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EDGE DETECTION USING FUZZY LOGIC

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Abstract

A rule based fuzzy-approach system based on the concept of fuzzy logic is applied to the curve partition point detection and segment classification processing. The concepts of curve partitioning and grouping as observed in the human visual perceptive process is used for edge classification. In this project, a set of fuzzy rules, membership functions, and algorithms for curve partition point detecting, curve classifying and grouping are developed and implemented. With these niles, the system is capable of detecting the curve partition point and accurate classifying of the edges into a predefined set of line and curve types.

Keywords- Fuzzy logic, Fuzzy interference system, Edge detection, SOBEL, CANNY OPERATOR.

1. Introduction-

1.1 Edge detection

In digital image, the edge is a collection of the pixels whose gray value has a step or roof change, and it also refers to the part where the brightness of the image local area changes significantly. The gray profile in this region can generally be seen as a step. That is, in a small buffer area, a gray value rapidly changes to another whose gray value is largely different with it. Edge widely exists between objects and backgrounds, objects and objects, primitives and primitives. The edge of an object is reflected in the discontinuity of the gray.

Therefore, the general method of edge detection is to study the changes of a single image pixel in a gray area, use the variation of the edge neighbouring first order or second-order to detect the edge. This method is used to refer as local operator edge detection method. An edge is boundary between two regions is shown in figure 1(a) which shows light stripes on a dark background and 1(b) which shows the dark stripes on light background.

Fig. 1(a)

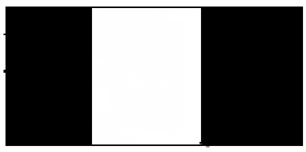
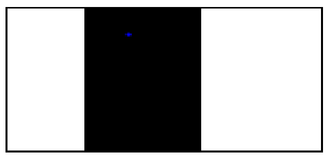


Fig.1 (b) - This figure shows the opposite of fig 1(a).



1.2 Introduction to all operators-

1.2.1 Sobel operator

SOBEL operator consists of a pair of 3*3 convolution kernel. One kernel is simply the other related by 90 degree. There is a one kernel for each of the two perpendicular situations like vertically and horizontally relative to pixel grid.

1.2.2 Robert operator

The Roberts Cross operator performs a simple, 2-D spatial gradient measurement on an image. Pixel values at each point in the output represent the estimated absolute magnitude of the spatial gradient of the input image at that point. The operator consists of a pair of 2×2 convolution kernels.

1.2.3 Prewitt operator

Prewitt operator is similar to the SOBEL operator and is used for detecting vertical and horizontal edges in images.

1.2.4 Laplacian of Gaussian operator

This is 2-D Isotropic measure of second spatial derivative of an image. The region of Rapid intensity change is given by LAPLACIAN so it is used to detect the edges. It is used to reduce the noise. It uses Gaussian smoothing filter in order to reduce the noise. This operator takes a single gray level image as input and produces another gray level image as output.

1.2.5 Canny operator

The Canny Edge Detector is one of the most commonly used image processing tools, detecting edges in a very robust manner. It is a multi-step process, which can be implemented on the GPU as a sequence of filters. Traditional operators like SOBEL, ROBERT,PREWITT, LAPLACIAN OF GAUSSIAN are widely used but most of these are very sensitive to noise and do not give satisfactory results. Canny operator removes all these problems but it does not give the good result in varying contrast areas. A Fuzzy logic edge detector avoids all these problems.

2. A Brief review on Fuzzy logic

2.1 Introduction

Fuzzy logic was first introduced in the 1965 as a new way to represent vagueness in everyday life. The definition of fuzzy logic as a superset of conventional (Boolean) logic that has been extended to handle the concept of partial time values between "completely true" and "completely false" By this definition, fuzzy logic departs from classical two-valued set logic. It uses soft linguistic system variables and a continuous range of true values in the interval [O, 1], rather than strict binary values. It is basically a multivalued logic that allows intermediate values to be defined between conventional evaluations like yes/no, true/false, etc. Fuzzy logic is also a structured, model-free estimator that approximates a function through linguistic input/output associations. Fuzzy logic is a powerful, yet straight forward, problem solving technique with wide spread applicability, special in the areas of control and decision making

2.2 Fuzzy logic has many applications such as:

- Control system (Robotics, Automation, Tracking, consumer Electronics).
- Information systems (DBMS, Information Retrieval).
- Pattern recognition (Image Processing, Machine Vision).
- Decision support (Adaptive HMI, Sensor Fusion).

