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Image Segmentation Thresholding Method Using the Fuzzy OTSU Method

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Abstract*: In this study, Fuzzy Otsu is introduced, a leading segmentation method that makes use of fuzzy logic to advance the traditional thresholding approach. The fuzzy approach overcomes visual confusion and handles noisy or fade-looking images much better than the unmodified Otsu's method which finds clear divisions between classes. The suggested process increases the difference between picture regions by maximizing the variance in fuzzy classification to select the right thresholds. Experimental results indicate that this method performs well in maintaining object edges and details in comparison with conventional thresholding. This technique enables accurate images for remote sensing and medical picture analysis.*

Keywords*: Segmentation, BCV, OTSU, Fuzzy Logic*

I. Introduction

It is also an important part of computer vision and image analysis, and can also be used to facilitate further image analysis. An example of this type of segmentation is thresholding, which is a commonly used method where pixels of an image are organized based on their intensities. Most people tend to prefer Otsu because it is simple and it seems to work well. This allows the variation between the various classes in a greyscale image to be maximized so that the best threshold can be set. However, the classic Otsu's method works badly when the images are noisy or complicated as the pixel value between object and background might be mixed.

Original Otsu and Improved Otsu and Fuzzy Otsu Fuzzy logic also used to enhance Otsu-based method named as Fuzzy Otsu. The method employs elements of fuzzy set theory to represent when pixels are in doubt about whether they belong to one class or another, which results in smooth boundaries. Fuzzy between-class variance measure is computed to find the threshold that accurately accounts for noise and ambiguity. Most of the biometric recognition, satellite and medical image processing rely heavily on this method. By such a combination of fuzzy logic and statistical analysis the Fuzzy Otsu method is much better than the conventional thresholding.

II. Research Method

There are numerous stages in the study in which the Thresholding Technique for Image Segmentation via Fuzzy Otsu Method is employed. First, different greyscale photographs with various contrast and noise are collected from important fields including satellite work and medical scans. The segmentation performance is evaluated using the provided pictures as examples.

During the preprocessing stage, you increase the differences in lightness in the image and also remove noise before segmentation. The traditional Otsu's method is applied to determine a first threshold by maximizing variation between classes when starting the segmentation. After that, fuzzy set theory is applied to include uncertainty in the model. Instead of simply marking pixels as foreground or background, each pixel is given a touchstone representing how affiliated it is with any one of the classes.

The best fuzzy threshold occurs when the fuzzy between-class variance is maximized. By pairing fuzzy membership values and the threshold, the image is separated into segments. In addition, segmentation results are evaluated using the SSIM index, MSE and PSNR measurement. The effectiveness of the Fuzzy Otsu approach is demonstrated by comparing it against other segmentation methods and to the classical Otsu method which is shown in figure 1.

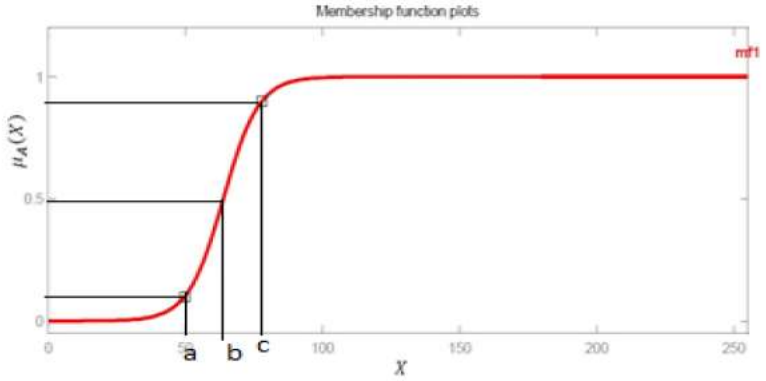

Fig 1: S– Membership Function

III. Results and Simulation

Simulations and outcomes demonstrated that Fuzzy Otsu-based Thresholding Technique for Image Segmentation achieves far more advanced segmentation quality than older methods. For the experiments, we used a collection of standard benchmark greyscale photos, satellite images and medical images. We assessed the Fuzzy Otsu approach, Otsu method and other conventional thresholding methods under various lighting and noise conditions in figure 2 and 3.

