A Highly Robust and Efficient Hand Gesture Recognition System Using Different Techniques for HCI Applications

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Abstract: - **Previous systems have used data gloves, markers or any other input devices for interaction. Hand gesture recognition system provides an alternative to interface devices for human computer interaction (HCI). There are several hand gesture recognition techniques are proposed. In this paper various hand gesture recognition techniquesare used for HCI applications and this system is real time system.**

It will recognize real time hand gestures. In this paper, overviews of various different methods for hand gesture are discussed. It has overview of the system that is completely divided into 3 main steps are segmentation, feature extraction and classification. The features that we are extracted are shape based and used in combination for hand gesture detection. In this, trained and untrained gestures are not used for training and testing respectively and the results yields a robust and efficient hand recognition.

Keywords- Otsu's method, Hand gesture recognition, feature extraction and human computer interaction.

I. INTRODUCTION

Hand gesture recognition using visual devices has a number of applications in virtual reality (VR), human computer interaction (HCI) and machine control. Vision based interfaces are feasible and at the present user are friendlier and more interactive with the machines without using devices for input. Computer recognition of hand gestures provide natural computer interface and reduces response time and it should provide no appreciable delay between when he or she makes a gesture motion and computer responds.

Hand gesture research can be classified into three categories. First category is glove based analysis that employs sensors attached to a glove that transduces finger flexion into electrical signals for determining the hand posture. Second category is vision based analysis that is based on human beings perceive information about their surroundings. Vision based hand gesture techniques do not require any extra hardware except high definition camera for more accurate results, so these techniques are very attractive and such kind of systems and methods are very suitable for omnipresent computing and developing applications.The third category is analysis of drawing gestures that make use of stylus as an input device. Visual sensing is most often used for gesture recognition than mechanical sensing because it is more practical and improve reliability, accuracy and electromagnetic noise.

Many methods for hand gesture recognition using visual analysis have been proposed for hand gesture recognition. Sebastiean Marcel, Oliver Bernier, Jean Emmanuel Viallet and DanienlCollobert have proposed the same using Input-output Hidden Markov Models [1]. Xia Liu and Kikuo Fujimura have proposed the hand gesture recognition using depth data [2]. For hand detection, many approached uses color or motion information [3, 4]. Attila Licsar and TamasSziranyi have developed a hand gesture recognition system based on the shape analysis of the static gesture [5]. Another method is proposed by E. Stergiopoulou and N. Papamarkos [6] which says that detection of the hand region can be achieved through color segmentation. Byung-Woo Min, Ho-Sub Yoon, Jung Soh, Yun-Mo Yangc and ToskiakiEjima have suggested the method of Hand Gesture Recognition using Hidden Markov models[7]. Another very important method is suggested by Meide Zhao, Francis K.H. Quek and Xindong Wu [8]. They have used AQ Family Algorithms and R-MINI Algorithms for the detection of Hand Gestures. There is another efficient technique which uses Fast Multi-Scale Analysis for the recognition of hand gestures as suggested by Yikai Fang, Jian Cheng, Kongqiao Wang and Hanqing Lu [9], but this method is computationally expensive. Chris Joslinet. al. have suggested the method for enabling dynamic gesture recognition for hand gestures [10]. Rotation Invariant method is widely used for texture classification and recognition. TimiOjalaet. al. have suggested the method for texture classification using Local Binary Patterns [11].

a) Motivation: - As the prevalence of ubiquitous computing, traditional user interaction approaches with mouse, keyboard and touch pen are not convenient enough for user. In addition, many emerging applications such as augmented reality and interactive entertainments require natural and intuitive interface. It is inconvenient to use traditional mobile phones or hand held devices because it has limited input space with tiny touch screen or keyboard. In this study, a hand gesture recognition system was developed to capture the hand gesture being performed by the user and to control a computer system by that incoming information. Many of such systems in literature have strict constraints like wearing special gloves, having uniform background, long-sleeved user arm, being in certain lightning conditions, using specified camera parameters etc. Such limitations ruin the naturalness of a hand gesture recognition system and also correct detection rates and the performances of those systems are not well enough to work on a real time HCI system. This research or project work aims to design a vision based hand gesture recognition system with a high correct detection rate along with a high performance criterion, which can work in a real time HCI system without having any of the mentioned strict limitations (gloves, uniform background etc) on the user environment. Both academic and commercial world lack such an assertive system and this presented research work intends to fill this gap.

