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Efficient and Simplified Adaptive Neuro Fuzzy Based Edge Detection for Digital Image Processing Using Anfis for Edge Strength

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Abstract

Edge detection in digital imaging processing is based on boundary characterization by parameters of strong intensity contrast .The important structured properties of the image have to be preserved by reducing useless information .Adaptive neural fuzzy information system can be used for making edge detection to test various images with varying properties .Fuzzy logic takes care of impreciseness where as neural techniques with adaptive training gives better results compared with Sobel or Robert type. In this paper, image content is utilized for application specific images based on Adaptive Neuro Fuzzy techniques suitable for optimization by training. The outputs of various cases have been compared to show the greater efficiency of ANFIS system over the conventional techniques.

Key Words: Edge detection, fuzzy logic, sobel operator, prewitt operator, canny operator, ANFIS.

1. Introduction

Several methods based on gradient are basically meant for measuring some local changes in the gray value such that a pixel is considered to be an edge pixel for substantial changes. The difficulty with those is that minimum value of change of intensity is always a point of controversy [1] [2] .It is expedient to compute the edge strength of each pixel on the premise of intensity gradient .In other words, edge strength is a measure of the prospect of a pixel being declared as edge pixel.

2. Literature Survey

In specific system the inputs to fuzzy inference system are determined by passing the image those high pass filters [3] [4]. Sobel operator and mean filter. The fuzzy rules are suited for the types of filters used .In another case [5]. ANFIS is used so that internal parameters are optimized by training as per artificial images. In some cases fuzzy logic based edge detection has been be without threshold [6] [7].

The proposed method involves a) evaluation of edge strength b) determination of threshold by multipreception classifier /SVM c) optimization through training arrangements.

3. Methodology

For generating scaled values form SVM classifier, a method was adopted in which the associated output value approaches one. Authenticated images were labeled 1 and others were named O. For neural fuzzy operate system input membership functions were consider Gaussian.The output membership is taken as linear.Final results were classified using threshold and the decision was taken when the point is above 0.5 for Authentication.

The basic principle is to compute the intensity pattern at every pixel and marking those pixels as “edge pixels” depending on high gradient of intense .Fuzzy rules are applied to determine if the edge strength is high or low. Let Ix and Iy be intensity gradients in horizontal and vertical direction. A fuzzy inference system can be applied to assess the limit up to which the pixel is related to a true edge of the image.

Edge pixels can be discriminated by determine the local change of intensity after application of threshold. First derivative of the image function can be used for identification .For two dimensional case, intensity function u(x,y) can be described a gradient function [7].

$$\frac{\partial u}{\partial x} = I_x, \frac{\partial u}{\partial y} = I_y \tag{1}$$

The value of edge strength at pixel can be estimated by Qx and Qy through fuzzy inference. Digital gradients are corrupted by gradient operators having two masks a) horizontal b) vertical .In this purpose method edge strength calculated is done by deductive fuzzy rules.

If horizontal gradient is low & vertical gradient is low the edge strength is low

If horizontal gradient is low & vertical gradient is low the edge strength is medium

If horizontal gradient is high & vertical gradient is low the edge strength is medium

If horizontal gradient is high & vertical gradient is low the edge strength is high

Using mamdani's techniques centroid defuzzification, edge strength can be calculated from the intensity gradients.

4. Threshold Determination (Neuro Technique)

This is done by neuro classifier techniques .Threshold is required to differential edge pixels from non edge pixels .Higher values of the may result in misdetection where as lose value my give false detection. The problem is reduced to image binariration through 2–class pattern classification which selects.

5. Threshold

Multilayer perception is a classification method suitable for distinguish edge & non edge pixels. Contrasted single perception network, multilayer neural networks can be used to learn non linearly separable data [8].

