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Hybrid Image Segmentation Using Edge Detection With Fuzzy Thresholding For Hand Gesture Image Recoginition

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Abstract:
The need of computer recognition sign language image processing is essential for hearing impaired people. Preprocessing is very much required task to be done in hand gesture recognition system. In preprocessing process, the segmentation is an important part to detect the hand sign. The faculty of vision based gesture recognition to be a natural, powerful, and friendly tool for supporting efficient interaction between human and machine. In this paper new hybrid image segmentation is provided to detect the hand sign language image based on canny edge detection method and fuzzy c means clustering with thresholding technique. Here canny edge detection is applied to extract the finger tips of hand sign image accurately. Followed by fuzzy c means clustering method for final tuning of segmented image with better image quality of index. The new method is validated with the parameters in terms of energy level, Entropy level, and Evaluation time (ET). The experimental result shows that the proposed model works efficiently.

Key words: *Image processing, segmentation, Hand gesture image, Recognition, edge detection, hybrid image segmentation, and fuzzy c means thresholding.*

1.Introduction

Hand image recognition is mainly considered in the context of man-machine communication. Here we focus on the first application area. The system's main attribute is given by the fact whether it is designed for static posture recognition or for (dynamic) gesture recognition. A useful application of the first type of systems would be the recognition of a "finger alphabet" (Marnik, 2003) or the Polish sign language postures (Flasi´nski and My´sli´nski, 2010) [4], as applied in mute people's communication. Segmentation is done to convert gray scale image into binary image so that we can have only two object in image one is hand and other is background. Otsu algorithm [1,2] is used for segmentation purpose and gray scale images are converted into binary image consisting hand or background. After converting gray scale image into binary image we have to make sure that there is no noise in image so we use morphological filter technique.

Hand gestures are spontaneous and powerful communication modality for HCI. Various traditional input devices are available for interaction with computer**,** such as keyboard, mouse, and joystick as well as touch screen**;** yet these are not considered natural interface. Proposed the primary step toward any hand gesture recognition (HGR) is hand tracking and segmentation. In the present work**,** three techniques for hand segmentation were explored [5,6]. The objective of this work is to overcome the vision-based challenges**,** such as dynamic background removal, skin color detection for natural human computer interface and variable lighting condition [7].

The first phase employs canny edge operator and produces an edge detected image which reduces the number of pixels to be processed at runtime. The Canny algorithm uses an optimal edge detector based on a set of criteria which include finding the most edges by minimizing the error rate, marking edges as closely as possible to the actual edges to maximize localization and marking edges only once when a single edge exists for minimal response [8,9,10,11].

The next phase traces the boundary of the image and in the process detects finger tips which aid in finger detection followed by fuzzy c means thresholding. The theory of fuzzy sets has immediately found its potential application in the fields of pattern recognition and image processing. The fuzzy c-means algorithm generalizes a hard clustering algorithm called the c-means algorithm [3]. This work has focused primarily on identifying the number of fingers opened.

This paper is organized as follows, Section 2. The proposed hybrid model edge detection based fuzzy c means clustering with thresholding is described followed by Section 3. Defines the criteria for quantifying the performance of the proposed model and presents experimental results for hand gesture images Section 4. Concludes the paper.

2.Edge Detection Based Fuzzy C Means Clustering With Thresholding

This paper explains a new segmentation method, based on Edge detection, boundary tracing and Fuzzy c means clustering with thresholding.. First, a preliminary segmentation based on the canny edge detection of finger images is first carried out to coarsely determine edge regions using boundary tracing This is followed by a fine segmentation using a FCMT based method for extracting the object from the images.. The algorithm are explained as follows

- Collecting Dataset
- Pre-processing the leaf images
- Preliminary segmentation using canny edge detection
- Boundary tracing
- Fuzzy c means thresholding

2.1.Collecting Datasets

The data acquisition is done by digital camera. The acquisition rate varied between 4 fps and 30 fps. The light source was a conventional He-Ne laser, with beam power of 10 mW.

2.2.Pre-Processing The Finger Gestures

The pictures are saved in JPG format. They are converted into grayscale images and then the finger region of each image is segmented by using a propose hybrid methodology.

Segmentation refers to the operation of partitioning an image into component parts, or into separate objects. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual

characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image [13].

