# Hand Gesture Recognition System (Static and Dynamic)

**Nikhil Thakur [1] Nikhil Devle [2] Nitish Singh [3]**
[1, 2, 3] B.E. Student
[1, 2, 3]Department of Computer Engineering
[1, 2, 3] K. J. Somaiya College of Engineering, Mumbai, India

*Abstract*—The focus of this research is divided into two different independent fields. First is to recognize hand gestures captured from a webcam in real-time, and then using the gestures to control real-world applications (in our case, apply its output to control Operating System operations). Gestures can be used to communicate much more information by itself compared to mice, keyboard etc. This comes under static hand recognition system. Second is to dynamically track the hand movements and control the mouse using these movements. Further functionalities in static as well as dynamic implementation can be increased to make the project much more effective.

**Keywords:** Adaptive skin color model, hand gesture recognition, motion detection, motion history image.

## I. INTRODUCTION

Nowadays, computers in all the fields have become very important as they provide an effective and possibly more accurate output. However, the interaction with computers is more or less done in a static manner specifically using mouse and keyboard. We humans have always aimed to make computers more intellectual, intelligent and possessing highly accurate predictive nature. Interactions with computers have to be improvised. Computers will be more intellectual if they start understanding human gestures. Gestures can be used to communicate much more information by itself compared to mice, keyboard etc.

Gesture-based interaction was firstly proposed by M. W. Krueger as a new form of human-computer interaction in the middle of the seventies and there has been a growing interest in it recently. As a special case of human-computer interaction, human robot interaction is imposed by several constraints the background is complex and dynamic; the lighting condition is variable; the shape of the human hand is deformable; the implementation is required to be executed in real time and the system is expected to be user and device independent.

R. Kjeldsen and J. Kender presented a real-time gesture system which was used in place of the mouse to move and resize windows. In this system, the hand was segmented from the background using skin color and the hand's pose was classified using a neural net.

## II. SYSTEM OVERVIEW

The implementation details of system specified in this section. The system is composed of three independent sub systems

They are

- Static hand gesture recognition system.
- Dynamic hand gesture recognition system(Virtual Mouse)

The two systems work independently and are selected using a Graphical Interface. The main objective of static hand gesture recognition system is to recognize number of fingertips present in the hand image captured through a webcam using K curvature algorithm. Virtual Mouse System changes the hand position implemented using the centroid tracking method. This paper focuses more on the static hand gesture recognition system.

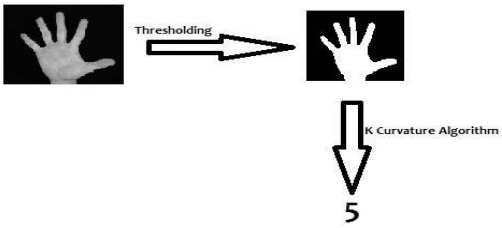


Fig. 1: Flowchart of System Flow (Static System)