2.3 Structure of Fuzzy Image Processing

Fuzzy image processing is not a unique theory. Fuzzy image processing is the collection of all approaches that understand, represent and process the images, their segments and features as fuzzy sets. The representation and processing depend on the selected fuzzy technique and on the problem to be solved. Fuzzy image processing has three main stages: image fuzzification modification of membership values, and, if necessary, image defuzzification is shown in figure 2.3(a). The fuzzification and defuzzification steps are due to non availability fuzzy hardware. Therefore, the coding of image data and decoding of the results are steps that make possible to process images with fuzzy techniques. The main power of fuzzy image processing is in the middle step i.e. modification of membership values.

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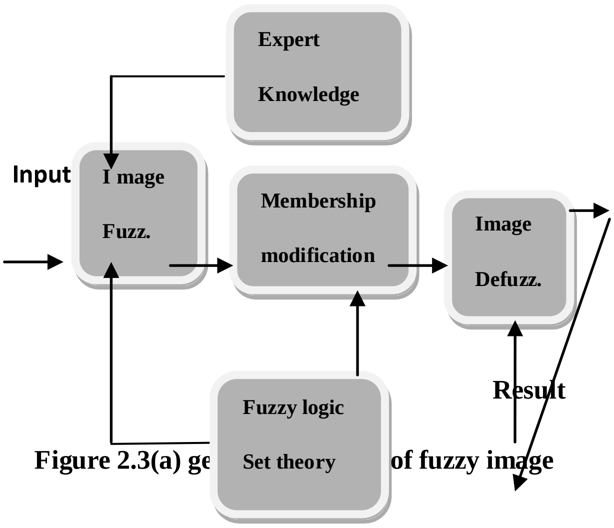
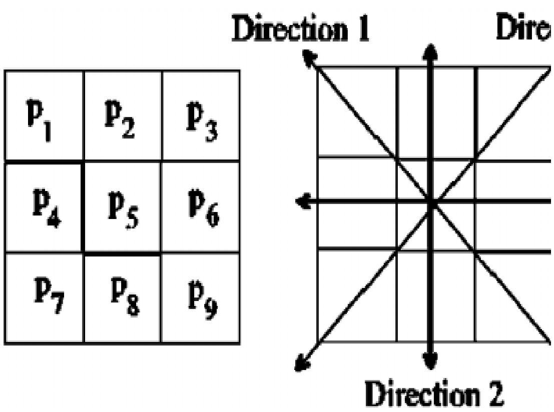


Figure 2.3(a) ge of fuzzy image

3. Fuzzy logic Algorithm

For edge detection a set of nine pixels, part of a 3x3 or 5x5 window of an image to a set of fuzzy conditions which help to highlight all the edges that are associated with an image. The fuzzy conditions help to test the relative values of pixels which can be present in case of presence on an edge in a gray scale image. This is shown in figure.



3.1 Noise Removal

Noise removal is performed at different intermediate levels of processing. The idea of noise removal is to remove the pixels which have been falsely recognized as edge by the processing. Size of the scanning mask for this task is 3*3 pixels window. 3*3 pixels mask is slid over the whole image pixel by pixel row wise and the process continues till the time whole image is scanned for unwanted edge pixels. Fig. 3.1(a) shows p5 as falsely marked edge pixel as all the surrounding pixels i.e. p1, p2, p3, p4, p6, p7, p8 & p9 are white. Such types of falsely marked edge pixels are changed to White by the noise removal algorithm.

p1	p2	p3
p4		p6
p7	p8	p9

Figure 3.1(a) false marked edge pixel.

Every pixel in the input image is evaluated with its eight neighbours, using each of the three masks shown in Figure 1 to produce edge strength value. The equation used for the calculation of edginess values between the centre pixel and the neighbourhood pixels of the three (3) masks using spatial convolution process is given by:

$$O(x, y)=a\,I(X-1,Y-1)+b\,I(X-1,Y)+c\,I(X-1,Y+1) +d\,I(X, Y-1) +e\,I(X, Y) + f\,I(X, Y+1)+ g\,I(X+1, Y-1)+h\,I(X+1,Y)+ i\,I(X+1,Y+1) \quad \text{--------------------1}$$

However, the result of convolution of the two Sobel kernels is combine thus, the approximate absolute gradient magnitude at each point is computed as:

$$\mathbf{Og} = |\mathbf{Ox}| + |\mathbf{Oy}| \quad \text{--------------------2}$$

