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# Gesture Recognition and finger tip detection for Human Computer Interaction

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***Abstract*— The paper proposes a novel gesture recognition and finger tip detection algorithm for Human Computer Interaction, in particular mouse control operations using real time camera. The hand gestures are captured using real time camera. First, the hand region alone is segmented using region growing algorithm followed by morphological operations. The centroid of the palm region is calculated and the finger tips are then detected using the convex hull algorithm. The proposed method is tested on five different gestures and the results prove that the gestures are able to be recognized and the finger tips detected. The method can be applied for hand gesture controlled mouse operations.**

***Index Terms*— Gesture recognition, convex hull, finger tip detection.**

## I. INTRODUCTION

The term gesture is defined as movement of body or limbs to convey an idea. It finds enormous applications in Human Computer Interaction (HCI). Hand gestures can be used for communication between human and computing devices. Numerous approaches have been developed to interpret hand gesture for HCI. The hand gesture recognition approaches can be mainly divided into Data-Glove based and Vision Based approaches [4, 5, 12, and 13]. The Data-Glove based methods use sensor devices for digitizing hand and finger motions into multi-parametric data. The extra sensors are used to collect hand configuration and movement, but these devices are quite expensive and it needs experience for the operation of the device. In contrast, the vision based methods do not require any extra device. The movement of hand is recorded by video camera and in the individual frame, the hand part alone is segmented. The isolated hands are then recognized for different postures.

Elakkiya et al [1] proposed the method in which the preprocessed data of the detected hand is transformed into a fuzzy hand-posture feature model using fuzzy neural networks. Then, the actual hand posture is determined by applying fuzzy inference from which the hand gesture is recognized. Hand gesture recognition algorithm based on the finger tip structure detection is proposed [2] in which 10 different gestures are recognized. Igorevich et al [3] proposed the method in which gray scale histogram is used to define depth threshold of calculated disparity map. The detected outstretched hand is filtered out then.

Shah et al [6] proposed the gesture recognition method in which the color marker is pasted on the finger and is used to track the movement of the finger. Operations such as thresholding are used to find the color and six different gestures are identified using the method. In the method proposed by Park, the hand image is captured using the camera, the RGB color space is converted to YCbCr, and then the hand region is segmented using the skin color range. Then, the finger tips are identified using the convex hull algorithm [7]. In the method proposed by Umadevi and Divyasree, from video acquisition, the hand region alone is segmented using skin color based background subtraction and then morphological filtering operation is done to detect five different hand gestures [8].

Elsayed et al. proposed the method of adaptive background subtraction with skin color based threshold followed by morphological operations [9]. In the method proposed by More and Sattar, the different hand postures are recognized accurately using Scale Invariance Feature Transform (SIFT) and tested for all sign alphabets [10]. Jingbiao et al. proposed the dynamic gesture recognition algorithm in which the least square method is used to fit the trajectory of hand gravity motion and 80 hand gestures are tested [11].

In this paper, a hand gesture recognition method is developed using region growing segmentation and convex hull algorithm. The method can be applied for mouse control operations using hand gesture recognition.

## II. PROPOSED METHOD

The block diagram of the proposed method is shown in Figure 1.

The video of the hand gesture is captured using the HP Webcam which is in the YUY2 format. The YUY2 format is converted to RGB bitmap format. The individual frames are obtained and converted to grayscale which are of resolution 960 x 1280 pixels. The image is then resized to 320 x 430 pixel resolution.

Region growing segmentation followed by morphological operations is applied to segment the hand region alone from the

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background region. Then centre and radius of the palm region are calculated. The convex hull is computed and based on these computations, the location of finger tips are identified.

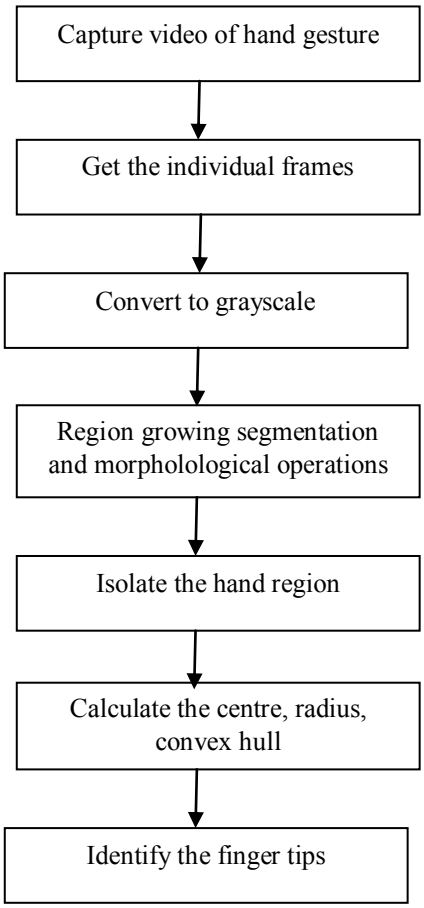



Figure 1 – Proposed Method

### A. Region Growing Segmentation and Morphological Operations

The main criterion in region growing segmentation is the homogeneity of regions based on features such as gray level, color, texture, shape etc., The steps involved in the region growing segmentation are given below.

1. Set the number of regions to be segmented as $R_1, R_2, \ldots . R_n$ and the initial seed points of the regions as $s_1, s_2, \ldots . s_n$.
2. For every neighboring pixel of the seed point $s_i$, $i = 1,,2, \ldots n,$ compute the difference between its pixel value and the pixel value of the seed point. If the difference value is less than the threshold value, the neighboring point is classified into the region $R_i$.
3. Recalculate the boundary of $R_i$ and set those boundary points as the new seed points.
4. Repeat steps 2 and 3 until all pixels have been allocated into the regions

After region growing segmentation, the connected component-based morphological operations are performed to segment the hand region accurately.

