

Commanding Computer using Gesture Based Patterns

Salil Batra, Chandra Prakash

Abstract: - Gesture recognition is one of the popular methods for Human computer Interaction. This paper is mainly focused on the applications of this technology in the computing environment. The idea is to construct such a system which can take gesture inputs and on the basis of that controlling and commanding of the computer is performed. In doing so, such a module is presented which is based on the finger tracking through which different types of applications can be started. This module basically performs the finger counting and then on the basis of which actions are performed. Further these actions are used to control various functions of operating systems. Results reveal that the proposed technique works well in the robust conditions.

Index Terms: - Gesture Recognition, Human computer Interaction, Finger Tracking, Convex Hull Algorithm Coefficient of Correlation.

I. INTRODUCTION

Today's era of computing is rapidly moving towards more advanced and sophisticated means of input methods. Such methods are popular because, of their ease of use and simplicity. Human computer Interaction is the computer field which includes communication among Computer systems and Humans for exchanging data, receiving meaningful outputs when user gives some data sets as input. With the passage of time various methods are introduced in the computer science for interacting with the computer systems, such as: --- Keyboards, Mouse, Joysticks, and Touch Screens etc. [1]. But, now in the modern era of computer science interaction methods are changed. Some of the latest methods include the Speech recognition, Voice recognition & Gesture based recognition. These interaction methods are the latest topics for research under the computer science field of HCI. These methods of Interaction are boon for the disabled persons. People who are unable to command computer due to the disability of various body parts can adopt such methods and effective exchange of information can be obtained. Some of these methods come under the techniques of computer vision. Field of computer vision and Image Processing have made it possible for the programmers to construct such Interfaces which can let the user to interact with the computer without actually touching it.

This achievement under HCI led to the development of various recognition techniques. Out of many techniques, there is one technique which has really become very popular across the world, which is called as Gesture recognition. Gesture recognition is based on the Gesture Inputs.

Manuscript Received on June 20, 2012.

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Gesture Inputs are the movements generated by Hands, Head, Eyes, or complete features of Face [3]. After generating Gesture Inputs, the remaining work is of the computer system to interpret these inputs. Various techniques are already available for Interpretation of these inputs. The system which actually helps the computer for recognizing corresponding gesture input consists of various modules which works one by one in sequential order and produces the corresponding results. These modules are generally termed as Feature Extraction and Controlling of PC's actions. After development of such modules various inputs in the form of images/videos are given to the system and outputs are produced. Earlier systems based on Gesture recognition used various types of Hardware such as Data Gloves, Bulky Electronic devices for the monitoring of the gesture inputs [4]. As the cost and the efficiency of these hardware devices were not up to the mark so with the passage of time much cost-effective and efficient hardware is available now days. The most simpler and popular Hardware that is used is the real time Camera which captures the input from the external environment and produces the results. Various other features like number recognition will also be there in the system. Under number recognition user will give the dynamic hand gesture inputs to the system and it will display the outputs as the sign convention given by the hands. This module basically performs the finger counting and then on the basis of which certain actions are performed, e.g. if finger count is 5 then maximize the current window, if finger count is 0 then minimize the current window, for other finger count such as 4 open the calculator application etc. Like this we can do many things.

II. PREVIOUS WORK

The literature review starts with the classical methods of Gesture recognition which requires various types of Hardware were required for the earlier systems such as Data Gloves, Bulky Electronic devices for the monitoring of the gesture inputs. As the cost and the efficiency of these hardware devices were not up to the mark so with the passage of time various cost-effective and efficient hardware is there now days. The most simpler and popular Hardware that is used is the real time Camera which captures the input from the external environment and produces the results. Margrit Betke, James Gips and Peter Fleming (2002) presented The "Camera Mouse" system. This system has been presented in the paper is like boon for the disabled persons, because it provides ease of accessing the computer system. The proposed system uses the gesture techniques to identify The movements of the humans.

