Edge detection using Fuzzy Logic for Generating Automatic Theresholding

Aman Chopra, Arti Jain, Abhishek Jain

Abstract— **Digital image processing is a subset of the electronic domain wherein the image is converted to an array of small integers called pixels that representing a physical quantity such as scene radiance and stored in a digital memory,and processed by computer or other digital hardware. Edge detection is very useful in a number of context.Edges characterize object boundaries and are, therefore, useful for segmentation, registration, and identification of objects in scenes. Thresholding decision is the key uncertainty in the edge detection techniques. This paper explain how existing Fuzzy Logic ideas can be supplemented by the use of Automatic thresholding and generated threshold value has been used with Sobel Operator. Matlab Programming is done at different Stages.**

Index Terms— **Edge Detection,Thresholding,Fuzzy Logic.**

I. Introduction

Edge detection is one of the most commonly used operations in image analysis. Edge detection refer to the method of identifying and locating sharp discontinuities in an image. The discontinuities are abrupt changes in pixel intensity that characterize boundaries of objects in a scene.. Edge detection is difficult in noisy pictures, since both the noise and the edges contain high frequency content. Attempts to reduce the noise result in blurred and distorted edges .There are large number of edge detection operators available ,each designed to be sensitive to certain types of edged. Variables involved in the selection of an edge detection operator includes edge orientation, noise environment and edge structure [1].

There are various well known edge detector operators such as Nalwa,Binford ,Canon which are working well and researchers have done extensive study on the performance of these operators by applying large number of real life images. A problem very commonly faced by the detectors is the choice of threshold values,which are often chosen on heuristic basis. Robert's,Prewitt's,Sobel's operators and zero-crossings edge detectors use threshold's which are generally selected without any precise objective guidelines. In the MATLAB'S version of Canny's edge detector the default value of the upper threshold is suggested to be 75 percentile of gradient strength[2].

Thresholding is basically used to convert grey scale images into binary images. Thresholding techniques can be approximately classified into six categories.Histogram shape-based methods, where, for example, the peaks, valleys and curvatures of the smoothed histogram are analyzed.In Clustering-based methods, where the gray-level samples are clustered in two parts as background and foreground (object), or alternately are modelled as a mixture of two Gaussians.Entropy-based methods result in algorithms that use the entropy of the foreground and background regions, the cross-entropy between the original and binarized image, etc.Object Attribute-based methods search a measure of similarity between the gray-level and the binarized images, such as fuzzy shape similarity, edge coincidence, etc.Spatial methods use higher-order probability distribution and/or correlation between pixels.Local methods adjust the threshold value on each pixel to the local image characteristics. The best is global threshold selection based on the gray scale histogram of the image[3].

Fuzzy Logic is an effective problem solving method with some definite logic.FL provides a simple way to arrive at definite conclusion based upon vague, ambiguous,imprecise,noisy or missing input information. The FL can be implemented in haedware,software or both[4].

This paper is organised as follows: Algorithm of automatic threshold using fuzzy logic, simulation and results and finally conclusion.

II. ALGORITHM OF AUTOMATIC THRESHOLDING USING FUZZY LOGIC

Fuzzy Logic based automatic edge threshoding technique is similar lines of method proposed by dong.et.al [5].We suggest further modifications in the method we discuss.

In this scheme we determine multiple edge thresholds for an in out image, where the image is divided into multiple groups based on intensity histogram of an image .For each group there will be different threshold and the threshold value which we have find will be applied to Sobel operator[6].

Step I: In step I in an image,clusters the pixels into groups where the pixel intensities of each group belong to the interval defined by the two consecutive strong valleys on the intensity histogram of the image. The convex hull algorithm is used to find peak and valleys from histogram of the image.

Step II:Using fuzzy reasoning process determine the edge thresholds for each pixels group.We have used three statistics of a pixel group in determining the inputs of fuzzy reasoning process:mode,mean of edge magnitude and pixel count.Mode is most repeated value in group.Pixel count is the number of pixels in a group.We normalized pixel count between 0 to 1before applying it into input of fuzzy system.

