Segmentation of Color Image with Improved Watershed Algorithm

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Abstract **-** Watershed Transformation in mathematical morphology is a powerful tool for image segmentation. Improved Watershed transformation based on adaptive threshold and morphological image reconstruction with regionporop() can compute the gradient magnitude. This image segmentation technique includes image enhancement and noise removal techniques.. The proposed method is evaluated and compared to existing method. The results show that the proposed method could effectively reduce the over segmentation effect and achieve more accurate segmentation results than the existing method.

Keywords **-** Image Segmentation, Morphological Reconstruction, Watershed Algorithm, Local Adaptive Threshold.

I. INTRODUCTION

An Image segmentation is an essential component of image analysis and pattern recognition system. It is one of the most difficult tasks in image processing and determines the quality of the final result of analysis. During the segmentation, a digital image is partitioned into set of pixels where pixels in a region are similar according to some criteria such as color, intensity or texture, so as to locate and identify objects and boundaries in an image. The color based segmentation attracts more and more attention mainly because color images can provide more information than gray level images and use of color images in PCs and computers are increasing rapidly [1]. Segmentation is the first stage in any effort to analyze or interpret an image automatically. It bridges the gap between low-level and high-level image processing. A particular type of image segmentation method can be found in any application involving the detection, recognition, and measurement of objects in an image. There is no single color representation that can be said to have stood out from others for segmenting all kinds of color images. Segmentation, thus, may be looked at as an image classification problem based on color and spatial features. There is not one image segmentation technique or algorithm but several. The same can be said about color systems. In most of the existing color image segmentation approaches, the definition of a region is based on similarity of color. Thresholding is easier as it requires only the intensity levels to set up a threshold value and then compare [2].

II. RELATED RESEARCH

The watershed transformation is a powerful tool for image segmentation based on well-known mathematical morphology based approach. It has a good response to the weak edge, but it is unable to obtain meaningful segmentation results directly by using the watershed transform to the phenomenon of excessive segmentation in image segmentation. The watershed algorithm is more representative in the application of mathematical morphology The authors proposed method performs better than original watershed algorithm with a strong anti-noise performance. Several approaches exist to solve the over-segmentation problem, such as integrating watershed with region merging algorithm [12], watershed based on gradient modification and hierarchical region merging algorithms [13], morphological gradient applied to new active contour model [14]. Our research into methods for evaluating and comparing segmentation algorithms revealed that several, relatively recent, methods for evaluating modified watershed image segmentation algorithms had indeed been proposed.

Md.HabiburRahman, Rafiqual Islam et.al proposed modified version of the watershed algorithm for image segmentation. an adaptive masking and a thresholding mechanism over each color channel to overcome over segmentation problem, before combining the segmentation from each channel into the final one. [1].

Amrita Mohanty et.al illustrates that the segmentation of color images is necessary for efficient pattern recognition and feature extraction involving various color spaces such as RGB,HSV and CIE L*A*B* etc. The different cluster based segmentation techniques used for segmenting the different color images and the resultant is analyzed within subjective and objective measures.[2]

Shilpa Kamdi&R.K Krishna et.al considered that Region Growing is an approach to image segmentation in which neighboring pixels are examined and added to a region class if no edges are detected. This process is iterated for each boundary pixel in the region. If adjacent regions are found, a region-merging algorithm is used in which weak edges are dissolved and strong edges are left intact. Region Growing offers several advantages over conventional segmentation techniques. [3]

K. Singh, A.Singh et.al refers to the process of partitioning a digital image into multiple segments (sets of pixels, also known as superpixels).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. [4]

X.Han et.al present fast two-step marker-controlled watershed image segmentation method in CIELAB color space. A number of seed points distributed nearly uniformly as the makers to perform the first marker watershed segmentation step, and obtain super pixels of the input image. These markers have the minimal gradient in a 3 ×3neighborhood, which is able to avoid placing them at an edge and to reduce the chances of choosing a noise pixel. After super pixels segmentation, we do not adopt the traditional region merging strategies based on the different features of the adjacent regions.[8]

XuemeiCui et.al presented an improved watershed image segmentation method, where, firstly, the morphological opening/closing reconstruction filter is applied to remove the image noise and secondly, multi-scale structure elements are used to calculate morphological gradient. Also, the morphological gradient is modified by viscous morphological operators to remove the most irregular minimums. The region merging method based on neighbor regions edge value is applied after standard watershed transform to improve the segmentation result. [9].

