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A SURVEY ON HAND GESTURE RECOGNITION

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Abstract - *The interaction between human and computer is becoming stronger day by day. Gesture recognition plays an effective role against the issues of different applications. This consists of various aided tools and gesture detection and classification algorithms and techniques. This paper introduces the main stages for constructing hand gesture classification system and investigates various studies that utilized different algorithms and techniques. Gesture recognition system challenges that hinder the performance of any recognition system related to complexity, accuracy and speed problem have been explained. Comparisons between various recognition factors are demonstrated as well in the conclusion and results.*

Key Words: *Hand gestures recognition, Human Computer Interaction, Segmentation, Complex background, Feature Extraction*

1. INTRODUCTION

In present day lot of research has been taking place to develop a natural and simple interaction between human and computer. By using image processing vision based hand gesture recognition interaction can be established. For hearing impaired people it is very difficult to express their thoughts and it is very difficult when it comes for teaching and parenting them. Hand gestures are used as a primary language for deaf people and when they want to communicate with people. Hand gesture involves hand shapes, orientation and movement of hands.

Further hand gesture can be classified into two categories, namely static and dynamic hand gestures. Static hand gestures is defined as the configuration of the sign of hand gestures and poses that are represented in the form of images while dynamic hand gesture defined as the sign of moving hand gesture represented by the image sequence or video[6]. In this paper we are concerned in recognition of dynamic hand gesture. The inputs are taken from web camera or any other camera. These images are subjected to modest MATLAB algorithms which pre-process the image and detect the skin region and count the number of active fingers. The main steps for a general gesture recognition system are: acquired gesture, features analysis, and finally classification tool. Figure 1 demonstrates these steps.

Fig.1: Recognition gesture system stages [1]

Gesture recognition systems suffer from some challenges which can be raised at any stage of recognition. Some of these challenges are easy to handle, like scaling problem or skin color but some like cluttered background or lighting variation can pose problems in recognition. However these challenges could be classified as follows.

1) Complexity
2) Illumination change
3) Aging
4) Rotation:
5) Size of the image

2. RELATED WORK

In recent years, many largely different approaches have can been used to recognize static hand postures. In this section, we introduce the different approaches, specifically focusing on vision-based interfaces need to recognition from a hand gestures.

Many research papers related to hand gestures recognition in one represents a novel method for hand gesture recognition based on Gabor filters and support vector machine (SVM). Gabor filters are first convolved with images to acquire desirable hand gesture features. The principal components analysis (PCA) method is then used to reduce the dimensionality of the feature space. With the reduced Gabor features, SVM is trained and exploited to perform the hand gesture recognition tasks. To confirm the robustness of the proposed method, a dataset with large posed-angle (>45 deg.) of hand gestures is created. The experiment result shows that the recognition rate of 95.2% can be achieved when SVM is used. A real-time video system for hand gesture

recognition is also presented with a processing rate of 0.2 s for every frame. This result proves the efficiency and superiority of the proposed Gabor-SVM method [1].

A vision-based static hand gesture recognition algorithm consists of three stages: preprocessing, feature extraction and classification. The preprocessing stage involves following three sub-stages: segmentation which segments hand region from its background using a histogram based thresholding algorithm transforms into binary silhouette; rotation that rotates segmented utilize sensors to measure the joint angles, the positions of the gesture to make the algorithm, rotation invariant; filtering that effectively removes background noise and object noise from binary image by morphological filtering technique [2].

Rudy[6] had proposed a prototype system that can recognize the hand gesture sign language in real time. We use HSV (Hue Saturation Value) color space combined with skin detection to remove the complex background and create segmented images. Then a contour detection is applied to localize and save hand area. Further, we use SURF algorithm to detect and extract key point features and recognize each hand gesture sign alphabet by comparing with these user image database. Based on the experiments, the system is capable to recognize hand gesture sign and translate to Alphabets, with recognize rate 63 % in average [6].

3. HAND GESTURE RECOGNITION ALGORITHM

This study analyzes different algorithms for the application of gesture recognition. Each of them are best with accuracy and/or computational speed. If the accurate requirement is needed, much complicated algorithms would be implemented with hardware complexity in real time. So, there is always a trade-off [9] [10].

3.1Pixel Count Algorithm

The pixel count algorithm is the basic and less complicated algorithm for hand gesture recognition. The input image which is obtained from the camera will be in RGB format. This RGB image is converted to Binary image (BW) using MATLAB function im2bw. Once the binary image is obtained, the skin region will be represented by the white (1) pixels and the background is represented by black (0) pixels. In this approach, the algorithm will count the number of white pixels and check the range in which the count falls. The ranges must be predefined in the algorithm by taking some sample values as shown in the Table I. By finding the white pixel count we can find the number of fingers raised. Since the output depends only on the white pixel count, this algorithm is invariant to rotation of hand [7].

