



Recent Trends and Technologies in Hand Gesture Recognition

Anu P.D

M.Tech Scholar, Dept. of CSSE
Govt. Engineering College
Idukki, India

Philumon Joseph

Asst. Prof. in Dept of CSE
Govt. Engineering College
Idukki, India

Abstract: Hand gesture recognition is a growing field of research. Gestures are an important aspect of human interaction, both interpersonal and in the context of human computer interface. The interaction between computers and humans are provided by the hand gestures. Gestures provide a way for computers to understand human body language. Hand gesture recognition deals with the goal of interpreting hand gestures via mathematical algorithms. The techniques discussed are based on detection of some shape based features like centroid, orientation of hand, presence of finger, thumb in image and contour based features like convex hull and convexity defects. Hand gesture recognition system provides a user friendly way of interaction with the computer which is more familiar to the human beings. Hand gesture recognition process includes capturing input image which will be processed and segmented so as to extract features to identify different gestures. Different methods of hand gesture recognition techniques are evaluated and proposed a novel method for recognition. This method explains how the users hand is detected and the corresponding gesture is identified in an accurate manner. This paper also explains the various applications that can take advantage of this type of interaction mechanism.

Keywords: Hand gesture recognition, Human Computer Interaction, Convex hull, Convexity Defects, Contour based features, and Shape based features.

I. INTRODUCTION

Gestures are the visible body actions through which humans express information to others without saying it. In our daily life, we can see several hand gestures which are frequently used for communication purposes like thumbs up, thumbs down, victory, directions etc.

Hand gesture recognition is one of the advanced research field which provides way for human machine interaction. Hand gesture recognition provides an intelligent method for human computer interaction (HCI). Its application ranges from medical rehabilitation to consumer electronics control. Different types of sensing techniques are used to identify various hand gestures. The sensing techniques are used to obtain various signals for the pattern recognition. In this paper we are surveying different hand gesture recognition techniques.

Different types of prototypes developed are easy to use and understand and it is more cost effective than the traditional interface devices such as the keyboard and the mouse. Hand gestures are very expressive with the purpose of interacting with the environment or communicating any information. Static Hand Gestures depends on the position and orientation of hand in space without any movement. Dynamic Hand Gestures depends on the position and orientation of hand in space with movement in a pre determined time duration.

In this paper proposed an innovative method for gesture recognition without using any additional devices, and merely by the convexity defects and Decide Gesture Algorithm [4].

II. HAND GESTURE RECOGNITION TECHNOLOGIES

There are different types of approaches used for the hand gesture recognition. Some of the approaches are listed below:

A. Data Glove Based Hand Gesture Recognition System

In this approach, a device of glove type is worn by the user. This glove type device includes sensor devices. The sensors which sense movement of hands and fingers are used in capture the motion and position of hand. The information about the hands and fingers are passed to the computer for the further processing [11]. Data glove is a dedicated hardware device which is used to detect hand motion, position and finger bending. User must wear this glove like device. It has the ability to collect data from different joints of fingers and hand. The collected data are analysed usually using neural network. This approach can deliver accurate coordinates of hand and finger's position. In the data glove, the user should physically connect to computers. This causes less interaction between the computers and users. Data glove approach working is not sufficient in virtual reality. Due to its accuracy, in real time it can analyse and identify a variety of gestures. Data glove [11] is designed for applications which include direct object manipulation with hand, evaluation of hand impairment using interface devices for general purposes, finger spelling. One of the major disadvantages is the acquisition of additional devices.

B. Visual Based Hand Gesture Recognition System

The user need not wear any extra hardware devices in vision based gesture recognition (VGR) approach. No intermediate media is required, only a camera is required as a capturing device and takes hand as a direct input equipment. In this approach, the camera is used to collect real time gesture image sequence. In the case of HCI using vision based hand gesture, it has different stages. First stage is identifying the hand region from the captured frame. Next stage is tracking the identified hand region throughout the time.

C. *Depth Based Hand Gesture Recognition System*

The depth camera based technology reveals a new stage for 3D geometric information acquisition [12]. There are mainly two approaches which are used currently in depth camera technology. The first one is based on light coding and the second one is based on the time of flight principle. Hand gesture recognition using Kinect depth data is one of the most popular and accurate method in this area. When compared to the traditional sensor device, it has advantages in the case of resolution and cost.

