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HAND GEUSTER RECOGNITION SYSTEM FOR MAN MACHINE INTERACTION AND SECURITY ENHANCEMENT USING FUZZY CLUSTERING

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Abstract- The core idea behind this system is derived from use of gesture recognition system in smart homes [1]. Here in this paper we will try to generate the outputs for man-machine interaction system and analyze that output for security enhancement. Generally two types of user are interacting with the application based on gestures. They are skilled users and novice users (non skilled). We will use this result to declare whether the user is authorized or not. Clustering is done in such a manner that it will group gestures with small variation in primary gesture. The classical FCM algorithm is modified to handle feature weighted clustering, and is supervised using a new cluster labeling algorithm for the recognition system [3]. FCM is used because it requires smaller training sets and shorter training times [2].
Keywords- Introduction, Overall design of system, obtaining labeled gesture class data, Calculating Gesture Recognition accuracy, Security enhancement using recognition accuracy, Hand Gesture as a command to Virtual Object, Application.

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Introduction

This software system will recognize the meaningful movement of users and compare that gesture with trained database of gesture and display the result. This system will follow specific sign conventions to specify the input to the system(both online and offline). Results for Skilled users and non skilled users will be compared. The system will be designed to maximize the recognition ratio for both types of users by training the gesture database. The hand-gesture recognition system is comprised of an image-processing feature-extraction operation followed by an FCM gesture classifier. The FCM clustering algorithm is a popular method for image-recognition tasks [3]. Recognition system [3]. Moreover, this system will also try to pass the gesture as a command to the virtual object. Virtual object may be any virtual robot or virtual animated object. Security is required to this system because it never reject the gesture due to concept of fuzzy logic is used in the system. Both types of user are interacting with the system so by security enhancement, the system will easily come across the difference between skilled user and novice user. At the same time system can predict some users as unauthorized users. So it will stop giving functionalities to such unauthorized user. Novice users may become unauthorized user if its recognition accuracy will not crossed the cut-off criteria within specific attempts of giving hand gesture as input to the system.(sometimes 2 or sometimes 3, this number is depends on confidentiality and importance of). Gestures are expressive, meaningful body motions-i.e., physical movements of the fingers, hands, arms, head, face, or body with the intent to convey information or interact with the environment. Three functional roles of human gestures are semiotic, erotic and epistemic. These functional roles are helpful to design efficient gesture recognition system. Later part of the system is passing gesture as a parameter to some virtual object to ask that virtual object to take specified action depending upon the input gesture. This method increases the man-machine interaction through gesture. This part of system is very helpful to deaf people who know only the sign languages. This is basically focuses on fuzzy clustering for man machine interaction using hand recognition system for vocabulary of gestures by considering the method of passing gesture as command to virtual object.

Overall Design of System

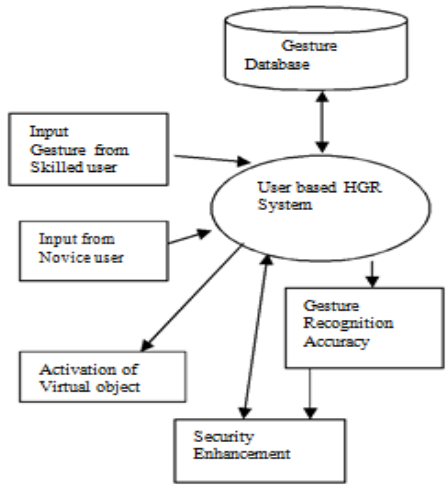

Fig. 1- Overall System design

Following functionalities will be requiring implementing the given system

Image Capturing

This stage involves capturing the image through web camera having good quality. Here we are keeping the background static and uniform. Light intensity remains uniform. It is helpful in saving time for segmentation otherwise segmentation requires lot of time to identify the area of interest [18].

Efficient Preprocessing

The 2D continuous image a(x, y) is divided into N rows and M columns. The intersection of a row and a column is termed a pixel. The value assigned to the integer coordinates [m, n] with {m=0,1,2,…,M–1} and {n=0,1,2,…,N–1} is a[m, n].In fact, in most cases a(x, y) which we might consider to be the physical signal that impinges on the face of a 2D sensor is actually a function of many variables including depth (z), color (l), and time (t).