Image segmentation techniques are classified in three different classes (1) feature-space based method, (2) image-domain based method, and (3) edge-based method [2]. The feature-space based method is composed of two steps, feature extraction and clustering. Feature extraction is the process to find some characteristics of each pixel or of the region around each. After we get some symbolic properties around each pixel, clustering process is executed to separate the image into several meaningful parts based on these properties. There are also many kinds of clustering algorithms. Image-domain based method goes through the image and finds the boundary between segments by some rules. The third class is edge-based image segmentation method, which consists of edge detection and edge linking.

2.3.Canny Edge Detection

In the first step, the canny edge detector is used to process the two parameter images and then the derived edges are added to derive the final edge detection result.

The Canny edge detection operator [ ] was developed by John F. Canny in 1986 and uses a multi-stage algorithm to detect a wide range of edges in images. It arises from the earlier work of Marr and Hildreth, who were concerned with modeling the early stages of human visual perception. His work is a gradient-based edge-finding algorithm that has become one of the most widely used edge detectors. This algorithm is known as the optimal edge detector. In this situation, an "optimal" edge detector is based on the following three criteria:

- Good detection: The algorithm should mark as many real edges in the image as possible.
- Good localization: Marked edges should be as close as possible to the edge in the real scene.
- Minimal response: A given edge in the image should only be marked once, and where possible, image noises should not create false edges.

Figure 1 shows an hybrid image segmentation architecture for hand sign language.

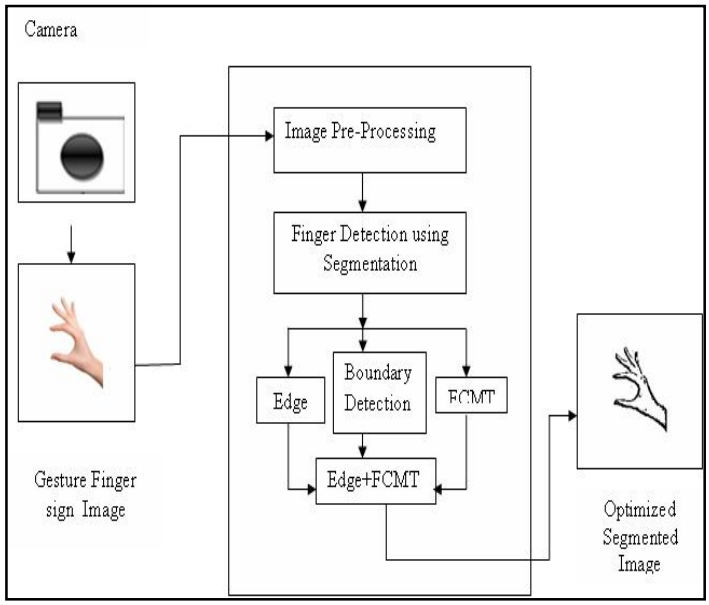


Figure 1: Hybrid Image Segmentation System Architecture

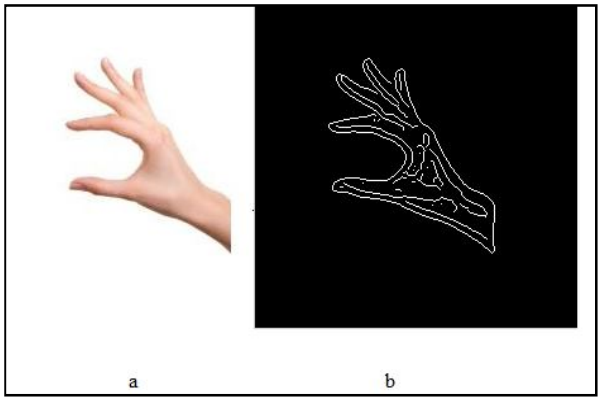


Figure 2: a & b. Original Hand gesture Image and Segmented Hand gesture Image

The above figure 2 shows the edge segmented part of hand gesture image**.**

2.4.Boundary Detection

The basic goal of segmentation procession echocardiography is to identify boundary points between blood and myocardial tissue. Thresholding is the simplest form of regional segmentation for converting a multilevel (grey scale) image into a binary image, to separate the foreground object(s) from the image background. In our proposed method, the implementation to this purpose is determined by a single parameter known as the intensity threshold which equals to average value of image pixels intensities. In a single pass, each pixel in grayscale image is compared with this threshold. If the

intensity of pixel is higher than the threshold value, the pixel is set to intensity value equal '255'. If it is less than the threshold value, it is set to '0'. In boundary tracing the extract regions of the edge detected by the canny method is traced and the exact edges are produced after applying this method.