D. *Color Glove Based Hand Gesture Recognition System*

Color glove based approaches represent a compromise between data glove based and vision based hand recognition approaches. Marked gloves or colored markers are gloves that are worn by the human hand. The color markers are used on the fingers or wrists. The positions of markers are fixed here. The color glove shape might consist of small regions which are of different colors. The wool glove is used in which 3 different colors are used to represent the fingers and palms. Some of the colors are used in the process of tracking the hand and locating the palm and fingers. The geometric features needed to find the hand shape is extracted. The main attraction of this approach is its ease of use and low cost compared to the data glove approach. However, this approach limits the naturalness of HCI for the computer interaction.

III. RELATED WORKS

A great deal of work is focused on the hand gesture recognition. In this section, gives a brief overview of the previously proposed methods for recognition of hand gestures and its fingertips, for human computer interaction. The comparison of different related works of hand gesture recognition is shown in table 1.

Chethana N S et.al. [1] Include the recognition of hand gesture in real-time. It deals with the Gesture Recognition to create a system which can recognize specific human gestures and can be used to convey information or for device control. The technique used to recognize hand gesture is based on Computer Vision. The system consists of three stages: image acquisition, feature extraction, and recognition. In the first stage input image of hand gestures are acquired by digital camera in approximate frame rate. Convert acquired image from RGB to Gray Scale. Background is separated by subtracting image from the captured background. To extract the feature of the input image a scaling, orientation and rotation invariant feature extraction method has been introduced. Finally, Binary conversion is done to apply edge detection and K-Curvature algorithm is applied for hand gesture recognition. The recognized gesture command is sent through serial interfacing and device controlling (Robotic arm) is done.

Georgiana Simion et.al. [2] Proposes a fingertip-based approach for hand gesture recognition. For the tracking principle, an improved version of the MSMF algorithm is used to extract finger features by looking for similarities in length and thickness. Then, the fingertips are also tracked by using the palm region of the hand. This enables us to define a supplementary point that is used to design the final set of natural gestures to be recognized. This approach achieved a global recognition rate. The main characteristics of the proposed framework for fingertips detection and tracking are

robustness and high accuracy with reduced computational costs. For the classification step, the scale invariant distances and angles are calculated. By analysing the position of just two fingers, various interface actions, such as clicking and moving, are recognized. The system performances were analysed further with respect to the real-time capability and the recognition rate. Thus the proposed architecture is suitable to support different types of applications such as touch less info-point machine or smart TVs.

Guat Yew Tan et.al. [3] Presents a finger tip detection using hybrid convex hull algorithm. In this paper a method is suggested to reduce the computational resources by leveraging on two proven algorithms and techniques in order to extract the convex hull vertices directly from a binary image without going through the edge detection process. This is done by combining Bresenham algorithm and Jarvis March algorithm to find finger tips without edge detection process. This algorithm is expected to reduce the resources allocated for edge detection and to apply the convex hull algorithm directly on the pixels in binary image with minimal processes. The hybrid convex hull algorithm requires only four global extreme points to begin with and thus the pre-processing step takes much less resources. The new algorithm yields time complexity of $O(N^2)$. This algorithm is different from the ordinary convex hull algorithm and helps to detect the convex hull of the original image without using the edge detection process.

Swapnil Chandel et.al. [4] Presents a sign language recognizer. For physically impaired persons, sign language is the only way of communication. With the help of sign language, these physical impaired people express their emotions and thoughts to other person. Physically impaired people need a translator along with them to communicate with others. This is a difficult situation. In this situation sign language recognition have a great advantage. Since sign language consist of various movements and gesture of hand therefore the accuracy of sign language depends on the accurate recognition of hand gesture. It presents a method of hand gesture and sign language recognition.

