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Fast Fuzzy C-Means Clustering for Color Image Segmentation

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ABSTRACT:A great number of improved techniques for clustering like K-means clustering and FCM algorithms are used for both greyscale and color image segmentation. FCM is better than k-means clustering in good outputs. FCM is also known as soft k-means or soft clustering. FCM was proposed by J.C. Dunn, and improved by J.C. Bezdek. Though there are a good number of improved algorithms most of them fail to give the desired outputs and are highly time consuming due to calculation of distance between the pixels and clustering centres of a cluster repeatedly. The reason for poor segmentation is the breaking up of a regular neighbouring window into real local spatial structure of images. A novel method is being proposed for colour image segmentation to overcome the drawbacks of the algorithms which are existing till date.

KEYWORDS:clustering, super pixel image segmentation, morphological gradient reconstruction, FCM

I.INTRODUCTION

Image segmentation is the major step in recognizing an object and in classification of images in the computer point of view. The main problem statement for image segmentation is there is no perfect image and a perfect solution for any problem. So, this is the most challenging area with a good scope of research because image segmentation has multiple solutions and we have to do is increasing the perfection percentages by improving existing methods or by developing new algorithms. Image is always complex because it contains low signal to noise ratio, noise and non-uniform intensity.Image segmentation algorithms are mainly made into two groups as supervised and unsupervised image segmentation. Supervised image segmentation algorithms require data sets or images which are labeled and these require lot of training samples. Unsupervised image segmentation algorithms are mostly popular because they are independent of training samples and labels. k-means clustering algorithm and FCM are some of the unsupervised algorithms.

II.IMAGE SEGMENTATION

Image segmentation is the method of dividing a digital image which contains some pixel values into multiple parts in image processing and computer point of view. The term "image segmentation" refers to the process of findingboundries and objects in images. The pixels in the input image are divided into two groups as a result of this: Pixels with an intensity value that is less than or equal tothe threshold. Pixels with a higher intensity than the threshold.In some cases we'll have no idea where either animal or object is located in the shot or both. In such cases Image localization and object detection plays roles. Where Image localization allows us to locate a single object in an image. We rely on the concept of detecting object when the image contains several objects in it (OD). Using OD, we can detectlocation of every object as well as the cluster it belongs to. Before finding the the objects in the image we must know how the image is made of.

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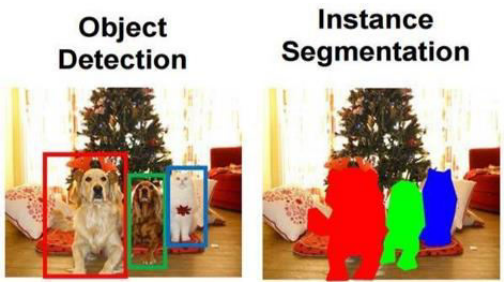

Fig-1: difference between detection and segmentation

III.PROPOSED METHOD

The method to be proposed consists of two stages, the first step is to convert the image into super-pixel image using multiscale morphological gradient reconstruction-based watershed transformation (MMGR-WT). second step is to perform the fast fuzzy C-means clustering using the histogram segmentation.Super pixel is a pre-segmentation tool which is used to segment the image into smaller regions. This process is known as over segmentation. Super pixel can get the pre-segmented image by using the local spread information of the image. The ability of the program or an algorithm to withstand the noise in the image is known as the robustness of the algorithm. MMGR-WT is robust in image segmentation.

The obtained superpixel image is worked on a fast fuzzy C- means algorithm which works on histogram segmentation. Histogram segmentation is a method of segmenting the color images based on the histogram plotting of the values of pixels on the image. Generally, a color image has large number of pixel values which makes the histogram segmentation harder to compute. Image after converting into super pixel image it has far less colors in it than the original image. This makes the algorithm to work faster and with less computational complexity.