III. PROPOSED WORK

The following section describes the proposed work for implementing local adaptive thresholding on colored images for color based segmentation with improve watershed algorithm and morphological image reconstruction.

The following section describes the proposed work for implementing local adaptive threshold and morphological image reconstruction on colored image for color image segmentation. In the work color models are utilized along with adaptive threshold and morphological image reconstruction for better color image segmentation. Modified Watershed Algorithm based on Morphological Image Reconstruction (Dilation-based gray-scale image reconstruction & Erosion-based gray-scale reconstruction).By considering adaptively selecting local threshold, local minimum information and region prop function for smoothing the image. MWS approach can enhance the image segmentation performance. Proposed method has less computational complexity, which makes it appropriate for real-time application. It works incredibly well in practice. More exactly, all the training data is needed during the testing phase.

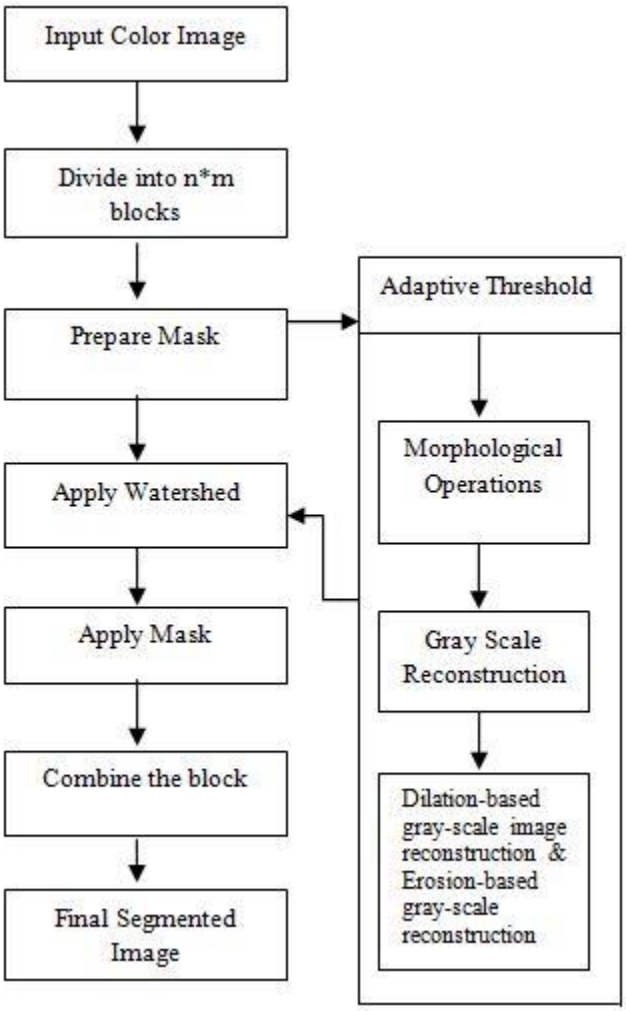

Fig1: The flow chart of the proposed modified watershed algorithm.

A. Thresholding - Thresholding method proposes the use of a threshold value set by the administrator. If a pixel value lies is equal to or greater than the threshold value the pixel could be picked up else left. The local thresholding refers to use of threshold values over small region. Global thresholding is considered when intensity variation of object and background is conveniently distinct. Further if the threshold value is depending upon the spatial co-ordinates, adaptive thresholding could be used. Histogram shape-based, entropy-based, spatial methods and local methods are some algorithms based on thresholding.[5] Thresholding is the most simple and versatile technique that decides for each pixel value of the image that whether it belongs to region of interest or not. Thresholding can be utilized in applications like extracting out the objects from video using background subtraction [6]

(i) Local Adaptive Threshold - The Adaptive Threshold module is used in uneven lighting conditions when you need to segment a lighter foreground object from its background. In many lighting situations shadows or dimming of light cause thresholding problems as traditional thresholding considers the entire image brightness. Adaptive Thresholding will perform binary thresholding (i.e. it creates a black and white image) by analyzing each pixel with respect to its local neighborhood. This localization allows each pixel to be considered in a more adaptive environment.
A threshold *T*(*x*,*y*) is a value such that

$$b(x,y)=\begin{cases}0 & if\ I(x,y)\le T(x,y)\\ 1 & otherwise\end{cases} \quad (1)$$

where b(x,y) is the binarized image and I(x,y)∈[0,1] be the intensity of a pixel at location (x,y) of the image I. In local adaptive technique, a threshold is calculated for each pixel, based on some local statistics such as range, variance, or surface-fitting parameters of the neighborhood pixels. [7]