Ruchi Manish Gurav et.al. [5] Says nowadays new technologies of Human Computer Interaction are being used developed to deliver user's command to the robots. Users can interact with machines through hand, head, facial expressions, voice and touch. The hand gestures can used to control the robot or for offices and household applications. Hand gesture detection algorithms are based on various machine learning methods such as neural networks, support vector machine, and Adaptive Boosting. Adaptive Boosting on based hand-pose detectors are trained with a reduced Haar-like feature to make the proper detection process. The corresponding context-free grammar based proposed method gives effective real time performance with great accuracy and robustness for more than four hand gestures. Fingertip detection using convex hull algorithm are also used here to solve the problems created by the rectangles. The aim of this project is to develop a real time Gesture recognition system. It is determined that contour is very important feature and can be used to discriminate two different gesture

Table I. Comparisons of Related Works

Title	Mechanism	Merits	Demerits
Static Hand Gesture Recognition System For Device Control [1].	K Curvature Algorithm.	No Template Matching, Rotation and Scaling Invariant.	Not Compatible under Different Light Conditions.
Fingertip-based Real Time Tracking and Gesture Recognition for Natural User Interfaces [2].	Multi Scale Mode Filtering Algorithm.	Robustness, High Accuracy with Less Cost, No need of external devices	Analyze position of two fingers Only.
A Hybrid Convex Hull Algorithm for Fingertips Detection [3].	Hybrid Convex Hull Algorithm.	Less Time Complexity, Apply Directly On Image Pixels	The binary image used should be free from noise after partitioning Method.
Hand Gesture Recognition for Sign Language Recognition [4].	Automatic Sign Language Recognition.	Implemented Practically.	Less Efficiency.
Real Time Finger Tracking and Contour Detection for Gesture Recognition Using OpenCV [5].	Viola and Jones algorithm, Adaptive Boosting Based Learning Algorithm, Convex Hull.	Invariant to Rotation, Translation and Scaling, Easy Learning Machine Training.	Create Confusion in recognition when combine gestures.
Real-Time Hand Gesture	Recursive Reduced	Performs Well and is Highly Efficient.	Degrade the Performance if there

Recognition Using Finger Segmentation [6].	Polynomial Regression Method.		are Moving Objects with the Skin Color.
An Analysis of Hand Gesture Recognition Technique Using Finger Movement Detection Based on Color Marker [7].	Color Marker Based Approach.	Easy Notepad Usage.	Only the Finger Wearing Red Color Marker is Detected.
Glove-Based Gesture Recognition System [8].	Data Glove Based Approach	High Accuracy, Provide Exact Coordinates of Fingers Orientation Location and Hand Configuration	Expensive, Not suitable for Natural HCI.
Comparative Study for Construction of Gesture Recognition System [9].	Static Gesture Recognition	Used under Cluttered Background, Solve the Problem of Translation and Scaling.	Difficult to Handle rotation.
Real-Time Hand Gesture Recognition Using a Color Glove[10]	Color Glove Based Approach, Learning Vector Quantization.	Provide the Ability to Extract Geometric Features Necessary to Form Hand Shape.	Unnatural and not Suitable for Applications With Multiple Users , Complex to Use.

Zhi Hua Chen et.al. [6] Present a novel real-time method for hand gesture recognition. The hand region is extracted from the background with the background subtraction method. Thereby finger recognition and detection the segmentation of palm and fingers are done .For the prediction, hand gestures label rule classifier method is applied. The experiments on the data set of 1300 images show that the method performs well

and is highly efficient. Moreover, our method shows better performance than a state-of-art method on another data set of hand gestures. The experimental results show that this approach performs well and is fit for the real-time applications. The performance of the hand gesture recognition will degrade if the background has similar color as the skin. However, the machine learning algorithms can discriminate the hand from the background. The depth information of the Hand gestures is provided by ToF cameras which improves the performance and accuracy of hand detection.

Nancy et.al. [7] Develops a technique for recognizing the gestures made by user using MATLAB and implement this technique to control the computer remotely without any keyboard or mouse. We present a real-time hand tracking technique by using a white cloth glove with a red color marker Placed at fingertip. In this paper, a hand gesture recognition method based on color marker detection in which used a red color marker that is mounted on the fingertip of right hand to track the users hand and proposed a technique for natural, finger-tip based interaction with computer. The pointed gesture with the help of red color marker, only the finger wearing red color marker is detected and it is used for pointing on the computer screen. As the user finger wearing red color marker move, the cursor will move accordingly, and for selecting the pointed things use the speech recognition.

