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Gesture Based Computing as an Alternative to Mouse by Calibrating Principal Contour Process Actions

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Abstract- Computing is no longer a discrete activity bound to a desktop; network computing and mobile computing are fast becoming a part of everyday life and so is the Internet. In the present day framework of interactive and intelligent computing, an efficient human computer interaction is assuming utmost importance. The topic of user experience and interaction has been increasingly popular and widespread lately. Unlike decades ago, when people place most of their attentions on the quality and functionality, or brand of a product, at the present time, the user interaction experience and usability seems to be the vital element when people are considering and selecting a product. Gesture based computing enables humans to interface with the machine (HMI) and interact naturally without any dedicated devices. Building a richer bridge between machines and humans than primitive text user interface or even (graphical user interfaces) GUIs, which still limit the majority of input to keyboard and mouse. In fact we are bridging this gap by bringing intangible, digital information out into the tangible world, and allowing us to interact with this information via natural hand gestures. Gesture Based Computing provides an attractive alternative for human computer interaction (HCI). A novel approach is proposed for implementing a real-time Human interaction system capable of understanding commands with emphasis on hand gestures by analyzing the principal contour and fingertips.

Index Terms- Human Machine Interface; Human Computer interaction; Hand Gesture; Gesture based Computing.

1. INTRODUCTION

No doubt, Present world framework of technology is seeking for an interesting interface for Human Computer Interaction (HCI) which can provide an environment where a user can interact with a computer or roughly speaking a machine in a more user friendly way. We are bridging the gap of interaction by bringing immaterial, digital information out into the material world, and allowing us to interact with this information via natural hand gestures. Gestures considered as a natural way of communication among human especially for hear-impaired, since it is a physical movement of hands ,arms, or body which conveying meaningful information by delivering an expressive message. Gesture recognition then, is the interpretation of that movement as semantically meanings command.

Vision Based approach of hand gesture recognition has received much attention from academia and industry in recent years, largely due to the development of human-computer interaction (HCI) technologies and the growing popularity of smart devices such as smart phones. The essential intention of building hand gesture recognition system is to create a natural interaction between human and computer where the recognized gestures can be used for controlling a robot [15] or conveying meaningful information [1]. How to form the resulted hand gestures to be understood and well interpreted by the computer considered as the problem of gesture interaction.

Hand gestures recognition (HGR) is one of the major innovative areas of research for the engineers,scientists and bioinformatics. Today many researchers in the academia and industry are working on different application without wearing any extra and dedicated device to make interactions more easy, natural and convenient. However, human-robot interaction using hand gestures provides a remarkable challenge. For the vision part, the complex and cluttered backgrounds, dynamic lighting conditions and a deformable human hand shape, extraction of wrong object can cause a machine to misunderstand the gesture. If the machine is mobile, the hand gesture recognition system also needs to satisfy other constraints, such as the size of the gesture in the image and adaptation to motion. Moreover, to be natural, the machine must be person-independent and give feedback in real time.

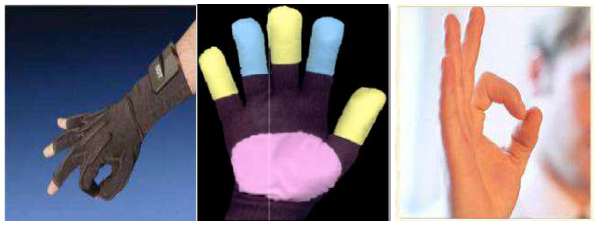
The main focusing point of the paper is to presents a Hand gesture recognition system emphasizing the detection of the motion of the hand in a real-time scenario, track it, identify its features such as fingertips and use those to create a simple application, which is measured to be challenging problem in the human-computer interaction context and promising as well. Although recent reviews [1,6-8,15,19,20] in computer vision based have explained the importance of gesture recognition system for human computer interaction (HCI), this work concentrates on vision based techniques method and it's up-to-date. With expecting to point out various research developments as well as it emphasis good beginning for interested

persons in hand gesture recognition area. Conclusively, we give some discussion on the current challenges and open questions in this area and point out a list of possible directions for future work.

The rest of the paper is organized as follows. Section 2 explains the basic concepts and approaches of the vision based hand gesture approaches. Section 3 includes several related works. The proposed work is detailed in Section 4. Finally the work is settled in Section 5.

2. HAND GESTURE TECHNOLOGY

To enable hand gesture recognition, numerous approaches have been proposed, which can be classified into various categories. For any system the first step is to collect the data necessary to accomplish a specific task. In order to acquire input data for hand posture and gesture recognition system different technologies are used. A common taxonomy is based on whether extra devices are required for raw data collecting. In this way, they are categorized into data glove based hand gesture recognition, vision based hand gesture recognition [5], and color glove based hand gesture recognition [6]. Figure 1gives an example of these technologies.