B. Morphological Image Reconstruction and regionprops()
(i) Morphology Morphological reconstruction turns out to be particularly effective, detect or remove objects touching the image border,and filter out spurious high or low points. Based on the morphological reconstruction, opening-by-reconstruction operation and closing-by-reconstruction operation is utilized to smooth image and eliminate the noise. The opening-by-reconstruction is erosion followed by a morphological reconstruction while closing-by-reconstruction is a dilation followed by a morphological reconstruction. Compared to simple opening and closing, reconstruction-based opening and closing can restore the original shapes of the objects after erosion or dilation.

(a) Morphological Opening - γμβ(f)(x)

Opening - The opening of *A* by *B* is obtained by the erosion of *A* by *B*, followed by dilation of the resulting image by *B*:

$$A \circ B = (A \ominus B) \oplus B \quad (2)$$

The opening is also given

$$A \circ B = \bigcup_{B_x \subseteq A} B_x \quad (3)$$

by which means that it is the locus of translations of the structuring element *B* inside the image *A*. In the case of the square of side 10, and a disc of radius 2 as the structuring element, the opening is a square of side 10 with rounded corners, where the corner radius is 2.

(b) Morphological Closing - ϕμβ(f)(x)

Closing - The closing of *A* by *B* is obtained by the dilation of *A* by *B*, followed by erosion of the resulting structure by *B*:

$$A \bullet B = (A \oplus B) \ominus B \quad (4)$$

The closing can also be obtained by

$$A \bullet B = (A^c \circ B^s)^c \quad (5)$$

Opening is anti-extensive, i.e., $A \circ B \subseteq A$, whereas the closing is extensive-

i.e. $A \subseteq A \bullet B$.

(ii) Regionprops (bwconncomp PixelIdxList) - After dividing the image into blocks, We apply connected component function called "bwconncomp" to each block and need to store the PixelIdxList field of the structure produced from function "bwconncomp" for each block.the function bwconncomp returns a structure with 4 fields :- Connectivity: connectivity of the connected components (can be defined with an input variable)- ImageSize: size of the image- NumObjects: number of connected objects found in the image- PixelIdxList: a cell array which contains the linear indices of the objects (the indices of the kth object are in PixelIdxList{k}).To access to an object of a specific block, and find it in the whole image, you "just" have to add the x and y offset that define the position of the block in the whole image. Note that computing certain groups of measurements takes about the same amount of time as computing just one of them because regionprops takes advantage of intermediate computations used in both computations. Therefore, it is fastest to compute all of the desired measurements in a single call to regionprops.

IV. RESULTS AND DISCUSSION

The proposed watershed transform based on adaptive threshold and morphological image reconstruction is tested in the different test images and also compared with the existing watershed transform The MATLAB is the tool which is used for the simulation. In the results it is shown that proposed algorithm performs well in terms of PSNR, MSE, BER and RFSIM.

(i). PSNR - The PSNR is based on color texture based image segmentation by using the following equation. It is the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its image.

To compare the proposed technique with existing technique, first PSNR parameter has use. We are measuring PSNR in decibel.

