Hand Gesture Recognition Techniques

Anoop A[1] Chidananda.H[2]
[1,2]Department of Computer Science & Engineering
[1,2]RYMEC , Bellary KA, India

Abstract— Hand gesture recognition is an natural way of interacting with the machine by the humans. The interactions is being increased rapidly by using multidimensional hand gestures methods when comparison made with other input methods. Here the main thing I want to explore in this paper that three main techniques of the fingertips detection methods in hand gesture recognition system. Those three techniques are convex hull, k curvature and curvature of the perimeter. This technique is being act as an aid for the physically disabled peoples. And here the images are being captured in the webcam and the toolboxes and algorithms which are being used in this methods are the Matlab toolboxes and computer vision programs.

***Key words*:** hand gesture recognition (HGR), human computer interface(HCI) ,finger tips detection

I. INTRODUCTION

Hand gesture recognition is an very much interesting and active topic in the research of an computer vison. Here the main purpose of using this hand gesture recognition system is that an end user can be communicated easily if that end user doesn't know more about technical knowledge about the system also this computer vision programs allows the use of the system without any difficulties facing. And here without any external devices can be used for interaction. In some of the hand gesture methods some glove should be wearing for the hand for detection but its totally an impractical in nature. People wanted to be used natural and bare hand. So here in this methodology no need of wearing the any type of glove for the hand for recognition.

There are several number of methods and here I am mentioning two methods there are :-

- Template matching.
- Finger tips detection

A. Template Matching:

Here the main approach in this method is that the image or an part of an image is being matched with the template which is being stored in the data base of the machine. It finds some of the patterns in the image. The diagram 1 and 2 represents the template matching approach.

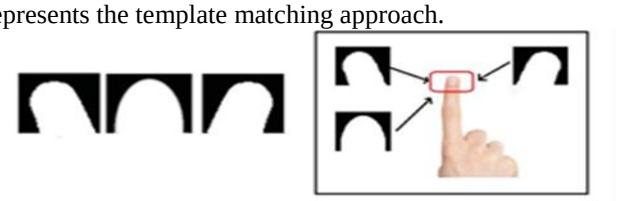


Fig. 1: Template Matching

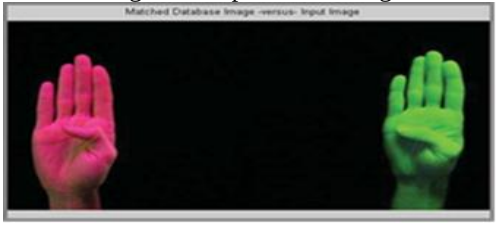


Fig. 2: example for template matching

B. Finger Tips Detection:

many researchers are being used this method only for detection of the hand recognition. In this paper I am also using finger tips detection technique. In this paper I am using three algorithms.

They are:-

- Convex hull method
- K-curvature method
- Curvature of perimeter.

II. SYSTEM MODEL

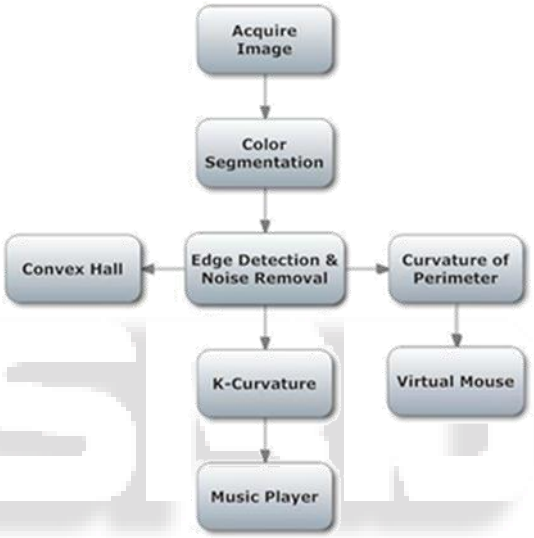


Fig. 3: system model flow diagram of the system(hand gesture recognition)

The diagram 3 above represents the flow diagram of the system. Here initially the image is being acquired by the webcam. This output of the webcam is being sent into the machine. This system converts these video file into number of frames called sequences. Matlab software has an efficient toolbox for this purpose. After capturing the image it is being converted into L*a*b for colour segmentation method. And those edges which are represented by using edge detection algorithm called canny edge detection algorithm. Andin parallel with that noise is also being removed. From the hand segmented image the finger tips detection can be made.