b) Related Work: - Considering the requirement of a highly robust and efficient gesture recognition system for real time HCI development for varied gesture based applications, in this research work or project work a real time and effective operating hand gesture or hand posture recognition system will be developed and uses three hand shape based features for identification of what posture it is supporting. The overall algorithm has been divided in three main steps: segmentation, calculating features and last is classification. The proposed algorithm takes real time gesture input through high definition camera and then calculates three features of the image, two based on compactness, and one based on radial distance. On the basis of variables estimated for compactness and radial distances, a final parameters is estimated which in comparison to defined compactness threshold generates interpretations. The generated counts can be employed for gesture recognition based Human computer/machine Interface developments. A tentative flow of the proposed system has been given as follows:

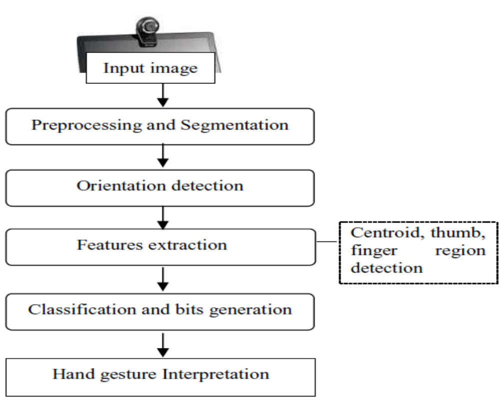


Figure1.1:- A Proposed System Model

II. THE IMPLEMENTED PROCEDURE WITH DIFFERENT TECHNIQUES

The Fig. 1.1 shows the flow chart of the proposed procedure and the description is as follows:-

1) Segmentation

The proposed system uses traditional methods of segmentation but it is implementing the Otsu's method rather than using a defined threshold values for segmentation of the input image. In this way it calculates the space between upper and lower edges of the arm and arm is exactly cut from the wrist, where the space between upper and lower corners increases promptly. This procedure reports for variation in hand and arm sizes by using proportional changes in area between upper edge and lower edge of the arm, rather than a fixed distance changes.

2) Feature Extraction

After segmentation feature extraction is next phase and in this features are extracted that are shape based and used in combination. The core idea of this paper is to recognize ten hand patterns using shape-based features. The hand can assume different shapes and gestures, so shape based features have not been extensively used in hand gesture recognition algorithm. To overthrow this obstacle, uses the combination of three hand shape based features. These features are explained below:

Fig.2.1A sample set of hand gesture patterns used. From topleft going counter-clockwise pattern Zero to pattern nine

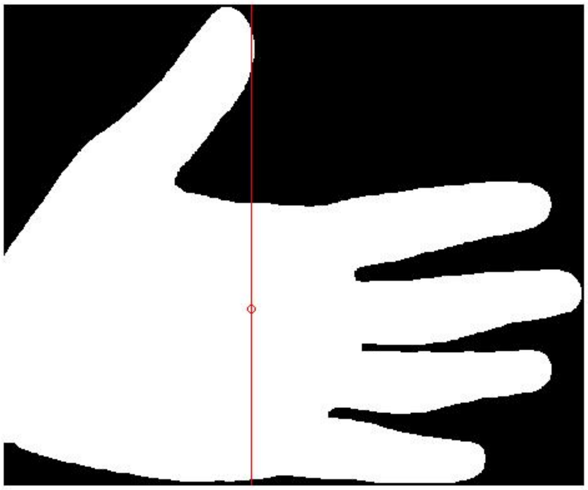


Fig.2.2. Hand partitioning. The circle representsthe centroid and the image is partitioned along the vertical line

2.1) Compactness I (CA)

The feature of the image to be extracted is compactness and it's a hand shape based descriptor. The following equation is used for calculating compactness of hand shape:

$$Compactness = \frac{Perimeter^2}{4\pi \times Area}$$

According to above mentioned equation it is clear that compactness of the entire image is calculated by the ratio of the square of the perimeter of the hand shape to the shape area. It is vibrant that the compactness value of the entire image will be same if the two hand patterns have most likely same squared perimeter to area ratio, but sometime the compactness values becomes overlapped due to same hand patterns. So the next feature is useful to overcome this failure. Fig 2.2 shows the compactness I(CA).

