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Analysis of Edge Detection Techniques for Image Segmentation using Neural networks

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Abstract

Neural network edge detection is associate rising field that consists of complementary parts of fuzzy logic, neural computing and biological process computation. Neural network edge detection techniques have found wide applications. One among the foremost necessary applications is edge detection for image segmentation. The method of partitioning a digital image into multiple regions or sets of pixels is termed image segmentation. Edge could be a boundary between 2 consistent regions. Edge detection refers to the method of characteristic and locating sharp discontinuities in an image. During this paper, the main aim is to survey the idea of edge detection for image segmentation exploitation neural network supported the fuzzy logic, Genetic algorithmic rule and Neural Network. Similar to an individual's observer, an automatic image vision system is ready to recognize most components of associate object if the system may accurately trace and reflect its true form. This has prompted the event of the various edge detection techniques. Neural networks are with success applied to edge detection. However, there is a good necessity to investigate neural network models thus on reach close insight into their internal practicality. During this paper an effort is formed to review the performance of most typically used edge detection techniques for image segmentation associated additionally the comparison of those techniques is carried out with an experiment by exploitation MATLAB software package

1. Introduction

Image segmentation normally is outlined as a method of partitioning an image into same groups such every region is same however the union of no 2 adjacent regions is same. Economical image segmentation is one among the foremost important tasks in automatic image process. Image segmentation has been understood otherwise for various applications. Segmentation acts because the beginning to supply description of the image. Segmentation divides the spatial domain into significant elements or regions. Most of the segmentation algorithms use psychotic physical approaches for region identification. As in standard images a general rule is not appropriate for document image segmentation. Some document image is also of pure text. Some document image is also a mix of text and images. Some might consists of images, sketches etc. certain document is also of written text and photos. Thanks to this drawback the whole segmentation algorithms works on ad hoc basis. The new rule introduced here identifies the uniform property of lines of text like uniform spacing of lines, words etc. once a photograph happens within the text, the boundary of the photograph is fixed by detecting edge and rectangular region within the text.

In order to phase the document image, it is necessary to classify the patterns within the document image. Completely different approaches of pattern classification are by exploitation Polynomial classifier (PC), Multilayer Perceptron (MLP), Radial Basis perform, Nearest Neighbor classifier (NNC). There are analysis results associated with internal and external character segmentation ways for character segmentation. Soft computing could be a term coined by Zadeh, that is essentially a synergistic integration of 3 computing paradigms- neural networks, formal logic and probabilistic reasoning to supply a frame work for flexible information science, applications designed to work within the globe. Bezdek referred to as the synergizing of fuzzy logic, neural networks and genetic algorithms as machine intelligence.

Edge detection is the most acquainted approach for detecting important discontinuities in intensity values. There are 3 differing kinds of discontinuities within the gray level like purpose, line and edges. Spatial masks are used to notice all the 3 kinds of

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discontinuities in an image. There are many various approaches of Edge Detection the foremost normally used separation based edge detection approaches are reviewed during this section as shown "figure.1"

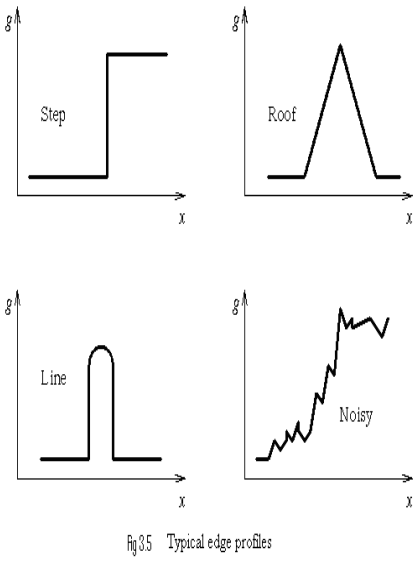

Fig 8.5 Typical edge profiles

Figure.1. Type of Edges (a) Step Edge(b) Ramp Edge (c) Line Edge (d) Roof Edge

Since edges encompass in the main high frequencies, we can, in theory, notice edges by applying a high pass frequency filter within the Fourier domain or by convolving the image with an applicable kernel within the spatial domain. In follow, edge detection is performed within the spatial domain, as a result of it is computationally less costly and infrequently yields higher results.