TABLE I: RANGES USED WITH PIXEL-COUNT ALGORITHM[7]

Fingers	Sample 1	Sample 2	Range (approx.)
Zero	-	-	< 25,000
One	27,594	37,016	25,000 - 40,000
Two	71,047	73,742	40,000 - 80,000
Three	1,16,968	104,473	80,000 – 1,20,000
Four	1,41,964	1,50,293	1,20,000 – 1,60,000
Five	2,06,634	2,53,456	> 1,60,000

3.2 Detection of Circles

The disadvantage of Pixel Count Method can be eliminated by Detection of Circles algorithm. In this approach the fingers are to be marked with black circles prior to placing them before camera. The images are taken and the RGB image is converted to Binary image. In the obtained binary image the skin region is represented with white pixels whereas the background and the black circles are represented by the black pixels. From this image the number of circular objects is detected. The number of circular objects gives the finger count as shown in Figure 3. Since the algorithm concentrates on the number of circles alone, this is independent of both size and rotation of the hand. The circles are to be drawn on the fingers in a manner that each circle should be detected properly in the image[9].

3.3Morphological Operations

In this algorithm the RGB image is converted to Binary image. The binary image is filtered using a median filter of dimension 3. The obtained binary image is eroded by using appropriate structural element of dimension 3 to5. This image is further dilated by using another structural element of dimension 10 to 12. This pre-processing of the binary image is done to enhance the skin region [8].

The image obtained after pre-processing is subjected to hit or miss operation. The hit or miss transform is a morphological operation which recognizes the given pattern in a binary image [3]. The pattern is specified by two structuring elements SE1 and SE2. This transform recognizes the pattern of first structural element by deleting the pattern of second structural element.

3.4Scanning Method

This is the robust algorithm when compared to the above algorithms. In this method, RGB image is converted to Binary image. The skin regions are represented by white pixels and the background is

represented by black pixels. In order to enhance the skin region, the binary image is preprocessed by a median filter of suitable dimension. The image is divided into two halves. The lower half contains the thumb and the upper half contains the remaining fingers. Now, 3-5 linear horizontal scans are performed in both halves as show hand it is efficient only when the background is noise free. in Figure 5(a). The presence of thumb is detected in the lower half whereas the remaining fingers are detected in the upper half. The total count is equal to the sum of counts in two halves as shown in Figure 5(c).

In order to make this algorithm rotation invariant, vertical scanning is done besides horizontal scanning as shown in Figure 5 (b). While doing vertical scanning the image is to be divided into right half and left half and the way of finger counting is same as horizontal scanning. The block diagram of the Scanning method is as follows in Figure 2. The given RGB image is converted to the binary image before processing the algorithm for finger count. Then erosion and dilation morphological operations are performed. A comparison is done after scanning for transitions from (1-0) and (0-1) is applied in both horizontal and vertical directions to count number of fingers.

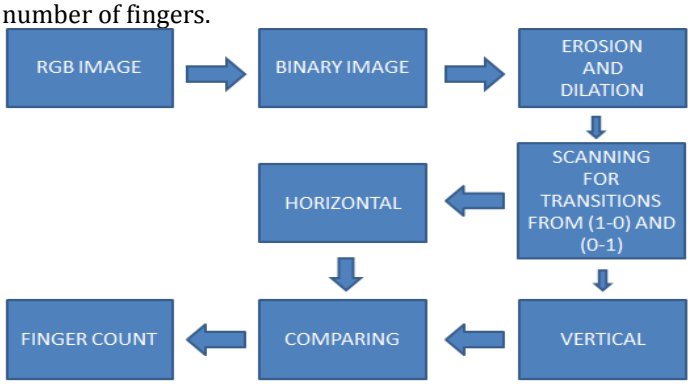

Fig.2: Flowchart of Scanning Method

4. SIMULATION RESULTS

Simulation results are obtained using Mat lab software.

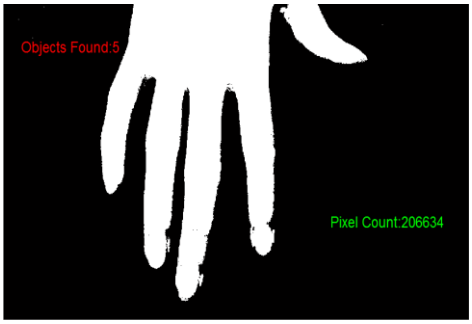

Fig. 3: Pixel count output

For the given input image shown in figure 2 the pixel count algorithm has counted the white pixels in the image which is 2,06,634 and this count falls in the range of five fingers.

