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Obtaining Hand Gesture Parameters using Image Processing

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***Abstract*— This paper presents a technique to develop a vision based interface system for controlling and performing various computer functions with the aim of making the human-computer interaction. The main aim of human computer interaction is to develop simpler ways for users to interact with computers. One of the main areas of research in human machine interaction is hand gesture recognition. It makes interaction with machines intelligible and effortless. In this investigation, with the use of a camera and computer vision technology such as image segmentation and feature extraction, a technique is developed which can be used for computer control using hand gestures.**

***Keywords*— Human computer interaction, computer vision, hand gesture recognition.**

I. INTRODUCTION

Human-computer interaction (HCI) is a growing area of research and it involves multiple computer science-related disciplines (image processing, computer vision, programming languages) as well as human science disciplines (ergonomics, human factors, cognitive psychology, and interaction design). These disciplines are concerned with the design, evaluation and implementation of interactive computing systems for human use. Research in HCI primarily deals with the design, implementation, and assessment of new interfaces for improving the interaction between humans and machines. Gesture Recognition, an emerging field in HCI, enables humans to communicate with the machine and interact naturally without the use of any mechanical devices. Extensive research is being carried out in this field to design simpler ways to interact with computers. The aim in each step is to make the interaction more and more natural i.e to reduce the gap between a human mental model and the process of performing the task.

In this paper, the convex hull and convexity defects algorithms are programmed in Open CV platform using C++. Later these are manipulated to find various parameters which can be used for computer control. These parameters can be used for designing hand gestures for computer control. For performing all these actions, the webcam present in our laptops is the only hardware required. Programming is done using Open computer vision library and C++.

II. LITERATURE REVIEW

Many methods have been developed by several researchers for controlling the mouse movement using gesture recognition. Many of them have been developed around the Hidden Markov Model [1]. But the computational cost involved in this method is quite high. Viola and Jones [2] provided a novel approach to detect an object efficiently using Adaboost to interpret the hand motion by palm recognition. Park [3] used a method, where the action of clicking of mouse was done by keeping a track of the finger tips. Nayana & Kubakaddi [4], made use of feature extraction, for counting the number of fingers displayed. Jinda-apiraksa et al. [5] used the shape base descriptor method, which calculated the ratio of squared perimeter of the shape to its area. If two different hand shapes with same perimeter to area ratio exists, these two different shapes will be classified as same. Thus, it limited the number of gesture pattern that can be classified.

III. METHODOLOGY

The software used in this work are Open CV and C++. Open CV is an open source computer vision library which mainly focuses on real time image processing and computer vision. Programming is done using C++, a is a general-purpose object oriented programming language.

The steps involved are:

1. Derive the binary image from the colored image frame which was obtained as input from webcam.
2. Find the contour of the binary image and draw this on another blank image.
3. Find the center of mass of hand.

4. Find and draw the convex hull and convexity defects on a blank image.
5. Define and manipulate certain points which can be used for gesture control.

From the obtained colour image, the binary image is derived using image segmentation technique. This is followed by extracting the contour of the image. This will be required for drawing the convex hull and convexity defect. The hand contour and the convex hull are represented in Fig.2. The center of mass of the hand is computed. This is done using algorithms available in Open CV. centroid of hand image is calculated using the image moment:

$$X = \frac{m_{10}}{m_{00}}$$

$$Y = \frac{m_{01}}{m_{00}}$$

Where,

m_{00} : The moment of order zero. It is equivalent to the total intensity of the image.

m_{10} : First order moment about X- axis.

m_{01} : First order moment about Y-axis

Convex hull of the hand contour is drawn as represented in Fig. 1. The region between the fingers forms the convexity defects. The number of fingers present in the hand gesture is determined by counting the number of convexity defects present in the hand gesture. The vertices of the convex polygon are found out to identify the convexity defects. The number of fingers is counted based on the number of convexity defects present in the convex polygon.

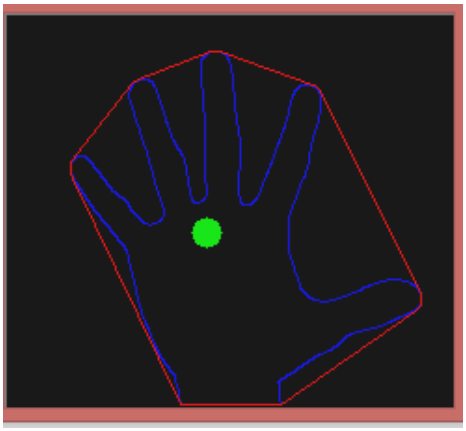

Fig. 1. Center of Mass of Hand.

Fig. 1 Blue colour indicates the hand contour, red colour indicates the convex hull of hand, and Green colour indicates the centroid of the hand.

In this drawing, we define various parameters as follows:

1. ***Point Start***— Point of contour where the convexity defect begins.
2. ***Point End***— Point of contour where the convexity defect ends.
3. ***Point Far***— Point within the defect which is farthest from the convex hull.
4. ***Depth***— Distance between the convex hull i.e the outermost points and the farthest points within the contour.

