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Survey on Vision based Hand Gesture Recognition

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***Abstract*—** A natural interaction technique in the field of Human Computer Interaction (HCI) has been the core interest of researchers in recent years. Numerous applications of real time hand gesture based recognition in the real world have been deployed where we interact with computers. Hand gestures rely upon camera based detection technique. Use of a Web Camera to develop a virtual HCI device is the primary mode of interaction. This paper investigates recent methods used in vision based Human Computer Interaction using hand gestures. Methods were evaluated by comparing the techniques they rely on, type of work, use of theoretical proofs and simulations.

***Keywords*—** Human Computer Interaction, hand gestures, camera vision, computer vision;

I. INTRODUCTION

Vision based hand gesture recognition system consists of five major steps. The five major steps are input image acquisition, pre-processing, feature extraction, classification of gesture and generation of suitable command for the system [2]. Vision based Gestural Controllable Human Computer Interaction system, adopts various methods in the pre-processing stage and feature extraction stage. Designing an intelligent and efficient Human-Computer Interface where the user can interact with the computer in novel ways beyond the traditional boundaries of the keyboard and mouse has been a great source of motivation for HCI researchers. Now a day robotics, visual surveillance, manufacturing and medicine are few domains where visual sensors can be seen most commonly [12]. Vision based hand gesture recognition can used for applications like industrial robot control, sign language translation, smart surveillance, lie detection, visual environment manipulation, in the rehabilitation device for people with upper extremity physical impairments [3]. Vision based hand gesture recognition techniques also have the advantage of being unobtrusive and might be a natural way of interaction with machines and hence form an important type of input mechanism. A challenging aspect of this technique is to accurately detect gesture at multiple angles.

The main goal of this study is to explore some of the recent research in vision based hand gesture recognition system for Human Computer Interaction. To perform a feasibility study on recognizing human activity using hand gesture analysis, to gather details of best practices in design and development of these innovative systems and to establish a base for further research. In this paper, we present a survey exploring the power and possibilities of vision based hand gesture recognition system for Human Computer Interaction and also to study design issues and challenges in the area. Here a qualitative analysis is made on the different vision based hand gesture recognition systems for Human Computer Interaction including their strengths and weaknesses. Further a proposal is made on the possible future trends of these systems.

The main problem statements in this paper can be outlined as follows:

- Identify Camera vision-based Human Computer Interaction techniques using hand gestures.
- Organize and analyze the approaches used for building vision based hand gesture recognition system for Human Computer Interaction.
- Define the strength and weakness of each system.
- Infer enhancements and enrichment that could be added to the systems.

Rest of the paper is organized as follows, Section I contains the introduction, main goal and problem statements, Section II talks about our motivation to undertake this study, Section III compares various methodologies used in recent research papers as a part of literature review, Section IV provides conclusion and future scope for the study undertaken.

II. MOTIVATION

The main goal of this study is to explore some of the recent research in Vision base Gesture Recognition in Human Computer Interaction, to perform a feasibility study on recognizing human activity using hand movement analysis,

to gather details of best practices in design and development of these innovative systems and to establish a base for further research. In this paper, we present a survey exploring the power and possibilities Vision base Hand Gesture Recognition in Human Computer Interaction techniques and also to study design issues and challenges in the area. Here a qualitative analysis is made on the different Hand Gesture Recognition systems to identify their strengths and weaknesses. Further a proposal is made on the possible future trends of these systems.

III. LITERATURE SURVEY

Here, we categorize seven of the recent research papers on Vision base Hand Gesture Recognition. In this section an overview of different architectural approaches used to build Hand gesture applications is given, with emphasis on research direction, technology and results from theoretical proofs or simulations.

The important objective of this paper is to use two of the most important modes of interaction – head and hand to control any Computer Vision algorithms based application running on a computer. Video input stream hand is segmented. The corresponding gesture is recognizing based on the shape and pattern of movement of the hand. Hidden Markov model is used for the head gesture. Pre-processing common to hand and head gesture recognition 1st Capture a frame from camera.2nd: Hand and face are detected using Viola Jones algorithm. Classifiers are trained on the images of hand and face to detect them using an artificial neural network. Face detected can be used to figure out the area of the head. Method specific to Head gesture recognition: 1st: Optical flows of the all pixels, calculated with the gradient method, in the extracted head region are treated as values representing a head movement.2nd: The results of head movements are then used for recognition using finite state automata [1].