The normal edge strength is given by

$$NO\,(x, y) = \text{round}\,[(O(x, y)\,/\max\,(O)) \times 100] \quad \text{------------------------3}$$

where $x = \{0,1, . . . ,M -1\}$ and $y = \{0,1, . . . , N -1\}$foran M-by-N image. The edge strength values derived from the three (3) masks served as the inputs used in the construction of the fuzzy inference system based on which decision on pixel as

belonging to an edge or not are made. Membership functions are defined for fuzzy system inputs. Many membership functions have been introduced in the literature.

$$u_{mn} = G(x_{mn}) = e^{[-(x_{mn} - x_{mn})^2/2\sigma^2]} \quad \ldots\ldots\ldots 4$$

a	*b*	*c*
d	*e*	*f*
g	*h*	*i*

Every pixel in the input image is evaluated with its eight neighbors, using each of the three masks shown in Figure 1 to produce edge strength value. The equation used for the calculation of edginess values between the center pixel and the neighborhood pixels of the three (3) masks using spatial convolution process is given by: In the proposed edge detection Gaussian membership functions are used. To apply these functions, each of the edge strength values of *g Hp Lp O* , O , and O are mapped into fuzzy domain between 0 and1, relative to the normalized gray levels between 0 and 100, using Gaussian membership functions given as

$$h_{LP} = \begin{bmatrix} \frac{1}{9} & \frac{1}{9} & \frac{1}{9} \\ \frac{1}{9} & \frac{1}{9} & \frac{1}{9} \\ \frac{1}{9} & \frac{1}{9} & \frac{1}{9} \end{bmatrix}, \quad h_{HP} = \begin{bmatrix} -1 & -1 & -1 \\ -1 & 9 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$

$$h_x = \begin{bmatrix} -1 & 0 & +1 \\ -2 & 0 & +2 \\ -1 & 0 & +1 \end{bmatrix}, \quad h_y = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$

Fig : 3×3 kernels used for edge detection

Each of the mapped values are partition into three fuzzy regions Lo wǁ, Me diumǁ, and H ighǁ. The defined regions and membership functions are shown in Fig. 2. Fuzzy inference rules are applied to assign the three fuzzy sets characterized by membership functions *Low Medium High* , , and to the output set. The rules, tabulated in Table 1 are defined in such a way that in the fuzzy inference system, output set L M H E , E , and E correspond to pixels with low, medium and igh probability value respectively. The output of the system *Final P* representing the probability used for final pixel classification as edge or non-edge was computed using a singleton fuzzifier, Mamdani defuzzifier method given by;

$$P_{Final} = \frac{\sum_{e=1}^{M} y^{-e} \left(\prod_{i=1}^{n} u_{k_i^e}(a_i)\right)}{\sum_{e=1}^{M} \left(\prod_{i=1}^{n} u_{k_i^e}(a_i)\right)}$$

Conclusions and Future work

Although the proposed fuzzy system for curve partition point detection **and** segment classification works very well, more research work is needed for further improving the performance of the system.

1. Testing more images should increase the rate of finding correct CPPs and classifying segments by obtaining better fuzzy rnembership function parameters and filter sizes.

2. Developing fuzzy algorithms should help find join points on edge data since the current proposed fuzzy system does not define the rules for detecting **join** points (the join point is a point which connects two **same** type curve segments). Figure below shows the join points (small **black** squares).

REFERENCES

[1] Ng Geok See and Chan Khue hiang. “Edge Detection using supervised Learning and voting scheme”. Nanyang Technological University, National university of Singapore, Singapore.

[2] Hamid R. Tizhoosh, “Fuzzy Image Processing”. www.pami.uwaterloo.ca/tizhoosh/edge.html

[3] Md. Shoiab Bhuiyan, Yuiji Iwahori, and Akira Iwata. “Optimal edge detection under difficult imaging conditions”. Technical report, Educational Center for
Information Processing and Dept. of Electrical and Computer Engineering,
Nagoya Institute of Technology, Showa, Nagoya, 466-8555, JAPAN,
URL:-
http://www.center.nitech.ac.jp/people/bhuiyan /pub.html.

[4] Ursula Kretschmer, Maria S. Orozco, Oscar E. Ruiz and Uwe Jasnoch, “Edge and corner identification for tracking the line of sight”.

[5] Renyan Zhang, Guoling Zhao, Li Su. “New edge detection method in image processing”. College of Autom., Harbin Engineering University, China.

[6] Zhengquan He, M.Y.Siyal. “An image detection technique based on morphological edge detection and background differencing for real-time traffic analysis”. Elsevier Science Inc. New York, NY, USA