In the input lager ,each neuron represents a feature size of the input layer is directly related to dimension of data .The hidden layer gives the nonlinearity by nonlinear activation function selection of the hidden layer is adjusted (or increased) result no further improvement is found .Each output neuron repreruts one class. For our paper, the selection can be optimized with 8 users in the input layers .The hidden layers has 10 neurons for optimized proposed. The output is one only neuron which is 1 or 0 depends on edge on non edge pixel.

Reducing would increase scientist of the edge detection at the expense of noise tolerance.$\alpha = 3$ or 4. Results in acceptable compresses between seusitity & resistance.

6. Pixel Feature

The pixel features are determine by compare the pixels features with neighbor pixels .By extracting 3x3 matrix of neighbor pixels ,can be adapted for this purpose .Odd numbers 5x5 ,7x7 are also useful. The neighbor pixels are [x-1, y-1] [x+1,y+1] features can be variances ,entropy ,gradient ,busyness of each pixel. These are used for determine edge non edge pixel of the image .For example, in case of grayscale imaging, the value of the function various form 1 to 255.

$$\text{Variance: Mean}\mu(x,y) = \frac{1}{9}\sum\{f(xf_i),(y+j)\} \quad (2)$$

Low variance = small variation in grayer pixel with high variances is fit to be edge pixel.

$$\text{Variance} = \frac{1}{9}\sum[f(x+i,y+i) - \mu(x,y)]^2 \quad (3)$$

Entropy

Smaller entropy = higher is the information gain & rate of change in the intensity is .Pixel with big local entropy is likely to be edge pixel.

$$\text{Entropy} \quad (x,y) = \sum\sum p_{ij}\log p_{ij}$$

$$p_{ij} = f(x,y)\sum\sum f(i,j) \quad (4)$$

SVM classifier

$$s(t) = \frac{1}{1 + e^{\alpha+\beta}} \quad (5)$$

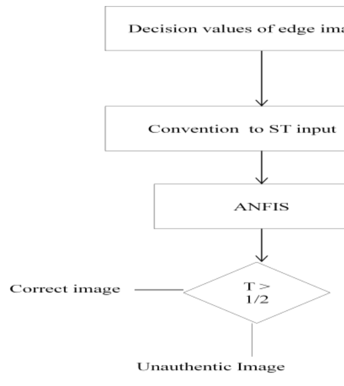


Figure 1: Flow Chart of Edge Detection to ANFIS

T is the decision value of the following signal function generated

POS TRUE: Detected as copy, really duplicate

POS FALSE: Detected as correct, really duplicate

NEG TRUE: True, really true

NEG FALSE: Detected as duplicate, actually correct

$$s = \frac{PT}{PT + NF} \tag{6}$$

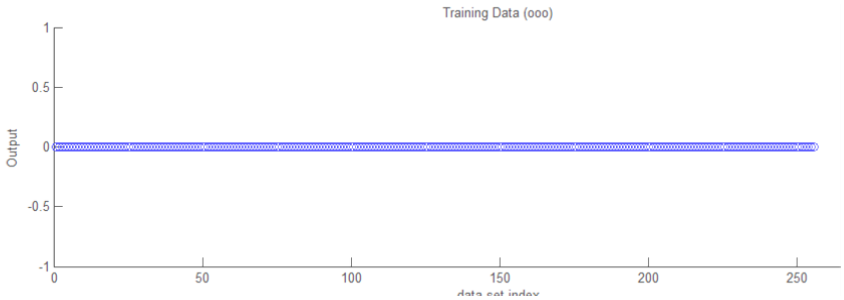
7. Simulation Results

Comparison of MSE shows that in case of the ANFIS method, it is the lowest. Due to heavy density the proposed edge detector if found to be more efficient for Gaussian noise ANFIS has 0.4215 MSE whereas Sobel detector may have around 0.52.The performance of Sobel and Roberts is a function of threshold and has high chance of misdetection. Due to edge strength computation and optimization of threshold this dependence is eliminated. Canny method has similar failures. Prewitt type has defects of thin edges. In the proposed method, chance of misdetection is higher when threshold is higher.