Manuscript received July 18, 2013
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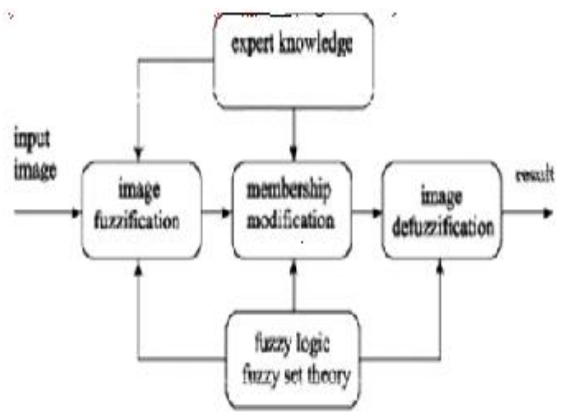

Fig 1 :Structure of Fuzzy Inference system

Step III:Apply these inputs of a group to FIS system. Fuzzy rule is comprised of18 rules. Membership function we used are experimentally chosen and denoted by “S”,”M”and “L” representing “small”, “medium” and “large”. Table 1 shows the fuzzy rule which comprises of three inputs and two outputs. The first input (mean) shows the strength of a meaningful intensity change in pixel group, second input (mode) indicates the level of prevailing small intensity change in pixel group and this input can estimate the underlying noise strength. The last input (pixel count of a group) takes effect only when it is very large or small.

Step IV: A crisp output β is determined using the output membership functions. According to the total number of pixels groups in an input image, we selectively use one of the two outputs in the rule:OUT1 and OUT2 .If the total number of pixel group is larger than 2,OUT 1 is chosen otherwise OUT 2.Because the total number of pixel groups in an image implies the degree of complexity in the scene, we set up the rule base such that OUT 2 has a higher threshold than that of OUT 1as shown in table 1and in the rule no.2 ,OUT 1 becomes “S” instead of “M” only when the first input (In 1) is smaller than the second input(In 2).Finally we adopt the MIN-MAX composition proposed by Mamdani to determine the support of composite input conditions for each rule and use centroid of area(COA) to produce a crisp output from the composition rules .Finally we determine the edge threshold using

For k=1~(number of group)

thr[k]=mode[k]+β[k]

where,

thr[k] is the threshold for k^{th} group

mode[k] is the mode of edge magnitude of k^{th} group.

β[k] is the fuzzy reasoning output for kth group.

III. Simulation Results

We have simulated the algorithm with MATLAB (2007Ra) for the greyscale images. In convex hull algorithm, we used duration threshold 20 empirically. We also restricted number of groups upto 4 using convex hull algorithm.We used FIS of fuzzy tool box for finding β value for each group threshold. We use fuzzy based automatic thresholding in Sobel method and observed its effect with automatic threshold value. We presented result for(256*256) with the input image for automatic thresholding and comparison of result with MATLAB version Sobel method without threshold is provided to see effect of automatic thresholding.

Fig 2(a) Input Image

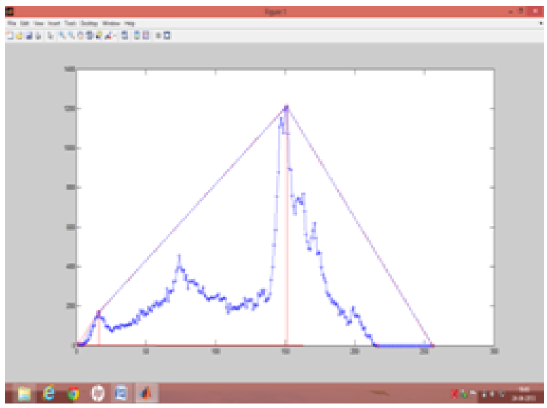

Fig 2(b) Grouping from range intensity histogram

Rule no	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
In 1	S	S	S	S	S	S	M	M	M	M	M	M	L	L	L	L	L	L
In 2	S	S	M	M	L	L	S	S	M	M	L	L	S	S	M	M	L	L
In 3	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L
OUT 1	M	M(S)	M	M	M	M	M	M	M	L	M	L	M	L	M	L	L	L
OUT 2	L	L	M	L	M	M	L	L	L	L	L	L	L	L	L	L	L	L

