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Modified Fuzzy Inference System for Edge Detection of Real Colored Image

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Abstract— In the field of computer vision and image processing the edge detection of an image has been dominating since last few decades. The main usage of edge detection is in image segmentation, registration and identification. In physical aspects an edge of an image is nothing but a sudden change in intensity. Edge detection of an image remarkably lessens the amount of data and filters out useless information, while keeping the important structural property intact. In this paper we have tried to propose a model using a modified fuzzy inference system. The modification has mainly concerned on fuzzy rule and some preprocessing techniques. We have also reported the design issue of this fuzzy edge detection model in each step. The proposed model does not need parameter setting like other edge detection method does. Our model is dynamic with respect to fuzzy rule changes and robust. Even this model is ineffective under high level noise. It can work suitably under some circumstances where other traditional edge detection techniques cannot work. In our work we have focused to perform our edge detection method in special domain, for this reason computational cost will be less.

Keywords— Fuzzy Logic, Fuzzy Rule, Fuzzy Membership Function, Fuzzy Inference System, Edge Detection, Regression Analysis.

I. INTRODUCTION

Interpretation of image contents is a significant objective in computer vision and image processing, and it has received much attention of researchers during the last three decades. An image contains different Information of scene, such as object's shape, size, color, and orientation, but discrimination of the objects from their background is the first essential task that should be performed before any interpretation. In order to extract the contour of an object, we must detect the edges forming that object, and this fact reveals the constitutional importance of edge detection in computer vision and image processing. Edge detection results benefit wide range of applications such as image enhancement, recognition, morphing, restoration, registration, compression, retrieval, watermarking, hiding, and etc.

An image edge detection refers to a method of identifying and locating sharp discontinuities in an image. The discontinuities are abrupt changes in pixel intensity which characterize boundaries of objects in a scene. Since, it can be proven that the discontinuities in image brightness are likely to correspond to: discontinuities in depth, discontinuities in surface orientation, changes in material properties and variations in scene illumination. In the ideal case, the result of applying an edge detector to an image may lead to a set of connected curves that indicate the boundaries of objects, the boundaries of surface markings as well curves that correspond to discontinuities in surface orientation. However, it is not always possible to obtain such ideal edges from real life images of moderate complexity. Edges extracted from non-trivial images are often hampered by fragmentation, missing edge segments, as well as false edges, which all lead to complicating the subsequent task of image interpreting.

In rest of the section we have discussed the following-Section II we have tried to report and refer some of the influential work in edge detection field. Section III we have discussed mainly methodology, where initially we have given some basic foundation for edge detection of an image, then we have put some light on fuzzy inference system and finally we have taken care of our proposed approach including a pictorial representation of flow chart and output of each individual step. Section IV we have tried to compare our techniques with other existing edge detection methods. Section V and Section VI we have finally talked about the extension of our work and conclusion.

II. RELATED WORK

In the domain of image processing, there is so many contributions that has been done in the field of medical images to enhance its quality in many ways like- contrast image enhancement, color image enhancement, Degraded image enhancement, Non-Linear Image Enhancement, Hue-preserving color image enhancement, but there was a few work reported in which the contribution is mainly to reconstruct the unidentifiable edge & area of a medical image, specifically in MRI images. Among all alluring works on identification of unidentifiable edge of an image, the work by Boopathi Kumar E., Sundanese M. is having significant influence in the application of unidentifiable edge using Fuzzy Inference System based edge detection [3] and by the same authors a little more specific work is done using trapezoidal membership function based on Fuzzy's Mamdani Inference System [5]. Another interesting contribution is done by Naik P.Ravindra, S.J.Saritha and G.Natraj Sekhar [6], where they have analyzed the edge detection techniques for image segmentation using neural networks. Jenkinson M., Stephen Smith. [1], have proposed a global optimization method for

robust affine registration of brain images for medical image analysis. Bhagabati B., Das C. [7], they have implemented a model for edge detection of digital images using fuzzy rule based technique.

III. INPUT DATA

For the implementation of our experiment we have taken the image data of our college repository. The image data is image of our institute (Kalinga Institute of Industrial Technology). It is a real coloured image having dimension 256x256.

IV. METHODOLOGY

The edge representation of an image drastically reduces the amount of data to be processed, and filters out the useless information while preserving important structural property. The edge detection process consists three basic steps.

A. Basic Steps

- Initially, a noise removal method is accomplished to acquire superior outcome of edge detection.
- In the middle, a high-pass filter like differential operator is used for finding horizontal, vertical, or diagonal edges.
- Finally, an edge accumulation operation is performed locally to recognize the authentic edges.