2.5.FCM Thresholding (FCMT)

In fuzzy clustering methods, fuzzy c means clustering (FCM) is a universal method that suits to any type of application in uncertainty area. The characteristic of FCM is that every sample point attributes to the clustering center according to fuzzy membership. Fuzzy clustering is a process of assigning these membership levels, and then using them to assign data elements to one or more clusters. One of the most widely used FCM Algorithm is combined with thresholding to give better results. The FCM algorithm partitions [3] a finger image *X* into clusters $X=\{x_1,...,x_N\}$. Further it is classified into a collection of fuzzy clusters based on pixel values. Then the threshold value is calculated. Initially the image pixels are divided into three clusters [3,15]. Thresholding is calculated using maximum in the class with the smallest center and minimum in the middle center. The parameters are adjusted to get maximum clarity. Over segmentation and under segmentation problems comes based on the level selection

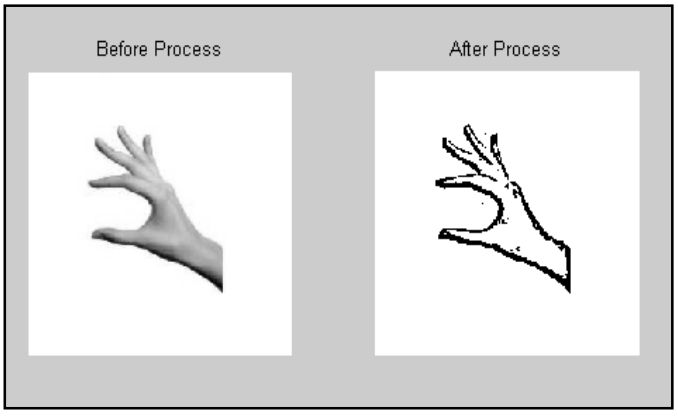


Figure 3: Reconstructed Image of the hand gesture

The above figure 3 shows the reconstructed image using hybrid segmentation. Starting with an initial guess for each cluster center, the FCM converges to a solution for v_i representing the local minimum or a saddle point of the cost function. Convergence can

be detected by comparing the changes in the membership function or the cluster center at two successive iteration steps [17].

3.Experimental Results And Analysis

To test the accuracy of the preprocessing algorithms, three steps are followed.

- First, a Finger gesture image is taken as input.
- Second, proposed segmentation algorithms are applied for finger gesture image..
- Third, the Energy, Entropy and Evaluation time value is calculated for validating the proposed algorithm.

The reconstruction of an image has the dimensions of 256 pixel intensity. The images in this contain a wide variety of subject matters and textures. Most of the images used are finger gesture images. The Energy, Evaluation time and Entropy must be less value for a better segmentation algorithm.

To estimate the quality of the reconstructed images, following parameters are used.

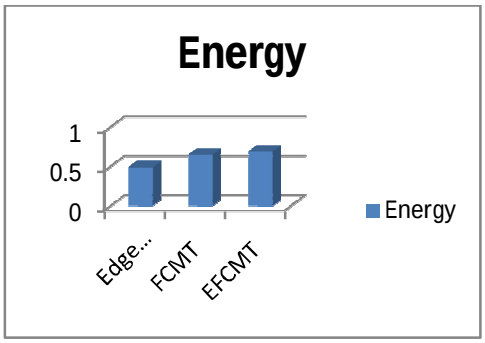
- Energy
- Entropy
- Evaluation time

3.1.Energy

The gray level energy indicates how the gray levels are distributed. It is formulated as,

$$E(x) = \sum_{i=1}^{x} p(x)$$

where E(x) represents the gray level energy with 256 bins and p(i) refers to the probability distribution functions, which contains the histogram counts. The energy reaches its maximum value of 1 when an image has a constant gray level. The following figure 4 shows the graph for estimating the quality of reconstructed image using the parameter energy values.



