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Dynamic Hand Gestures Recognition System with Natural Hand

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Abstract— In this paper a real time system for natural hand gesture recognition with dynamic hand movements is presented. Besides using static hand gestures it is always easy to user to use dynamic hand movements. This paper gives a system which can work for both static and dynamic hand gestures as required by the user. We can use this system in robotics, PowerPoint presentations, media players, rotating 3D objects etc. The system is tested in both of the indoor and outdoor environments and shows the robustness to lighting change and users' errors.

Keywords — HCI, Thresholding, Trigonometric circular scan, Blob Detection, COG.

I. INTRODUCTION

Now a day's human uses most of time gestures and face expressions for interaction with others. Gestures are nothing but meaningful expressions on human body parts and Gesture recognition is recognizing that meaningful expressions for further use. Likewise most common gesture for best luck is thumbs up or for saying hi anyone we just move our palms etc. On type of gesture there are two basic types of it, they are Static and Dynamic Gestures. Using this system it becomes easy to communicate with computer from a distance and intelligently. But still when we are interacting with machines or say computer it requires more understanding and analysis of desired commands which make interaction sophisticated and unnatural. There's need for communication using sign languages, such as chatting with speech and hearing challenged individuals. Additionally, there are some situations where silent communication is preferred over the voice: for example, In Hospitals at time of Operation, surgeons typically uses gestures to communicate with assistants. It becomes challenging for communication with deaf people without an interpreter to communicate without knowing a symptom language [1]. Thus, software that transcribes symbols in sign languages into plain text can help with real time communication and it's going to also provide interactive training for individuals to find out a symptom language. Recognizing Gesture is a vital research field with main target emotion recognition and Hand Gesture Recognition.

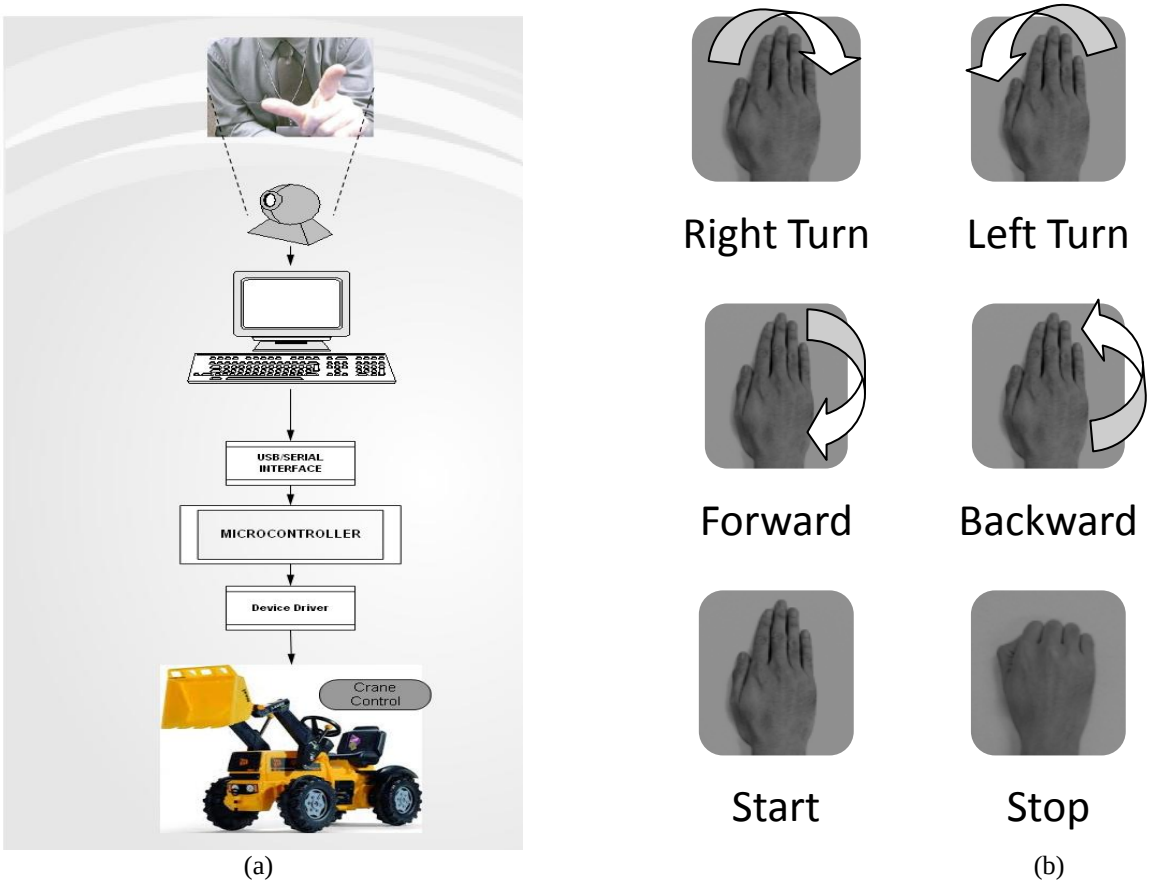
As a serious fulfillment of machine intelligence, gesture recognition has been an outstanding domain of analysis since the last 3 decades. Gestures square measure a very important variety of human move ion and communication: hands square measure typically wont to interact with things (pick up, move) and our body gesticulates to speak with others (no, yes, stop) [2]. Thus, a good vary of gesture recognition applications has been knowledgeable up to currently due to an explicit level of maturity reached by sub-fields of machine intelligence. As an example, humans will move with machine through gesture recognition, Cyber Glove [4] and Multi-touch screen. Nevertheless, contact device based mostly ways square measure intrusive and need the user cooperation to use properly the device. Therefore, vision-based ways propose to beat these limits and permit the popularity of gestures remotely with or while not slight user cooperation [3]. Since it's preferred to avoid these constraints, vision based mostly ways got to overcome many challenges like illumination changes, low-contrasted or/and creaking videos. Notwithstanding, ways supported cameras tend to be brittle and fewer precise than those supported contact devices.