$$PSNR\,(GI,SI) = \frac{10log10s^2}{MSE(GI.SI)} \quad (6)$$

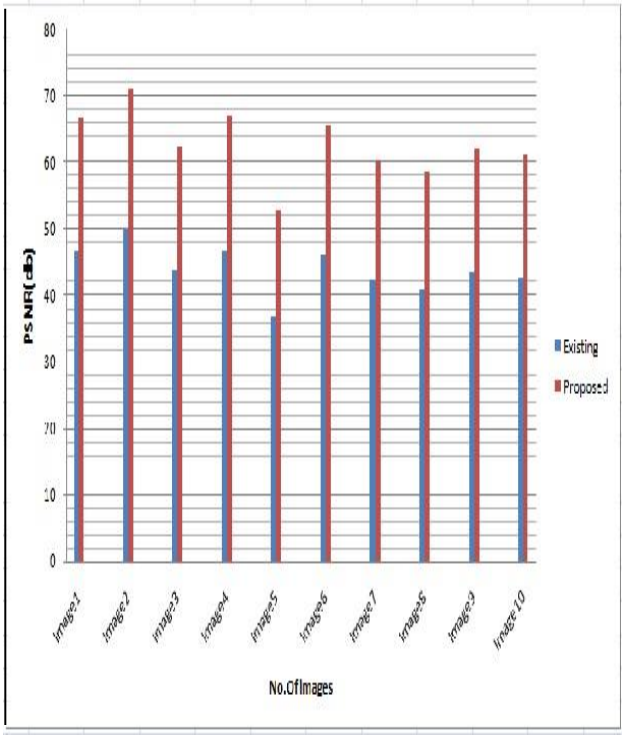

Fig2: Comparison of PSNR for existing and proposed technique

From above given graph, we can easily compare the peak signal to noise ratio between the existing and proposed technique. From the graph, it is clear that proposed technique has more signal strength as compare to the existing technique.

(ii). MSE - To compare the proposed technique with existing technique, secondly Mean Square Error has used. Mean Square Error (MSE) is calculated pixel-by-pixel by adding up the squared difference of all the pixels and dividing by the total pixel count. MSE of the segmented image can be calculated by using the equation.

$$\frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}(A_{ij} + B_{ij})^2 \quad (7)$$

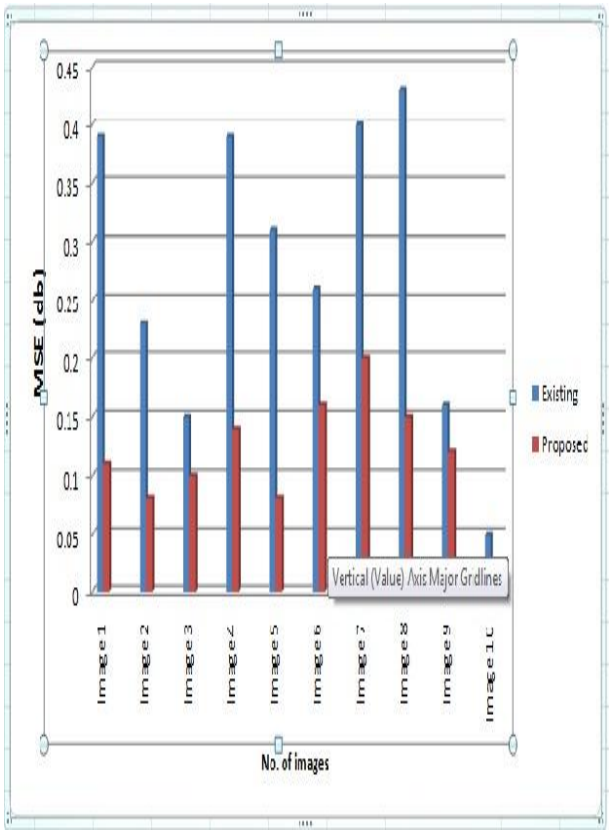

Fig3: Comparison of Mean Square Error for existing and proposed technique

From the above given graph, we can easily compare the mean square error difference between the existing and proposed technique. From the graph, it is clear that proposed technique is more accurate as compare to the existing technique.

(iii) BIT (Bit Error Rate) - As shown in graph 3, the proposed and existing algorithms are compared with bit error rate. It is very clear from the plot that there is decrease in bit error rate value of images with the use of base paper method over other methods. This decrease represents improvement in the objective quality of image.