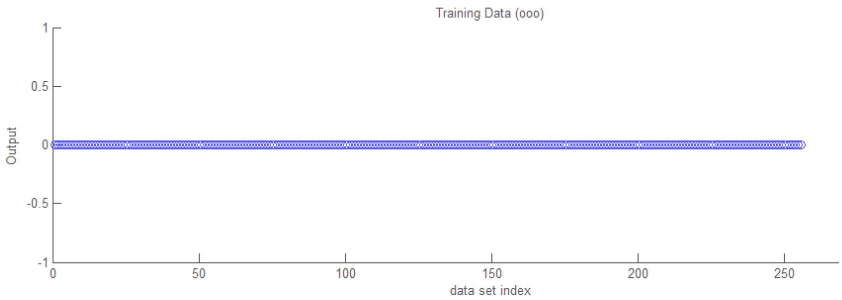
Figure 2: Compring with Original Image

Average performance measures

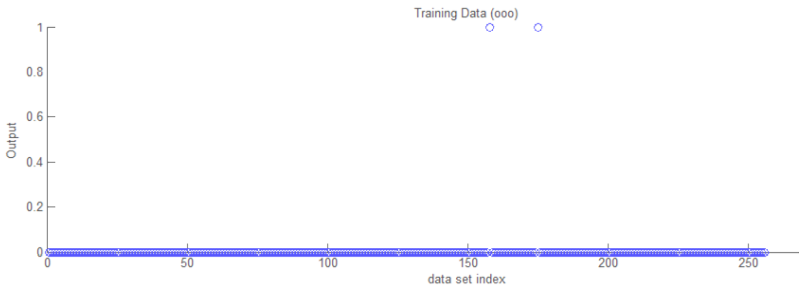
	Sample 1	Sample 2
Sobel	0.20	0.18
Canny	0.10	0.12
Proposed	0.23	0.29



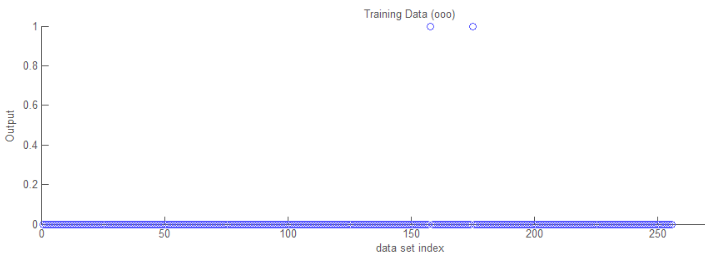
Canny with ANN



Robert with ANN



Sobel with ANN



Prewitt with ANN

Figure 3: Comparing with Edge Detection Methods vs Artificial Neural Networks

8. Conclusion

Considering a tradeoff between two objects sensitivity and specifics, bench mark is set for gray scale images. Decreasing number of features has the positive effect on runtime. By deep learning neural networks further improvement is possible. The proposed method has been compared with adaptive threshold to fixed threshold values .Classified edge detection have been compared .Performance of Sobel & Robert is dependent on the threshold and shows misdetection at lower threshold values. This is taken care by edge strength estimation; optimal threshold in the proper method .Canny classical edge detector has best performance in compassion with classical methods. Canny method is dependent on the value of threshold selected .In the proposed method, true edge is approximately detected by authentic threshold. It is observed that when fixed values of thresholds are used, there is more probability of miss detection for high value of threshold .Similarly more false indication is there for value of threshold .Selection of optimal threshold helps better edge detection by ANFIS. Spectral estimation technique offers good resolution; modified covariance overcomes and minimizes the sum of squares of the forward prediction errors and also the backward prediction errors without applying the windowing techniques to the data. These characteristics of signal make modified covariance method more efficient. SNR is improved by this method and reducing the noise using the FIR band pass filter and can obtain the desired seismic data.

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