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After capturing the gestures there is a translation of these gesture input into mouse cursor movements. The proposed system uses the tracked features with the help of algorithm of visual tracking. The tracked features are matched with the database entries and corresponding mouse movement is produced if the tracked feature matches. The correlation coefficient is calculated every time the gesture positions are changed from one location to another. On the basis of this correlation coefficient the corresponding mouse movement is produced. The proposed system was tested on various persons and after checking this various results were proposed. Success rate shown by the system was on the higher side and accordingly various future scopes were decided. So this is the entire working of camera mouse suggested in the paper. The applications of the suggested system were many such as the people used the proposed system in playing games, opening various computer applications etc.

M.K. Bhuyan, D.Ghosh and P. K. Bora (2005) proposed a threshold based FSM by incorporating some additional features in the FSM. These additional features are in terms of different thresholds. These new features greatly enhance the gesture recognition accuracy. They got recognition rate of about 96%, which demonstrate that their proposed threshold FSM is ideal for Human Computer Interaction (HCI) platform. They represented a particular gesture as a sequence of key frames and the corresponding key frame duration, which constitute a finite state machine (FSM) for gesture recognition. The redundant frames actually bear only the temporal information of dynamic gestures and hence discarded for computational efficiency.

Rajesh Kumar, Anupam Kumar (2008) presented "Black Pearl" system which is one of the human-computer interface by which user can have access to the computer system by using various available gestures. The proposed system acted as a replacement for mouse and keyboard and was very much helpful for the disabled people. The proposed system uses the concept of correlation coefficient and track the current position of the mouse pointer and the moving gesture. User had various flexibilities with the Black Pearl system as it provides the option of selecting the size of sub-image window and mouse cursor's speed. The system is implemented in visual basic which uses the programming constructs to perform the desired operations. Again the system suggested by author was meant for the disabled people and was much efficient as compared to the existing systems. The proposed was also efficient in the way such as it does not allow the other object to get interfered in the ongoing tracking. The object occlusion is not the problem; hence the system is far much suitable in the robust conditions. The existing of other objects will not affect the overall working of the system. This is the way can say that Black Pearl system is suitable enough for the disabled people because it act as a replacement for the mouse and the keyboard. The dwell time feature of the system makes it much suitable for the adverse environments. But the system do not uses the concept of finger tracking.

Yee Yong Pang, Nor Azman Ismail, Phuah Leong Siang Gilbert (2009-2010) presented a real time vision based hand gesture interaction prototype. This was built for controlling the desktop cursor and concerned the tasks involving in Navigation the desktop cursor by using hand gesture input

modality. This research simulated the movement of desktop cursor, hence a fist or close hand has been selected to simulate and replace the movement of desktop cursor.

III. PROBLEM FORMULATION

The proposed idea is to construct such a system which helps the computer to take gestures such as hand signs as its input and with the help of finger tracking numbers from 0-5 are recognized by the system. Further this feature can be used for maximizing/minimizing window such as fully closed hand means 0 i.e. minimize the window and fully open hand means 1 i.e. maximizes the window. All these features will be combined with the proposed system. So the proposed idea is to full utilization of the computer vision technology to control various computer related operations.

The proposed system will consists of various modules. Each module uses different techniques and algorithms to perform its specific tasks. After a particular module completes its task, its output will become input for the next module. In the end the combined effort of each module will be displayed. Following are the modules which are expected in the proposed system:-

Module1:-Image capturing through webcam module

Module2:-Image preprocessing module

Module3:-Image Segmentation module

Module 4:-Finger Tracking Module

Module 5:-Commanding Computer based on the no. of fingers tracked

These are the expected modules for the proposed system. The first four modules can be collectively termed as gesture tracking modules. After doing this we directly shifts to the Operating system control module in which commands the system based on no. of fingers tracked.

A. Objective

The main objective of doing this research cum implementation work is to prepare such a system which can take signs or gestures as input and controlling of computer and its various applications can be obtained. The system can recognize the hand movements and interpret the numbers formed by the fingers of hands. Such type of feature can be helpful to construct many good applications such as calculator which can understand the sign languages and perform the various mathematical operations.