The purpose of image segmentation is to partition an image into significant regions with reference to a selected application. The segmentation is based on measurements taken from the image and could be gray level, color, texture, depth or motion .Usually image segmentation is an initial and very important step during a series of processes aimed toward overall image understanding the form of the image are often distinguished in "Figure 2"

Applications of image segmentation include

1. Identifying objects in a scene for object-based measurements such as size and shape

2. Identifying objects in a moving scene for *object-based video compression (MPEG4)*

2.1 Steps in Edge Detection

1. Noise reduction, wherever we try and suppress the maximum amount noise as attainable, while not smoothing away the meaningful edges.

2. Edge improvement, Emphasize pixels having vital modification in native intensity wherever we tend to apply some reasonably filter that responds powerfully at edges and debile elsewhere, so the edges is also known as native maxima within the filter's output . One suggestion is to use some reasonably high pass filter.

3. Edge localization, find the sting accurately, estimate edge orientation wherever we tend to decide that of the native maxima output by the filter are meaning edges and that are caused by noise

4. Filtering, Filter image to boost performance of the sting Detector w.r.t noise

5. Detection, establish edges - thresholding

2.2 different Approaches of Edge Detection

Five most often used edge detection strategies are used for comparison. These are 1) Gradient edge detection 2) Robert's Edge Detection 3) Sobel Edge Detection 4)Prewitt Edge Detection 5)Canny's Edge Detection the details of strategies as follows,

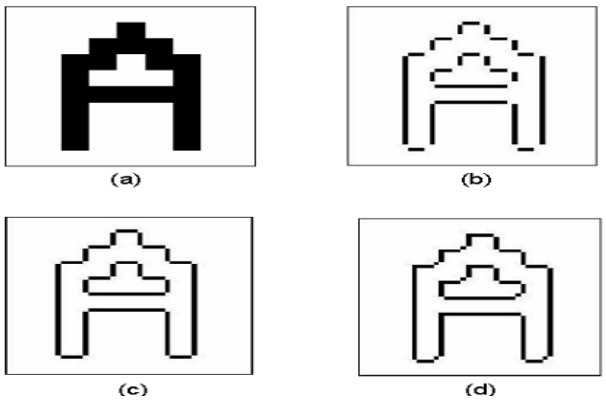

Figure.2. The comparison of the edge detections for the example image. (a) Original Image (b) Prewitt Edge Detection (c) Roberts Edge Detection (d) Sobel Edge Detection

1 .Gradient edge detection:

Gradient edge detection is the second and more widely used technique. Here, the image is convolved with only two kernels, one estimating the gradient in

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the *x*-direction, *gx*, the other the gradient in the *y*-direction, *gy*. A changes of the image function are based on the estimation of **gray level gradient** at a pixel.

The gradient is the two-dimensional equivalent of the first derivative and is defined as the gradient vector.

$$g_x = f(x+1)-f(x) \quad g_y = f(x,y+1)-f(x,y) \quad (1)$$

$$g_x(x,y) \approx f(x+1,y)-f(x-1,y)$$
$$g_y(x,y) \approx f(x,y+1)-f(x,y-1) \quad \ldots\ldots\ldots\ldots \quad (2)$$

$$\nabla f(x,y) = g = \begin{bmatrix} g_x \\ g_y \end{bmatrix} \quad \ldots\ldots\ldots\ldots\ldots \quad (4)$$

The two gradients (in *x* and in *y* direction) computed at each pixel by Equation (1) or Eq. (2) can be regarded as the *x* and *y* components of a gradient vector Eq.(4) as shown "Figure.4"

2. Robert edge detection:

A simple approximation to the first derivative Marks edge points only; does not return any information about the edge orientation. The simplest of the edge detection operator and will work best with binary image. Roberts operator has missed a few edges. The primary disadvantage of the Roberts operator is its high sensitivity to noise, because very few pixels are used to approximate the gradient The calculation of the gradient magnitude and gradient magnitude of an image is obtained by the partial derivatives,

$$\frac{\partial f}{\partial x} \text{ and } \frac{\partial f}{\partial y}$$

at every pixel location. The simplest way to implement the first order partial derivative is by using the Roberts cross gradient operator. The Roberts operator masks are shown below "Figure.3"