Table 1: Rule Base for Fuzzy Inference System

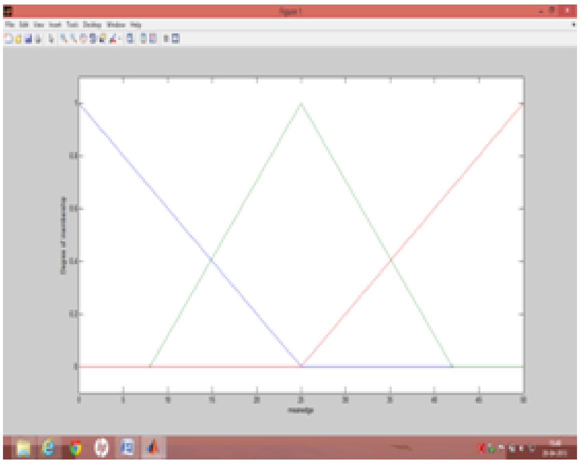

Fig 3(a)

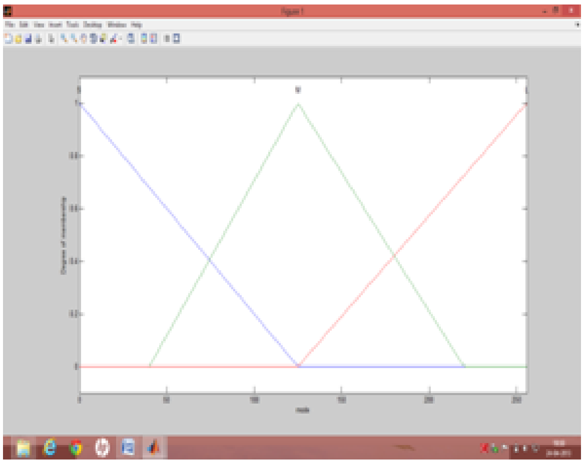

Fig 3(b)

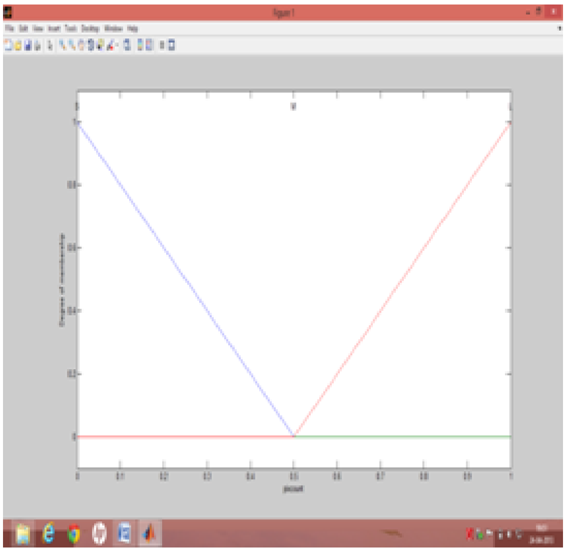

Fig 3(c)

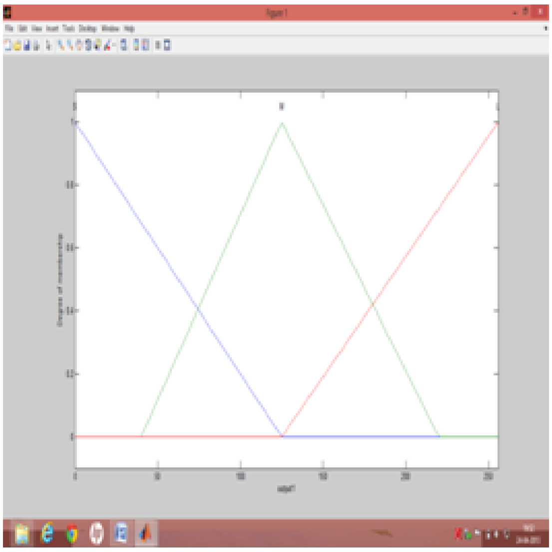

Fig 3 (d)

