed, and the coordinates are sent to the cursor. By coordinators, the cursor puts itself in the necessary location. It is expected that the object moves incessantly, thus creating an effect of tracking. So, as the user moves his hands across the field of view of the camera, the mouse moves proportionally across the screen.

RESULT AND EVALUATION

The proposed work tested mouse operations such as left click, right click, and movement of cursor on Windows. The tested system is that Core i5, 4 GB RAM, Windows 10. Based on the performance of current hardware mouse, it is lower. Instead it tabulates the time to acknowledge and perform the above mouse actions and from which it might be seen that the algorithm is strong enough for real time implementation because the delay is negligible. The table and graph are showing the performance the proposed add table 1 and figure 10.

Table 1: Performance of the proposed system

Events	No. of input samples	No. of recognized samples	Recognition rate
Move the cursor up	5	4	0.8
Move the cursor down	5	3	0.6
Move the cursor left	5	4	0.8
Move the cursor right	5	4	0.8
DragTo	5	3	0.6
MoveTo	5	4	0.8
Click	5	4	0.8
Double click	5	3	0.6
Increase speed of cursor	5	4	0.8
Decrease speed of cursor		3	0.6

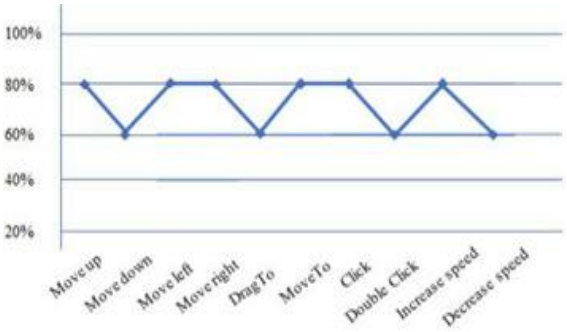

Figure 10: Performance Results

CONCLUSION

The mouse pointer control using hand motion are developed by language like python using the OpenCV collection. The system which may be ready to control the movement of a cursor by tracking the user's hand. The various hand motions are wont to perform cursor functions. Thanks to the constraints occurred. The scheme could also be replaceable for workstation mouse. The workstation mouse can't be replaced completely. The foremost constraint of the system is that it must be operated during a well-lit environment. This is often the most reason why the system cannot completely replace the workstation mouse since; it's quite common for workstations to be utilized in environments with poor lighting conditions. The accuracy of the hand motion recognition could are improved if the Template Matching hand motion recognition method was used with a machine learning classifier. It'll take while by using some methods and techniques to execute the work but the performance of the work is extremely high and enhanced. It's also very tough to arrange the cursor for precise movements since the cursor was very unstable. The steadiness of the cursor could are improved if a Kalman filter was incorporated within the design. It uses the Kaman filter which needs a substantial amount of your time to execute the method. At the present, the components like webcam, microphone, keyboard and mouse are an integral a part of the workstation system. This technique constraints are eliminated in near future.

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