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Research paper

Invariant Hand Gesture Recognition System

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Abstract

Hand gesture recognition plays a vital role in numerous applications, which can run from mobile phones to 3D analysis of anatomy and from gaming to medicinal science. In a large portion of research applications and current business hand gestures recognition, has been implemented by utilizing either vision based or sensor-based gloves strategies where hues, paperclips of synthetic substances are used on to capture the gestures. Another essential issue associated with vision-based procedures is illuminated conditions. The threshold used for the segmentation is changed based on the light variations. A system is proposed in this paper, which extracts the gesture part from the hand image by preprocessing, followed by extraction of orientation histogram based feature is done. Further, in order to recognize the gestures, the extracted HOG feature vectors are provide for support vector machine (SVM). The proposed system is tested with 84 images and it outperforms with an accuracy of 94.04%.

Keywords: *Hand gesture; HSV; Classification; SVM.*

1. Introduction

As computers are winding up progressively inescapable, there is a developing enthusiasm for the advancement of new methodologies and innovations for crossing over the human-computer hindrance. This leads to an administration where the interactions with computers move toward becoming as normal as the interactions between humans i.e, human computer interaction (HCI). As a piece of HCI, fusing hand gestures into specialized techniques is a critical research region. The common method for human machine interaction, is Hand gesture recognition (HGR) and numerous scientists in the scholarly community are contemplating diverse methods that make such communications less demanding, and advantageous without the necessity for any extra gadgets. The systems distinguish, perceive and translate human feelings through gestures offered by the Gesture Recognition Systems. Gesture distinguishing proof is a characteristic method to pass passionate signs to the algorithm, as a human communicates his/her emotions regularly via gestures. For the most part characterized as any important body movement, gestures assume a focal part in regular correspondence and frequently pass on enthusiastic data about the motioning individual.

Nowadays, the researchers are working on a gesture recognition system in light invariant conditions. In this regard, for some viable situations the hand gesture recognition frameworks may have applications in different conditions. The light power may not be same all over, henceforth a vigorous framework that works in a wide range of light conditions is required. In picture preparing applications, the light power assumes a critical part since it altogether influences the segmentation of the ROI from unique picture outline. In the event that the light intensity changes, at that point the skin channel threshold likewise must be changed. This persuades the improvement of systems that are material to various light intensity. In this paper we examine the impact of light force on uncovered hand gesture recognition. Due to the variation of the light intensity during the day in this work, specifically we consider light intensity for every two hours. The proposed system interprets the hand gestures, whether it is a legitimate gesture or not. If it is legitimate the system will respond and perform the necessary actions. Our system considers the predicted hand gestures as predefined even it varies with light intensity.

2. Previous Work

There are numerous methods in the literature discriminating the features of the hand in gesture recognition. The authors in [1] extracted some common features including hand silhouettes to develop an automated tutor for sign language [2] - [4], contours [5], the hand with key points distributed i.e. joints and fingertips. Also in [6] a recognition system with the combination of features angle, velocity, and location was proposed. In [7] a system is proposed which recognizes forty six MAL digits and alphabet letter. According to [8] gesture recognition is where a user makes a gesture and a beneficiary remembers it. On the marketable side, the mobile companies are trying to integrate automated gesture recognition with handsets mobile companies are trying to make handsets recognize gestures naturally and to operate in lesser distances [9], [10]. There is anyway still a prerequisite for a framework for effective and powerful system finger identification. Recognizable proof of a hand gesture can be implemented from multiple points of view, which are chosen based on the issue to be unravelled.

3. Methodology

The computer vision principles in two-dimensional space plays a vital role in developing this hand gesture system. Fig. 1 shows the overview of the proposed system. The gesture of the user is captured by using a camera in the interface of the system. While mov-

ing the hand in front of camera live video is recorded from which frames are given as input to the system.
The system pre-process the image by using skin filter and the steps involved in pre-processing is discussed in next section The result image would be region of interest (ROI) i.e. only gesture image. After the gesture image is extracted, feature vectors are formed using it to recognize with the help of support vector machines (SVM) [11,12,13].

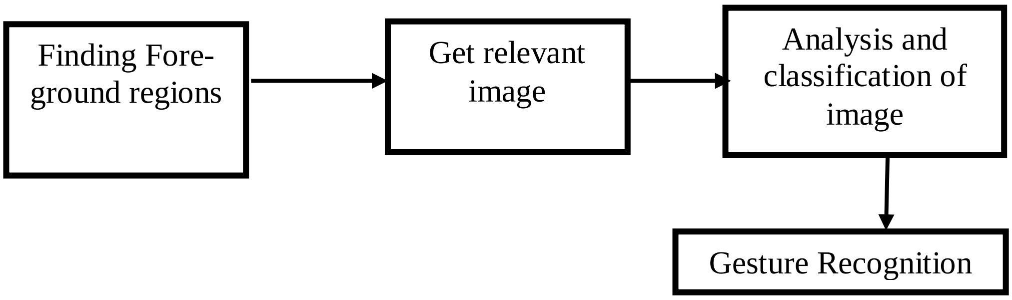

Fig. 1 The proposed methodology for hand gesture recognition

3.1 Pre-processing

The skin filter is used on the input image in order to diminish the light effect for some extent which works based on YCbCr or HSV color space. The chromacity (hue and saturation) values in the HSV color space are used to filter the skin while in the YCbCr color space the Cb, Cr values were utilized for filtering the skin. A skin filter which works on HSV color space is connected to the present image outline for hand segmentation, which separates the three components viz., brightness (I, V or L), saturation (S) and hue (H). The HSV color space can be mapped by using nonlinear transformation, as they are distortions of R, G and B color cube. This color space allows users to commonly state the limit of the skin color class with regards to saturation and hue. Also for reducing the illumination dependency of skin color, I, V or L are often dropped as the give brightness information. The images after applying skin filter is displayed in Fig. 2.