A. Super pixel using MMGR-WT

Watershed transformation is proposed mainly to perform segmentation on gray scale images. Watershed transformation is a fast algorithm works by calculation the local minima in the image and finds the local maxima in between those minimal points. These local maxima are the watershed lines or the segmentation lines. This algorithm is very sensitive to noise. It performs over segmentation if there is any noise in the image. Many algorithms were proposed to overcome the over segmentation problem by changing or modifying the gradient image in which morphological gradient reconstruction is one of the methods. We chose this algorithm because it has the ability to store the details of objects while removing noise. MGR consist morphological erosion and dilation which are used for extracting the features and removing noise but less capability than morphological opening and closing which performs same operation mentioned above.MGR works by dividing the image into structure elements (SE) which are of circle in shape and with the radius r. If the radius is small then there will be over segmentation that is the image is divided into lot of parts and if radius is large then the image will be under segmented i.e., very few divisions of the image are formed thus good segmentation is not possible. To overcome this a method MMGR isproposed in which different SEs will be used for gradient image reconstruction and sum-up all the results obtained by using different SEs.

MMGR contains two radius parameters r1 and r2 which represent the radius of minimal SE and radius of maximum SE used. If r1 is too small the image undergo over segmentation and the segmentation result does not depend on the r2 value. The number of segmentation regions will be decreasing till it reaches its threshold value after that the image segmentation result will be independent on the size of SE or structure element. SLIC and mean shift algorithms can also generate the super pixel image as per the task requirements by performing some changes in the parameters. But we choose MGR because they have long run time than MGR algorithm. To produce results fast for segmentation of color images we must consider for less runtime.

A. Fast fuzzy C- means clustering

To get better local spread information for FCM clustering a method was given which gives a super pixel image as output. Enhanced FCM is efficient and most popular algorithm to obtain image segmentation because a gray scale has only 256 values but a color image has far more large values than 256. To decrease the count of colors in a color image we use quantization techniques. Traditional algorithms for quantization can be used but they can only decrease the count of colors containing in an image but they cannot change the color distribution because those algorithms neglect the local spatial information. By using super pixel image, we can overcome this because it mainly works by considering

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the local spatial information.For better quantization of color image, we used MMGR-WT and obtained a super pixel image of a color image, now compute the histogram of the image obtained which has far less colors than in an original color image. By using MMGR it is shown that the histogram of quantized image has less colors that are different from each other. Based on the super pixel quantized image obtained a new method id used which contains objective function of super-fast fuzzy c means clustering.

The main difference between the new objective function and the traditional FCM is the new proposed function is only included with the histogram formation of information of the different colors of the super pixel image. In FCM every color pixel is replaced with the calculated mean of color pixel values but in a super pixel image the different colors are reduced and made into histogram information such that to reduce the complexity to calculate the mean of the color pixels. Thus, this algorithm is fast when compared to other segmentation algorithms. Advantages of using superfast fuzzy C- means clustering are it is very fast than other algorithms because it reduces the count of colors containing in the image by using quantization algorithm to produce super pixel image. The change in parameters cannot affect the SFFCM because the super pixel image is a convergent image. SFFCM provides an excellent result for the color image segmentation because the objective function is incorporated with global color features and adaptive local special information. The that we work on are taken from the Berkeley segmentation dataset and benchmarks (BSDS).

IV. RESULTS AND DISCUSSION

Watershed transformation is fast and effective algorithm for image segmentation because it calculates local minima in the gradient image and search for local maxima between local minima and finds the segmentation lines but it is sensitive to noise. So we use morphological gradient reconstruction which uses morphological erosion and dilation to extract features of the image or remove noise from the image. It uses structuring elements of circular shape with radius r and the segmentation results are dependent on the value of radius.

$$R^0(g) = R^\delta(R^\varepsilon)$$
$$R^c(g) = R^\varepsilon(R^\delta)$$

Where R^0 is morphological opening and R^c is morphological closing functions whose functionality is same as morphological erosion and dilation but are stronger than these functions. To overcome the drawbacks of MGR multiscale SEs are used and fused to obtain good super pixel results. This new method MMGR consists of two parameters r1 and r2 where r1 controls the minimal region of SE and r2 controls the maxima size of SE. It is very hard to set a value of r2 for each and every image. So, we have to set minimal error threshold value η instead of r2. The formula is

