HAND GESTURE RECOGNITION SYSTEM

Mini Project Report
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III Semester
M. Sc. Computer Science

By

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CERTIFICATE

Date:

This is to certify that the Project entitled "HAND GESTURE RECOGNITION SYSTEM" is a bona fide study and research carried out by Nafeesath Musfira under my guidance in fulfillment of the degree of MSc Computer Science from the Central University of Kerala, Kasaragod during the academic year 2013-2015.

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Declaration

I, Nafeesath Musfira, Roll No: MCS051308, III Semester M.Sc Computer Science, School of Mathematical and Physical Sciences, Central University of Kerala, do hereby declare that the Mini Project entitled "Hand Gesture Recognition", submitted to the Department of Computer Science is an original record of studies and bona fide research carried out by me from July 2014 to December 2014.

NAFEESATH MUSFIRA

Acknowledgement

If words are considered as symbol of approval and tokens of acknowledgement, then the following words play the heralding role of expressing my gratitude. Many great people have participated directly and indirectly in the completion of this project work.

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ABSTRACT

Hand gesture recognition is one of the most novel and convenient method for Human Computer Interaction. There are two type of hand gestures, static and dynamic. Here, it is concentrated on dynamic hand gesture recognition. An initiative to ebstablish a hand gesture recognition was made in this paper. Various features of the hand gesture have been studied and an attempt to implement some of the feature extraction techniques has been made. This paper presents the methods used for motion detection for region of interest tracking, segmenting the hand regions from the background, finding the palm point, etc.

Table of Contents

CHAPTER 1:

1. Introduction

    1.1. Application
    1.2. Purpose of the project
    1.3. Objective
    1.4. Software Requirement
    1.5. Outline of the project

CHAPTER 2:
2. Literature Review

CHAPTER 3:
3.About Dataset

CHAPTER 4:
4. Materials and Methods
    4.1. Feature Extraction
    4.2. Classification

CHAPTER 5
5. Result
6. Conclusion
7. Reference

CHAPTER 1

INTRODUCTION

Gesture recognition is one of the most potential methods to enhance spontaneity of human computer interaction. According to Kurtenbach and Hulteen(1990) [1], " A gesture is a motion of the body that conveys information". In general a gesture can be any motion of the human body that conveys any information, like nodding the head, waving the hands, gestures of the face that shows emotions, etc. And the movements that doesn't convey any information is not considered as gestures, like pressing key in computer keyboard. Usually human gestures constitute a space of motion expressed by body, face, hands etc. Among which the hand gesture is most expressive and more frequently used. Thus it becomes an easy way to communicate with computers.

Hand gesture recognition is at present, a most explored field. A lot of works have been developed based on Hand Gesture Recognition System. It was first proposed by Myron W. Krueger as a new form of human-computer interaction. It became a very significant research area and got swift advancements in computer hardware and vision systems.

There are two types of hand gestures, macro gestures (dynamic gestures) and micro gestures (static gestures)[3]. Dynamic gestures describe various positions of the hands associated with the human body. Static gestures describe relative position of the fingers of the hand. Several algorithms have been presented for gesture recognition techniques. Hasanuzzaman et al. (2004) presented a real time hand-gesture recognition system [4] to detect micro hand gestures using skin color segmentation, multiple-feature based template matching technique. Murthy and Jadon (2010) proposed a simple vision based gesture recognition system [5] which used web cam to detect hand, count the fingers and find the directon of the hand in which finger is pointed. And the dynamic gestures constitute a space of motion the hand.

The task of gesture recognition is highly challenging due to complex background and presence of non-gesture hand motions. The former researchers presented ideas using markers, marked gloves or requiring a simple background. Glove-based gesture interfaces require the user to wear a cumbersome device, and generally carry a load of cables that connect the device to a computer. Another system presented by [6], recognizes dynamic gestures using single gesture in complex background. This system doesn't

use instrumental gloves or markers. This bare hand technique uses only 2-d video input. This technique involves: detecting hand location (determining its center), tracking trajectory of the moving hand, analyzing hand position variations and thus obtained information is used recognition phase of the gesture.