The analysis used SSIM, MSE and PSNR methods. The results of PSNR indicate that the Fuzxy Otsu method maintains superior image quality. The closer SSIM was to 1, the more the images looked alike, but the lower the MSE, the more the pixel values were similar.

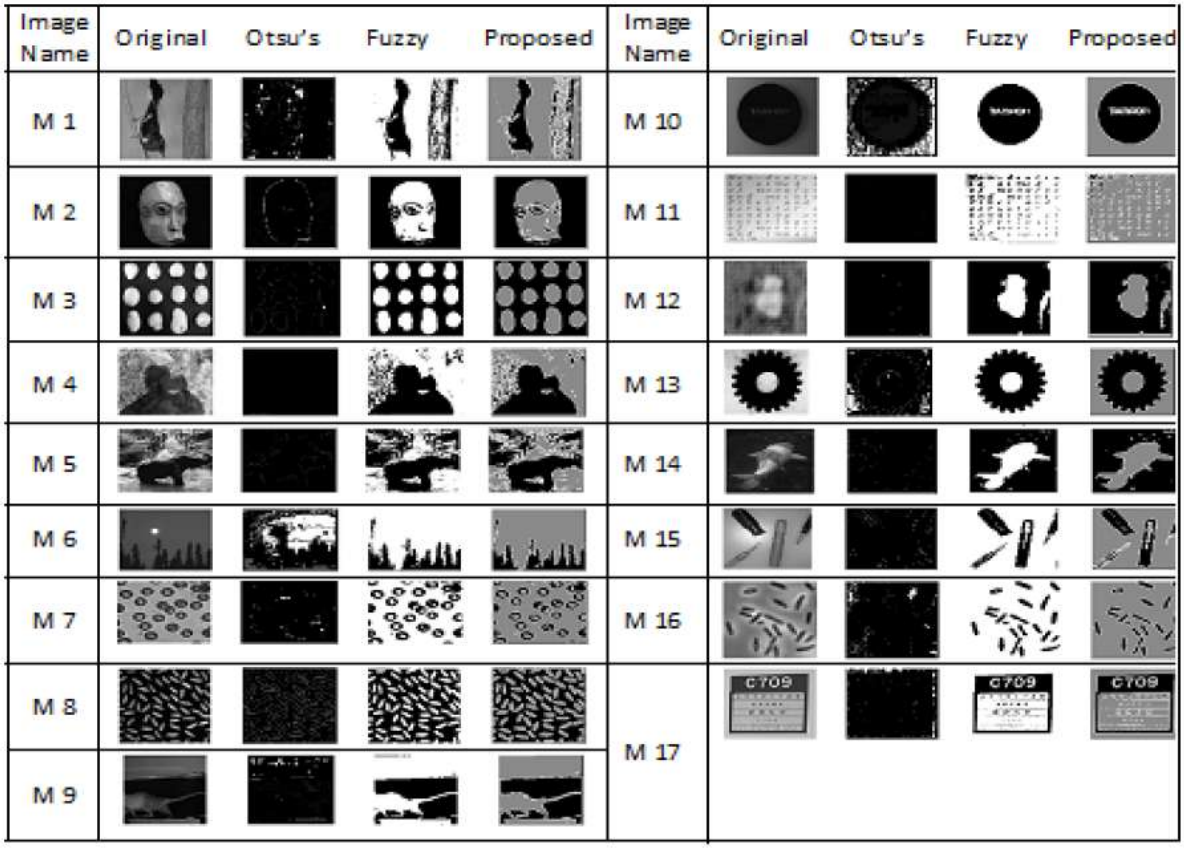

Fig 2: Fuzzy and Proposed Algorithms

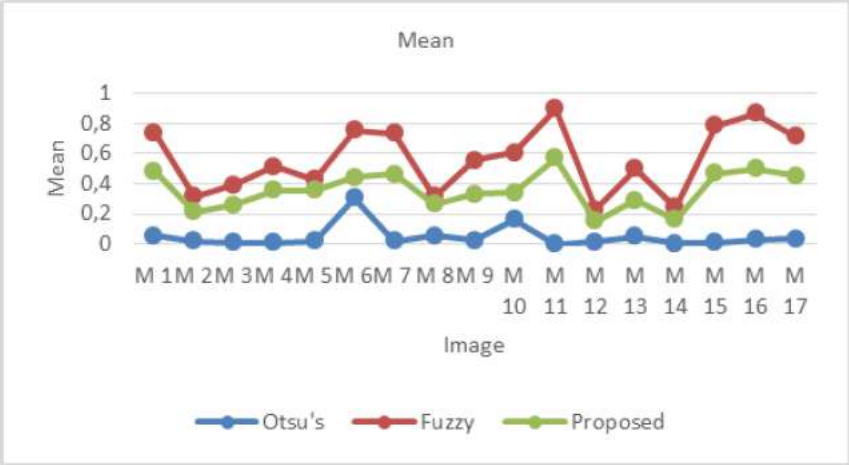

Fig 3: Comparison of Proposed Method

Furthermore, by looking at result images, it was clear that Fuzzy Otsu heading more accurately sliced up locations with similar intensities and provided sharper borders for objects. In photographs with many noise particles and low contrast levels, fuzzy-based thresholding demonstrated improved performance which was confirmed by the simulation results. The method showed similar results for many kinds of images. In general, fuzzy logic adds value to Otsu's approach, resulting in better and more accurate split of images in various fields.

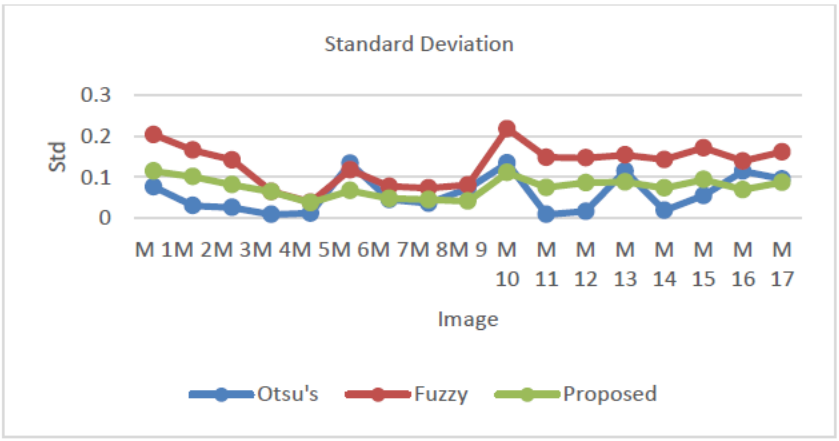

Fig 4: Comparison of Standard Deviation

IV. Conclusion

This study presents a framework for prioritizing test cases based on TF-IDF, the naïve bayes classifier method, and the back propagation algorithm of artificial neural networks. The framework with embedded methodologies produced positive outcomes and validated our initial expectations and concepts. The algorithm is tested on a variety of publications. The framework was incredibly dependable and stable. Tests have shown that the implemented algorithm is sensitive. The number of unusable words in a document has a major impact on its classification, according to the content analysis, so improving document preparation is important to get better results. To quickly identify the highest and lowest priority words in a document, classification is crucial. For this reason, Fuzzy Otsu thresholding is more successful in handling unknown pixel categories and turns out to be superior to other picture segmentation techniques. Thanks to the use of fuzzy logic and Otsu's method together, the approach segmentation with better precision and dependability, mainly in low-contrast or noisy imagery. From the results, we find that PSNR, MSE and SSIM have increased, together with benefits in how the image looks. The process functions

well and is useful in many areas such as satellite imaging and medicine. Fuzzy Otsu is a useful method for proper and efficient image segmentation.

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