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Segmentation Using Outlier Based Adaptive Thresholding

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Abstract: ***Image segmentation plays an important role in image analysis as a frequent pre-processing step, which divides the image into set of different segments. Thresholding is an easy yet efficient method for image segmentation, while dividing different objects with distinct gray levels. Finding an effective threshold is especially complicated task in the segmentation. In this paper, for efficient threshold selection fuzzy methodology used which produces better segmentation results than other methodologies. It was observed that at different background intensity levels favourable results were obtained.***

Keywords: Image segmentation, thresholding, fuzzy methodology

I. INTRODUCTION

Many methods of segmentation have been proposed during the past 30 years Image segmentation is such a challenging yet interesting problem that it had attracted researchers who have different backgrounds, for instance, psychology, pattern recognition, neural networks, computer vision, and computer graphics. It is due to this fact that the literatures on segmentation were vast and diverse. Often, a single system involved technique having different principles. The usage of a mixture of techniques made it tricky to classify these systems based purely on what types of techniques they used for segmentation techniques [1].

There have been previous attempts at numerical image segmentation method comparisons, although the number is small. Here some examples were summarised to note how the works differ. Many researchers attempted to compare variants of popular spectral clustering algorithms like, normalized cuts, a variant method and the Multicut algorithm [2]-[3]-[4]-[5]-[6]. All these algorithms were combination of different parts of different algorithms to create new ones. The measure of correctness used, was the Variation of Information, which considers the conditional entropies between the labels in two segmentations [6]. The results of this comparison were largely unexciting, with all of the algorithms and variants performing well on 'easy' data, and all performing roughly on 'hard' data. Comparisons currently exist between brightness, texture, and/or edges for segmentation.

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All the algorithms discuss above were not suitable for all type of images or in any lighting condition. Still a unique method for the segmentation needs to be developed which is able to deal with all type of images in several conditions.

Fuzzy methodology overcomes the difficulties in segmentation to make it more effective. The threshold value was automatically getting selected for binarization of an image. Then by morphological analysis, all the unnecessary objects were removed. Finally on the basis of different gray shades segmentation was carried out on the input image.

II. PROPOSED ALGORITHM

A. *Focused Images*

Proposed algorithm is suitable for images having uniform background, than images having non-uniform background. Background with single colour and slight intensity variations is considered as uniform background.

B. *Implimentation*

There are various approaches to adaptive threshold selection, for instance, threshold selection based on mean value, median value. In this approach threshold value was selected by using fuzzy methodology. It works on the fact that in an output image most of the pixels belongs to background and very few of the pixels belongs to the objects present in that which corresponds to foreground. In this methodology, the foreground was assumed as an outlier and experimentally the histogram shows that outlier was detected. A block diagram different implementation steps involved in the algorithm is as shown in figure 1;

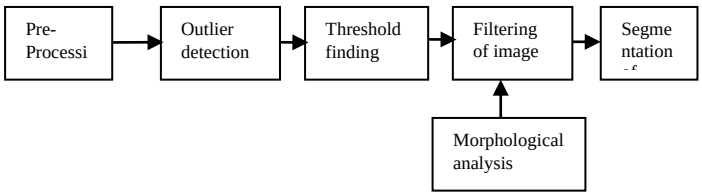

Fig.1. Block diagram of showing different steps in given algorithm

A. *Pre-processing*

The images were subjected to various types of noises. These noises may degrade the quality of the image and consequently it cannot provide correct information for resulting image segmentation and edge detection. Poor contrast is usually one of the most common defects found in the acquired image. In order to improve the quality of the image, operations need to be performed to remove or decrease degradations suffered in image acquisition.

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Pre-processing of an image can be done by different methods depending upon the type of an image or the algorithm which used in the particular type of segmentation. In this pre-processing was done by Histogram Normalization on gray scale image. A normalized histogram gives the relative proportions of each pixel in the image and hence approximates to the probability distribution of pixel intensities. In normalized histogram the sum of the frequencies exactly one. Therefore, when each frequency express as a percentage of the total, a normalized histogram was obtained in the range [0, L-1] by using following function,

$$h(r_k) = n_k \qquad (1)$$

Where

- r_k is the intensity value.
- n_k is the number of pixels in the image with intensity r_k.
- $h(r_k)$ is the histogram of the digital image with Gray Level r_k