The basic intention of static hand gesture recognition is to analyze the given hand gesture data represented by some features into some predefined finite number of gesture classes. The main interest of this effort is to explore the use of two feature extraction methods, especially, hand contour and complex moments to resolve the hand gesture recognition issue by identifying the main advantages and disadvantages of each method. Artificial neural network is built for the purpose of classification by using the back-propagation learning algorithm. The hand gesture image is passed through three stages, namely, pr-processing, feature extraction, and classification. In the sate of pr-processing, some operations are practiced to extract the hand gesture from its background and prepare the hand gesture image for the feature extraction stage. In the very initial method, the hand contour is used as a factor which treats the scaling and the translation issues. The complex moment's algorithm is, however, used to outline the hand gesture and treat the rotation problem in addition to the scaling and translation. The results show that the hand contour method has a performance of (71.30%) recognition, while complex moments have a better performance of (86.90%) recognition rate [2].

The gesture recognition system consists of five major steps. They are input image acquisition, pre-processing, feature extraction, classification of gesture and generation of suitable command for the system. Vision based hand gesture recognition can used for applications like industrial robot control, sign language translation, in the rehabilitation device for people with upper extremity physical impairments. Vision based Gestural Controllable Human Computer Interaction system, to obtain robust and more accurate result, adopted various methods in the pre-processing stage and feature extraction stage. In the pre-processing stage skin color threshold method is used in background modeling for more accurate hand region segmentation. After this, in the feature extraction stages SIFT and MBC algorithm is used. Monogenic signal representation decomposes an original signal into three complementary components: orientation, amplitude, and phase. The monogenic variation in each local region and monogenic feature in each pixel are encoded, and then calculates the statistical features of the extracted local features. The proposed MBC scheme has significantly lower time and space complexity than other local feature extraction methods. The features extracted using SIFT are more prone to variation in scale and rotation [3].

Gesture Recognition system's is to create an interface that is natural for humans to operate or communicate with a computerized device. Objective of this work was to develop a control system for a robot freight ramp, based on gesture recognition. With that purpose, They decided to use a generic webcam for the image acquisition process, and they have defined a gesture vocabulary for the telerobotic control, using gesture recognition algorithm based on histograms and motion detection, which makes it suitable for real time control, easy to implement and efficient in unconstrained environments. This paper presents a fast, robust and accurate method for hand gestures recognition under unconstrained scenes [4].

Gesture recognition for gestures made from side angles are one of the most common problems encountered while using a single camera. Based on combination of Affine Transform and Discrete Fourier Transform (DFT), a hand gesture recognition system for multiple viewing angles using a single camera, is presented. Experimental result s show that the system can efficiently detect gestures made from multiple angles with an average recognition rate of 95.28% and 90.30% for gestures made at +-30 degree and +-45 degree respectively, which is considered good in the field of computer vision. The proposed system is made invariant to translation, rotation and scaling by the inclusion of the properties of DFT. The original shape of the sign is

reconstructed by finding out Inverse Discrete Fourier Transform (IDFT). In this technique, affine transformation at particular angle makes the gestures input from various angles approximately similar to the gestures being made at 0 degree platform. Hence, the proposed method can be considered as an effective method for multi angle gesture detection. It is observed that the system is simple to use and cost effective also because only a single camera is used and from the experimental results, it can be said that the system performance is good enough and can be used [5].

A vision based system to control various mouse activities such as left and right clicking using hand gestures to make the interaction more efficient and reliable is proposed. This paper delineates a vision based interface for regulating a computer mouse via 2D hand gestures. Hand gestures rely upon camera based color detection technique. This method mainly focuses on the use of a Web Camera to develop a virtual HCI device in a cost effective manner. Centroid of each input image is found. Hand movement also moves the centroid thus making it the principle of sensing for the alteration of cursor on computer screen. The hand image is treated here as the parent image. The left and right click functions of a mouse are implemented by folding the first and middle fingers of hand respectively and develop a baby image. So, by comparing the length of fingers in baby images with those in mother image gives an idea about the functionality performed by the hand gesture. When the length of finger crossovers the threshold length in baby image, it executes a clicking operation. Here, the efficiency of tracking the hand is improved by using red and blue colored caps on the fingers to make centroid looking more prominent. Post study, author believes that this technology has great future in HCI based systems. It can be widely used in the fields of robotics, biomedical instrumentation, computer gaming and many more [6].