2.2) Compactness II (CL)

The algorithm for second hand feature extraction is focused on the thumb. In another hand posture recognition algorithm, the hand portion is treated like a one complete area by algorithms. But in our employed algorithm we treat the image and the hand as subsisting of two halves:- the first half that consisting the thumb is referred to as first half, and the remaining half that consisting of four fingers is referred to as right half. The user's hand is divided into two halves at its centroid or geometric center, through a vertical line projected parallel to the edge of the image. The image moment is calculated by using the following formula for deriving the centroid of the digital image of the user

$$M_{ij} = \sum_x \sum_y x^i y^j I(x, y),$$

Where (x; y) is the intensity at coordinate $(xi;\ yi)$. the coordinate of the centroid ($\bar{x}$; $\bar{y}$) is found by using

$$\bar{x} = \frac{M_{10}}{M_{00}},$$

$$\bar{y} = \frac{M_{01}}{M_{00}}.$$

The geometric center of a hand lies within the hand and accordingly convenient for separating the thumb and the fingers from the hand. The above figure shows an example of hand partitioning. To examine the presence of the thumb from the left half of the image we used compactness. The thumb has peninsula like shape due to that the thumb shape somewhat increases the compactness value. If the hand patterns have the thumb i.e. pointing away from the palm surely will have a eye catching compactness value higher in the left half then the hand patterns that do not include thumb. Compactness is RST invariant (rotation, scaling and translation invariant), but it is massively shape dependent. The human hand inherently varies, hence it may be possible for one hand pattern to produce fluctuating compactness values. To upgrade this compactness recognition it is required to use another feature that give results in discrete values. The next feature establishes this purpose.

2.3) Radial Distance

Radial distance of a hand gesture will be determined by using the Euclidean distance. This distance is applied between all the boundary points of the input hand and a reference point within the same hand.

The following equation is used to calculate Euclidean distance:

$$ED(p, q) = \sqrt{(x_p - x_q)^2 + (y_p - y_q)^2},$$

Where p indicates all the boundary points of the hand and q indicates a reference point within the hand. In previous version the reference point was calculated from the center of the wrist. In the new version, the reference point is calculated from the centroid, and any other boundary point that are left of the hand centroid are not considered in this version.

3) Classification

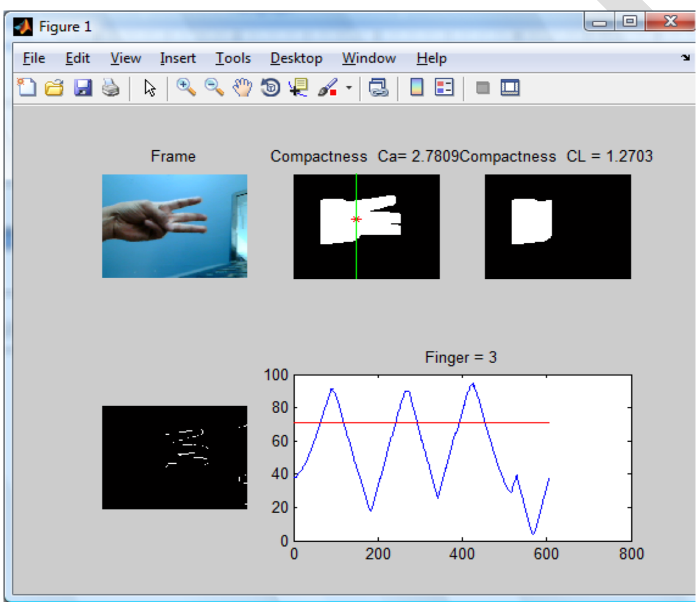
Classification of various hand gestures is based on thefeatures calculated in part II. The five bit binary sequence isthus generated to uniquely recognize and utilize theserecognized hand gesture for supporting human computerinteraction. Thesignificant peaks we identified in previous step is encoded as'1' and insignificant peaks is encoded as '0' based on theintersection status of various finger tips to threshold line.Leftmost bit in the 5 bit binary sequence is reserved for statusof thumb in hand image. If thumb is present, leftmost bit willbe 1 otherwise 0.