III. HAND GESTURE RECOGNITION METHODS

A. Image Acquisition:

here the user should wave his or her hand in front of the webcam. In Matlab the image acquisition tool box converts the image into number of sequences called frames. The two main functions which is being used for image acquisition are 'getsnapshot' and 'getdata' for grabbing the frames.Frame = getsnapshot(obj)

Data = getdata(obj)

B. Colour Segmentation:

this is the second step where the segmentation of the hand from the background. Skin colour segmentation is very much challenging and difficult task in the real time. For this reason this RGB is converted into L*a*b colour space. This colour space is derived from CIE XYZ tristimulus values. L*a*b contains the luminosity 'L*' or brightness layer and chromatically layer 'a*', indicating where exactly the colour pixels falls in the red green axis. And chromatically 'b*' indicating where exactly the colour pixel values falls on blue and yellow axis.

Converting L*a*b moves colour on the three dimension (RGB) onto two chrominance channels and one luminance channel. Then should make an calculation of thereference colour to colour of the given pixel. And these pixels should be classified by using nearest neighbour rule. Finally any pixel value which is closest enough will be set as '1' hence the binary image of the hand segmented image is obtained.

skin colours can be extracted by choosing the values of 'a*' as 17.3 and 'b*' as 13.83.

And these values will be varied for different colours. Diagram 4 shows the colour segmentation of different colours.

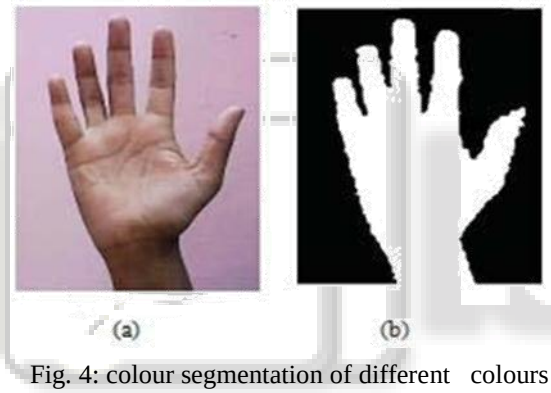


Fig. 4: colour segmentation of different colours

C. Edge Detection and Noise Removal:

in this third step the edges are being detected or to find the number of contours in the segmented image. And this can be implemented using 'Canny edge detection' method. Here the hand image of an RGBis being converted into L*a*b colour space and the hand region is being segmented from the input image. Noise removal is being done by considering the blob or segmented hand image. By removing the small objects. The diagram 5 shows the edge detection mechanism shown below :-

Fig. 5: canny detection of edges in an segmented image

D. Finger Tips Detection:

the three techniques which are being shown below which are being used in this paper are :-

E. Convex Hull:

its an first method to detect the finger tips using this convex hull detection algorithm. In this method a convex hull or an polygon around a blob or an segmented image this convex hull algorithm can be implemented to detect the finger tips. The smallest convexwhich will be enclosing all the points of the binary image is being made.

Here the 'kinks' are being used to detect the finger tips.thiscan be done bygoing around each and everypoint at theconvex hull and calculating the angle at those points. Here the law of cosine is being used to find the angles. Filter the angles to detect the finger tips. Diagram 6 shows the results.