IV. METHODOLOGY

Methodology of constructing the proposed system will consists of various modules. Each module uses different techniques and algorithms to perform its specific tasks. After a particular module completes its task, its output will become input for the next module.

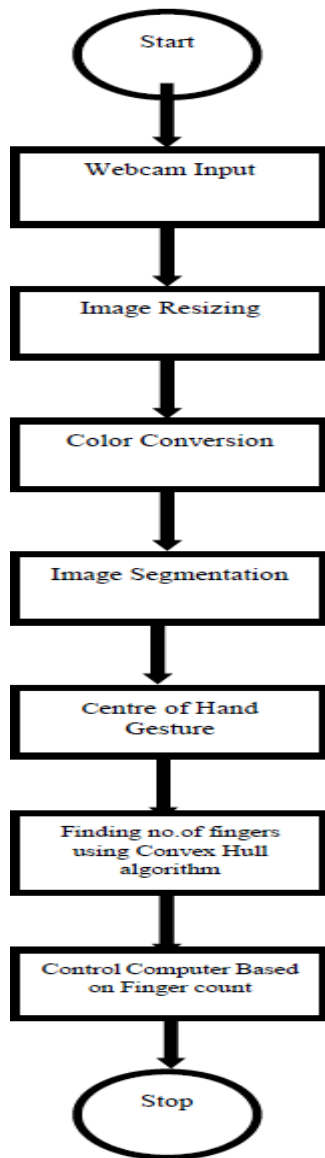


Figure 1: Flowchart showing steps

The flowchart is describing the order/sequence in which the different modules are required to be executed. The execution is started with the image capturing from webcam and then the subsequent modules are executed. The flowchart is describing how the output from one module can become beneficial for the other module. The following description is very much helpful for having insight of how each and every module is working. The following detail is also showing the more technical details such as the equations, algorithms, scientific formulas that are used for the execution of the modules.

Following is the detail of the modules which are to implement:-

A. Image capturing through Webcam

Under this step Image/video will be captured from the user who wants to operate the computer with the help of its gestures. This step is the very first step of the gesture recognition. For capturing the image there is a need of real time camera and its capturing speed should be adequate enough so that the continuous frames are captured without any sort of delay. Open CV library can be used for connecting the webcam with the system's working.

B. Image Preprocessing

Once the Image is captured by the Webcam, the next step is to preprocess the Image. Under the various small steps are performed such as Resizing of Image, Conversion of color space, Identification of various attributes of Image ,etc. .

C. Conversion of color space

This step is performed right after Image is captured by the webcam. Under this step the color space conversion RGB to YCbCr is done. In order to perform a specific domain and range of colors need to be defined which will consist of the skin colors. For achieving better results the pixels related to skin color are whitened while the other one such as background are blackened.

D. Image Resizing

For the recognition of the gesture this is the main step in which need to resize the input image, so that mapping of heterogeneous coordinated can be done. Here the heterogeneous coordinates are the screen and the input device coordinates. For detecting the screen coordinates we can use the following equation:-

$$a = \frac{a'}{640} * ca, \quad b = \frac{b'}{480} * cb \quad (1)$$

Where (a' , b') is the camera position, (ca , cb) is the coordinated represented by the current location of the screen, and (a , b) is the location of the input device.

E. Image Segmentation

Segmentation is the process that subdivides an image into a number of uniformly homogeneous regions. Each homogeneous region is a constituent part or object in the entire scene. In other words, segmentation of an image is defined by a set of regions that are connected and non-overlapping, so that each pixel in a segment in the image acquires a unique region label that indicates the region it belongs to. So in this step the system will segment the gesture that will be used by the user to control the computer. Suppose user gives hands as the means of gesture input. So in this step hand gestures are separated from the entire image. CV Rectangle () function can be used to find out the area of interest in the entire Image. There are many illumination and environmental problems so sometimes it becomes hard to recognize the skin colors. In order to achieve this there is need to change the color space. For this there is need to change the RGB color space to the YCbCr color space which produces the much efficient results as compared to the RGB color space.