The process of representing the amplitude of the 2D signal at a given coordinate as an integer value with L different gray levels is usually referred to as amplitude quantization or simply quantization.

Preferred Common Values- There are standard values for the various parameters encountered in digital image processing. These values can be caused by video standards, by algorithmic requirements, or by the desire to keep digital circuitry simple. Table 1 gives some commonly encountered values. Parameter Symbol Typical values parameters. The number of distinct gray levels is usually a power of 2, that is, L=2 *B* where *B* is the number of bits in the binary representation of the brightness levels. When B>1 we speak of a *gray-level image*; when B=1 we speak of a binary image. In a binary image there are just two gray levels which can be referred to, for example, as “black” and “white” or “0” and “1”.

Table 1- Common values of digital image

Parameter	Symbol	Typical value
Rows	N	256,512,525,625,1024,1035
Columns	M	256,512,768,1024,1320
Gray	L	2,64,256,1024,4096,16384

Rectangular sampling: Rectangular sampling is a type of Neighborhood operations and it play a key role in our system digital image processing[19].

In most cases, images are sampled by laying a rectangular grid over an image. We can use either 4 – connected pixels or 8 – connected pixels method.

4- Connected method: In this method we consider the solid circle as a pixel with coordinate (x, y).Now in this method we consider the other effective neighboring pixel so that we can cover the area of interest effectively. So we can move to neighbor as follows.

right pixel (x+1,y),
left pixel (x-1,y),
above pixel (x,y-1),
down pixel (x,y+1)

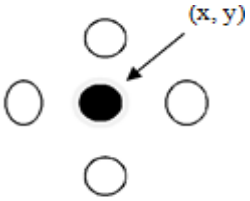

Fig. 2- Four way connected method

8- Connected method: In 8 ways connected method the area of interest from the captured image is efficiently covered because this method considers the diagonal pixels also. So it considers 8 neighbor to increase the efficiency of image analysis and segmentation. So coordinates of neighboring pixels are as follows:

(x+1, y), (x-1, y), (x, y+1), (x,y-1),
(x+1, y-1), (x+1, y+1), (x-1, y-1), (x-1,y+1).

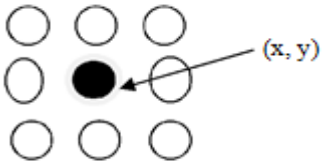

Fig. 3- Eight way connected method

Different properties of chain codes are also used in 4 connected methods. Preprocessing of the image starts with segmentation of the hand from the background using a threshold value λ to obtain a black and white image. The threshold value used is found through a parameter-search algorithm to be discussed later. Using a component-labeling algorithm, the largest component (assumed to be the hand posture), is identified; and a bounding box is constructed around it to represent the segmented hand. Let R b and C b represent the number of rows and columns, respectively, of the block partition. This results in a feature vector of length v = 1+R b×C b, denoted as f =(f 1 ,...,f i ,...,f v). The first feature represents the aspect ratio of the bounding box, and the remaining represent block averages indexed row-wise from left to right. All feature values are scaled to lie in the range [0,255].

W = (*W*1 . . . *Wi* . . . *Wv*) represent the weight vector where, *Wi* is the weight attributed to feature *i*. The weights are normalized to sum to one having 0<=Wi=1constain on it. *x* = (W1 f1 . . . Wi fi . . . Wv fv) be data pattern.