### B. Finding the radius and centre of the hand region

The centre of the hand region is calculated using equations (1) and (2).

$$x_c = \frac{\sum_{i=0}^{k} x_i}{n} \quad (1)$$

$$y_c = \frac{\sum_{i=0}^{k} y_i}{n} \quad (2)$$

$(x_c, y_c)$ denotes the $x$ and $y$ coordinates of the centre of the hand region, $(x_i, y_i)$ denotes the $x$ and $y$ coordinates of the $i^{th}$ pixel in the hand region and $n$ denotes the number of pixels in the hand region.

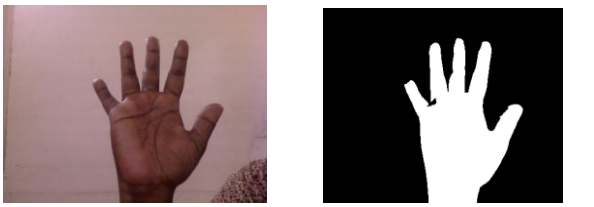
### C. Convex Hull Algorithm

The finger tips on the hand are detected using the Convex Hull Algorithm which finds the biggest polygon including all vertices. The convex Hull of a finite set of points $S$ in the plane is the enclosing convex polygon $P$ with smallest perimeter. A set $S$ is convex, if the points $p$ and $q$ are in $S$ implies that the line segment $pq$ is a subset of $S$. The computation of convex hull of a set of points is used to detect the finger tips. The distance between the centre of hand region and a pixel in the convex hull set is calculated. If this distance is longer than the radius of the hand, it can be identified that the fingers are spread and otherwise the fingers are folded. The longest vertex is identified as the index finger. The vertex with distance less than 30 pixels compared to the neighboring vertex is deleted. The other finger tips are identified as the vertices with subsequent maximum distances, after deletion of the neighboring vertices.

## III. Experimental Results

The proposed hand gesture recognition algorithm is implemented using MATLAB. The real time hand gestures are captured using HP Webcam. The individual frames in YUY2 format are obtained and converted into RGB format, then converted to grayscale and resized to 320 x 430 pixel resolutions. Then region growing segmentation followed by morphological operations is applied to segment the hand region. Then, the finger tips are identified using the convex hull and radius computation. The proposed method is tested on five different gestures and the results are shown in Figure 2.

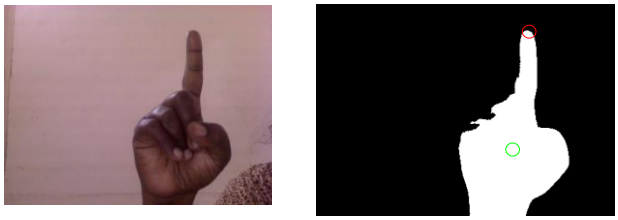
Figure 2 (a) shows the input frame of gesture, (b) shows the segmented hand region after region growing segmentation and morphological operations. Figure 2 (c) shows the radius of the hand region and (d) shows the convex hull. Similarly, Figure 3 (a), (c), (e) and (g) show the different hand gestures. The segmented outputs with centers and finger tips detected are shown in Figure 3 (b), (d), (f) and (h). The proposed method is tested for the five different gestures and recognized. The finger tips are detected as shown in the results.



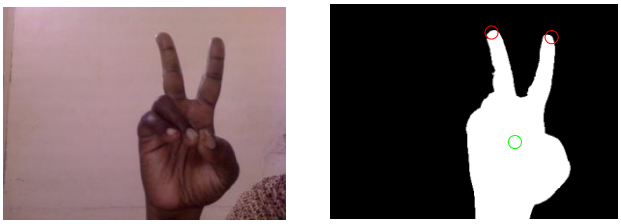
(a) (b)

(c) (d)

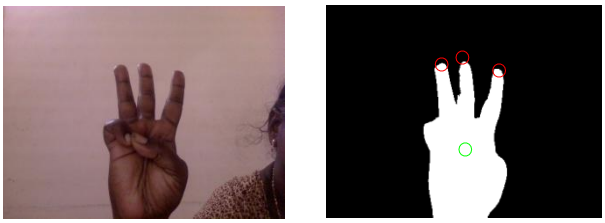
Figure 2 – Hand Gesture Recognition Results for Gesture 1
(a) Input frame of gesture (b) Segmented Hand Region
(c) Segmented hand region with plotted radius (d) Convex Hull of the hand region



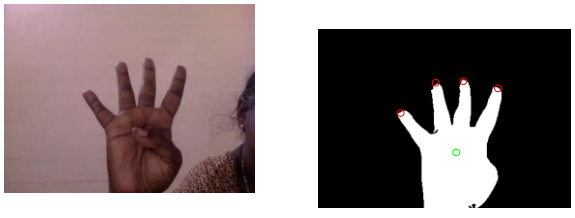
(a) (b)



(c) (d)



(e) (f)



(g) (h)

Figure 3 - Hand Gesture Recognition Results for Gesture 2, 3, 4 and 5

(a), (c), (e), (g) - Input frame of gesture
(b), (d), (f), (h) - Segmented gesture with finger tip and Centre of hand detection

## IV. CONCLUSION

A real time gesture recognition and finger tip detection algorithm for Human Computer Interaction is proposed. Region growing segmentation is used for hand detection and convex hull algorithm is used for finger tip detection. The method can be used for automatic mouse control operations. Five different gestures are tested and it is verified that the gestures are recognized and the finger tips detected. The work is to be extended for real time mouse control operations in future.

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