Hand Gesture Recognition based on Shape Parameters*

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***Abstract*— This work covers the implementation of a static gesture recognition program by using image processing techniques to recognize pre-set patterns.**

I. INTRODUCTION

Many technologies have been appeared related to signal processing and pattern recognition, such as digital printing, voice recognition and, lately, face recognition enhancement (Apple Face ID). Our work lies on the development of a static pattern recognition, here appraised with hand patterns recognition.

Many programming languages can assist the project, we have chosen python. The choice was based in simplicity and friendly syntax, aiming to reduce any learning curve necessary.

Since human beings tend to differ in terms of size and shape, the most challenging problem consists of the segmentation and the correct classification of the information gathered from the input data, captured by one or more cameras.

A. BACKGROUND

In some passed decades Gesture recognition becomes very influencing term. There were many gesture recognition techniques developed for tracking and recognizing various hand gestures. Each one of them has their pros and cons. The older one is wired technology, in which users need to tie up themselves with the help of wire in order to connect or interface with the computer system. In wired technology user can not freely move in the room as they connected with the computer system via wire and limited with the length of wire. Instrumented gloves also called electronics gloves or data gloves is the example of wired technology. These instrumented gloves made up of some sensors, provide the information related to hand location, finger position orientation etc through the use of sensors. These data gloves provide good results but they are extremely expensive to utilize in wide range of common application. Data gloves are then replaced by optical markers. These optical markers project Infra-Red light and reflect this light on screen to provide the information about the location of hand or tips of fingers wherever the markers are wear on hand, the corresponding portion will display on the screen. These systems also provide the good result but require very complex configuration. Later on some advanced techniques have been introduced like Image based techniques which requires processing of image features like texture, color etc. If we work with these features of the image for hand gesture recognition the result may vary and could be different as skin tones and texture changes very rapidly from person to person from one continent to other. And also under different illumination condition , color texture gets modified which leads to changes in observed results. For utilizing various hand gesture to promote real time application we choose vision based hand gesture recognition system that work on shape based features for hand gesture recognition. This is universal truth that every person poses almost same hand shape with one thumb and four fingers under normal condition. The success of approach discussed in paper [1] for hand gesture recognition based on shape features is highly influenced by some constraints like hand should be straight for orientation detection in image, if it will not be followed then result could be unexpected or wrong and also we fix the new parameter to detect the presence of thumb. In paper [2], the approach is based on calculation of three combined features of hand shape which are compactness, area and radial distance. Compactness is the ratio of squared perimeter to area of the shape. If compactness of two hand shapes are equal then they would be classified as same, in this way this approach limits the number of gesture pattern that can be classified using these three shape based descriptors and only 10 different patterns have been recognized[1]. The algorithm implemented in this paper is divided into four main steps. First one is image pre-processing and segmentation of hand in the image using k-means clustering. The second step includes orientation detection, which is done in order to categorize image sequence into vertical and horizontal class. In the third step it calculates some of the essential shape based features required for hand pattern detection and for generating the unique 5 bit sequence for 45 different hand shapes. Finally, these resulted bits are used for assigning different key press events to various hand gestures. This proposed approach is designed and implemented for working on single hand gesture with uniform background.

II. PROPOSED SOLUTION

The flowchart of the proposed algorithm is shown in Fig. 1 and its main steps are discussed in the following.

A. Image Segmentation

The distribution of human skin color is located in small area of the color space, so the chosen color space must represent the advantage of separating luminance from chrominance information. Thus, the first step of the algorithm is the conversion of image to the YCbCr color space. In computer vision, image segmentation is the process of partitioning a digital image into multiple segments. This step is necessary

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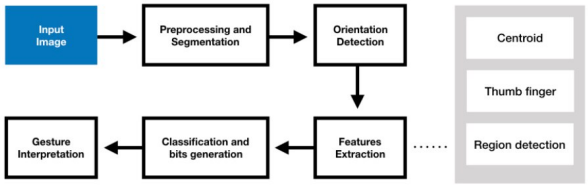

Fig. 1. Algorithm Flow Chart

for image enhancement, and was performed using the opencv K-means algorithm, a method of vector quantization which aims to partition n observations into k clusters in which each observation belongs to the cluster with the nearest mean. In this approach images is having uniform plain background consist of only one hand object, so we have two clusters, for representing the hand object and background of the image. Cluster 1 which represents hand, has all pixel values set as 1 and cluster 2 which represents background has 0 intensity pixels. To reduce the background noise we remove all small insignificant smudges or connected components from the image that has fewer than P pixel. And then apply filling of holes on binary image.

