# Image Edge Detection based on Soft Computing Approach

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## ABSTRACT
Edge detection is one of the most important techniques used for image segmentation. Image segmentation remains a puzzled problem even after four decades of research. In this paper, a soft computing approach based on fuzzy logic is applied on histogram of an image to enhance edge detection technique. We used BSD images for experimentation and their respective ground truths for qualitative evaluation of proposed approach.

## General Terms
Image Processing, Segmentation, Experimental Results

## Keywords
Edge detection, Fuzzy Logic, Histogram, Ground Truth, BSD (Berkeley Segmentation Database)

## 1. INTRODUCTION
Image Segmentation process simplifies, further analysis of image by reducing the amount of data to be processed significantly, at the same time useful structural information of object boundaries is preserved. Edge detection is one of the important techniques used for image segmentation. It is a discontinuity based approach for segmentation of digital images. An Edge is a sudden change in the pixel intensity of t image, It contains the critical characteristics and important features of an image. An edge is a boundary between the object and its background. Edge detection is most common approach to detect discontinuity in an image. Many traditional edge detection methods such as Sobel, Prewitt, Kirsch and Robert have a major drawback of being very sensitive to noise. Canny proposed a method which is able to detect both strong and weak edges and seems to be more suitable to detect edges in noisy images. There are numerous applications of image segmentation like Remote sensing, Analysis of medical images, Industrial machine vision for product assembly and inspection, Automated target detection and tracking, Fingerprint recognition, Face Recognition, Astronomical study etc. As a result it remains an active area of research.

## 2. RELATED WORK
Research on image segmentation is currently conducted in three levels.1) Development of image segmentation algorithms.2) Evaluation of segmentation algorithms.3) Performance and study of evaluation methods. J Patel and *et al.* in [1] proposed an algorithm based on fuzzy systems and fuzzy rules. Using Sobel and Lapalacian approaches first edge values are computed and applied to fuzzy system. The approach reduces false edge detection and detection of multiple responses to a single edge.

An algorithm to detect continuous and smooth edges using particle swarm optimization was proposed by Mahdi Setayesh and *et al.* in [2].The result showed that the algorithm performs better and less sensitive to impulsive noise than Canny. The algorithm takes much longer time to execute when compared to Canny's approach. Abdallah A. Alshennawy, and Ayman A. Aly in [3] proposed a fuzzy logic technique for edge detection without determining the threshold value. The image is segmented into 3x3 binary matrix. The algorithm works well and gives line smoothness and straight for the straight lines, corners get sharper and less detection of double edges when compared to Sobel method. An approach for edge detection using independent component analysis is proposed by Kaustubha Mendhurwar and *et al.* in[4] The proposed approach works well under noisy conditions when compared with Canny .Song Wang and *et al.*[5]introduced an approach for evaluating edge detection by checking the likelihood of object boundaries from the detected edges. The performance evaluations show that the performance of Sobel, Log, and Canny is very similar. However the default parameters in these methods not best suited for boundary detection. The problem arises with traditional approaches and soft computing approaches applied on methods like (Canny, LOG, Sobel) gives better performance, on noisy images. But due to filtering on image, results in more blurring. Hence, smaller edges are not preserved and the actual edge location is shifted due to blurring operation. The comparative analysis of these algorithms is given in Table 1.

## 3. EDGE DETECTION USING IMAGE HISTOGRAM BASED ON FUZZY LOGIC
Fuzzy Logic based Edge Detection using histogram of an image is proposed in this paper. BSD color images are used for experimentation. The algorithm steps are as follows.

Step1: In Psychological terms, when humans view a color object, we tend to describe it by its hue, saturation and brightness. Keeping in mind these terms first RGB color image is converted into HSI image.

Step 2: The saturation component is removed from obtained HSI image and Histogram of image with hue and intensity is obtained.

Step 3: Fuzzy logic is applied on the obtained histogram, where peaks are taken as membership value 1. The other bars in the histogram having membership values greater than 0.8 and having difference between gray values less than 32 are added to the peaks to get a valley for segmentation.

Step 4: Finally a 4x1 operator in both horizontal and vertical directions is convolved with partially segmented image obtained in step 3 to get final output edged image.

**Table 1: Comparison of Methods**

| Sr No. | Source | Nature of Algorithm | Ground Truth Evaluation | Algorithms Compared | Performance Evaluation Parameter | Findings |
|---|---|---|---|---|---|---|
| 1 | J Patel and *et al.*, ICWET'11, ACM 2011. | Fuzzy Logic using Sobel and LOG. | No | LOG, Sobel | None | Reduces false edge detection |
| 2 | Mendhurwar and *et al.*, Eurasip journal ISRN Signal processing.2011 | Edge detection in noisy images using independent component analysis. | No | Canny | PSNR | Robust to noise, |
| 3 | Abdallah A. Alshennawy, and Ayman A. Aly, 2009. | Fuzzy logic on 8 neighborhood pixels. | No | Sobel | None | Straight edges, corner gets sharper. |
| 4 | Setayesh and *et al.* ACM 2011. | Particle swarm optimization. | No | Canny | PSNR | Computationally expensive. |

## 4. EXPERIMENTAL RESULTS, CONCLUSION AND FUTURE SCOPE.

We simulated algorithm using MATLAB 7.11 (R2010b). Experimental results are shown in figure 1 and figure 2. BSD images and respective ground truths are used for qualitative comparison of algorithms. Generally real images comprises of both strong and weak edges. The proposed method gives both strong and weak edges having different thresholds. In future, comparison with other methods can be checked.


**Figure 1: Column (a) Original BSD image, Column (b) Ground truth, Column (c) Proposed approach**

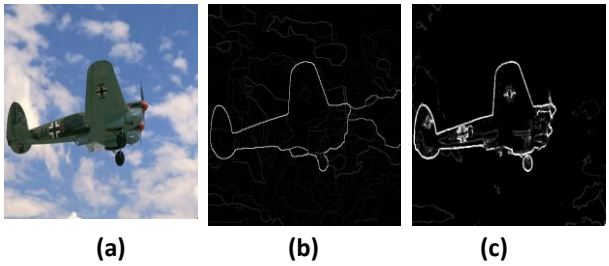


**Figure 2: Column (a) Original BSD image, Column (b) Ground truth, Column (c) Proposed approach**

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