$$\text{Max}\ \{R_f^{Mc}(g, r1, r2) - R_f^{Mc}(g, r1, r2+1)\} \leq \eta$$

The super pixel image obtained is subjected to fast FCM clustering which is included with the histogram of information with multiple colors which are different from in the image obtained which makes the FCM to have less computational complexity and fast segmentation results. The proposed method is tested with multiple segmentation images from Berkeley Segmentation dataset and benchmarks (BSDS). The proposed method is compared with multiple segmentation algorithms such as FLICM, fuzzy C- means clustering, watershed transformation, K- means clustering. We set minimum error threshold value to 10^{-4} and maximum number of number of iterations to 50, number of clusters to 2. Three indispensable features or parameters are the weighing exponent, convergence condition and maximum number of iterations. The performance indications are the degree of equality in between the pixels which sets the ground truth and is named as quantitative score and the ratio of sum of the pixel values that are classified correctly to the total sum of pixel values. The results obtained from the proposed method are

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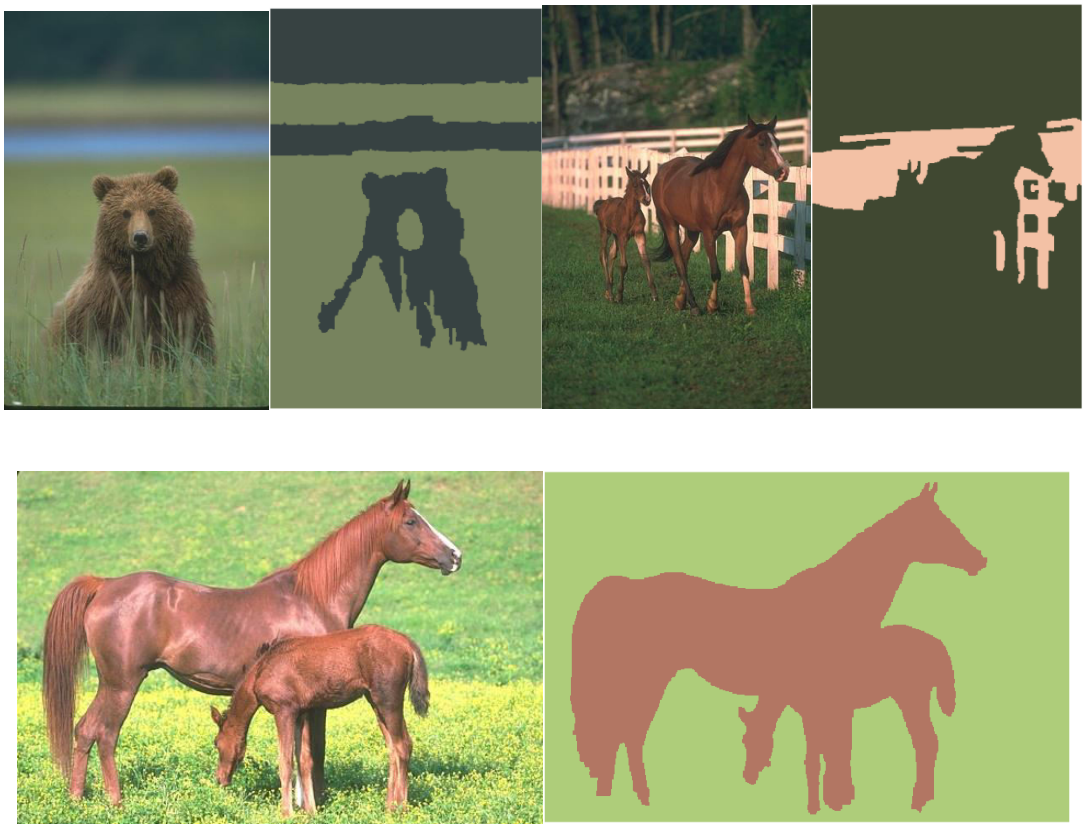

Fig-2: Inputs and Outputs of the proposed algorithm

V. CONCLUSION

An SFFCM algorithm has been proposed for segmentation ofcolor images. Major contributions involve MMGR algorithm which is used to obtain a very good super pixel image and including the histogram which contains the information of different colors into the objective function to obtain fast fuzzy C- means algorithm. This method also has some drawbacks as the previously proposed algorithms that is this method requires the pre-declaration of count of clusters the image to be obtained. In future work we can try to explore the algorithms or methods that can evaluate or predict the no. of clusters required depending on the image automatically.