Figur 4: A graph for Estimating the quality of reconstructed image using the parameter energy

The larger energy value corresponds to the lower number of gray levels, which means simple. The smaller energy corresponds to the higher number of gray levels, which means complex.

3.2.Entropy

The entropy is the measure of image information content, which is interpreted as the average uncertainty of information source. It is calculated as the summation of the products of the probability of outcome multiplied by the log of the inverse of the outcome probability, taking into considerations of all possible outcomes {1, 2, …, n} in the event {x1, x2, …, xn}, where n is the gray level; p(i) is the probability distribution, considering all histogram counts. DE is formulated as

$$H(x) = \sum_{i=1}^{k} p(i) \log_2 \frac{1}{p(i)}$$

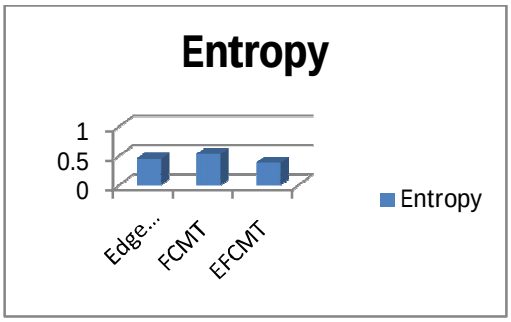


Figure 5 :A graph for Estimating the quality of reconstructed image using the parameter entropy

However, the measure ET is very important in case of real-time application. The following figure 6 shows the graph for estimating the quality of reconstructed image using the parameter evaluation time in seconds. The above figure 5 shows the graph for

estimating the quality of reconstructed image using the parameter entropy values. The entropy is a statistical measure of randomness to measure. The maximal entropy occurs when all potential outcomes are equal. When the outcome is certainty, the minimal entropy occurs which is equal to zero. The discrete entropy represents average amount of information conveyed from each individual image.

3.3.Evaluation Time

Evaluation Time (ET) of a filter is defined as the time taken by a digital computing platform to execute the filtering algorithms when no other software, except the operating system (OS), runs on it. Though ET depends essentially on the computing system's clock time-period, yet it is not necessarily dependant on the clock time alone. Rather, in addition to the clock-period, it depends on the memory-size, the input data size, and the memory access time.

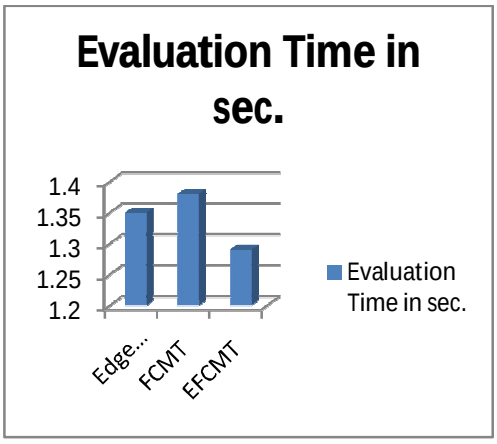


Figure 6: A graph for Estimating the quality of reconstructed image using the parameter evalution time

S.N0.	Methodology	Energy	Entropy	Evaluation Time in sec.
1.	**Edge detection**	0.49	0.45	1.45
2.	**FCMT**	0.65	0.53	1.38
3.	**EFCMT(Proposed Methodology)**	0.79	0.38	1.20

Table1: comparative result of the estimations of the reconstructed image using the parameters energy, entropy and evaluation time

The above table 1 shows the Comparative result of the estimations of the reconstructed image using the parameters energy, entropy and evaluation time.

4.Conclusion

The need of computer recognition sign language image processing is essential for hearing impaired people. In this paper, new hybrid image segmentation is provided to detect the hand sign language image based on canny edge detection method and fuzzy c means clustering with thresholding technique. Here canny edge detection is applied to extract the finger tips of hand sign image accurately. Followed by fuzzy c means clustering method for final tuning of segmented image with better image quality of index. This method is compared with other methods like Edge detection and Fuzzy c means thresholding to prove the efficiency. The new method is validated with the parameters in terms of energy level, Entropy level, and Evaluation time (ET). The experimental result shows that the proposed model works efficiently.

5.Acknowledgement

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