Fig 3: Membership function for (a) Mean of Edge Magnitude (b) Mode (c) Pixel Counts (d) Output

Fig 4(a)

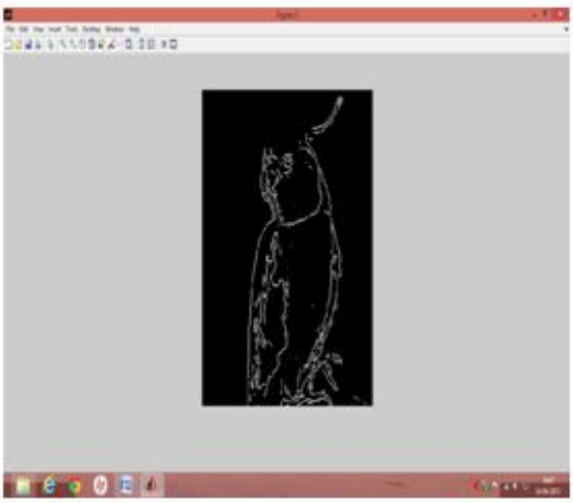

Fig 4(b)

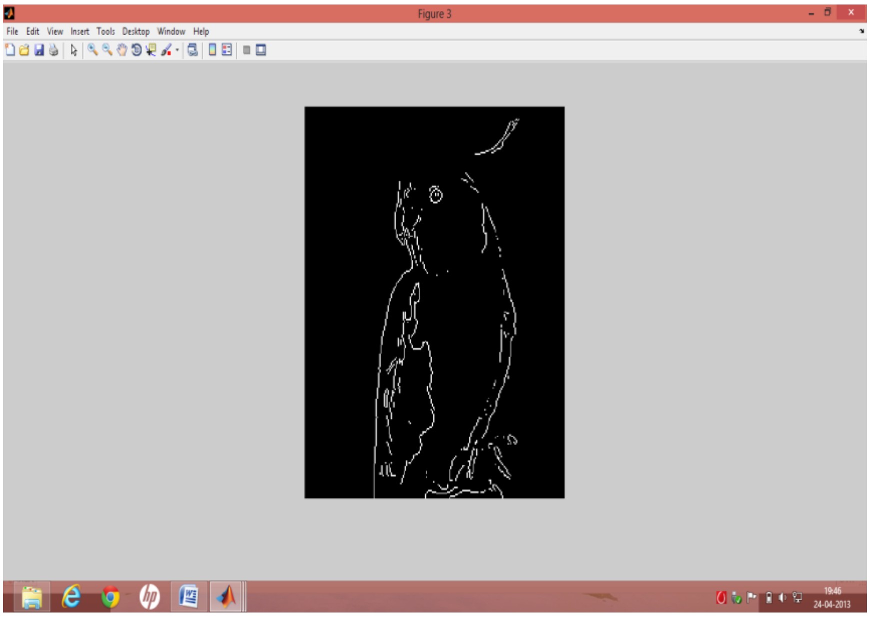

Fig 4: (a) Original Image (b) Edges using fuzzy based automatic thresholding (c) Edges using Sobel operator.

IV CONCLUSION

Edge detection is widely used these days in image processing and computer vision. Many edge detectors have been widely used .Because of the uncertainties that exist in many aspects of image processing, fuzzy processing is desirable. In this thesis work proposed algorithm shows that fuzzy based edge thresholding improves the edge image when the threshold value range assign to the Sobel operator using fuzzy rules. This algorithm is adaptable to various environments. The results show us there are some thick edges in the final image using this algorithm.

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