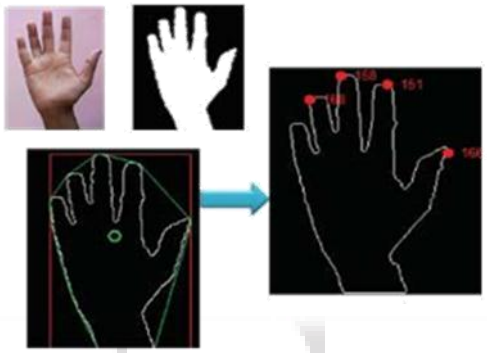


Fig. 6: Convex Hull approach

F. Convex Hull Flaws:

here it is not an robust in nature. And it is faster method. Example of the flaw in convex hull method is shown below when making an fist knuckles is being identified as an finger tips since they are points in the convex hull. When moving inwards then it losses the finger tips. The diagram 7 shows the faults in this convex hull methodology.

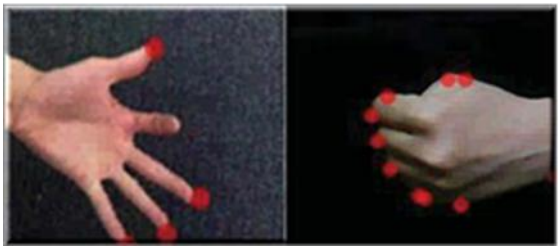


Fig. 7: convex hull defects

G. K- Curvature Method:

its an second method to detect the finger tips and here the main approach is to find the number of contours in the boundary of points p(i)=[x(i),y(1)]. And here we will make the k-curvature calculation as the angle between the two vectors p[(i-k),p(1)], p[(i+k),p(1)]. Where k is an constant value and we set k value as 35. And this k-curvature is being calculated easily by the dotproduct. In this approach the main idea behind is that the points which are closer to 0 called as an candidates points.and these represents peaks and valleys. The diagram 8 shows the approach of this k-curvature method. Here the threshold angle $\theta th=30$ is being used and the points below this will be considered further.

Here to calculate the values whether the value is peak or an valley this can be converted into 3-D. lying in that XY plane and computing their crossproduct. If the z-component value is positive value then it is being considered as the peak and if the z-value is negative then it is valley. Finding the number of peaks and valleys we can find hand gesture. Diagram 8 shows the live video of k-curvature.

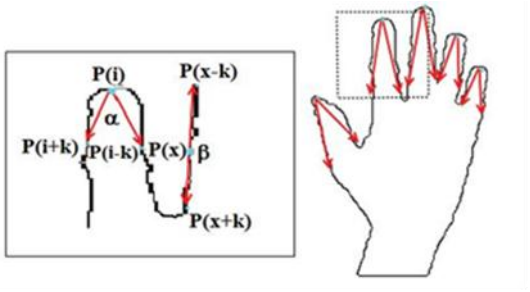


Fig. 8: K-Curvature Method

H. Limitations of K – Curvature:

this method cannot be used in dynamic hand gesture recognition and its not robust method in nature. For K-curvature algorithm if there is a fist then it will always recognises as "1" finger.

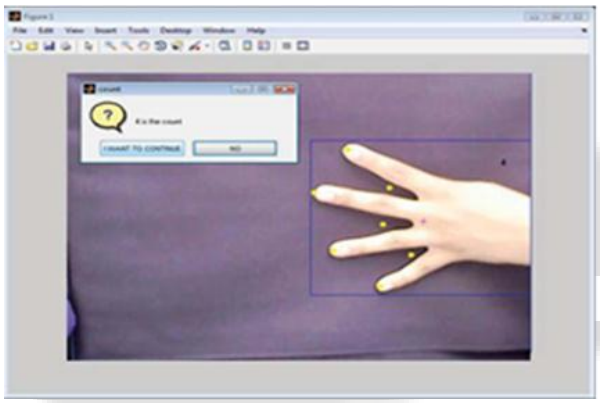


Fig. 9: shows the limitation of K – Curvature

I. Curvature of Perimeter:

this is third approach where here some of the morphological operations are being carried out for the finger tips. Here the steps are being shown below that is the first step is first the segmented hand is being eroded using distance transform method and will be finding the perimeter of the regional hand image. After this step the corner points segmented hand of the eroded version is beingexplored. All the corner points are being considered as the candidate points. Eliminate the corner points which will be closer to the boundary. At each and every point the cropoperation should be performed to the section of the perimeterof the segmentedhand and to calculating the eccentricity. Lower eccentricities shows the circles which are similar indicates the finger tips detection .with certain values of the eccentricity it can be said that it is closed to the finger tips. Other candidate points such as knuckles it is going like a straight line. Now the candidate points along the finger tips and on the candidate points on the finger tips can be distinguished.