Gesture recognition utilized in several areas like recognizing linguistic communication, HCI, automaton management, good police investigation, lie detection, visual environments manipulating etc. several tools and techniques are used for gesture recognition like mathematical models like Hidden Markov Model and Finite State Machine to approaches supported computer code computing ways like fuzzy clump, Genetic Algorithms and Artificial Neural Network [2]. For implementing gesture recognizing system totally different devices are needed for capturing and pursuit image/ video image like camera(s), instrumented gloves, and colored marker [5]. These devices used for HCI to facet by ancient interfaces like keyboards and mouse that are inconvenient and unnatural.

The aim of this paper is to how within which natural hand gestures ought to be utilized in Gesture Recognition method. Formula used for Gesture recognition is quick to mechanically acknowledge hand gestures. The most challenge of vision-based gesture recognition is to deal with the massive sort of gestures. Gesture Recognition involves handling some range of degrees of freedom, vast variability of the second look reckoning on the camera read purpose totally different silhouette scales and lots of resolutions for the temporal dimension. Moreover, we'd like additionally to balance the accuracy, performance, quality trade-off in line with the sort of application, and therefore the price needed for the answer and lots of different criteria's.

This paper is organized as follows: In Section 2 focuses on system overview. Section 3 gives explanation about gesture detection and recognition system. Experimental results are given in section 4. Future work and conclusion is in section 5.

II. SYSTEM OVERVIEW



(a) (b)

Fig. 1. (a) System Overview (b) Hand Postures Used

The system setup is illustrated in Fig. 1 (a). It consists of web camera with 640×480 resolution. Web Camera is directly connected to computer. A robotic device can be connected to computer for interaction between human and robot. The camera is placed on the screen. The human stands or sit at the front side of web camera so the human can see the camera and the screen simultaneously. The human uses his/her hand for interaction.

