A Survey on Dynamic Hand Gesture for Number Recognition

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ABSTRACT

Hand gesture system recognition has received great attention in the current few years because of its ability as it is very important for developing an attractive alternative through human computer interaction modalities. However a more natural form of communication system would make the interaction easier, even the performance would increase and additional cost for hardware would also decrease in fact we might not need extra hardware as well. Thus one of the steps towards the goal of achieving such natural form of communication is Dynamic Gesture Recognition. In dynamic gesture recognition we consider the hand as our only interest of object and our primary focus is on the motion of this object. Therefore here dynamic gesture means the gesture made by a moving hand. In this paper a survey of various hand gesture recognition systems is perceived. There are so many numbers of devices that have been invented, each bringing with it a new aspect of interaction. This paper presents the review of ongoing research on various techniques for determining hand gesture recognition.

Keywords
HCI, Dynamic Gesture Recognition, Skin color detection, HMM

1. INTRODUCTION
The essential aim of building this recognition system is human hand movements have controlling functions, that is, used for natural communication between human and computer and also the logically explainable functions where that the gestures can be used for conveying any kind of meaningful information or controlling a robot. Hand gestures are form of nonverbal communication, which is either static or dynamic. Gestures are used for communicating between people using sign language and as well as between human and machines. Gestures can be dynamic (sequence of phases) which are complex but even suitable for real time environments. There are methods that have been proposed for acquiring information that are necessary for recognition gestures system. Some methods have used additional hardware devices such as color markers and data glove devices to easily extract the descriptive features of gesture . Based on the appearance of the hand skin color segmentation method has been used for extracting necessary features of the hand [8], which are considered simple and at a reasonable cost compared with other methods [8].In order to make the human-machine communication more flexible and user friendly automatic hand gesture recognition appears to be the suitable means. Hand gesture recognition system is used to detect, track and recognize a movement of hand through capturing the image that is used to express an idea or meaning of particular event. It makes use of digital image as input and then recognizes the meaning of that gesture with the application of advanced digital image processing techniques. The interaction between human comes from various sensory modes like gesture, movements, speech, facial and hand expressions. The main motive of using this hand gestures is to communicate with computer with less use of hardware that increases input modality.
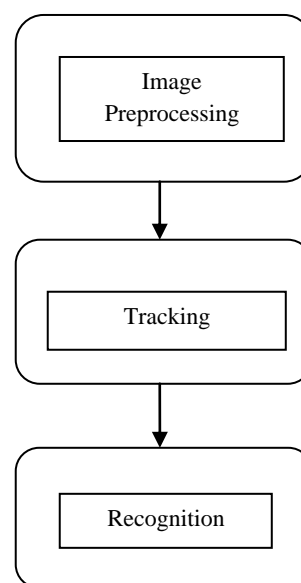

Fig 1: Three common stages of gesture recognition systems

2. LITERATURE SURVEY
Gesture recognition provides a means that are used for communicating between machines and humans as well as between people. Based on the type of gesture several classification methods have been proposed in the literature. This section provides a brief description of these methods.

1. Trajectory Guided Recognition of Hand Gestures having Global Motions by Bhuyan et al. In this paper, segmentation of the frames into video object planes (VOPs) and use of centroid based method for estimating hand trajectory is stated.

The advantage of using this above stated method is its ease of use. Also, user does not need to wear a glove; neither there is need for a uniform background.

Limitation: Increase in the computational load of classification for large vocabulary size because dynamic time wrapping (DTW) has to align the test and prototype trajectories during each classification.

2. C. Keskin, A. Erkan, L. Akarun "Real time hand tracking and 3D gesture recognition for interactive interfaces using

HMM". In this paper, the author have proposed an automatic system which determines isolated gesture; in addition it also have gesture that is taken from hand motion which is continuous for Arabic numbers from 0 to 9 in real-time applications based on Hidden Markov Models. Hidden Markov Model (HMM) using (LR) Left-Right and (LRB) Left-Right Banded topologies was applied over some discrete vector feature in order to handle isolated gesture that was taken from stereo color image sequences. The topologies got after applying some vector feature were then matched to different number of states ranging from 3 to 10.

In this approach towards the dynamic hand gesture recognition, the hand is extracted from the image frames, captured by the camera, applying skin color detection which helps in converting the RGB color model to HSV (Hue, Saturation, and Value).

In this approach, the authors have also talked about the use of kalman Filter that is used to track the filtered trajectories of the hand motion.