Gx =

1	0
0	-1

Gy =

0	-1
1	0

Figure.3. Robert Mask

3. Sobel Edge Detector:

The Sobel operator performs a 2-D spatial gradient measurement on an image and so emphasizes regions of **high spatial frequency** that correspond to edges. Typically it is used to find the approximate absolute gradient magnitude at each point in an input grayscale image. The Sobel edge detector is very much similar to the Prewitt edge detector. The difference between the both is that the weight of the center coefficient is 2 in the Sobel operator. The Sobel operator performs a 2-D spatial gradient measurement on an image. Then, the approximate absolute gradient magnitude (edge strength) at each point can be found. The Sobel operator is more sensitive to diagonal edges than vertical and horizontal edges. The Sobel operator uses a pair of 3x3 convolution masks, one estimating the gradient in the x-direction (columns) and the other estimating the gradient in the y-direction (rows). A convolution mask is usually much smaller than the actual image. The actual Sobel masks are shown below "Figure.4", "Figure 2"shows the comparison of the edge detections for the example image.

G_x=

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

G_y=

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

Figure.4. Sobel Mask

4. Prewitt edge detector:

The Prewitt edge detector is a much better operator than the Roberts operator. This operator having a 3x3 masks deals better with the effect of noise. The Prewitt edge detection masks are one of the oldest and best understood methods of detecting edges in images. Basically, there are two masks, one for detecting image derivatives in X and one for detecting image derivatives in Y. This Prewitt operator is obtained by setting c = 1. Various kernels can be used for this operation; for the following discussion we will use the Prewitt kernel. Two templates out of the set of *8*are shown below "Figure.5".

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G_x =

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

G_y =

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

Figure.5. Prewitt Mask

5. Canny Edge Detector:

The canny detector (canny [1986]) is the most powerful edge detector provided by function edge. The method can be summarized as follows:

1. The image is smoothed using a Gaussian filter with a specified standard deviation, σ, to reduce noise.
2. The local gradient, $g(x, y) = [G^2_x+G^2_y]^{1/2}$, and edge direction, $\sigma(x,y)=\tan^{-1}(G_y/G_x)$, are computed at each point. Any of the first three techniques. Can be used to compute G_x and G_y. An edge point is defined to be a point whose strength is locally maximum in the direction of the gradient.
3. The edge points give rise to ridges in the gradient magnitude image. The algorithm then tracks along the top of these ridges and sets to zeros all pixels that are not actually on the ridge top so as to give a thin line in the output, a process known as non maximal suppression. The ridge pixels are then thresholding using two thresholds, T1 and T2, with T1<T2. Ridge pixels with values greater than T2 are side to be "strong" edge pixels. Ridge pixels with values between T1 and T2 are side to be "weak" edge pixels.
4. Finally, the algorithm performs edge linking by incorporating the weak pixels that are 8-connected to the strong pixels.

3. Analysis Neural networks Approach

NNs are designed to simulate the manner a straightforward biological system is believed to control. Biological neural networks are the native assemblages of neurons and their nerve fiber connections that kind the (human) brain. They are supported simulated nerve cells or neurons, that area unit joined along during a type of ways in which to make networks. These networks have the capability to find out, memories and make relationships amongst information. There are unit types of styles of NNs however some area unit a lot of in style than others. The foremost widely used NN is thought because the feed forward Back Propagation NNs. this kind of NN uses supervised learning once remodeling input vectors into output vectors and is superb at e.g. pattern recognition. Another style of NN is that the Kohonen or self-organizing network that is wonderful at finding relationships amongst complicated sets of knowledge area unit shown below "Figure.6"

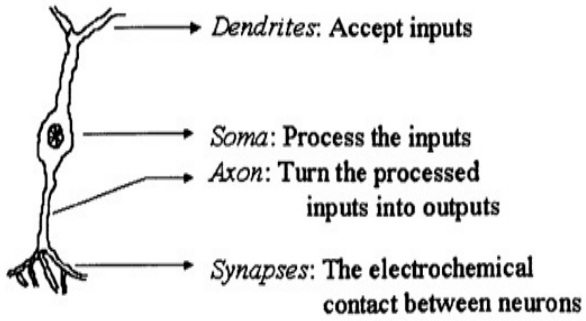

Figure.6.Four parts of a typical nerve cell

3.1 Learning NNs

Analogous to neurons within the brain the network during a sense learns from examples or by experience even as individuals do. Neural networks use a collection of nodes (processing elements) that are generally described as connectionist systems, due to the connections between individual process nodes. generally the NNs is named as reconciling system or machine learning rule, as a result of changing of its association (training NNs) weights would create the system acquire new information every association between the neurons is keep as a weight-value or strength for the particular association. Therefore, for the network to find out the answer to a given downside, the values of those connections will modification so the neural network performs additional effectively. NNs also are known as parallel-distributed process systems, are shown below "figure.7" that offer stress to the approach during which the numerous nodes or neurons in a very neural network operate in parallel