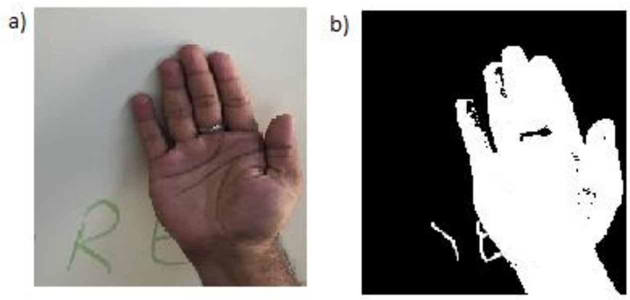

Fig. 2 Original and Binary image after applying skin filter.

The skin filter results in a binary image with the hand region in white and background in white color. Single bit (0 or 1) is used to store each pixel in a binary image. Further in order to smooth the jagged edges smoothening of resultant image is required. In this work, averaging filter is used for smoothening the image.
There may be false positives because of misclassification of some objects like skin color out of sight or skin pixels in the background. This can produce couple of undesirable spots in the resultant image as depicted in Fig. 2 (b). The biggest Binary Linked Object (BLOB) is taken as the mask to remove the errors and remaining are taken as background which is displayed in Fig. 3 (a). The 0' are considered as background while 1' represents hand coordinates i.e., biggest BLOB. The hand image after filtering and expelling all faults is exposed in Fig. 3 (b). Here, the restriction is BLOB hand should be a biggest one. Therefore, falsely distinguished skin pixels are removed as shown in Fig. 3.

3.1.Text

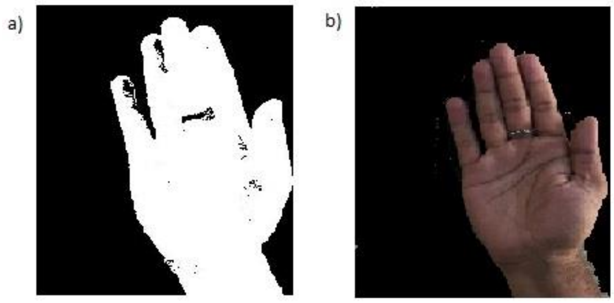

Fig. 3 Result of BLOB (a) Biggest BLOB (b) Filtered Hand

3.2. Feature Extraction

The result image will be the region of interest (ROI) i.e. just gesture image. After segmenting the ROI, the succeeding step is to extract the features from ROI and to recognize using support vector machines (SVM). McConnell proposed a feature extraction technique called Orientation Histogram (OH) which is simple and robust to light intensities. There are certain problems to be considered, due to varying illumination. In this regard, for two different images pixel by pixel contrast for the same gesture is considered, when there is same illumination condition. While distance between them is large, the image itself is considered as a feature vector. In this case the image itself acts as an element vector. For handling the lightening and position invariance orientation histogram is used. It is essential that the gesture recognition system should provide same result for same gestures, though, the hands presented in image with irrespective orientation. This should be possible by shaping a nearby histogram for neighborhood orientations. Therefore, this approach is suitable for both invariance and lighting conditions.

3.3. Classification

In this research a dataset is taken with six different gestures, which was previously used by different researchers. These six unique gestures utilized in this work, are shown in Fig. 4. Every individual gesture is considered for training SVM classifier, were taking in different skin colors and different light intensity. On recognizing the gesture, the corresponding action linked for that gesture is executed.

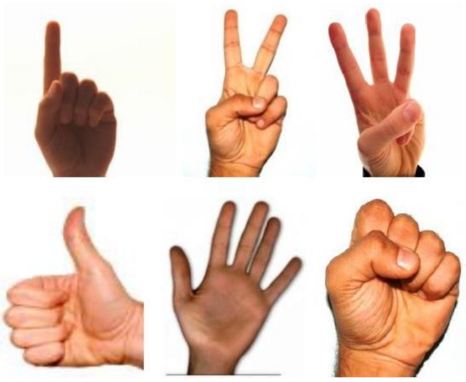

Fig. 4: Sample Hand Gestures

In addition, the corresponding audio file is played while the gesture is recognized. The images are collected manually and also from online sources to train the SVM. As we collected the images from heterogeneous sources, they may differ in skin color and light intensity to maintain the robustness. By default, the look of the skin color changes when there is a change in light intensity. For training SVM using each gesture fourteen different images are used.

4. Experimental results

The confusion matrix illustrates the number of images considered in each category of gestures and the result of the proposed system in classifying each category. For instance, the test design 4 (three fingers gesture), 13 gestures were mapped out of 14 testing images, similarly for the four finger gesture 1 was misclassified as two fingers gesture and the rest 13 were mapped accurately. Totally, 79/84 images were classified accurately. The precision rate is acquired is 94.04%.

Table 1. Confusion matrix of SVM Classifier

Test/ Target	2 Fingers	Single Finger	5 Fingers	Thumb Finger	Closed Fingers	3 Fingers
1	13	1	0	0	0	0
2	0	14	0	0	0	0
3	0	0	13	1	0	0
4	1	0	0	13	0	0
5	0	0	0	1	13	0
6	0	1	0	0	0	13

5. Conclusion

This paper proposed system to recognize the hand gestures irrespective of lighting conditions. In this proposed system skin filtering is used to extract the gesture and orientation features are extracted from the gestures. The extracted features are then utilized to recognize with the help of support vector machines. Informational index can be added to enhance the proposed system with the next stage. A database is used in this system to tie with the test case, then it is unfeasible to accumulate the hand movements. Therefore, it is necessary to be distinguish the hand geometry by identifying the amend hand gesture in image outline.

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