$$\text{Bit Error Rate (BER)} = \frac{1}{PSNR} \quad (8)$$

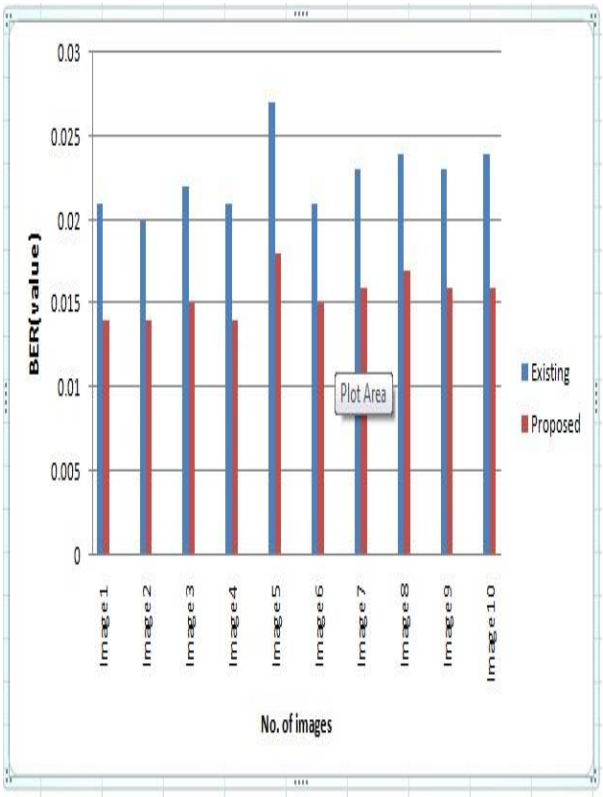

Fig4: Comparison of Bit Error Rate for existing and proposed technique

(iv) Riesz Transform - The objective quality measurements are save time more than subjective quality measurement. (RFSIM), is proposed based on the fact that the human vision system (HVS) perceives an image mainly according to its low-level features. The 1st-order and 2nd-order Riesz transform coefficients of the image are taken as image features, while a feature mask is defined as the edge locations of the image. The similarity index between the reference and distorted images is measured by comparing the two feature maps at key locations marked by the feature mask. The 1st-order and the 2nd-order Riesz transforms can extract some low-level image features effectively and efficiently in a unified theoretic framework. Thus, in this paper, we utilize them for the feature extraction.

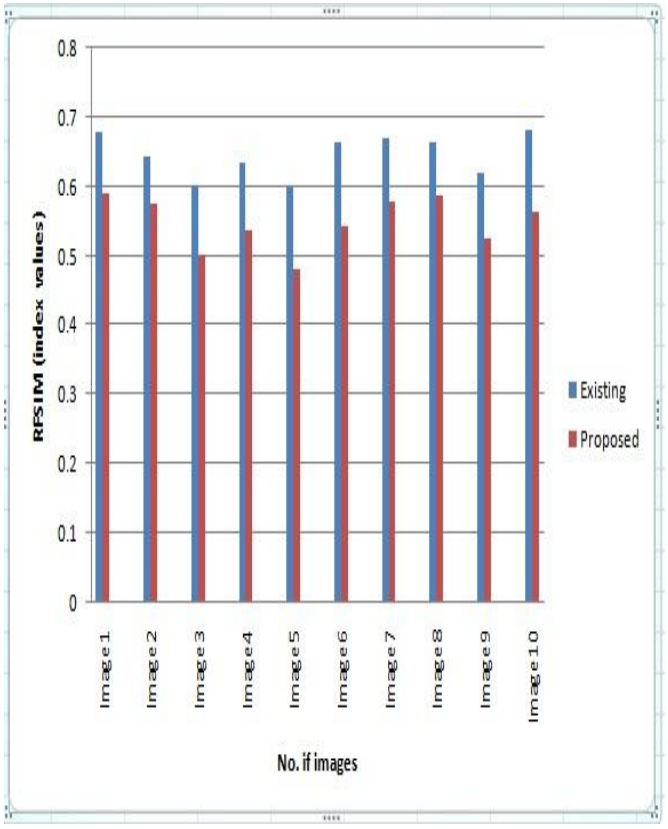

Fig5: Comparison of Riesz Transform for existing and proposed technique

As shown in graph 4, the difference between Riesz transform is done between proposed & existing algorithm. RFSIM index outperforms. It is based on the belief that the image degradation will induce perceived changes in image features at key locations. RFSIM is computed via comparing the features at key locations of two images.

V. CONCLUSION

The goal of image segmentation process is to identify the segments of the image according to the characteristics of objects e.g. object shape, image color etc. In order to solve the over segmentation problem of traditional watershed technique an improved technique is proposed that uses adaptive threshold and regionprops() to reduce the noise of image and adjust the image intensity. Also we concluded with the performance parameters useful in judging an algorithm's utility. A useful lay of knowledge lastly is hopeful in extending the reader's repository of intellect. Similarly, it is worth noticing that our proposed method is less computational complexity, which makes it appropriate for real-time application. In future a robust algorithm should developed for the segmentation of color and video images & Focus on a

more standard performance measure which could well reflect the difference between segmentation results.

VI. REFERENCES

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