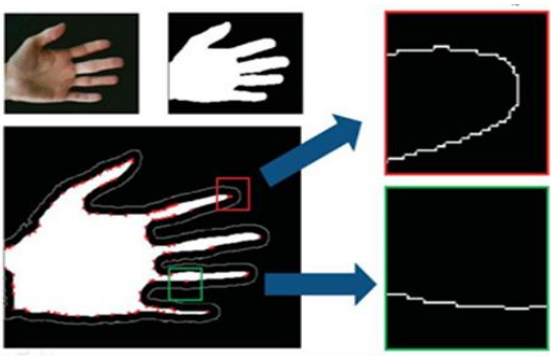
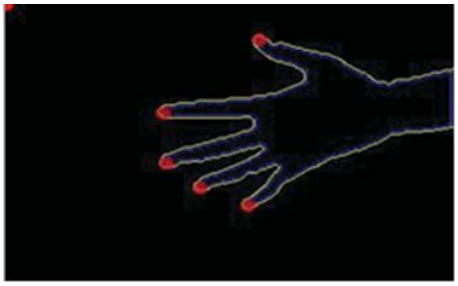
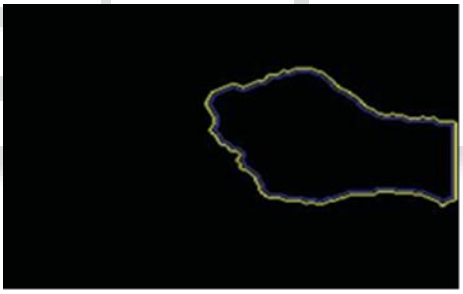


Fig. 10: curvature of perimeter idea,the red box shows the candidate point of the finger tip and green box indicates the candidate at the knuckle.

The above diagram 10 shows the idea of the curvature of perimeter. This approach is much faster and it can be used in the dynamic hand gesture recognition and it is robust in nature.



(a)



(b)

(c)

Fig. 11: above shows the live video results of perimeter of curvature.

IV. APPLICATIONS

A. Music Player:

its an major application in the static gesture using Active-X protocol using K-curvature method. Active –X protocol is being designed by the Microsoft and it is an set of technologies. This is being designed for the main purpose of sharing the information for different applications. It is an

outgrowth of the two other Microsoft technologies OLE(object linking and embedding) and COM(component object model). By using this Active –X protocol it is very much possible to integrate the windows media player in matlab software by using the following h=actxcontrol('progid'). where the 'progid' for windows media player is 'WMplayer.OCX7'. it is also possible that we can change the song by changing along the path or along the flle name.different tasks are being carriedfor different gestures. "open hand" here it is being used to stop the music. The diagram 12 shows the live video results of the music player using Active-X protocol.

Fig. 12: live video snap shot of the music player of the operations of different gestures.

B. Virtual Mouse:

The main approach is that to make control of the mouse pointer location, position and clicks and motion. Which these are not available in Matlabsoftware. To resolve this problem the java class is being imported by name "java.awt.Robot" which has this ability to make these operations mentioned.