## III. STATIC HAND GESTURE RECOGNITION

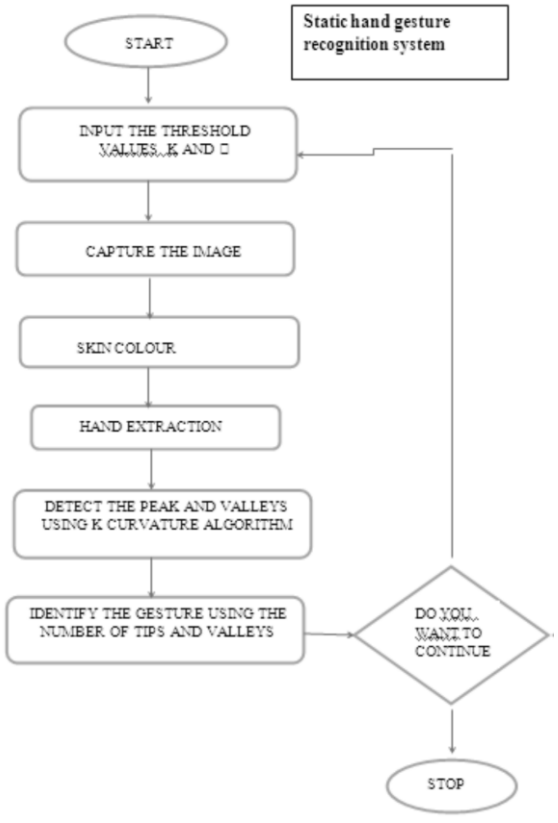


Fig. 2: Flowchart of Static Gesture System

The static hand gesture recognition is used to find out the static hand movements like the number of fingers in the hand and performs application according to that. The peaks and valleys are extracted using the k curvature method. Using the co- ordinate values of tips and valleys we plotted the captured image.

 

From the number of peaks and valleys we can identify the number of fingers in the current hand gesture.

Fig. 3: Types of Hand Gestures

## IV. K CURVATURE ALGORITHM

- Let C*i* represent the contour for the hand.
- We attempt to find pixels that represent peaks along the contour perimeters.
- At each pixel *j* in a hand contour *i*, we compute the k-curvature which is the angle between the two vectors [C*i*(*j*), C*i*(*j* – *k*)] and [C*i*(*j*), C*i*(*j* + *k*)], where *k* is a constant. The k-curvature can be computed with the help of vector algebra.
- The equation that we use for angle calculation is:

$$\theta = \tan^{-1}\left(\frac{m2-m1}{1+m1.m2}\right)$$

Where $m1$=the slop of the line joining vector[C*i*(*j*), C*i*(*j* – *k*)]

$m2$=the slop of the line joining vector[C*i*(*j*), C*i*(*j* + *k*)]

- We use a threshold theta for the k-curvature such that only points below this angle will be considered.

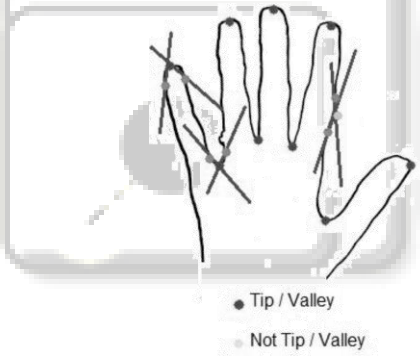


Fig. 4: Tips and Valley

An important issue in K Curvature Algorithm is about obtaining co-ordinates of the points on the hand contour to draw tangents in order in which they appear. For this we use Edge Tracking Algorithm:

- Let the initial points be Po Qo.
- Given P and Q find the next pair P' and Q' as follows:

| R2 | R3 | R4 |
|---|---|---|
| Q | P | R5 |
| R8 | R7 | R6 |

Table. 1: Edge Tracing Point Scenario

- We now traverse in clockwise direction from R2 and find 1st white pixel.
- Assign this white pixel to P and assign R(i-1) to Q.

We repeat this process until the last point on the hand contour is reached.

## V. APPLICATION

MUSIC PLAYER

ActiveX is a Microsoft Windows protocol for component integration. With help of ActiveX, it is possible to integrate MatLab and Microsoft media player.

Han = actxcontrol ('WMPlayer.OCX.7');

Fig. 5: Example GUI for Music Player

It will create an object of WMPlayer. By changing the pathname and filename we can change the song. We assign different operation for each hand gesture.

## VI. DYNAMIC HAND GESTURE RECOGNITION SYSTEM (VIRTUAL MOUSE)

The main objective of this section is to track the hand movement and feasibly apply it to control mouse pointer movements. This system tracks the hand motion that is it identifies whether the hand moves right, left, up or down. Apart from this some dynamic gestures can be recognized to perform mouse clicking operations.