3. Survey on various gesture recognition techniques for interfacing machines based on Ambient Intelligence by Harshith. C et al., the author introduces several approaches for hand gesture recognition which can be divided into Data-glove and Vision based approaches. The approaches to Vision based hand posture and gesture recognition are:

(i) 3D hand model based approach

(ii) Appearance based approach

The author has concluded some methods regarding Hand Detection and Tracking for hand gesture that using Skin Color Segmentation i.e. YUV followed by CAMSHIFT algorithm will help in the tracking and effective detection as the centroid values can be simply obtained by calculating the moments at each point, and later on we could add Hidden Markov Training for further system applications.

This method deals with recognition of hand gestures. It is done in the following five steps.

Step 1. Camera helps to record a video stream of hand gestures.

Step 2. Then skin colour based segmentation is performed using YUV colour space taking all the frames into consideration. The YUV colour system is used for distinguishing chrominance and intensity. The symbol Y denotes intensity while UV denotes chrominance components.

Step 3. After that for separating the hand we can use CAMSHIFT [2] algorithm .As, it is the largest connected region, so we can segment the hand from the body.

Step 4. The position of the hand centroid is calculated in each frame after performing colour segmentation.

Step 5. After this to form a trajectory various centroid points are joined which shows the path of the motion of hand for tracking procedure that is to be determined.

4. Gestuelle: A System to Recognize Dynamic Hand Gestures using Hidden Markov Model to Control Windows Applications by Malvika Bansal et al.,. This paper introduces an application, "Gestuelle" that makes use of some easy gestures to operate on windows applications such as Windows Media Player. The system makes use of the model called as Hidden Markov Model (HMM) that works in real time which is designed to work in static backgrounds. This system also makes use of LRB topology of Hidden Markov Model in addition with the Baum Welch Algorithm and the Forward and Viterbi Algorithms for training, testing and evaluating respectively the input observation sequences for evaluating the best possible sequences for pattern recognition.

The author also discusses about the ways performed for gesture recognition:

- Sensory gloves
- High resolution camera

5. Hand gesture recognition using Hidden Markov Model (HMM) by Min et.al. The procedure used in this concept is Hidden Markov Model

Advantage: As gesture is the continuous motion on the sequential time series HMM proves to be a very effective tool for dynamic hand gestures recognition on a time series domain.

Limitation: This method doesn't fully reflect the characteristics of the dynamic gesture such as optical flow information, the hand posture, eccentricity.

6. Real-time Dynamic Hand Gesture Recognition using Hidden Markov Models by M.M.Gharasuie, H.Seyedarabi: In this paper, the English numbers from 0-9 is identified by the system making the use of dynamic hand gesture. System includes two steps:

- Pre-processing
- Classification step.

As gestures are of two types Key gestures and Link gestures. Key gestures are used for linking gestures in continuous form. The path assigned for the points of continuous gesture is given for the classification which is done by using Discrete Hidden Markov Model used for the classification.

7. Hand Gesture Contour Tracking Based on Skin Color Probability and State Estimation Model by Qiu-yu Zhang et al. In this paper, the author have talked about the hand gesture segmentation and hand gesture tracking method that is multi mode and state estimation respectively. The author also focuses on the various hand gesture tracking methods such as:

a. Shape based Statistical model: It is considered on the basis of the shape object tracked in previous frame. In this method the object shape is not taken into consideration and as the parameter the distance between the pixel and the middle point is used. Considering this deficiency, a shape based statistical model of the moving object is built here.

b. State estimation method: It determines the pixel probability of hand gesture in current frame.

8. Geometric feature extraction for hand gesture recognition by Rafiqul Zaman Khan, Noor Adnan Ibraheem. The author has highlighted about the detailed steps to hand gesture recognition:

a. Segmentation,

b. Hand gesture modeling,

c. Features extraction stage,

d. Gestures classification

The author also discuss about the representation of the extracted features, to introduce a full and correct portray of the gesture in the feature space to recognize the gesture correctly by the classifier model.

The most important step for extracting geometric features is to locate and detect the fingertip which leads to create a model with flexible and effective characteristics.

9. Hand Gesture Recognition: A Literature review by Rafiqul Zaman Khan and Noor Adnan Ibraheem. In this paper, the author have talked about the recent hand gesture recognition systems. The key issues of hand gesture recognition system have also been discussed with challenges of gesture system. Many of the researchers has classified gesture recognition system mainly into three steps after acquisition of the input image from videos taken by a camera or any kind of instrumented data glove device.