Selection of Threshold value for segmentation This technique is based upon a simple concept. A parameter Θ called the brightness threshold is chosen and applied to the image a[m, n] as follows[19]:
If a[m, n] ≥ Θ a[m, n] *object* = =1
a[m, n]
Else a[m, n] =*background* = 0
This version of the algorithm assumes that we are interested in light objects on a dark background. For dark objects on a light background we would use:
If a[m, n] < Θ a[m, n] *object* = = 1
Else a[m, n] = *background* = 0
The output is the label "object" or "background" which, due to its dichotomous nature, can be represented as a Boolean variable "1" or "0". In principle, the test condition could be based upon some other property than simple brightness (for example, If (Redness {a [m,n]} ≥ Θ_{red}), but the concept is clear. The central question in thresholding then becomes: How do we choose the threshold? While there is no universal procedure for threshold selection that is guaranteed to work on all images, there are a variety of alternatives.
Fixed threshold - One alternative is to use a threshold that is chosen independently of the image data. If it is known that one is dealing with very high-contrast images where the objects are very dark and the background is homogeneous and very light, then a constant threshold of 128 on a scale of 0 to 255 might be sufficiently accurate. By accuracy we mean that the number of falsely-classified pixels should be kept to a minimum.
Unsupervised Clustering- Fuzzy C-means is partitioned clustering. An important step in any clustering is to select a distance measure, which will determine how the similarity of two elements is calculated, as some elements may be close to one another according to one distance and further away according to another. here in this project work Fuzzy C-means clustering technique is used which is work under Partitioned clustering.
Hand Gesture Classifier based on Feature Weighted FCM- In the weighted-feature FCM algorithm, a weighted-feature vector represents each gesture. The set of weighted-feature vectors are clustered for subsequent use in a recognition system. The particular clustering obtained depends on the number of clusters and the respective values of the feature weights. Let *xk* be the weighted feature vector of the *k*th exemplar in a training set of gestures. Given *q* data patterns *X* = *{x*1 . . . *xk* . . .*xq}*, and a fixed number of clusters *c*, the FCM algorithm finds *Vl* (the prototype weighted feature vector of cluster *i*), and *μik* (the degree of membership of *xk* in the *i*th cluster). This is done by minimizing a membership-weighted within-group sum-of-squared-errors objective function, where *m* is a weighting exponent on each fuzzy-membership value. In this application, the number of clusters should be set greater or equal to the number of gestures in the vocabulary. After convergence of the FCM algorithm, each weighted feature vector *xk* is assigned to a cluster by finding *μi_k* = Max*{μik, i* = 1*, . . . , c}*. This simple method is selected to reduce computational complexity for real-time operation and to reduce the time taken for large-scale validation studies

Gesture database Training
The training stage involves running the Fuzzy C-Means algorithm for a set of exemplar hand gestures [3]. Fuzzy C-means Clustering (FCM) is also known as Fuzzy ISODATA, is a clustering technique which is separated from fuzzy c-means that employs hard partitioning. The FCM employs fuzzy partitioning such that a data point can belong to all groups with different membership grades between 0 and 1.FCM is an iterative algorithm. The aim of FCM is to find cluster centers that minimize a dissimilarity function.

Obtaining labeled gesture class data
Valid and proper Cluster labeling is a very important part of this project. So we are adopting the new cluster labeling algorithm which follows the principles of artificial intelligence.
New Cluster Labeling Algorithm**:** A new cluster labeling algorithm is developed optimal labeling.

1. In this algorithm we are forming gesture cluster matrix.
2. We are trying to obtain the maximum entry from each column of cluster and labeled with some valid name. This represents an assignment of a label to each of the clusters.
3. Count the number of marked cell in each row of matrix. If there is only a single marked cell then delete the column and row associated with that marked cell and give label of row to column for cluster.
4. Continue this procedure for all gestures and labeled the clusters.
5. At the same time we should keep the time less for moving few cells from one place to other place of gesture cluster matrix.
6. We are keeping the cost of cluster labeling low by following the heuristic approach. Due to this heuristic approach the worst case time complexity is improved.

Supervised and Unsupervised Learning-
This section gives a brief overview of supervised and unsupervised learning. In supervised learning, the algorithm is provided with both the cases (data points) and the labels that represent the concept to be learned for each case. On the other hand, in unsupervised learning the algorithm is provided with just the data points and no labels, suitable rep-presentation of the underlying distribution of the data. One major approach to unsupervised learning is data clustering, which will be the focus of this paper. Both supervised and unsupervised learning have been combined in what some people called semi- supervised learning. The unsupervised part is usually applied [3].

Calculating Gesture Recognition accuracy
We are considering the highest degree of membership from gesture cluster matrix for specific cluster and give us the recognition accuracy. This degree of membership is one of the fuzzy logic parameter [2]. We are also considering the image parameters like brightness of pixel to draw certain conclusion.