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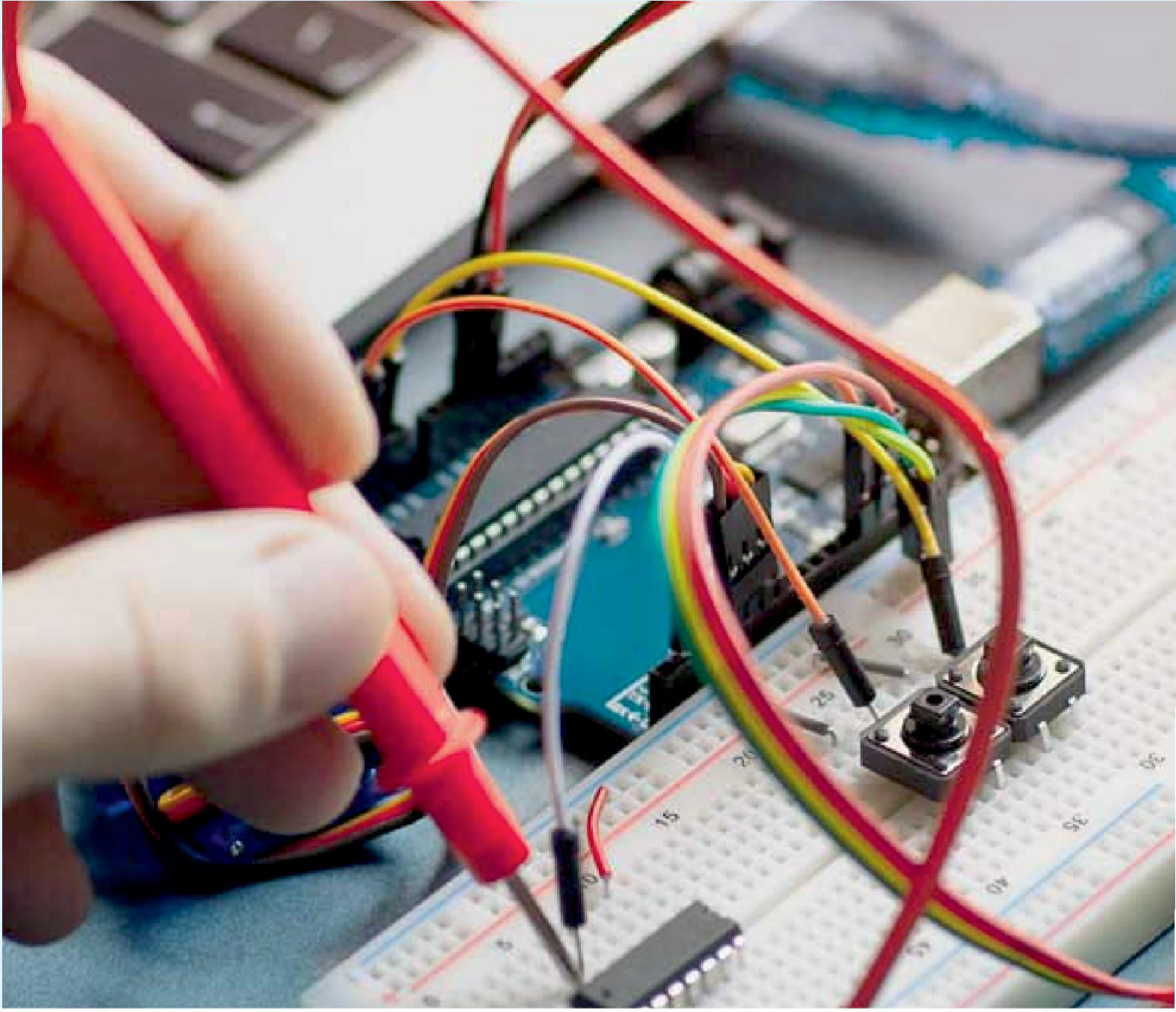

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