These steps are:

- Extraction

- Feature Estimation

- Classification

3. APPLICATION AREAS OF HAND GESTURES SYSTEM

Hand gestures recognition system has been applied on different domains for different applications that includes; sign language translation, virtual environments, smart surveillance, robot control, medical systems etc. Description of some of these application areas are listed under:

1) *Sign Language Recognition*: As the sign language acts like interpreter, it has received special attention for recognizing gestures and has a lot of systems to recognize gestures for different type of sign languages.

2) *Robot Control*: Controlling the robot using gestures is considered as one of the interesting application in this field [6]. In [4], a system was proposed to count the five fingers using numbering to control a robot by the use of hand pose signs.

3) *Numbers Recognition*: This is the another recent application of hand gesture that recognizes numbers that could recognize a meaningful gesture isolating from hand motion of Arabic numbers 0 to 9 automatically in a real time system using HMM.

4) *Medical Fields*: As some surgeries are to be performed in very critical areas of human body parts, machine can be used to perform the same task and hand gesture can be used to control such machine.

4. VARIOUS METHODS FOR IMAGE SEGMENTATION

Image segmentation is the way of partitioning an image into a non-overlapping clusters or regions according to the processing methods that follows it. The main focus in

segmentation is according to the application which requires segmentation for extracting the object of interest in the image. In hand gesture recognition the object of interest in the image is the hand that needs to be further processed. Manual segmentation can also be performed but it is time consuming process and it may delay the detection of rejection at a very crucial stage. The segmentation that is performed manually leads to inconsistency. Segmentation procedure to give proper and accurate result demands simple and complete automatic algorithms. Segmentation algorithm should be statistically robust to any type of noise and computationally efficiently to handle large sets of data.

Some of the segmentation methods are discussed below:

4.0.1 Edge Based models
Different object in the image can be segmented by using the edge information. By identifying the sharp changes in the image the edges of various objects are extracted. It is easy to implement and computationally very fast. It requires a threshold value for extracting the edges. This technique is very much sensitive to noise and may not give satisfying result as it generates broken segments which further need to be reconstructed. This technique highly relies on the threshold value provided to it so selection of threshold value is a crucial part.

4.0.2 Region-Based Models
In this method the objects are segmented using the region growing and merging technique. Here a particular region is identified and then the region is grown and merged as it continues to segment the image. This technique considers the statistics of the entire image and is robust to any type of noise.

4.0.3 Color cue segmentation
Skin color segmentation is referred to as the method of discriminating the skin and non-skin pixels. There are some difficulties that are involved in robustly detecting the skin color. Moreover even by the same person with different camera it produces different color values and also the object in motion can cause blurring of colors. Main part of the skin color segmentation is to choose the suitable color space. Red, Green, Blue (RGB) color space is the most common color space used to represent images, normalized RGB still suffer by uneven illuminations. HSV and YCbCr color spaces have the luminance and chromaticity information. Brightness information separated from the chrominance and chromaticity in the HSV and YCbCr color space diminishes the effect of uneven illumination in an image. Therefore, both color spaces are typically used in video tracking and surveillance.

5. GESTURE RECOGNITION TECHNIQUES

The recognition of gesture involves several methods such as

- Pattern Recognition,
- Motion Detection
- Analysis and Machine Learning.

Different tools and techniques are used in gesture recognition systems, which are: computer vision, image processing [6], pattern recognition, statistical modeling etc.

6. CONCLUSION

In present environment there are a number of facilities and modes that are available for providing input to any application. With the ever increasing technologies in this

smart environments it is unfortunate that still not many applications are available that are controlled using current technique that is by hand gesture which has a smart facility of providing input . The most important advantage of using the hand gesture based system is that using this method the user can have a communication link with the application from a distance without using any kind of external devices like the keyboard or mouse. This leads to the less use of hardware devices which increases system efficiency and makes the system the user friendly human computer interface. With the help of this application in this ever growing environment the user's interaction can be by the use of hand gesture with the virtual objects instead of any other physical input devices. Hand gestures provide a nonverbal communication that helps a person to communicate their tasks in a large range with or without speech. In this current technology it has received a great attention specifically for the physically challenged users to share their views to define the gesture with ease of use.. Human centered means of interacting with computers have gained interest. So, in future works, machine learning methods and ToF cameras may be used to address the complex background problem and improve the robustness of hand detection.

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