Gesture movement recognition system uses common USB camera and the method of skin color segmentation to get the image. The input image is converted from RGB space to YCbCr space with Otsu algorithm for threshold segmentation on the Cr channel of skin color clustering to get a better segmentation result. In the process of image preprocessing, filling small area algorithm is used to improve segmentation result by filling small outline inside the gesture image with white, so as to solve the problem of the hole in the gesture image and improve the recognition accuracy of the system, which help realize the gesture recognition and mouse virtual control system. This system achieves using gestures instead of the mouse clicking, pointer movement and other virtual operations. Compared with the data glove and multifunction camera, the required equipment is simple and low cost, which is in favor of gesture recognition application and promotion. The development of human-computer interaction has been developed increasingly. The combination of gesture recognition and mouse control will make people's lives more convenient and intelligent; therefore this gesture movement recognition system has huge practicality and space for further development [7].

In this paper, the use of a camera and computer vision technology such as image segmentation and feature extraction, a technique is developed which can be used for computer control using hand gestures. The convex full and convexity defects algorithms perform in open CV platform using C++. From the obtained color image, the binary image is derived using image segmentation technique. Convexity defects are formed by the regions between the fingers. The number of convexity defects present in the hand gesture determines the count of the number of fingers present in the hand gesture. Point start describes Point of contour where the convexity defect begins. Point End describes Point of contour where the convexity defect ends. Point Far describes Point within the defect which is farthest from the convex hull. Depth is distance between the convex hull. This point as parameters for designing hand gestures for computer control. Further studies are going on in this topic to develop the applications using these parameters [8].

In this paper, hand gesture recognition(HGR) algorithm capture the image of a single- handed gesture of hearing an impaired person using a simple webcam for an eccentric approach. An image capturing 12megapixel iball c12 webcam captured RGB color format and resized 160*120 to reduce the computational time. Image Preprocessing consists of hand segmentation by mapping In YCbCr color space into YCbCr color plane various possible ways of segmentation using different color spaces and models. The Region of Interest Extraction (ROI) uses the Sobel algorithm to find edges where the gradient of input binary image is maximum. A Gesture from 1 to 5 recognized correctly and zero, one, six, nine are count 1. The value of radius R varies with max, this method is invariant to size, distance from webcam and orientation of user's hand. In the experiments, we assume a stationary background in order to get good segmentation results. The system is completely autonomous and easy to use as users [9].

In this paper, The Hand gesture recognition system focus on thresholding approach and skin color model along with an effective template matching using principal component analysis. Sensor base and Vision base are hand gestures recognition techniques. Sensors are attached to hand which record to get the position of the hand and collect data for gestures. Vision- based techniques use colored markers to get a position of data and various image processing algorithms. Image Acquisition, Hand Segmentation, Feature Extraction are the methodology for hand gesture system. Images of 4 gestures used with 5 different poses per gesture from 4 subjects making 20 images per gesture. The Skin color of different person can vary and background image can also contain the skin pixels so after skin color model Otsu thresholding is applied to remove the background are steps of hand segmentation. PCA method used for feature extraction and it reduces the dimensionality of the image while

preserving information. The system is tested for 4 gestures with 5 different poses per gesture from 4 subjects making 20 images per gesture and shows 91 .25% average accuracy and average recognition time of 0.098251 sec [10].

Table 1: Literature Survey

Sr. No	Paper Name	Year of Public	Technique name	Methodology	Advantage
1	Vision-based Multimodal Human-Computer Interaction using Hand and Head Gestures[1]	2013	1. Viola Jones algorithm. 2. ANN. 3. Gradient method. 4. Finite state automata.	• Pre-processing common to hand and head gesture Recognition. • Method specific to hand gesture recognition. • Method specific to Head gesture recognition. • Integration of hand and head gesture recognition modules	• Fast, robust and accurate method for hand gestures recognition under unconstrained scenes. • Satisfactory recognition percentage of the gestures.
2	Recent methods in vision-based hand gesture recognition[2]	2016	1.ANN	• Image Capture • Image Processing • Feature Extraction • Classification • Evaluation and Comparison	• The gestures are more intuitive and user friendly. • Hand and Head gestures were used increased accuracy