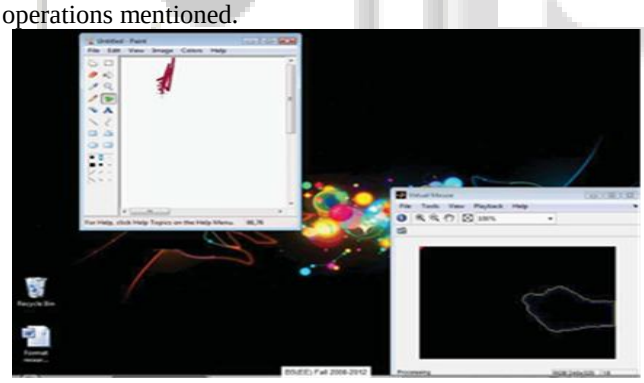


Fig. 13: live video snap shot of the virtual mouse in paint application

Here to make the control over the motion and position of the mouse pointer "centroid tracking" is being used here. And the centroid of the binary hand image is being passed to class mouse.mouseMove(X,Y). so here the mouse pointer is being moved according to the centroid motion. Other tasks can be performed by different gestures in the same frame. If the system doesn't not affect any fist then it will track only the hand. And when it detects all the five fingers it will perform click operation. The diagram 13 displays the virtual mouse live video snap shot.

V. SUMMARY AND FUTURE SCOPE OF THIS PAPER

This paper explores and explains the three different techniques of finger tips detection methods such as convex hull,K-Curvature and curvature of perimeter methodologies. Here the most robust and method is the curvature of perimeter method by experimental results. The main two applications are being discussed here is music player and virtual mouse. The system has other applications also such as Robotics with navigation and computer games and touch less interactions with the system by the end users. The next work in the future is by using the kalman filter algorithm to find where the finger tips is exactly going on so by this the method of segmentation can be improved from the background. Here the background was simple in nature so it can be segmented easily but for ,more complex background K-mean clustering algorithm should be used for the segmentation mechanism. And it is an statistical approach. Here the algorithms can be optimized further by converting them into an fixed point and an C code can be generated and it can beembedded into systems like DSP or FPGA systems.

REFERENCES

[1] ankit Chaudhary, J. L. raheja , Karen Das , Sonia raheja, " Intelligent Approaches to interact with machinesusing Hand Gesture Recognition in Natural way". InternationalJournal of Computer Science& Engineering Survey (IJCSES) Vol.2, No.1, Feb 2011.

[2] K. G. derpanis, "A Review of Vision-Based Hand Gesture," Department of Computer Science, York University, February, 2004.

[3] Thiago R. trigo, Sergio Roberto M. Pellegrino, "An analysisof Features for Hand-Gesture". IWSSIP 2010 - 17th International Conference on Systems, Signals and Image Processing .

[4] Jong-Min Kim; woong-Ki Lee, "Hand Shape Recognition Using Fingertips" Fuzzy Systems and Knowledge Discovery, 2008.FSKD '08. Fifth International Conference on , vol.4, no., pp.4448,18-20 Oct. 2008

[5] Oka, K.; Sato, Y.; Koike, H., "Real-time fingertip tracking and gesture recognition," Computer Graphics and Applications, IEEE, vol.22, no.6, pp. 64-71, Nov/Dec 2002.

[6] http://www.mathworks.nl/matlabcentral/fileexchange/30447 -point-pattern-matching-algorithm-for-hand-gesture-american-sign-language-asl-recognition

[7] nolker C., Ritter H., Visual Recognition of Continuous Hand Postures, IEEE Transactions on neural networks Vol 13, No. 4, July 2002, pp. 983-994

[8] Nguyen D.D., Pham T .C., Jeon J.W., Fingertip

[9] Detection with Morphology and Geometric Calculation, IEEE/RSJ International Conference on Intelligent Robots and Systems, St. Louis ,USA, Oct 11-15, 2009, pp. 1460-1465.

[10] Lee D. and Park Y., Vision-Based Remote Control System by Motion Detection and Open Finger Counting, IEEE Transactions on Consumer Electronics, Vol. 55, issue 4, Nov 2009, pp. 2308-2313.. MATLAB example, Colour based segmentation using the L*a*b colour space , Copyright 1993-2007 The MathWorks, Inc.Published with MATLAB®