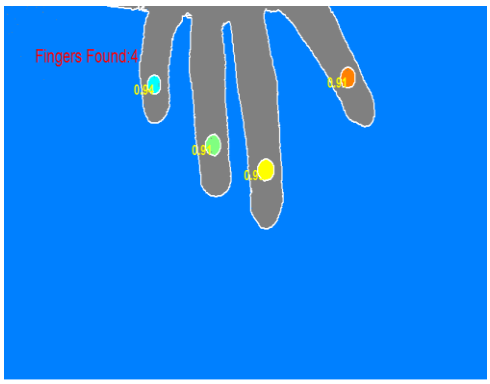

Fig.4: Detection of circles Output

The detection of circles algorithm calculates a unity metric, which is the ratio of area and parameter, for all the closed objects in the image. In the figure 4 shown above four circular objects are found.

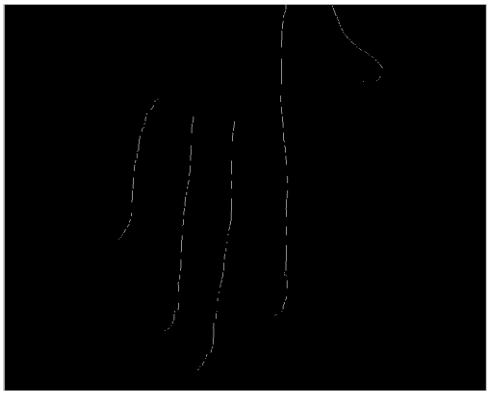

Fig.5(a): Hit or Miss operation

Fig.5(b): Morphological operation output

The hit or miss transform recognizes the transition of pixels from 1 to 0 as shown in figure5 (a). After dilation of figure5 (a) the edges are thickened and the number of

closed solid objects gives the count of active fingers as shown in figure5 (b).

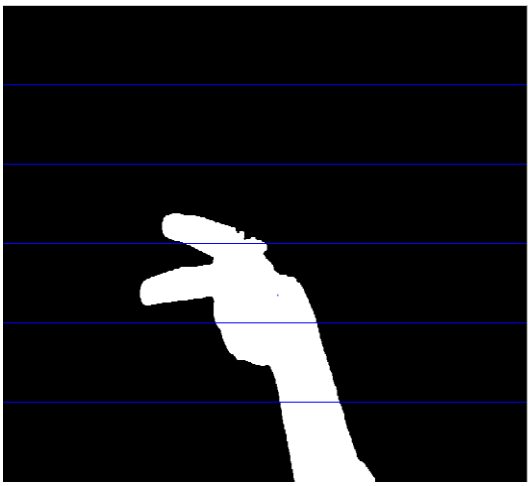

Fig.6: Linear horizontal scanning

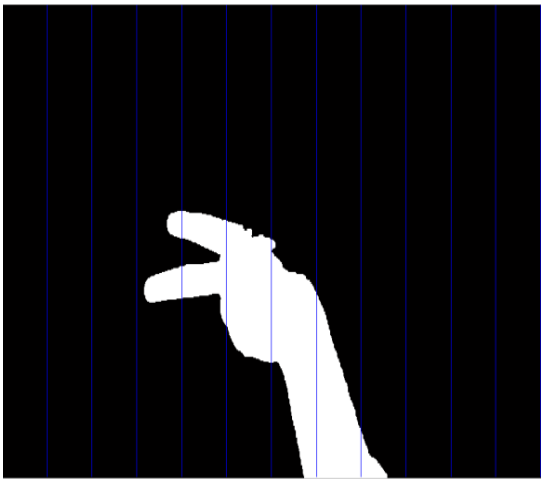

Fig.7: Linear vertical scanning

Fig.7: Scanning Method Output

Table II gives the time taken for MATLAB to execute the four algorithms. It is clear that execution time for pixel count Algorithm is less due to its simple procedure while execution time for morphological operations is more due to more preprocessing. Among all the methods the scanning method takes optimum execution time with more accurate results.

TABLE II. EXECUTION SPEED COMPARISON

Algorithm	Execution Time (sec)
Pixel count	0.6741
Detection of Circles	1.1811
Morphological Operations	2.0053
Scanning Method	1.0564

4. CONCLUSIONS

This modeling approach is fundamental for gesture recognition which is invariant to rotation. Out of all the algorithms scanning method is the robust method which delivers accurate results for 82.47% of images. In these algorithms the background is clear without any objects; this can be extended to gesture recognition with varying background. But in every method there are still some drawbacks.

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