(a) Data-Glove based. (b) Colored marker (c) Vision based.

Fig 1: Examples of hand gesture recognition input technologies.

2.1 Data glove based approaches

Data glove based approaches require the user to wear a cumbersome glove-like device, which is equipped with sensors that can sense the movements of hand(s) and fingers, and pass the information to the computer. Hence it can be referred as Instrumented glove approach. These approaches can easily provide exact coordinates of palm and finger's location and orientation, and hand configurations, The advantages of these approaches are high accuracy and fast reaction speed. However these approaches require the user to be connected with the computer physically which obstacle the ease of interaction between users and computers, besides the cost of these devices are quite expensive.

2.2 Colored Markers based approaches

Color glove based approaches represent a compromise between data glove based approaches and vision based approaches. Marked gloves or colored markers are gloves that worn by the human hand [6] with some colors to direct the process of tracking the hand and locating the palm and fingers [6], which provide the ability to extract geometric features necessary to form hand shape [6]. Compared with instrumented data glove the amenity of this technology is its simplicity in use, and it costs low price. Intrinsically, they are similar to the latter, except that, with the help of colored gloves, the image preprocessing phase (e.g., segmentation, localization and detection of hands) can be greatly simplified. The disadvantages are similar to data glove based approaches: they are unnatural and not suitable for applications with multiple users due to hygiene issues.

2.3 Vision Based approaches:

Vision based approaches do not require the user to wear anything (naked hands). Instead, video camera(s) are used to capture the images of hands, which are then processed and analyzed using computer vision techniques. This type of hand gesture recognition is simple, natural and convenient for users and at present they are the most popular approaches to gesture recognition**.** Although these approaches are simple but a lot of gesture challenges are raised such as the complex and cluttered background, lighting variation, and other skin patches with the hand object, besides system requirements such as robustness ,velocity, recognition time, throughput, and computational efficiency [1][10].

3. RELATED WORK

William F. and Michal R applied orientation histogram in [3] a method for recognizing gestures based on pattern recognition. Mentions some issues include similar gestures might have different orientation histograms and different gestures could have similar orientation histograms, besides that, the proposed method achieved well for any objects that dominate the image even if it is not the hand gesture. Xingyan L. In [5] presented fuzzy c-means clustering algorithm to recognize hand gestures in a mobile remote. There are some restrictions with current system as the recognition accuracy drops quickly when the distance between the user and the camera is greater than 1.5 meters or when the lighting is too strong. The system cannot deal with an image that has two or more patches of skin with similar size.

Stergiopoulou E. [1] recognized static hand gestures using Self-Growing and Self-Organized Neural Gas (SGONG) network. Three geometric features was extracted, two angles based on hand slope and the distance from the palm center was determined, where these features used to determine the number of the raised fingers class. The system recognized 31 predefined gestures with recognition rate 90.45%, in processing time 1.5 second, but it is time consuming and when the number of training data increase, the time needed for classification are increased too. Hasan [4] applied multivariate Gaussian distribution to recognize hand gestures using nongeometric features.

Table1: comparison between various methods of hand gesture recognition system

METHOD	**MERITS**	**LIMITATIONS**	**APLLICATIONS**
a novel distance metric, Finger-EarthMover's Distance (FEMD), Thresholding decomposition	robust to hand articulations, distortions and orientation or scale changes, and can work in uncontrolled environments	False and confusing gesture orientations	Rock-Paper-Scissors Game, Arithmetic Computation
Learning Vector Quantization, HSI color space.	Cluttered backgrounds can be managed Accuracy Of Capturing.	Color variations upon lighting changes	Multimedia presentation command
Fuzzy C-Means algorithm , Threshold.	Enough speed and sufficient reliability Recognition Rate : 85.83%	wrong object extraction, environment lighting changes, Distance variations, Cannot distinguish two or more patches of skin.	mobile robot
Self-Growing and Self-Organized Neural Gas (SGONG) network, YCbCr color space, Gaussian distribution	Reliable since it is relatively immune to changing lighting conditions and provides good coverage of the human skin color. Fast - does not require post-processing of the hand image Recognition Rate : 90.45%	Time consuming Complex	3D Modeling, Numbers Recognition
Laplacian filter Euclidian distance metric, HSV color model	Promising solution for illumination changes Recognition Rate : 91%	Different orientation histograms Background is plane and uniform, Computational complexity	Helicopter Signaller for Marshaling Operations, Television Control.
Orientation histogram, Euclidean distance metric	simple and fast to compute offers some robustness to scene illumination changes	similar gestures might have different orientation histograms different gestures could have similar orientation histograms wrong object detection	Pattern Recognition, Graphic Editor Control

The input hand image is segmented using two different methods ; skin color based segmentation by applying HSV color model and clustering based thresholding techniques. Lamberti [6] presents a real-time hand gesture recognizer based on a color glove. Color markers are employed to get the features as five distances from palm to all fingers and four angles between those distances. Daeho Lee and SeungGwan Lee [11] presents a novel vision based method in which , fingertips are detected by a novel scale-invariant angle detection based on a variable *k*-cosine. Table1 shows the comparisons between different hand gesture recognition techniques.