Maria Eugenia Cabrera et.al. [8] Introduce the design and implementation of a hand gesture recognition system, based on the information gathered with a data glove. The data glove sensors convey the degree of flex ion in each finger of the hand .Accelerometer sensor was placed on top of the glove to acquire the orientation of the hand in three axes. With this information, the system would begin a decision making process based on artificial intelligence tools, like neural networks, to recognize the American Sign Language signs for finger spelling. The whole system is executed by interfacing with a user, to collect the data and display the result of its classification. The performance of the Glove-Based Gesture Recognition System is directly related to the efficiency of the classification stage within it. Based on the results given by different number of hidden layers in the neural network, the best validation percentage obtained was when there were 60 neurons in the hidden layer. Among the many benefits of using neural networks for classification duties, there is the ability to adapt and generalize when properly trained, and they can be easily retrained to adapt its synaptic weights to variations in the system.

Mokhtar M.Hasan et.al. [9] Introduce a new gesture recognition system based on vision based method with uniform background for computer image browsing. System uses HSV color band for segmentation of hand gesture and Euclidean Distance is used for obtaining the correct database posture for the new presented tested posture .The static hand gesture used since which can convey much expressions than face can. After image pre-processing image is divided into blocks. From these blocks feature extraction is done. Thus each trained image can be represented by a single feature vector and the posture is represented by six samples. The normalization is used to solve the problem of translation and scaling. Rotation is the most difficult to manage problem, so many samples with many different angles are taken to solve this problem. Block Division Method is used here. This is applicable under cluttered background since the HSV

segmentation which will be efficient for such kind of background.

Luigi Lamberti et.al. [10] Presents a real-time hand gesture Recognizer based on a color glove that can also run on devices that have moderate computational resources. Hand Gesture Recognizer consists of 3 modules. The first module includes image acquisition. The hand image is represented by a nine-dimensional feature vector by the feature extractor module. The third module, the classifier, is performed by means of Learning Vector Quantization. The high recognition rate displays after tested on a large dataset of hand gestures. Gesture recognition include the carrying out of a multimedia presentation command is actually used by the first author in his teaching duties.

IV. PROPOSED HAND GESTURE RECOGNITION

The Decide Gesture Algorithm [4] is used when searching for a gesture found in current input frame. It will return the name of gesture detected and will return none if no suitable match is found. Compare the current frame gesture passed as 1st argument in the function with every element in the dictionary passed as 2nd argument in the function. While comparing, first check if the number of fingers in the current frame gesture and gesture being compared are same. If the number of fingers are same and more than 1, generate an array of differences in angles made by each finger of source1 and that of source 2 and so on. If the values turn out to be nearly constant, then the hand has a constant tilt and the gestures might be same. If comparison passes the angle stage, go for doing the same for fingers. But here take the ratio of finger lengths instead of difference. From this whether the hand has shrunk or grown by a constant factor can analysed. If the array thus obtained has absurd variations, it means the wrong fingers are making the correct angles and this will again reject the gesture from list. If both the stages are passed, return the gesture thus obtained. If the number of fingers is 1, compare angle and length of finger to radius of hand ratio. In this case, a tilted hand with single finger making the same gesture also gets rejected. By comparing ratios of length of finger to radius of hand, we get to know whether the correct finger is being used in the gesture. Return if match found. The name of the gesture thus detected is displayed on the output screen. The whole process of hand recognition and gesture recognition repeats with every input frame.

V. RESULTS AND DISCUSSION

The experiments were tested on system with web camera. The platform used is Python 2.76 and it was built on Linux. The major libraries used are Open CV 3.1.0 and Numpy. The finger tip detection is done for both static and dynamic gestures. The Hand Gesture recognition part is done only for the dynamic gestures. Image is captured using web camera. Back ground of image is captured and subtracted using Back ground subtraction algorithms. After background capturing hand histogram is created using hand pixels. Search for the hand using the generated histogram .After that performs the morphological operations, erosions and dilations. Then find the largest contour of hand, and its convex hull and convexity defects. The finger tips can be identified using the convexity defects methods. After finger tips detection the gestures can be recognised using gesture dictionary and the decide gesture

Algorithm. Thus in this manner the gesture recognition of Dynamic gestures and the finger tip detection of dynamic gestures is obtained. Next to get the finger tip detection of static postures repeat the process of finger tip detection by inputting hand postures from the data set.