The system flowchart is illustrated in Fig. 2. The camera detects and tracks the human's hand (gesture detection), and the hand trajectory is segmented and recognized (gesture recognition). Once predefined gestures are recognized, the corresponding interactions are performed and processed at computer end or at hardware. Robust and fast gesture detection by locating the interaction hand largely determines the system's performance and serves as our major emphasis. Being aware of the difficulties in directly locating hands, we first segment the human body. Based on the segmented human silhouette, we develop a fast hand localization algorithm for our real-time application. The human body is roughly divided into three parts: the head, the torso, and the arm, and they are localized sequentially. The hand is finally localized by skeletonizing the arm [8].

In the system firstly web camera placed on or computer tracks hand movements of human. According to that computer process that frames calculates output gesture of given input. Using that we can make its use in computer for interacting with power point slides, media players etc [6], [9]. If we want to use robotic device then it should be connect through USB serial interface, microcontroller and device drivers to computer [7].

Figure 1 (b) show dynamic hand motion being used in the system. For right we can slide our hand in right direction similar for left hand. While using forward and backward motion just move hand back and front respectively. To stop and start a operation we can use closed fingers to palm and strait hand with fingers respectively to use.

III. GESTURE DETECTION AND RECOGNITION

Many researchers have been suggested on gesture recognition system for different applications, with different recognition phases but they all agree with the main structure of the gesture recognition system. These phases can be briefly stated as segmentation, features detection/extraction, and then final the classification or recognition phase [5], [10].

Following figure shows actual flow of proposed Gesture recognition system. Our proposed system has following major steps for gesture.

- Extracting Hand- like regions based on skin color and produce black & white image o/p.
- Do region based segmentation of hand removing hand-like regions.
- Calculate COG and farthest distance of hand form COG

- Using Center as a COG constructs a circle which intersects all fingers of hand region.
- Making use of circle and x, y co-ordinates of hands obtain desired gestures.

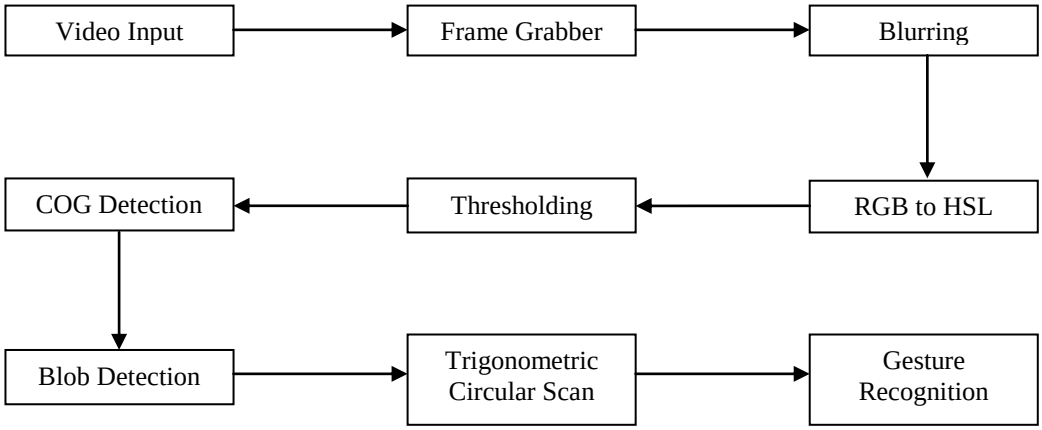


Fig. 2. Gesture Recognition System Steps

A. Video Input

Input from Web Camera to desired machine is obtained for further processing of Gesture. As it involves not only static but also dynamic approach we want video input.

B. Frame Grabbing

In Frame Grabbing individual digital frames are captured from a digital video stream. The Required frame from video is obtained for further processing of gesture. The Grabbing should be accurate because it can affect further processing.

C. Gaussian Blur

Blurring is nothing but to spread pixels from source image and mix it with surrounding pixels which is also called as Smoothing. Gaussian Blur is an image blurring filter technique which uses Gaussian function for mapping original image to blurred image [11]. In graphics software it widely used effect minimize image noise.