4. PROPOSED WORK

Gesture based computing interface makes the user more interactive with the PC. The power of controlling the PCs will be in our hands. With the help of mere bare hand and its gestures we can get the power of pointing device like mouse. Gesture based computing makes the interface more advanced compared to pointing device like mouse. We can get full access of our personal data on our finger tips.

The proposed system is illustrated in the Fig 1,consists of 3 main components viz Image Capturing, Image Processing And Application Handler. The Inage capturing mainly initiates the webcam to capture the image. After getting the captured image processing of the particulars are facilitated. Includes configuring skin color values and detecting the concerned skin color bands. Next emphasis the finding of different contours in the image and storing it in an array. From the contours detected we must identify the Principal Contour this will reduce the wrong object detection. Principal contour helps us to detect the finger tips ,to track the gesture actions and to find the current positions. This identified gesture action are send to application handler to control different applications.

4.1 Module Description

4.1.1 Image Capture Module

We need to capture the gestures provided by the hands .In order to do that we use an Image capturing device (Web cam) to pictures every movement of the hands, and this is marked as the input of our program to control the system. The **Java Media Framework** (JMF) is a Java library that enables audio, video and other time-based media to be added to Java applications and applets. This optional package, which can capture, play, stream, and transcode multiple media formats, extends the Java Platform, Standard Edition (Java SE) and allows development of cross-platform multimedia applications. Using this key feature in JMF it is used to detect the user hand movements and it is directed to the Computing device.

4.1.2 Color Detection Module

It should be processed in such a way that we have to identify the colors that are required by analyzing each

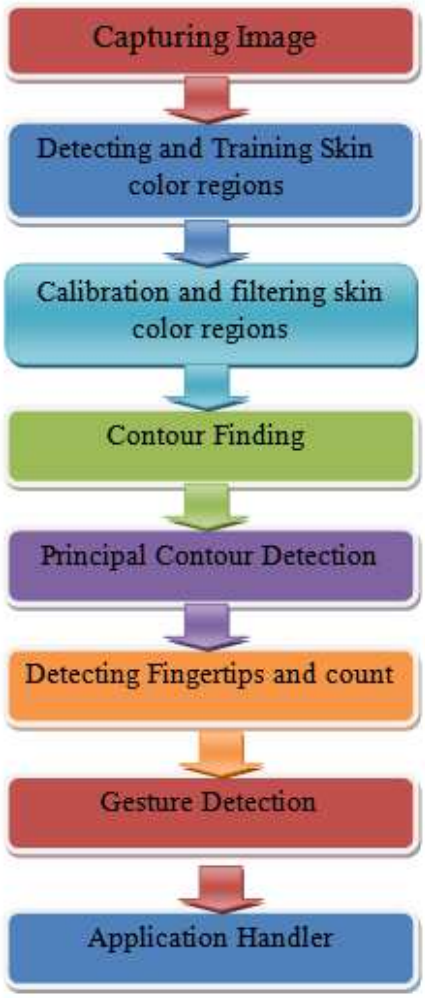


Fig 2. Block diagram of the proposed work

pixel. In order to identify color the pixels in the image is arranged in a one dimensional array. It makes the color analysis much easier. The RGB components in each pixel are calculated. The color value of each pixel can range from 0-255. Depending on this value of red, blue and green we can identify the pixel color. I.e. to get red color, the R value should be greater than 150 and the other must be less than 40.

This is the method that we are using here for processing image. In java a class named pixelGrabbe is used for this process. Here we are comparing the obtained RGB value with the already decided color values. If we are obtaining such an RGB value in the prescribed limit, the analysis will be terminated and the obtained color is taken as the input for the next process. Hence this module is considered as the

learning phase in which we should able to detect the skin color and make that recognizable by the HMI.

4.1.3 Image Comparison Module

From the image, the Skin color is detected and the coordinate value of that color pixel is obtained. This is done for each frame. From the coordinate value thus obtained, the position mouse is calculated. The position is calculated as the difference in coordinate value of that color in consecutive frames. Depending upon this value the different mouse operation such as mouse pointer movement, left click, right click and double click is performed.

4.1.4 ADD-ONS

GBC has got four applications. They are:

(1) Mouse activity handler module.
(2) Image viewer module.
(3) File transfer module
(4) Mail dispatcher.