The Hand Gesture Recognition experiments were conducted in a real time manner using the video captured by the web camera and the performance evaluation is done. The performance evaluation as shown in Figure 1 of hand gesture recognition is conducted using three gestures V shape, L RIGHT shape and Index Point. These gestures were tested by different peoples under different environmental conditions. The figure above shows the performance evaluation of gesture recognition. The proposed system has an accuracy of 88.6 percentages.

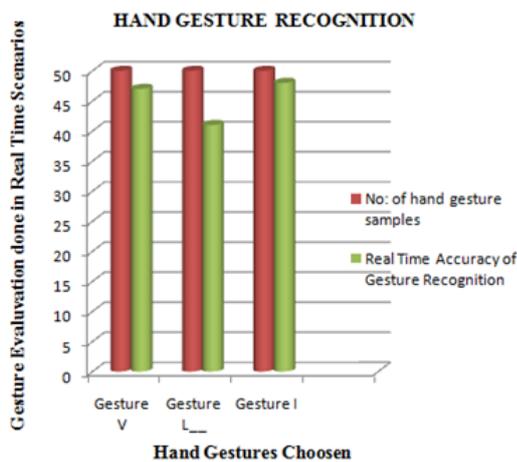


Figure 1. Performance Evaluation of Gesture Recognition Phase.

VI. CONCLUSION

In this paper, a review of different hand gesture recognition approaches done and proposed a novel and efficient gesture recognition method. The hand gesture recognition has a great role in human machine interaction applications. The review enrolled the basic and emerging various techniques of hand gesture recognition for supporting data glove, vision

based, depth based and color glove based human-computer interaction for hand gesture recognition. To evaluate the system efficiency, compared the proposed methods on previous method and results show that proposed method show better performance than the existing methods. This include wide range of applications in virtual Reality, Smart Surveillance, Sign Language Translation, Medical Systems ,Robotics, Human Manipulation and Instruction, Gaming etc and so on.

VII. REFERENCES

- [1] N.S. Chethana, Divya Prabha, and M.Z. Kurian, "Static Hand Gesture Recognition Systems for Device Control," International Journal of Electrical, Electronics and Data Communication, ISSN, Vol 3, Issue 4, April 2015
- [2] Georgiana Simion, "Fingertip Based Real Time Tracking and Gesture Recognition for Natural User Interfaces," Acta Polytechnical Hungarica, Vol 13, No. 5, 2016
- [3] Guat Yew Tan, "A Hybrid Convex Hull Algorithm for Fingertips Detection," Indian Journal of Science and technology, Vol 9, July 2016
- [4] Swapnil Chandel, "Hand Gesture Recognition for Sign language Recognition," IJSTE, Vol 2, April 2016
- [5] Ruchi Manish Gurav and Premanand K. Kadbe, "Real Time Finger Tracking and Contour Detection for Gesture Recognition using OpenCV," International Conference on Industrial Instrumentation and control, May 2015
- [6] Zhi hua Chen, "Real-Time Hand Gesture Recognition using Finger Segmentation," Scientific World Journal, Vol 2014
- [7] Nancy and Gianetan Singh Sekhon, "An Analysis of Hand Gesture Recognition Movement using Finger Movement Detection Based on Color Markers," IJCSC, Vol 3, June 2012
- [8] Maria Eugenia Cabrera, "Glove Based Gesture Recognition System," CLAWAR, July 2012
- [9] Mokhar M Hasan, "Comparative Study for Construction of Gesture Recognition System," International Journal of Computer Science and Software Technology, Vol 4, No. 1, June 2011
- [10] Luigi Lamberti, "Real-Time Hand Gesture Recognition using a Color Glove," ICIAP 2011.
- [11] Sturman, J. David and David Zelter, "A Survey of Glove based Input," Computer Graphics and Applications, IEEE 14.1 (1994):30-39.
- [12] Ni Chen and Qiu Peng, "The Research and Application of Kinect Technology in the Field of Human-Computer Interaction," Information Technology and Informatization, 2013