Histograms are frequently normalized by the total number of pixels in the image. Assuming M × N image, for a normalized histogram it gives,

$$p(r_k) = \frac{n_k}{MN} \text{ , K=0, 1, 2, 3…….L-1} \qquad (2)$$

Where

- $p(r_k)$ gives an estimate of the probability of occurrence of gray level r_k

B. Outlier Detection

The outlier of an object is defined as element of object which lies at the boundary in histogram representation. In this case the outliers of an image are the pixels which lie at boundary in true representation of image or some other representation of image. Since in the case of foreground and background separation (binary segmentation) in case of static and uniform background, number of pixels belonging to background will be much more than the number of pixels belonging to foreground, therefore the foreground will lie at the boundaries or at the extremes in normalized histogram representation of an image. Figure 2 shows a gray image of players playing cricket and figure 3 shows possible background and foreground in histogram representation of image. Histogram clearly shows that the number of pixels belonging to foreground is much lower than number of pixels belonging to background it means the foreground is detected as an outlier.

Fig.2 Gray scale image detected

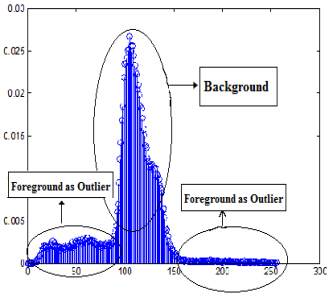

Fig.3 Histogram showing outlier

C. Fuzzy Methodology for Adaptive Thresholding

Image thresholding were widely used as a popular tool in image segmentation. It was used to separate objects from background, or discriminate objects from objects that have distinct grey levels. During the thresholding process, individual pixel in an image are marked as "object" pixels if their value was greater than some threshold value (assuming an object to be brighter than the background) and as "background" pixels otherwise. The key parameter in the thresholding process was the choice of the threshold value (or values, as mentioned earlier). Several different methods for choosing a threshold exist. Users can manually choose a threshold value, or a thresholding algorithm can compute a value automatically, which is known as automatic thresholding. In this approach the threshold value get automatically selected by using fuzzy methodology.

Following are the steps followed while performing segmentation;

- In this one function was defined in which as input a sorted row vector containing the data in increasing order and the output in the form of row vector having segmented data.
- Assume S shaped Curve, consider its start value, peak value and cross over value. On the basis of these three values with the sorted data the S-Membership function was calculated.
- Using membership function, the membership value for each element in the data matrix was calculated by using following functions,

Let,

a= start value
b= crossover value
c= peak value
d= value of single input data

Calculation of membership value for input data;

1. If, $d >= a$,
   Then, membership value= 0
2. If, $d < a$,
   Then, membership value=$2 * \left(\frac{d-a}{c-a}\right)^2$
3. If, $d <= b$,
   Then, membership value= $1 - 2 * \left(\frac{d-c}{c-a}\right)^2$
4. If, $d <= c$,
   Then, membership value= 1

- Threshold was calculated with the help of membership value for each value of the input data.

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- Finally after finding threshold the data matrix get binaries it means foreground and background where get separated.

The given fuzzy method for the selection of threshold is very useful in colour image segmentation.

By using this methodology the inverted image also get segmented very cleanly. The main advantage of this method is that, no hard code threshold selection is required for the binarization. The algorithm itself capable of calculating the threshold automatically for several images; however it will be more effective on the image with the uniform background.

D. Morphological Operation

Morphology is much important set of image processing operation. Structuring element to an input image was provided by using morphological operation to create output image. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbours. By choosing the size and shape of the neighbourhood, one can construct a morphological operation that is sensitive to specific shapes in the input image. Morphological operations are useful to change form, structure or shape of an object for betterment of result. The most basic morphological operations were dilation and erosion. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image.

III. RESULT AND DISCUSSION

The goal of image segmentation is to cluster pixels into salient image regions, i.e., regions corresponding to individual surfaces, objects, or natural parts of objects. Thresholding often provides an easy and convenient way to perform this segmentation on the basis of the different intensities or colours in the foreground and background regions of an image. Selecting a threshold is very tough task in the segmentation. Every time it gets changed as the image changed. Proposed methodology overcomes the threshold selection problem and introduces a different methodology which was more effective than any other. In this method, input colour image shown in figure (a) converted into the gray scale image shown in figure (b). Then histogram normalization was used on gray scale image for basic pre-processing. Then the fuzzy methodology was used for the adaptive threshold selection. Once the proper threshold value was found the input image gets binaries. After the separation of background and foreground the histogram was drawn and from histogram the outlier was detected as shown in figure (c). Binaries mage contain some objects having different intensity levels which produce some noise in the final output as shown in figure (d). To remove this objects morphological dilation and erosion were performed on the image and finally segmentation of given image was carried out as shown in the figure (e). The main advantage of this algorithm is its intensity independency. If the background of the certain image gets changed still the segmentation output will remain same. Applying the proposed method of the input image following observation was found at different stages. The resultant images are as shown below;