IV. RESULTS AND DISCUSSION

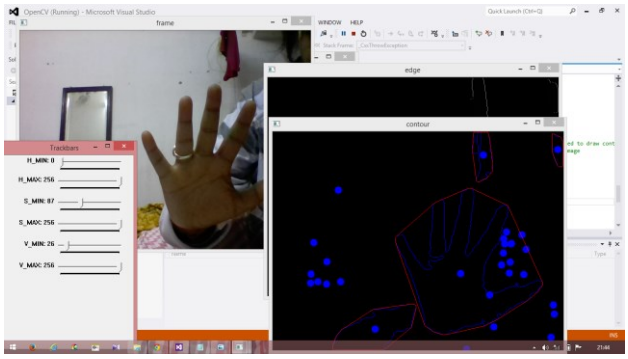

Fig. 2. Convex Hull of Hand Contour.

Fig. 2 Shows the convex hull drawn around the hand contour for real-time input from webcam.

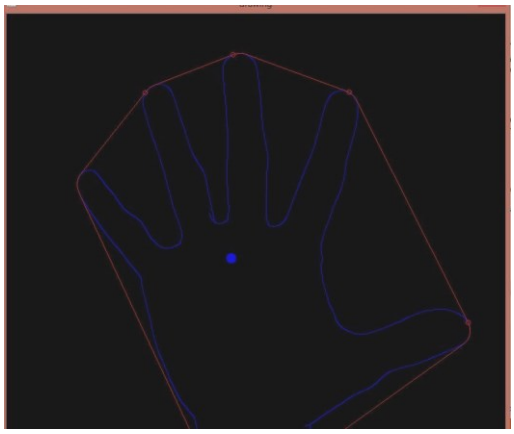

Fig. 3. (a) Point Start.

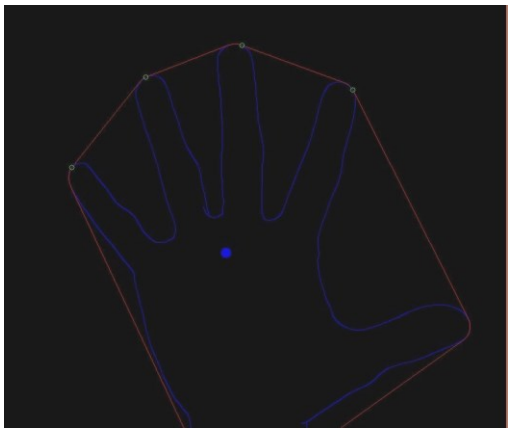

Fig. 3. (b) Point End.

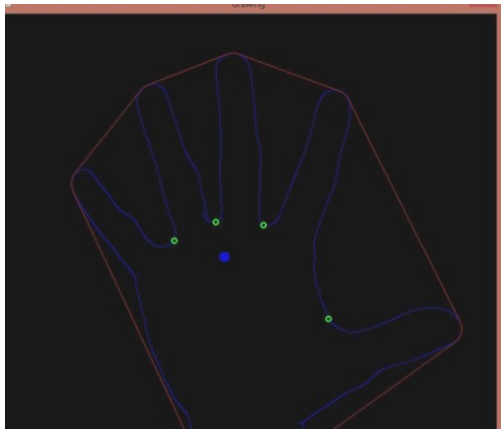

Fig. 3. (c) Point Far.

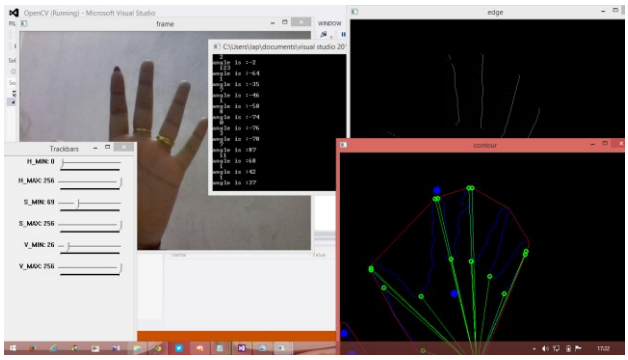

Fig. 4. Gesture Parameters for Human Hand

Static images were used and the corresponding parameters i.e point start, point far and point end were marked. The results ae represented in Fig.3. Similar results were obtained from real time image frame, represented in Fig.4. These points can be used as parameters for finding various angles or distances.

Fig.3 Representation of various parameters on convex hull.

Fig.4 shows the results for real time image frame read from webcam.

V. Scope of Future Work

The points obtained i.e Point start, Point end, Point far can be used to find angles and distances between the points. These angles and distances can be used as parameters for designing hand gestures for computer control.

VI. Conclusion

This paper focused on finding the parameters that can be used for hand gesture control. The points obtained can be used for defining other parameters such as lines (joining two points), angles between lines. They can be more improved and used for making hand gesture based computer control. Further research studies are going on in this topic to develop the applications using these parameters.

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