Gaussian function equation in one dimension is

$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}}$$

In two dimensions, Gaussian Function equation is the product of two such Gaussians, one in each dimension:

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

D. RGB to HSL Conversion

As we know RGB is basic color model where R is for Red, G is for Green, B is for Blue and HSL stands from Hue Saturation Lightness. From these basic colors we can from n number of colors. Due to varying light intensity the actual image and image captured may differ so it is a need to convert RGB color space to HSV or HSL color space [12]. Conversion of RGB to HSL or vice versa is easy to perform due to following simple equations,

Let us define some values as,
M = max(R, G, B)
m = min(R, G, B)
C = M – m

1) Hue:

$$H' = \begin{cases} \text{undefined}, & \text{if C=0} \\ \frac{G-B}{C} \bmod 6, & \text{if M=R} \\ \frac{B-R}{C} + 2, & \text{if M=G} \\ \frac{R-G}{C} + 4, & \text{if M=R} \end{cases}$$

$$H = 60° \times H'$$

2) Lightness:

$$L = \frac{1}{2}(M + m)$$

3) Saturation:

$$S = \begin{cases} 0, & if\ C = 0 \\ \dfrac{C}{1 - |2L - 1|}, & \text{otherwise} \end{cases}$$

E. Thresholding:

Thresholding is simplest method used for image segmentation. In Thresholding grayscale image, are used to create binary images [5], [16].

F. COG Detection:

COG is nothing but Center of Gravity. For every image we have find out where COG of image lies [10].

The COG is calculated by:

COG_X = COG_X + (I*x)
COG_Y = COG_Y + (I*y)
Total = Total + I

Where I = (R+G+B)/3 and x, y is the current pixel location for each pixel.

COG_X = COG_X/Total
COG_Y = COG_Y/Total

G. Blob Detection

Blob Detection refers to a field in area of computer vision, which is aimed to detect points or regions in the images that differ from properties such as brightness or color in comparison with the surrounding [13]. With the more recent terminology used Blob Detection they can also known as interest point Detection. Main Reason to use Blob Detector is it provides clear information about regions, which is not obtained clearly from edge detectors or corner detectors [11], [17].

H. Trigonometric Circular Scan Algorithm

Trigonometric Circular Scan is algorithm for Gesture Recognition in which a circle is formed that intersects all fingers and the wrist [10]. Algorithm works as follows,

1) Find Center of Gravity
   Use Above COG Detection formulas for Calculating COG.

2) Calculate Farthest distance from COG
   Farthest distance is extreme point in a hand from center.

3) Construct Circle with center COG.
   For Constructing circle use radius as,
   $R = 0.7 \times \text{Farthest distance}$

I. Gesture Recognition

After using Trigonometric Circular Scan Algorithm use vector Calculation to count number of fingers the circle is intersecting to hand [14], [15].

IV. EXPERIMENTAL RESULTS

System is experimented in outdoor and indoor environments in our college campus. The equipments used to carry out these experiments are computer, web camera. The configuration of system is Intel Core i5 2400 CPU @ 3.10 GHz with 2GB memory under windows 7. The Frame size of camera is 640 X 480.

The system is tested in various angles of hand motions, color, shapes to hand gesture recognition and detection. In all total 100 samples are taken, 50 from outside and 50 from inside. It finds that in outside testing the recognition is inaccurate in case of high intensity of light and if background is similar as color of user's hand. Indoor samples are may differ in low light as it becomes difficult to capture. Overall rate of accuracy is 97% which good using natural hand gestures.

TABLE I. EXPERIMENTAL RESULTS OF HAND GESTURE RECOGNITION

Environment	Total Samples	Accurate Samples	Accuracy	Overall Accuracy
Outdoor	50	48	96%	97%
Indoor	50	49	98%	

V. CONCLUSION

To develop good Human Computer Interaction is important in development of Gesture Recognition System. Gesture Recognition system has wide Varity applications from virtual reality to sign language recognition and robot control. In this paper a natural hand gestures are used to build an intelligent HCI system using Gesture Recognition. System uses limited and clear hand gestures which keeps it away from complexities. The algorithm used called Trigonometric Circular Scan is reducing time for processing and gives clear gestures after processing. Using natural Hand Gestures and Trigonometric Circular Scan algorithm it is possible to use system in outside environment.

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