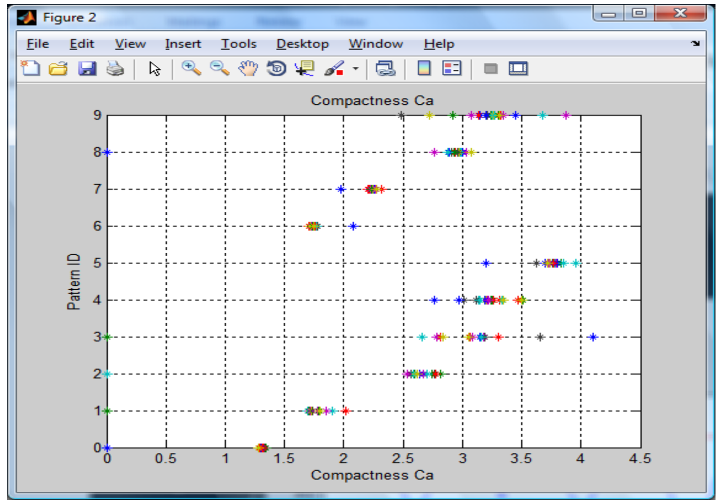
RESULTS AND ANALYSIS

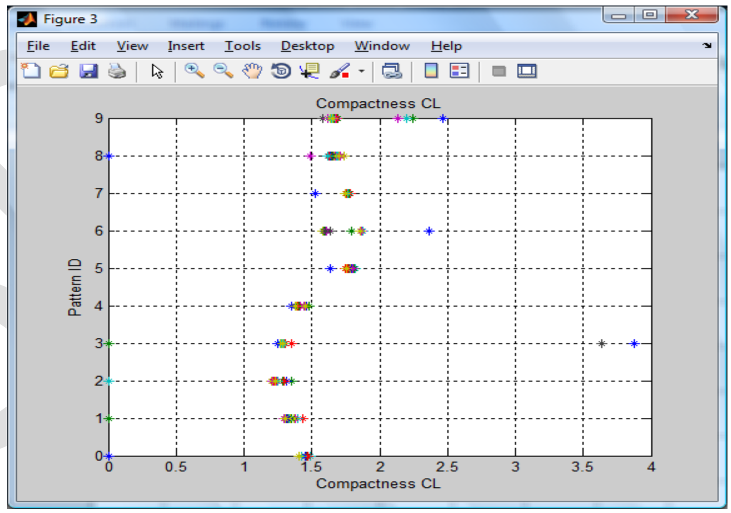
In this presented research work, a highly robust and efficient hand gesture recognition system with precise gesture based command generation scheme has been developed. The proposed system is functional with real time gesture data which is facilitates by means of an image capturing device or camera. A different approach as compared to conventional database and supervised training based schemes; the proposed scheme facilitates a highly robust mechanism.Overall system considers two predominant factors, one is compactness of left half of hand encompassing palm space and another represents the radial distance.

Conglomerating this variable altogether a final real time variable has been defined which states the gesture count. In order to accomplish overall objectives the following steps have been employed; feature extraction, compactness (Cl and Ca) estimation, radial distance estimation etc.

Being a threshold based scheme the proposed system considers following threshold parameters:
Compactness I (CA): The situation or event with compactness (Ca) less than defined threshold 1.65 represents the pattern zero while its value as 1.65 to 2.53 gives pattern either 1 or 6. Similarly, another compactness variable (Cl) with contemporary value less than 1.47 represents 1, 2,3 and 4 and on contrary the Cl value more than 1.47 gives 5, 6,,7, 8 or 9.
The examples of finger 3 snap of the developed modules and its results have been presented as below.







CONCLUSION

In this research work or project a highly efficient and robust hand gesture identification or detection scheme has been developed which is rooted on the shape based scheme or identification scheme. The proposed system in this thesis has encompassed a shape based gesture detection which functionally encompasses three independent features. The predominant features under consideration are feature calculation, compactness estimation and radial distance. In this work compactness which is a geometrical parameter has been considered for defining gesture pattern. There have been defined thresholds for segmented gesture space and on the basis of thresholds the classification of real time hand gesture has been done. The consideration of compactness which varies as per hand geometry has been enriched with manual variation and therefore it makes the system robust for varied user case and operational conditions. Unlike traditional systems, the developed system functions with real time gesture data which can be processed using a high quality camera devices. This is the matter of fact that the proposed system has exhibited better in terms of overheads, computational flexibility, color independence, and accuracy, but still it possess potential for optimization using certain artificial intelligence schemes. Since the proposed system might vary as per change in orientation of hand, certain 3D feature mapping or extraction schemes can be explored and further can be employed with threshold for classification.

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