(1) Mouse Activity Handler Module

Skin color and a concerned gestures are assigned for basic mouse action. Gesture1 – Movement, Gesture232 – Right Click, Gesture121 – Left Click. The coordinates of mouse pointer changes as the projected gesture move over the screen. This is done by calculating the co-ordinate axis frame by frame. The captured position of skin color is stored in a variable (current x & current y).if the same color is detected in the next frame at different position the present values of current x & current y will be moved to previous x & previous y respectively. The new co-ordinate value is moved to the current x& current y. By calculating the displacement of these two axes the movement of mouse pointer is done.

The rest mouse actions are done by other respective colors and it is managed by **Robot_class** which is provided by java. This class implementations. Using the class to generate input events differs from posting events to the AWT event queue or AWT components in that the events are generated in the platform's native input queue. For example, Robot.mouseMove will essentially move the mouse cursor instead of just generating mouse move events.

(2) Image Viewer

Image viewer is a application which helps us to view digital images that are stored in our computer. To change the magnification level to zoom in on the current picture click the magnifier and then drag the slider to zoom in on the picture. This lets us to get close up view of the image. The same way zoom out also can be done. To view next or previous image that is in the same folder as the current picture, can click on next or previous button.

In GBC instead of these buttons we use Gesture2 for viewing previous and next images. If skin color is moved from left to right, previous image can be viewed. For next image, skin color is moved from right to left. For zoom in and zoom out Gesture5 is used a time. As the distance between these color increases the picture will get enlarged and if the distance between the color decreases the picture is shortened. So by using GBC, it helps us to view images in a different way. Instead of sitting close to a system and always clicking on button to view previous and next images and to zoom in and zoom out we need only to show the specified gestures with specified skin color and gesture(count of fingertips).

(3) File Transfer

File transfer is the process of transferring a file from one system to another system. Here we use gestures and skin color band for this purpose. For that we need a server to control and manage those activities. More than two clients can take part in this. Two java classes, fileInputStream and file OutputStream are used. The system participating in this must be connected locally via Ethernet cable or by using switch.

The server initiates the application. The client program is run on those computers where the actual file is present and on those where the file needs to be copied. The file which is to e transferred between computers is selected first. When skin color band along with Gesture12 is shown on the system which is having the selected file, it gets copied. Now we need to show skin color band and Gesture5 on those computer to which the file is to be transferred. And the file will be pasted on the specified destination or folder.

(4) Mail Dispatcher

It is just like Gmail and Yahoo mail, we can access mail completely. We can compose, store, read and send mail. We can store email addresses and other confidential data here. Since the data must not be read by others we set password for such documents. Usually passwords are set of characters or numbers or combination of both. For a hacker it can be easily hacked and the data can be read. The data are no ore confidential.

But now a day instead of password, patterns are used. It is common in android phones. We just need to set a pattern by drawing a pattern. Using only this pattern one can open the phone. Just like this application, we use pattern based locking technique for login to the mail dispatcher. When the user first opens the mail dispatcher, he is asked for login, where he has to draw the pattern. It contains 9 rectangular boxes arranged in a 3*3 matrix form. By using red color glow he can move from one block to another and by using green glow he can select the box of his pattern. If the pattern is correct then only he can login into his account. Thus it ensures security.

5. CONCLUSIONS

Hand gesture recognition is considered to be very challenging for real-life applications because of its requirements on the robustness, accuracy and efficiency. In this paper , we described real-time hand gesture recognition system based on principal contour action analysis. Primarily a comprehensive review on tools and techniques of gesture recognition system has been provided with emphasis on hand gesture expressions. The major tools surveyed include Orientation Histograms, fuzzy clustering HMMs, ANN, HSV and Geometrical method have been reviewed and analyzed. Nearly all researchers are using colored images for achieving better results. Comparison between diverse gesture recognition systems have been presented with explaining the important parameters needed for any recognition system which include: the segmentation process, features extraction, and the classification algorithm. Despite the fact that the recognition rate increases gradually, the concerned algorithms experience several issues. The challenges include wrong object extraction, complex and nonuniform background, partial-occlusion, background disturbance, object reappearance, illumination change etc. The assortment of specific algorithm for recognition depends on the application needed. In this work, we proposed cost effective and user friendly Hand Gesture Recognition System by Principal Contour Action analysis which finds the principal contour from the background and analyses the position and contour of the detected fingertips, various interface actions such as clicking, moving ,zooming and pointing are recognized. Setting a threshold value of time in capturing gestures employed for differentiating the concerned gestures. Two-handed dynamic-gesture multimodal interaction is thus a promising area for future research. Customization of gestures also can be employed to make it more user friendly.

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