B. Fuzzy Inference System

Fuzzy Inference System is used to frame capable of certain rules for the given process [3] [5]. It contains five types of editor functions such as Fuzzy Inference System Editor, Membership Function Editor, Rule Editor, Rule Viewer and Surface Viewer. Rule Viewer and Surface Viewer are read only functions. However, the number of inputs may be limited by the available memory of the machine. If the number of inputs is too large, or the number of membership functions is too big, then it may also be difficult to analyze the FIS using the other GUI tools. The Membership Function Editor is used to define the shapes of all the membership functions associated with each variable. To describe the nature of the system by editing the list of rules, the Rule Editor is used. In this paper, 3X3 pixel windows are used to scan the input images and fuzzy inference system is built for image edge detection. In the rule base some specific of rules have been employed to the mask to highlight the pixel as white, black or edge. The complete process of Fuzzy Inference System is demonstrated in the following figure (1).

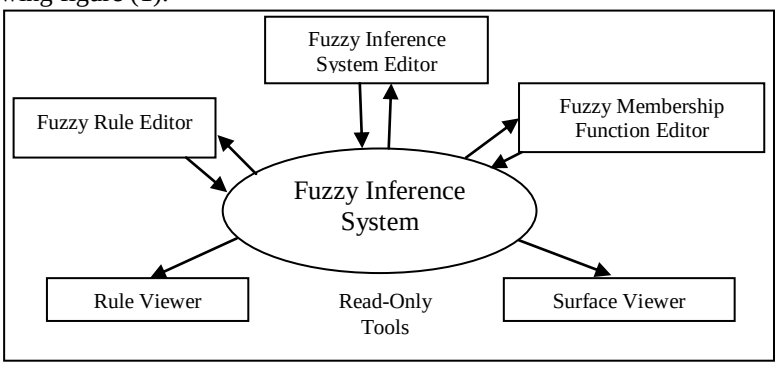

Fig 1. Block diagram of fuzzy inference system

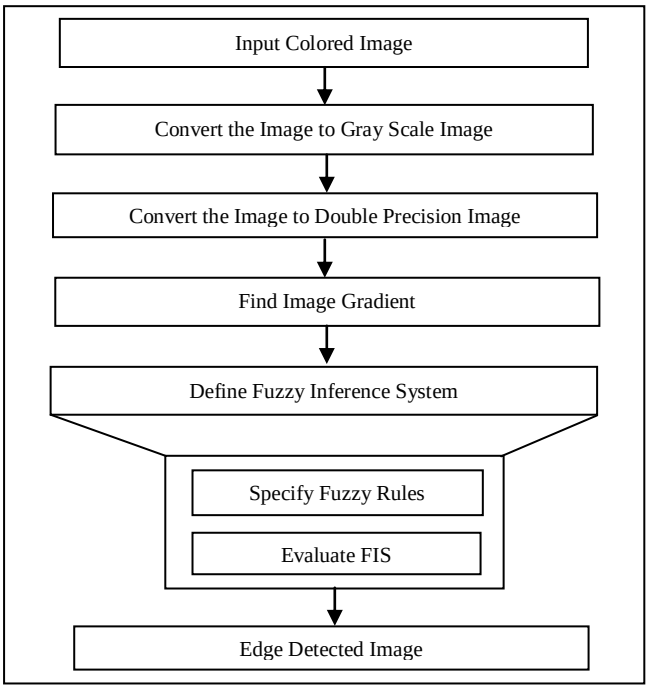

Fig 2. Computational flow chart of proposed approach

C. Proposed Approach

Fuzzy logic is a kind of heuristic representation where we are not able to describe value as we do in crisp set on their contexts. Fuzzy logic helps us to recognize the edges of an image, by using fuzzy inference system. For detecting an edge of our experimental image we have used a modified edge detection technique using fuzzy inference system. For FIS system we have used Gaussian membership function as input and used triangular membership function to represent the output.

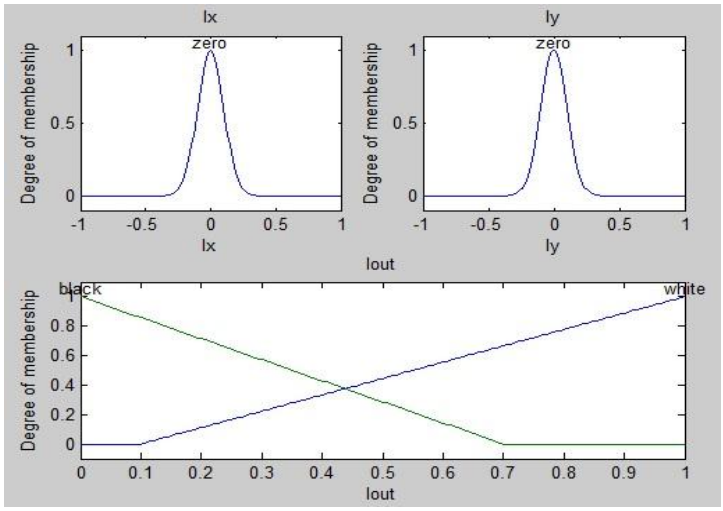

Fig 3. Output of fuzzy membership function used in FIS

a. Original Image

b. Grayscale image

c. Double precision image

d. Gradient image (Ix)