The Neural networks models differ greatly. The association topologies, process component capabilities and also the associated learning algorithms differ from one neural network model to a different. Supervised and unsupervised learning area unit the 2 main varieties of learning algorithms. In supervised learning, the specified outputs or target values are glorious and are given to the NN throughout coaching once training, the NN is tested

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by giving it solely input values, not target values, and seeing however shut it is to outputting the proper target values. In unsupervised learning the NN needs solely the input vectors (target values aren't provided), that area unit classified into distinct regions supported regularities and correlations.

3.2 Neural Networks in Edge Detection

A machine vision system usually deals with the process of digital images that include a matrix of pixels representing intensities of assorted positions. The main goal of this process is to supply image improvement for human understanding. This task is achieved by variety of steps. The initial step is the segmentation of the image into meaningful objects. Edge extraction is sometimes the beginning step in segmentation as a result of it effectively detects the bounds of the objects. These limits are normally referred to as "edges". Moreover, edge extraction is used largely in image recognition, classification or an interpretation procedure as a result of it provides a compressed quantity of knowledge for of information. The success of an image recognition procedure is related to the standard of the edges marked. Neural networks are with success applied to edge detection and image segmentation, this is as a result of their ability to handle incomplete or corrupted sets of information. Researches in neural networks edge detection have unconcealed the effectiveness of this technique once applied to real and/or artificial images. During this section, we tend to are primarily reviewing the existing neural networks edge detection analysis. However, there is a good necessity to research neural network models therefore as to achieve close insight into their internal functionality. to the present purpose, new and general training sets, consisting of a restricted range of prototype edge patterns, are proposed to research the problem of neural network edge detection. Neural network edge detector NNED has been applied to find sharp edge patterns in noisy artificial lesion images. it is interesting to say here that the previous add neural network edge detection. The images utilized in these studies were either artificial images (primarily created from totally different edge strengths and orientations) or real images.

One of the aims of this thesis is to research the application of neural network edge detection (NNED) to real and artificial noisy images. However, the NNED classification between edges and noise patterns is a crucial issue particularly for the case of terribly noisy images. in this case, the inputs to the NNED are the initial noisy patterns, and if we tend to conjointly considering that there are no preprocessing steps that are used like noise filtering operations that occur in non-neural network algorithms. Then exploitation the NNED are going to be advantageous to scale back the number of image process needed and to reduce the execution time. In below “figure.9”, the NNED methodology is taken into account in additional detail

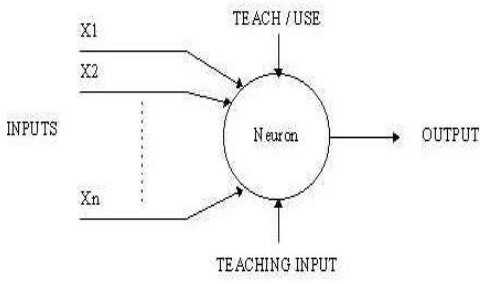

Figure.7. An artificial neuron with n inputs and one output

4. Fuzzy based Approach

There are different ways for development of fuzzy logic based edge detections. One method is to define a membership function indicating the degree of pixel in each neighbourhood. This approach can only be regarded as a true values fuzzy approach if fuzzy concepts are additionally used to modify the membership values. The membership function is determined heuristically as shown “figure.8”.

$$\mu_{Edge}\big(g(x,y)\big)=1-\frac{1}{1+\frac{\sum_N \| g(x,y)-g(i,j)\|}{\Delta}}$$

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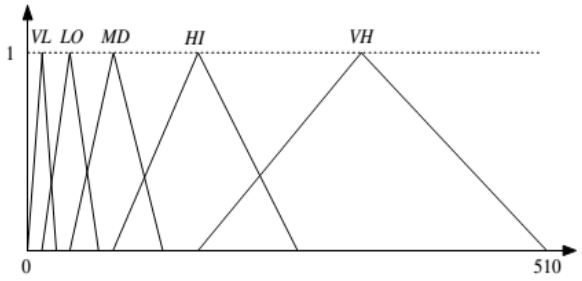


Fig.8.Membership functions

Using Fuzzy set theory defines fuzzy operators on fuzzy sets. The problem in applying this is that the appropriate fuzzy operator may not be known. For this reason, fuzzy logic usually uses IF-THEN rules, or constructs that are equivalent, such as fuzzy associative matrices

An edge is a boundary between two uniform regions. You can detect an edge by comparing the intensity of neighboring pixels. However, because uniform regions are not crisply defined, small intensity differences between two neighboring pixels do not always represent an edge. Instead, the intensity difference might represent a shading effect.