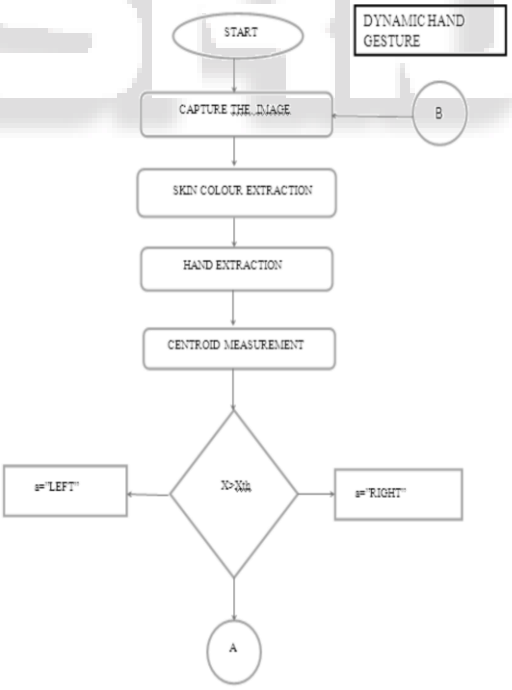


Fig. 6: Flowchart of Dynamic Gesture System

The centroids of the binary image can be calculated using the MatLab function region props (BW, *properties*) here the *properties* will be centroid. The result will be the vertical and horizontal (x, y) coordinates of the centroid as in fig 6. Since the input binary image BW will contain only one white region (hand extracted image) the result of the function region props (BW, *properties*) will be the centroid

 

of the hand. By passing this centroid value to the java.awt.Robot we can change the position of the mouse pointer. If the x coordinate of the centroid crosses a threshold value then the dynamic gesture 'right' can be detected else 'left'. Similarly if y coordinate crosses a threshold, the 'up' can be detected else 'down' as in Fig. 8 and Fig. 7.

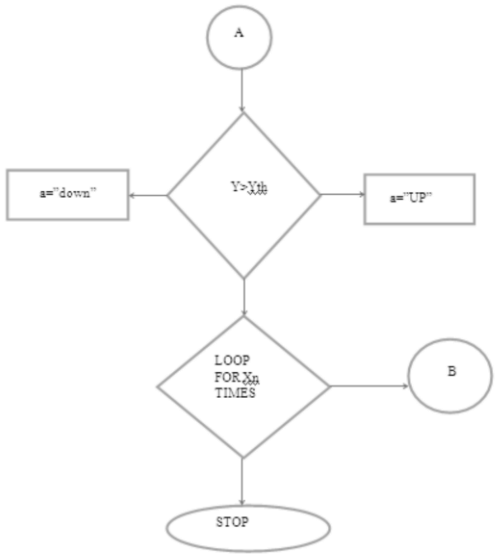


Fig. 7: Flowchart for Dynamic Gesture Recognition System (continued)

Virtual Mouse

The application of the dynamic hand gesture recognition system is the virtual mouse in which the mouse functions according to our hand movements as in fig. 6 and fig 7.

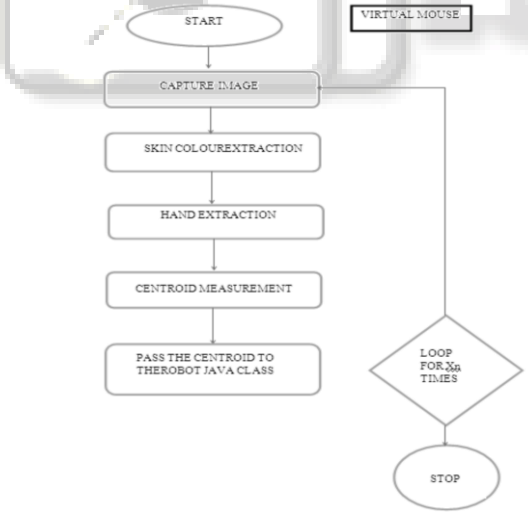


Fig. 8: Flow Chart of Virtual Mouse

## VII. Experimental Results

This section represents the results of the program used to detect the number of fingertips using K Curvature Algorithm.

Input is a hand image with 5 fingers. The method recognizes the number of tips and valleys present which if we count will come to know that it is 9.