Sr. No	Paper Name	Year of Public	Technique name	Methodology	Advantage
3	Vision Based Gesturally Controllable Human Computer Interaction System[3]	2015	1. SIFT 2. MBC	• Input image • Preprocessing • Feature Extraction • Monogenic Binary Coding-(MBC) • Scale Invariant Feature Transform-(SIFT) • Command Generation	• Avoid the over fitting problem can provide a more realistic evaluation about their future performance based on the training results.
4	Vision-based Gesture Recognition for Human-Computer Interaction and Mobile Robot's Freight Ramp Control[4]	2010	Motion detection and gesture recognition algorithm	• Image acquisition. • Image segmentation. • Feature extraction and gesture recognition.	• Fast, robust and accurate method for hand gestures recognition under unconstrained scenes
5	A Robust Viewing Angle Independent Hand Gesture Recognition System[5]	2015	Affine Transform Discrete Fourier Transform	• Capture video though camera. • Get frames • Face detection and removal • Remove color information • Morphological operation • Tracking hand path • Affine Transform • Discrete Fourier Transform • Recognized	• Simple to use and cost effective. • System performance is good enough and can be used.
6	Vision based Computer Mouse Control using Hand Gestures[6]	2015	Camera based colour detection technique.	Video acquisition • Real-time Video Acquisition • Flipping of Individual Video Frames • Extraction of Red and Blue component region extraction • Filtering • Binary Image Generation • Removal of small objects • Centroid Detection • Mouse Left and Right Click	• It can be widely used in the fields of robotics, biomedical instrumentation, computer gaming and many more.

Sr. No	Paper Name	Year of Public	Technique name	Methodology	Advantage
7	Design of control system based on hand gesture recognition[7]	2018	Otsu algorithm	Acquisition and pre-processing of gesture images • Color segmentation • Gesture image binarization • Gesture image enhancement Dynamic gesture recognition and control • Getting the bounding rectangle and centroid point of the • Gesture image. • Dynamic gesture recognition of the direction of movement. • Direction and motion control	• The combination of gesture recognition and mouse control will make people's lives more convenient and intelligent, therefore this gesture movement recognition system has huge practicality and space for further development
8	Hand Gesture Parameters using Image Processing[8]	2015	Camera and Computer vision technology	• Image Capturing • Image Preprocessing • Region of Interest Extraction • Finger Counting Logic • Gesture Classification • Display Recognition Result	• Further studies are going on in this topic to develop the applications using these parameters.
9	Vision-Based Hand Gesture Recognition Using Eccentric Approach[9]	2014	1. hand gesture recognition(HGR) algorithm 2. Sobel algorithm	• Derive the binary image from the colored image frame which was obtained as input from webcam. • Find the contour of the binary image and draw this on another blank image. • Find the center of mass of hand. • Find and draw the convex hull and convexity defects on a blank image. • Define and manipulate certain points which can be use for gesture control	• The system is completely autonomous and easy to use as the users

Sr. No	Paper Name	Year of Public	Technique name	Methodology	Advantage
10	Hand gesture recognition using principal component analysis[10]	2015	1. Sensor base and Vision base are hand gestures recognition techniques. 2. PCA	• Image Acquisition • Hand Segmentation • Feature Extraction • Gesture Recognition	• Empowers the medical experts to pass the instruction to the robotic hands remotely to add the accuracy in the operations.

IV. CONCLUSION AND FUTURE SCOPE

Using hand and head to gather, accuracy of combined multimodal gesture recognition system is increased. Still there are some problems while recognition, where accuracy is not 100% which need to be improved for some of the gestures. The more accurate TLIT -4 unconstrained scene detection rate is 93.2% and static scene detection rate is 95.3%.the system is invariant to translation, rotation and scaling tackled easily in gesture. In the process of image processing, filling small area algorithm is used to improve gesture image with white. A vision based virtual mouse tack the hand gestures using colours caps on the fingers. The system is completely autonomous and easy to use as the users do not have to wear any gloves or accelerometer thus making it more feasible. The proposed model works only with static gesture and does not evaluate the images clicked in other light colours where the hand gestures have been clicked. Further research studies are going on in this topic**.** Future work will focused on algorithm improvement, by using a combination of segmentation techniques and robot motion control by speed. Motion development acknowledgment framework has tremendous down to earth and space for the advancement. The focuses acquired Point begin, Point end, Point far can be utilized to discover edges and separations between the focuses. These points and separations can be utilized as parameters for hand signals for PC control. Our exploration enables the medicinal master so pass the guidance to the mechanical hands remotely to include the precision in the activities. In any case, the proposed model isn't equipped for working with the pictures containing hands of other than skin shading. The proposed model does not assess the pictures clicked in other light hues where the hand signals have been clicked and the model work just with static gesture. Create our own database for motion acknowledgment by utilizing low goals and more affordable industrially accessible camera. The application can be improved to a work with huge separation so it utilized information representation in restorative and logical field. It can be generally utilized in the field of apply autonomy, biomedical instrumentation, PC gaming and some more.

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