Fuzzy logic, based on fuzzy sets provides a formal and structured way to convert these rules into a control scheme. Fuzzy logic is a superset of Boolean logic. In Boolean logic something can be '1' ("hot") or '0' ("not hot"). In fuzzy logic a fuzzy bit can assume any value, called *degree of membership*, between '0'and '1'. Input membership functions are shown in “Figure.9”.

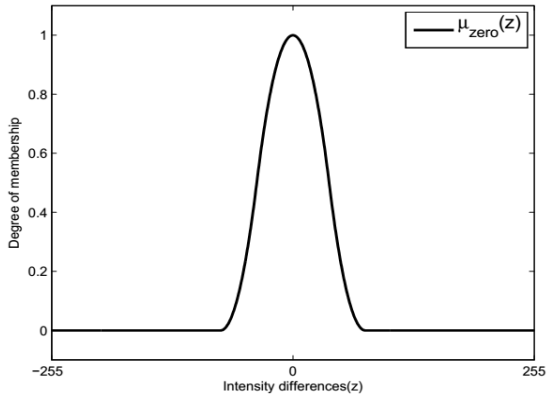


Figure.9. Input membership functions

The fuzzy logic approach for image processing allows you to use membership functions to define the degree to which a pixel belongs to an edge or a uniform region. The fuzzy logic edge-detection algorithm for the image gradient to locate breaks in uniform regions. Calculate the image gradient along the *x*-axis and *y*-axis.

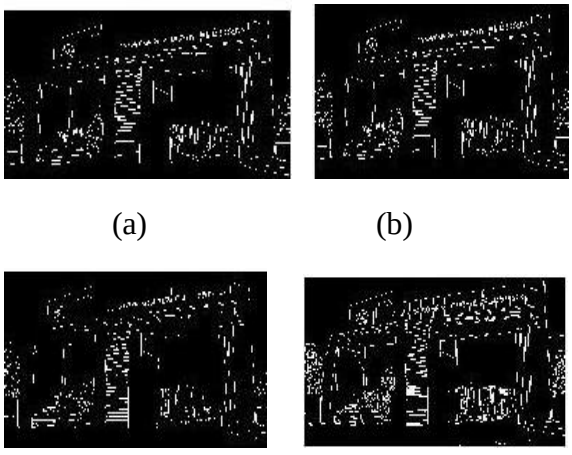
4.1 Fuzzy Inference System (FIS) for Edge Detection

You detected the edges in an image using a FIS, comparing the gradient of every pixel in the *x* and *y* directions. If the gradient for a pixel is not zero, then the pixel belongs to an edge (black). You defined the gradient as zero using Gaussian membership functions for your FIS inputs.

Comparison of Edge Detection Methods

Figure 10 and 11 shows the comparison of the five edge detection methods for the image of JNTUP University. Since different edge detections work better under different conditions and shows the comparison of the four edge detection Edge Methods based on Gradient image of Lena are shown “Figure.12”

Fig.10.Original Image



(a) (b)

(c) (d)

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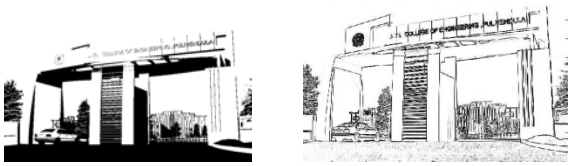

(e) (f)

Figure.11.Edge Detection Methods. (a)Prewitt Method (b)Sobel Method (c)Roberts Method (e) Neural Network Method (f) fuzzy method

(a)

(b)

(c)

(d)

Fig.12. Based on Gradient edge detection Edge Methods. (a)Method (b) Sobel Method (c) Roberts Method (d) Canny Method

5. Conclusions

This paper mainly focuses on the study of Analysis Neural networks Approach to edge detection for image segmentation. , fuzzy based approach is applied on a real life example image of nature scene and the results show the efficiency of image segmentation.

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