e. Gradient image (Iy)

f. Output image of FIS

Fig 4. Output of each step of proposed method

V. COMPARISION WITH DIFFERENT EDGE DETECTION METHOD

In case of fuzzy edge detector, it does not need parameter setting as for classical edge detector such as threshold and σ, and great computational complexity, even high level noise does not affect the detection [3][4][7]. Sometimes the filtering action is not effective as the fuzzy detection systematically evaluates the edges from a corrupted image without using that noise removal filter. Actually, the rule-based approach offers most advantages such as giving permission to adapt some parameters easily.

Even the edge thickness can easily be changed by adding new rules or changing output parameters. That is to say rule–based approach has flexible structure which can be adapted any time or anywhere easily. So the system has got the ability to cope with changing fuzzy rules dynamically, whenever needed.

The following diagrams shows the edge detection on our experimental image using different well-known edge detection method to compare visually with fuzzy edge detection method.

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-1	-2	-1
0	0	0
1	2	1

Sobel x-direction mask

-1	0	1
-2	0	2
-1	0	1

Sobel y-direction mask

-1	-1	-1
0	0	0
1	1	1

Prewitt x-direction mask

-1	0	1
-1	0	1
-1	0	1

Prewitt x-direction mask

-1	0
0	+1

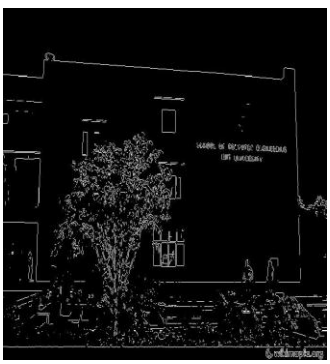
Roberts x-direction mask

0	-1
+1	0

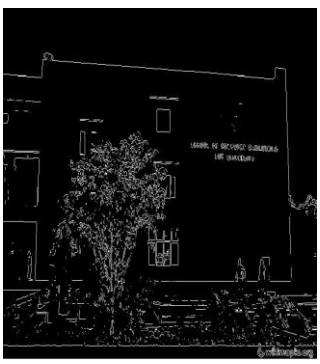
Roberts y-direction mask

-1	-1	-1
-1	8	-1
-1	-1	-1

Laplacian mask



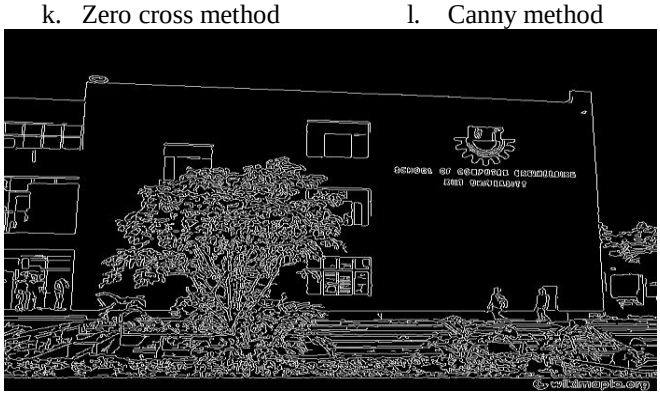
g. Sobel method



h. Prewitt method

i. Roberts method j. Log method

k. Zero cross method l. Canny method



m. Modified fuzzy edge detection

Fig 5. Comparison with other edge detection method

VI. FUTURE WORK

We are able to generate maximum possible edge, but not total edge. Some part of edges are still missing. So we can extend our work by changing fuzzy rule and membership function, which may fulfil the exact deficiency and improve the result. Even we can apply this approach for the edge detection of colour 3D image.

VII. CONCLUSION

Edge detection method is one of the most difficult task in image processing, in which we have to find out the edges present in the image. In this paper, we have tried to implement a method to evaluate more precise edge, using modified fuzzy inference system. The implementation of the method is very easy as the basis of FIS system is simple IF-THEN rules. However we have observed that this framework has got the ability in changing rule dynamically. Also it does not need any parameter setting like traditional edge detector operator, moreover it is very robust and flexible against noise. Thus, the results are very convincing, and the detection keeps the maximum edge information.

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