F. Reducing Noise from the Segmented Image

After segmentation of Image is done, it becomes important to reduce noise from the background and producing the Image which will not contain noisy pixels. For obtaining noise free image, Image morphology algorithm performs the most important functionalities which are stated as Erosion and dilation. Erosion trims down the image area where the hand is not present and Dilation expands the area of the Image pixels which are not eroded.

Mathematically, Erosion is given by,
 $P \ominus Q = \{x \mid (Q) x \cap P c = \phi\}$ (2)

Where P denotes input image and Q denotes the group of elements. Dilation is defined by,
 $P \oplus Q = \{x \mid (Q^c) \cap P \neq \emptyset\} = \{x \mid [(Q^c) \cap P] \subseteq P\}$ (3)
 Where P denotes the input image and Q denotes the group of elements. The same group of elements is operated accordingly.



Figure 2: Diagram showing Entire Working of Image Segmentation

G. Applying technique to find the center of gesture if the gesture input is given by Hands

This step will be used if the proposed is using the Hands as its gesture, so in order to calculate the center of the hand, use the following equations :-

$$A' = \frac{\sum_{i=0}^K A_i}{K}, \quad B' = \frac{\sum_{i=0}^K B_i}{K} \quad (5)$$

Where A_i and B_i are A and B coordinates of the i pixel in the hand region, and k denotes the number of pixels in the region. Now moving to the next step we need to find out the size of Hand gesture and for achieving this we need to use the circle and it needed to be drawn on the entire segmented hand gesture. Accordingly we can find out the radius of the hand gesture by moving along the boundaries of the drawn circle and we need to move the radius line until unless we have not touched the black pixel. As soon as the first black pixel is found the next step is to return the radius value. Further with the movement of the next subsequent frames the value of radius will keep on changing and we iteratively return the values of the radius. So with this we can see the importance of Image Segmentation which performs the entire working earlier and on the basis of which further results are obtained. Image segmentation reduces the work to great deal as the noise reduction is performed already.

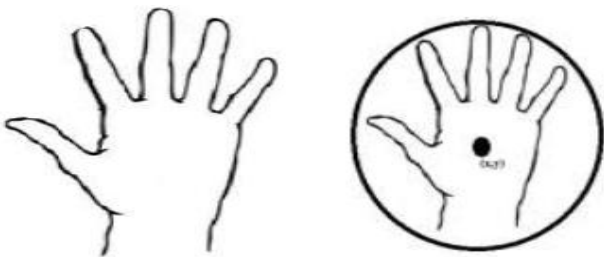


Figure 3: Figure showing Center of Hand Gesture

H. Using Convex Hull algorithm to find the tips and contours of fingers

The Convex Hull will be used after finding the center of Hand to and after that it is used to determine the finger locations and their corresponding area of coverage. Using this feature of this algorithm, we can detect finger tips on the hand. We used this algorithm to recognize if a finger is folded or not. To recognize those states, we multiplied 2 times (we got this number through multiple trials) to the hand radius value and check the distance between the center and a pixel which is in convex hull set. If the distance is

longer than the radius of the hand, then a finger is spread. In addition, if two or more interesting points existed in the result, then we regarded the longest vertex as the index finger and the hand gesture is clicked when the number of the result vertex is two or more. The result of convex hull algorithm has a set of vertexes which includes all vertexes. Thus sometimes a vertex is placed near other vertexes.