Security enhancement using recognition accuracy

1. The security criteria depend on the confidentiality and importance of application which is based on gesture.
2. The security is for both skilled and novice users. It is assumed that skilled user generally get application control in first attempt. The percentage of recognition accuracy for such user is above 99 %.The ideal situation in this case is obtaining 100 % recognition accuracy for given input gesture. For this case the system is highly efficient. This ideal situation will always

hold for skilled users or we can say that user dependent system is come under this ideal situation. This ideal situation is not hold for novice users.

3. Now we consider the novice user interacting with the system. In this case we put the cut-off recognition accuracy depending upon the importance and confidentiality of the gesture recognition system. When novice user is giving hand gesture to the system then.

Table 2- Cut-off criteria for novice user

System confidentiality & importance	Cut-off Recognition accuracy
High	70%
Less	50%

4. If recognition accuracy is > 70 % and less than 99 %, then, System considers this user as novice user and gives access to general functionalities but restrict access as a administrator.
5. For Highly confidential and important system, if recognition accuracy is less than 70 % for consecutive two times, then system must prevent that novice user from accessing the system and declare that user as intruder. System should display the message like "ACCESS DENIED". System should automatically get locked.
6. For less confidential and less important system, if recognition accuracy is less than 50 % for consecutive three times, then system must prevent that novice user from accessing the system and declare that user as intruder. System should display the message like "ACCESS DENIED". System should automatically get locked.
7. System is also storing the gestures inputted by intruder, if those gestures flows the sign language conventions and if those gestures are useful then administrator may think of adding that sign as a new gesture and assigning certain task to the system.

Hand Gesture as a command to Virtual Object

This section belongs to increasing the use human machine interaction through gestures. For our user based hand gesture recognition system, authorized users (may be skilled and novice user satisfying the cut-off criteria)are allowed to communicate with virtual object by passing inputted gesture as a activation parameter for virtual robot to perform specific task Here we are interfacing our User based hand gesture recognition system software with virtual object created using macromedia Flash.

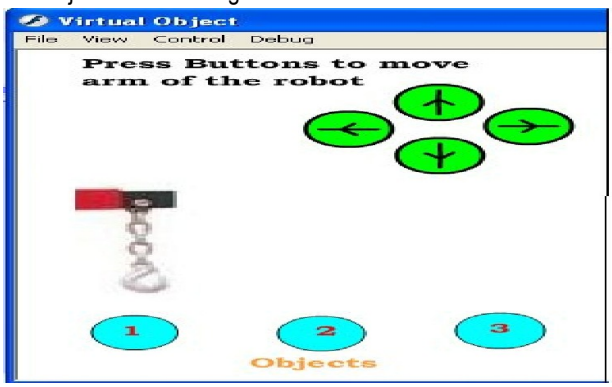

Fig. 4- Virtual object created in Flash

Figure 4 shows the hand of virtual robot and three objects as object1,object2,object3. Four control buttons as up, down, left, right are controlling the movement of virtual object using keyboard and mouse. We want to remove this dependency on mouse and keyboard to control the virtual object.

Applications

Now a day smart homes are strongly uses the concept of Hand Gesture Recognition system. i.e. when an owner of house enters inside the house then if he wants to play his favorite channel on television, then he will just give specific gesture as a command to the web camera and this gesture acts as a command to play the favorite channel on TV. The application domains for the system also include security and military applications where the key aspect is unnoticed monitoring and distant control; medical and surgery applications where the contact less interface is beneficial for the prevention of infections; public interactive media applications where big screens already on place but solid keyboards, mice can not be deployed; applications that require vast number of complex instructions which is unavailable, very difficult or slow to achieve with the conventional mouse and keyboard; and last but not least efficient computer user interface.

Conclusion

This paper is dealing with Fuzzy recognition for user based Hand Gesture Recognition System and security enhancement using recognition accuracy. FCM is used because it requires smaller training sets and shorter training times. Another reason for selecting a fuzzy clustering framework is that it makes the clustering approach less sensitive to initialization compared to the crisp methods. The classical FCM algorithm is modified to handle feature-weighted clustering, and supervised using a new cluster-labeling algorithm for the recognition system [2].

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