FUZZY APPROACHES FOR IMAGE ANALYSIS

By

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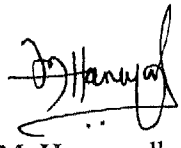
CERTIFICATE

This is to certify that the thesis entitled " Fuzzy Approaches for Image Analysis" being submitted by Mr. Devendra Jha to the Indian Institute of Technology, Delhi for the award of "Degree of Doctor of Philosophy" in Electrical Engineering Department is a record of bonafide research carried out by him.

He has worked under my guidance and supervision and has fulfilled the requirements for the submission of the thesis.

The result contained in this thesis have not been submitted, in part or full, to any other University or institute for the award of any Degree or Diploma.



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ABSTRACT

In this thesis, new fuzzy logic based image processing techniques are presented, so as to overcome the drawbacks associated with conventional image processing methods. In conventional approaches, decision-making is made by treating image data as crisp sets that introduce uncertainty in the image analysis. For example, crisp edge detection introduces error in edge localization; histogram modification for enhancement disturbs the original distribution of image pixels, and so on. Such problems are eliminated under fuzzy framework by making soft decisions at all stages of image processing. This framework is utilized to enhance the color image perception by contrast intensification and to detect edges by increasing the relative perception between edge pixels and non-edge pixels. Further, extension of fuzzy logic to filtering of noisy image has led to weighted fuzzy filter. Segmentation of color image has necessitated the use of fuzzy clustering techniques. The advantage of fuzzy based approaches is that the membership value of each pixel can be analyzed and modified. This leads to user interactive systems, where the user has a choice of parameter tuning at any stage of analysis for the desired result.

Considering the above advantages, fuzzy logic has been employed so as to develop various image processing tools. Different membership functions are devised to represent the image information. The parameters of these membership functions are obtained by the optimization method for enhancement, smoothing and edge detection. Fuzzy clustering approaches have been utilized for smoothing and for segmentation of color and texture images.

Image is modeled as Gaussian membership function and a new parameter based intensification operator is suggested for enhancement. A more appropriate color space HSI (Hue, Saturation and Intensity) in the sense that it does not alter the original color composition is used for color image enhancement. To assess the performance, image quality and visual factors have been defined.

For smoothing and to remove all types of noise concurrently, weighted fuzzy filter that is a combination of three types of existing fuzzy filters is proposed. The noisy image is classified into three clusters. Each cluster contains 3 membership functions, which act as weights due to impulse noise, Gaussian noise and image structure details. The smoothing action is the aggregated response of the products of filter outputs and weights.

The edge detection is accomplished by enhancing the relative strength of edge (boundary) pixels. For this purpose, a combination of global and local approaches is used on gray and color images. Further, for texture image segmentation, new fuzzy features are devised based on spatial interaction model. From these features, texture descriptors are derived. A comparison of fuzzy features and fractal features is done using both fuzzy C-means clustering and modified mountain clustering methods.

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