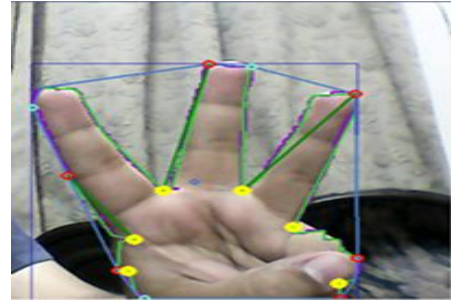


Figure 4: Figure showing the results after applying convex hull algorithm

I. Implementing Finger tracking for Opening Computer Applications

This is the last module which is the implementation of finger tracking. After counting the fingers, few patterns can be made which will be helpful in commanding computer, such as:-

Pattern vs. Action Table

Pattern	Action Performed
1	Minimize the current Window
2	Open Paint Application
3	Open Notepad Application
4	Maximize the current Window

V. RESULTS & DISCUSSIONS

After implementing the entire logic and algorithm some interesting results are found. These results are on the basis of algorithmic strategy used for moving mouse and finger tracking. The steps used for the moving mouse based on the gesture inputs were efficient such as lesser response time came into picture as compared to the other previous techniques. The finger tracking is performed on the basis of convex hull algorithm where center of the Hand gesture is found and after that tips of the fingers are tracked on the basis of the counters. The appropriate finger counting was performed and after that based on these patterns several operations like minimizing/maximizing of computer window is performed.

A. Graphical view of results

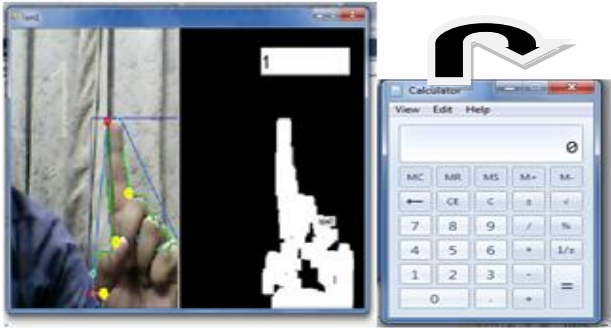


Figure 6: Showing the opening of Calculator based on the pattern one.

The Figure displayed here is showing the finger count of 1. On the basis of this count Calculator application is get opened. For achieving this again the Convex Hull will be used after finding the center of Hand to and after that it is used to determine the finger locations and their corresponding area of coverage. Using this feature of this algorithm, we can detect finger tips on the hand. The entire frame is divided into two parts:-first frame is displaying the original frame where the counters and segmented image is showed. The second frame is displaying the results after applying the entire algorithm. The second frame is displaying the whitened skin color pixels and black pixels which are other than skin color.

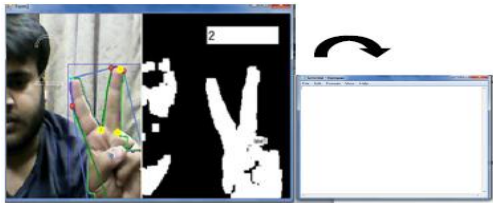


Figure 7: Showing the opening of notepad based on the pattern two.

VI. CONCLUSION & FUTURE SCOPE

From the entire study of the methodology and proposed algorithm it is very much clear that how we can use Gesture recognition technique for controlling computer. The new advancements in the gesture recognition field have made it possible to perform such tasks. The finger tracking has also helped in a many ways through which we can generate many permutations of patterns and therefore the computer system can be commanded and controlled. Talking further this technology is very much effective and easy to use. People who face difficulty in commanding and controlling the computer can easily control the functions of computer using this technique. Also, the input device here in this case is natural One so there is no need of special input devices for feeding the computer. The future scope of the above system is that it can be extended to create a gesture based calculator. Gesture based calculator will take inputs from the user in the form of numbers and after that various operations are performed such as addition, subtraction, multiplication etc. The other future utility of the proposed idea is that we can write on the notepad, word file on the basis of gesture patterns. The limitation of the proposed system is that

sometimes it does not work properly with less intensity of light. Hence in the future scope the system must be capable enough to work in the less light intensity. We can also perform mouse move based on the gesture input. In future these two modules can be merged to create a unique type of system.

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