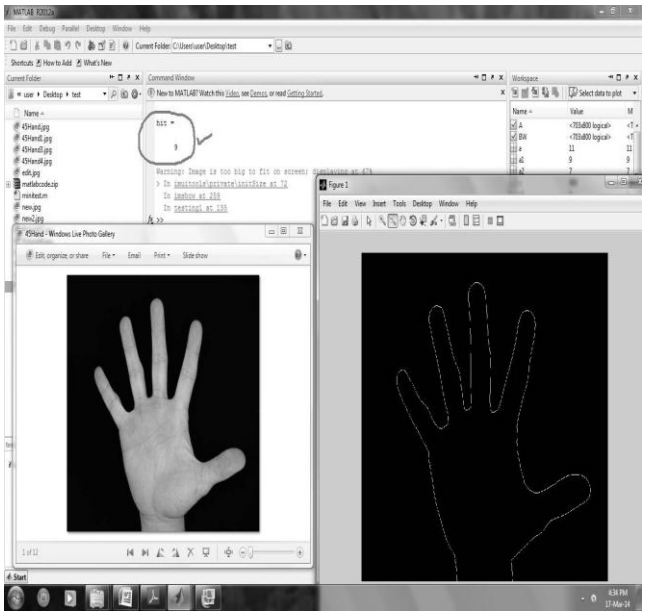

Fig. 9: Output of K Curvature Method

## VIII. Conclusion

In this paper, the work is completely done by using MATLAB. The system consists of two independent units Static and dynamic that is the virtual mouse. The static hand gesture recognition system uses K curvature algorithm and other system uses the centroid measuring and tracking. The performance of the designed system can be verified using hands of different people.

The major extension to this work can be done to make system able to work at much complex background and compatible with different light conditions. It can be made as an effective user interface and which can include all mouse functionalities.

## Acknowledgment

We have taken efforts in research of this project. However, it would not have been possible without the kind support and help of Prof. Rajni Pamnani (K. J. Somaiya College of Engineering). We would like to extend our sincere thanks to her. We are highly indebted to Prof. Rajni Pamnani for her guidance and constant supervision as well as for providing necessary information regarding the project.

## References

[1] BurakOzer, Tiehan Lu, and Wayne Wolf, "Design of a Real-Time Gesture Recognition System," *IEEE Signal Processing Magazine, 2005.*
[2] Chan Wa Ng, S. Rangganath, "Real-time gesture recognition system and application". Image and Vision computing (20): 993-1007, 2002.
[3] Chen-Chiung Hsieh and Dung-Hua Liou, "A Real Time Hand Gesture Recognition System Using Motion History Image, *"2nd International Conference on Signal Processing Systems (ICSPS), 2010.*
[4] D. H. Liou, "A real-time hand gesture recognition system by adaptive skin- color detection and motion history image," Master Thesis of the Dept. of Computer Science and Engineering, Tatung University, Taipei, Taiwan,2009.

 

[5] Kwang-Ho Seok, Chang-Mug Lee, Oh-Young Kwon, Yoon Sang Kim, A Robot Motion Authoring using Finger-Robot Interaction", *Fourth International Conference on Computer Sciences and Convergence Information Technology,2009.*
[6] Nguyen Dang Binh, Enokida Shuichi, Toshiaki Ejima," Real-Time Hand Tracking and Gesture Recognition System**",** *GVIP 05 Conference*, CICC, Cairo, Egypt, 19-21 December, 2005.
[7] S.M.Hassan Ahmeda, Todd C.Alexanderb, and Georgios C. Anagnostopoulosb, "Real-time, Static and Dynamic Hand Gesture Recognition for Human-Computer Interaction", *IEEE*, 2006.
[8] T. Maung, "Real-time hand tracking and gesture recognition system using neural networks," Proc. Of World Academy of Science, Engineering and Technology, vol. 38, pp. 470-474, Feb. 2009.
[9] Vladimir I. Pavlovic, Rajeev Sharma, Thomas S Huang, "Visual Interpretation of Hand Gestures for Human-Computer Interaction: A review" IEEE *Transactions of pattern analysis and machine intelligence*, Vol 19, NO 7, July,1997.
[10] XIAOMING YIN, "Hand Posture Recognition in Gesture-Based Human-Robot Interaction," *International journal of Robotics and Autonomous System*, 2006.

 