1.1 APPLICATIONS

Gesture recognition has a wide range of applications in real time systems. In fact, it tends to become a most convenient interface for interacting with computers and machines. It can control variety of operations like interacting with computers for opening an application, for designing a new user friendly interface etc, for controlling electronic equipments rather than using a remote control [2], for aiding physically challenged people, playing games, etc.

1.2. PURPOSE OF THE PROJECT

Choosing gesture recognition as a project work has a great significance these days since most agents are now keen on designing a user friendly or user interface. The quest for interacting with machines as we interact with human beings is growing day by day. And this is one way of tackling with machines in natural way of communication. Apart from gesture recognition researchers concentrate on face emotion recognition and gestures other than hand gestures.

1.3. OBJECTIVE

The objective of this project is designing a hand gesture recognition application that can interact with computers such as opening and closing an application, scrolling the pages, moving up and down as in arrow keys, etc.

1.4 SOFTWARE REQUIREMENT

MATLAB

Matlab stands for matrix laboratory. It is the language of technical computing. Matlab is the most widely used scientific research tool by

many researchers in different application areas such as image processing and speech signal processing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Matlab has a lot of tool boxes for different purposes such as image processing tool box, neural network tool box, fuzzy logic tool box etc.

1.5 OUTLINE OF THE PROJECT

This report contains five chapters in which, chapter 1 gives the introduction about 'hand gesture recognition'. Chapter 2 describes Literature reviews of the project "hand gesture recognition". Chapter 3 is about materials and methods. Chapter 4 describes about dataset used in this project.Chapter 5 describes theoretical result of the project. And finally chapter tells about conclusion.

CHAPTER 2

LITERATURE REVIEW

In the present era, a lot of effort has been put forward to make human-machine interaction more convenient and user friendly. As a result most of the research work today is concentrated on developing an interface for human-computer interaction in a natural way. It would be more convenient to use the system if we could control systems just by showing some simple gestures and it'll also feel hands-free.

There are different types of hand gestures, static gestures and dynamic gestures. Static gestures (as in[7]) are postures of the hand that shows some particular sign and dynamic gestures (as in[7])are the voluntary motion of the hand that conveys some message.

Hand gesture recognition has a variety of applications like user friendly HCI (Human-Computer Interface), sign language recognition (as in[7]), games, augmented reality (virtual reality) [7], sign language interpreters for the disabled [7], and robot control [7] .

Over past decades, several systems have been developed for human hand gesture recognition which include systems that required an additional pointing device such as markers and data gloves (sensor based solutions) [8] which were efficient for hand pose and motion estimation but still had drawbacks of cost and they weren't user friendly. Thus, the current research is focused on developing user friendly systems that draw gestures in the free air [8]. Several types of complexities may occur during the recognition process like occlusions, lighting variances, fast motion, or other objects present with similar appearance [8].

So far, different methodologies have been developed that can be used in the process of gesture recognition.

In paper [7], they recognize gestures using the process of finger segmentation. Here, the hand region is extracted from the background with the background subtraction method and then the palm and fingers are segmented so as to detect and recognize the fingers and finally, a rule classifier is applied to predict the labels of hand gestures.

Paper [8] proposes an adaptive superpixel based hand gesture tracking system which recognizes the hand gesture from its motion trajectories. This method employs the motion detection of superpixels, along with unsupervised image segmentation to detect the moving hand using first few frames of the video sequence. Then, the hand appearance model is constructed from its surrounding superpixels. This is done using 'Initial Hand Detection and Model Construction algorithm'. It then proposes an *'Adaptive Hand Gesture Tracking Algorithm'* for tracking the hand gesture motion trajectory. It incorporates failure recovery and template matching in the tracking process. Here, the problem of hand deformation, view-dependent appearance invariance, fast motion, and background confusion can be well handled to extract the correct hand motion trajectory. A trained SVM classifier is used to recognize hand gesture from the extracted motion trajectory.