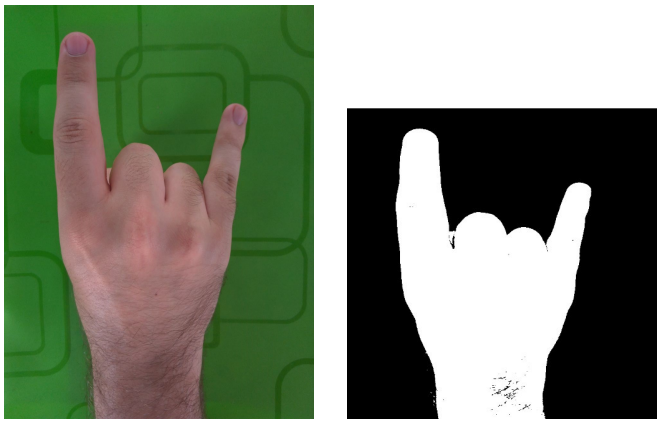

Fig. 2. (a) Original picture. (b) Image after Kmeans clusterization and segmentation.

B. Orientation Detection

The success of this approach is heavily depend on the correct labeling of hand orientation. In order to find it, we need to delimit the hand region area by detecting the pixels of the borders. To proceed, the image is scanned from top to bottom and left to right, the first white pixel is encountered is set as left most point of hand. The same thing is done for the other borders and the coordinates of the four extreme pixels represents the rectangle containing the useful information. After that, width and height of this rectangle are measured by subtracting the coordinates in order to find out image ratio (length/width). If hand is vertical then length of the bounding box is greater than the width of bounding box and their ratio would be greater than 1. And if hand is horizontal then width of bounding box is greater than the length of bounding box and their ratio would be lesser than 1.

C. Centroid

Centroid is also called centre of mass and it divide the hand in to two halves at its geometric centre if the image is uniformely distributed. It is calculated using image moment, which is the weighted average of pixels intensities of the image. In this work the built-in opencv function were used for moment measurement, and the centroid coordinates were calculated based on Figure 3.

$$\{\bar{x}\ \bar{y}\} = \{M_{10}/M_{00}, M_{01}/M_{00}\}$$

Fig. 3. Moments equation

D. Thumb detection

Since the thumb finger is located at the hand edge, if it is visible in the picture, it is necessarily located in one of the image borders. In order to detect its location, 30 pixels are taken from each side of the bounding box and the total number of white pixels (corresponding to skin color) is counted, if this amount exceeds 10 percent of the total of pixels in this area, it is supposed that there is a thumb in the evaluated side.

E. Finger detection

In this step we denote tip of the finger as peak. For finding the borders of hand, the open-cv findContours() function was used in order to get the boundary matrices, which is a list containing the index of pixels at the border of hand. These values are used for locating all the peaks, using a comparative method to determine whether a coordinate is highest to all its 15 nearest neighbors. After that, the euclidean distance from the peaks to the centroid are calculated, and 70 percent of the biggest distance (corresponding to the highest finger) is used as a vertical threshold to determine whether a finger is raised or not.

F. Classification and bits generation

Classification of various hand gestures is based on the features calculated in part II. The five bit binary sequence is thus generated to uniquely recognize and utilize these recognized hand gesture for supporting human computer interaction. Peak-Centroid plots are shown in Fig. 6. The significant peaks we identified in previous step is encoded as 1 and insignificant peaks is encoded as 0 based on the intersection status of various finger tips to threshold line. Leftmost bit in the 5 bit binary sequence are filled with zero in the opposite side of the detected thumb, for this, we supposed that the detected fingers are always next to the thumb on the vector.

III. CONCLUSIONS

With this project we learned the main points and features for gesture detection. We could reproduce the algorithm and make some changes which fitted better our data set. This implementation helped us to go deep in our image processing

knowledge, we could apply all concepts learned along the semester we could also learn some new tricks for this area. The work we did will help in future tasks and ideas since it's a initial proposal for gesture detection which is a unexplored area in some aspects as gesture controlled systems.

References are important to the reader; therefore, each citation must be complete and correct. If at all possible, references should be commonly available publications.

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