Fig. (a). Input Image

Fig. (b). Gray Scale Image

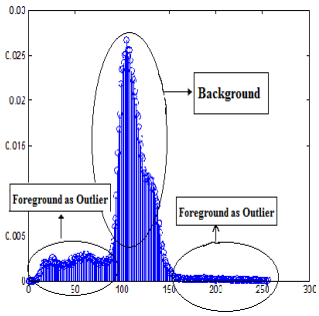

Fig.(c). Outlier Detection

Fig. (d). Binaries Image with Noise

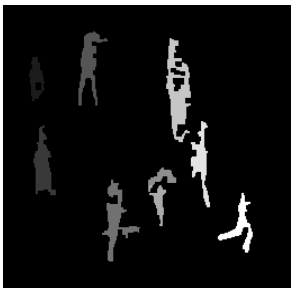

Fig. (e) Segmented Image Containing Different Gray Shades

In this way the segmentation using the adaptive thresholding was done in much efficient way. Mostly the fuzzy methodology which was used in this particular approach was the new one for finding thresholding automatically. This approach was also gives same results on the inverted (negative of the original image) image. This shows that, proposed algorithm is intensity independent. Figure (f) shows the negative of the input image (a), after applying given algorithm the output is same as simple input image shown in figure (g).

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Fig. (f). Inverted Image

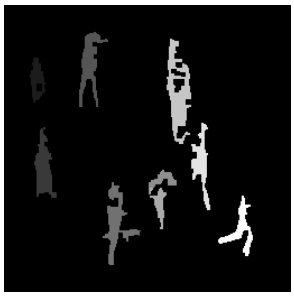

Fig. (g). Segmented image

IV.CONCLUSION

Image Segmentation is the process of partitioning an image into non-intersecting regions such that each region was homogeneous and the unions of no two adjacent regions were homogeneous. Many algorithms and methods were available for segmentation, but still there needs to be developed a unique method for it. This algorithm gives an effective methodology for the segmentation. It overcomes the main crisis in the segmentation that was threshold selection, the threshold value was automatically got selected by using fuzzy methodology and some morphological operation were also done on the image for betterment of result. Also the approach was applied on inverted image and similar results were obtained, which shows that the proposed method was applicable in different lighting condition and independent of absolute intensity value.

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Vishal B. Langote received the B.E. degree in Electronics and Telecommunication Engineering from the, Amravati University in 2010, and he is currently pursuing the M. Tech. degree in Electronic System and Communication (ESC) at Government College of Engineering, Amravati. He published a review paper entitled "'Segmentation Technique for Image Analysis', in International Journal of Advanced Engineering Research and Studies Vol. I/ Issue II/January-March, 2012/252-255.

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Dr. Chaudhari published research papers and presented papers in international conferences abroad at Seattle, USA and Austria, Europe. He worked as Chairman / Expert Member on different committees of All India Council for Technical Education, Directorate of Technical Education for Approval, Graduation, Inspection, Variation of Intake of diploma and degree Engineering Institutions. As a university recognized PhD research supervisor in Electronics and Computer Science Engineering he has been supervising research work since 2001. One research scholar received PhD under his supervision.

He has worked as Chairman / Member on different university and college level committees like Examination, Academic, Senate, Board of Studies, etc. he chaired one of the Technical sessions of International Conference held at Nagpur. He is fellow of IE, IETE and life member of ISTE, BMESI and member of IEEE (2007). He is recipient of Best Engineering College Teacher Award of ISTE, New Delhi, Gold Medal Award of IETE, New Delhi, Engineering Achievement Award of IE (I), Nashik. He has organized various Continuing Education Programmes and delivered Expert Lectures on research at different places. He has also worked as ISTE Visiting Professor and visiting faculty member at Asian Institute of Technology, Bangkok, Thailand. His present research and teaching interests are in the field of Biomedical Engineering, Digital Signal Processing and Analogue Integrated Circuits.

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