Paper [9] by Lathasree et al. is basically designed for recognizing the sign language for providing an aid for the disabled. It gives text output for the corresponding hand gestures of the dumb. It uses a rule based approach to recognize the gestures. Here the hand is cropped till the wrist. The process of hand gesture recognition includes segmentation and edge detection. *Segmentation* handles challenges like skin color detection, complex background removal and variable lighting condition.

The phases of hand gesture recognition is as given below,

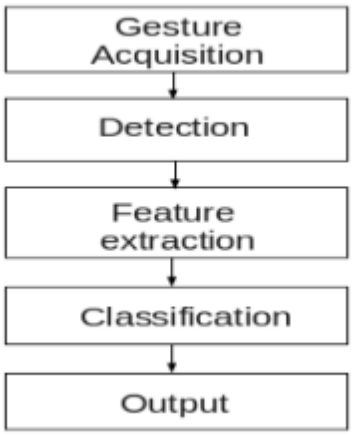

Figure 2: Hand Gesture Recognition System

Segmentation should be efficient for any recognition strategy. *Feature extraction* helps to calculate particular dimensions that capture the bulk of variation in the image data. And those features that do not contribute towards predicting the response are discarded. *Classifier* identifies the hand gesture from the alphabets of the sign language.[9].

All these approaches use a simple camera to capture the gesture in contradiction to the traditional data glove based and colored marker based approaches which were bulky and expensive.

CHAPTER 3

ABOUT DATASET

Here, the dataset used for carrying out the experiments is the 'Sebastien Marcel Dynamic Hand Posture Database' which consists of 4 hand gestures, (Clic, Rotate, Stop-Grasp-Ok, No) each of which has 13-15 sample sequences. The sample sequenes are shown below,

Figure 1: Dataset sample sequences

It is a standard dataset provided by Sebastian Marcel which can be used for training real time systems. The samples are of type '.pnm' which is a colored image. Thus, it facilitates in applying different types of feature extraction techniques like intensity based, texture based, color based, etc.

CHAPTER 4:

METHODS AND METHODOLOGIES

There are several steps to be followed and several features to be extracted to establish a dynamic hand gesture recognition system. Overview of the overall process can be viewed as,

IMAGE PRE-PROCESSING

The image pre-processing procedure is a very important step in the gesture recognition task. The aim of the pre-processing phase is to obtain images which have normalized intensity, uniform size and shape. In the proposed system the images in data base are already normalized. So here, there's no need of preprocessing images.

MOTION DETECTION OF POTENTIAL REGION OF INTEREST

Here, in this case as the gestures are captured within still background, the object can be easily segmented from the background by detecting the motion trait of the object in the scene. For this, we first have to detect the motion in the image. The motion detection can be made by subtracting the frames of an image sequence from a reference image frame.

FIGURE 4: original image sequence

FIGURE 5: Difference image

FIGURE 6: Cropped image

OBJECT EXTRACTION FROM BACKGROUND

Evidently, before we start with tracking of moving objects, we need to extract moving objects from the background. Different methods can be used for this purpose. Background subtraction is one of the common method in which each background pixel is modeled using a mixture of Gaussian distributions. Object detection can be achieved by building a representation of the scene called the background model and then finding deviations from the model for each incoming frame. The video is taken as input and it is divided into frames. It differentiates the foreground and background of the image (frame) and thus the image's foreground can be extracted from the background by considering each frame at a time, and then subtracting the background from the image, and then the foreground image will be left out.

Here 3 different methods have been used comparatively,

(i) Extracting the region with largest area after binarization,
Here, afer binarizing the image, as, there wa some noise in the image and there was no other objects in the scene. So, by taking the largest area containing white pixels, it could give hand region, but along with it arm regions were also extracted here.

(ii) Using hue-saturation-mask.

(iii) Extracting the region with intensity value between two particular thresholds.

GESTURE FEATURE EXTRACTION

From the segmented image, different features of the hand gesture can be extracted using different methods.

Palm point detection

Palm point detection is done here using a very simple method. i.e, distance transform of the object region was extracted which showed distance between each region pixel with its nearest boundary point. Here, city block distance was used. The palm point or palm center has the highest distance between its nearest boundaries.

Palm Mask Detection

Palm mask is created by extracting only the palm region from the image. It is done by drawing circles around the palm center. We can use two circles, an inner circle and an outer circle. First the inner circle is drawn until the black pixel regions included in the circle. When it starts including the black pixel in the circle, it stops increasing it radius. Thus, we'll get a circle that'll lie inside the palm. So we generate a second circle slightly greater than the first one based on the same center. We draw the circle using the equation,

$$x = \cos\left(\frac{angle * \pi}{180}\right) * rad + X$$

$$y = \cos\left(\frac{angle * \pi}{180}\right) * rad + Y$$

Where, (X,Y) are the points of the palm center, $angle \in [0,360]$ and (L is the image size)

If the black pixels are included in circle, i.e. P(x,y)==0, then stop, else go on increasing the radius until black pixels get included in the circle.

Finger Segmentation

Fingers can be segmented after extracting the palm mask, the foreground regions excluding the palm mask can be considered as the fingers and hence segmented.

Finger Tip Detection

Fingertip can be detected by mapping a small circle throughout each point in the image and capturing all the neighbors that fall in this circular region. If the contiguous neighbors have a certain number of black pixels, it's considered as a fingertip.

Hand Motion Tracking

Hand motion tracking can be done using the palm point. It can be tracked by tracking the position of the palm point in each subsequent frame.

CLASSIFICATION

After extracting the static features, the system should perform a robust classification for classifying the pattern into appropriate gesture. For this we've to choose appropriate type of classifier like neural networks, semi-supervised Fuzzy ARTMAP or even simple rule based classifiers can be used which classifies the gestures according to certain rules like number of fingers, hand motion estimation, etc.

CHAPTER 4
RESULT:

Motion detection of the hand regions was carried out successfully; regions were easily cropped out using the motion estimated image.

There are several features to be extracted to for the purpose hand gesture recognition system. Among them some of which are carried out. For hand segmentation from background, three methods were used; whose results were compared against each other.

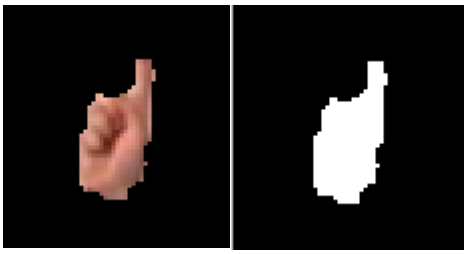

FIGURE 7: Segmentation using hue-saturation-value mask

FIGURE 8: Segmentation using selection of largest area region

FIGURE 9: Segmentation using selection of thresholded region

Segmentation by selecting the largest area region after binarization was checked first, but provided with the hand region along with the shirt sleeve.

Next hue-saturation-value based segmentation was used, but as the lighting condition was poor, or it is almost same as the color of hand regions, it is more difficult.

Next intensity based segmentation was used, by selecting only the intensity values between two certain thresholds.

Palm point detection was done using distance transformed image.

FIGURE 10: Distance Transformed Image with center marked as red.

CONCLUSION

Some of the feature extraction techniques were carried out which yielded acceptable results. It is found that more effective methods should be used for segmentation of the hand pixels from the background for real time applications. Method used for palm point detection was also effective.

FUTURE WORK

Many other hand feature are to be extracted like, palm mask, finger segmentation, hand motion tracking, etc.

And classification of the hand gesture based on the extracted hand regions in future. This recognizing of the gestures should be converted to the real time environment for real time applications.

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