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A Review of Techniques used for Edge Detection in Image

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ABSTRACT: In image processing identification of edges is one of the important steps. Image segmentation is also focused on edge detection, registration and recognition. There are many techniques used such as Gaussian's, Sobel, Preweitt, Laplacian and Laplacian. There are some drawbacks such as fixed edge thickness and it is difficult to implement any parameter such as threshold. The fuzzy rule-based methodology has no such constraint as it requires changing rules and output parameters for adjusting the edge thickness. This paper introduces the canny edge detection technique based on the fuzzy filter. Fuzzy methodology relies on a fuzzy rule system using a 2 × 2 window mask consisting of fuzzy rules which change the image's membership value in three fuzzy sets, edge, white or black. This image serves as the input canny edge detector. This paper reviews and introduces the edge detection using a fuzzy which can effectively detect edges from gray scale images.

Keywords: image, edge, fuzzy, canny, window mask, gray image, non-maximum suppression defuzzification,

I. INTRODUCTION

A. Image Processing

Image processing is a type of signal processing in which the input is a photo or picture or video clip. The image processing output may be an image, a collection of object-related parameters. Technique of image processing can be image enhancement, image compression, image recovery etc. [1].

B. Fuzzy logic

Fuzzy logic is a logic that is valued in many respects. Fuzzy logic variables can be truth value ranging from 0 to 1. This attempts to model modes with reasoning approximate. This is an essential role providing human ability to make rational decisions in imprecise environment. Many unique features of Fuzzy logic provides us a good choice for many issues. The main advantage is that noise-free inputs or accurate input is not necessary and, despite of wide input variations range, output is a smooth control function. It is possible to process any finite or fixed number of inputs that can generate multiple outputs. Fuzzy logic can manipulate nonlinear structures which are difficult or not possible to model mathematically. The human being can easily interpret fuzzy law structures [2].

C. Edge detection

A critical low-level image processing activity known as edge detection is used in multiple high-level tasks such as analyzing motion and features, understanding, recognizing and recovering from databases [3]. In image processing, including segmentation, registration, edge detection is a foremost important tasks. It is mainly based on identification and recognition [17]. Mostly edge detection results are set, such as the thickness of the edges or other parameters. Certain parameters must definitely be chosen for good results, such as the threshold and σ. But this is not the limitation of the fuzzy logic approach. Simply, setting certain parameters will change the processing result.

Canny [4] proposed technique by convolving a Gaussian filter in image for edge detection. This is the technique most widely used as it is stronger than available traditional techniques. It is a gradient-based technique that smoothes an image using Gaussian filter. No total suppression and minimum edges are observed by applying them. This shows unsatisfactory results on noisy images and with low contrast.

Zadeh [5] proposed Fuzzy array defined by membership function assigning membership value to each object between 0 and 1. Zhao, Fu and Yan [6] suggested 3-level thresholding method to find the best object edge by using fuzzy partitions. They derived the conditions for maximizing the entropy function that give us simple edges.

Other method [7] proposed fuzzy logic reasoning method using 3 × 3 masking that gave straightness to straight lines and better curved lines hence giving smoothness. This also provided corners easily defined and makes sharper corners.

Fuzzy logic is a knowledge representation that is appropriate for concepts that can not be precisely defined in their contexts. Fuzzy logic can help to determine the edge of the image [8-9]. In this proposed paper a 2 × 2 pixel window is scanned and a fuzzy inference system is to be developed to detect edges. To mark the pixel as white, black or edge, the rule reference of 32 rules is proposed to be applied. If the brightness near the 'A' pixel is close to white, it would be categorized as white.

Conversely, if the brightness is close to black, the corresponding pixel would be categorized as black. Finally, the pixels that are likely to be edge are selected as edge pixels.

For edge detection instead of Gaussian filter, the logic of fuzzy filter is used for low contrast image.

II. LITERATURE SURVEY

Edge computing allows further computational activities to be done at the edge of networks on the distributed nodes. Today, due to their on-site presence, edge devices reduce the time delay or even allow digital real-time decision-making in most delay-sensitive, mission-critical applications. Detection, behavior detection and prediction of human objects in smart surveillance fall into that category. Large amount of video streaming information will take precious time and put communication networks on heavy pressure. Image processing and object detection is widely recognized as being computing intensively and too expensively to be done by resource-limited edge computing devices. A lightweight Convolution Neural Network (L-CNN) was implemented in this paper, inspired by the depth-separable convolution and Single Shot Multi-Box Detector (SSD). The proposed L-CNN algorithm can identify pedestrians having an inexpensive computation work pressure to an edge system by narrowing down the search space of the classifier to concentrate on human objects in video frames for surveillance. Using open CV libraries, a prototype was implemented on (Raspberry PI 3) and satisfactory results was acheived across real-world video surveillance streams. The experimental study led to development of L-CNN and showed that it is a promising approach [10].

This research article uses morphological operator to present improved color picture edge detection scheme. It was called as the color picture detection scheme Multilevel Morphological Fuzzy Edge (MMFED). MMFED algorithm enhancing the image using a multilevel fuzzy algorithm based on morphology using a threshold-based transformation function. Two threshold values that of an image object and context of an image based on the morphological variable. Secondly the image is improved using a two-level edge detection system. The method of detection of the first level edge determines the edge properties and structure. It depends on the features of gray level of the image. Then the method of detection of the second level uses morphological operator to detect precise fine edges. Experimental outcome analysis shows that the scheme based on multilevel morphology extracts the fine edges with greater precision [11].

The proposal is based on a new server model that serves as heaters as well. They consider acoustic activity identification as a use case. A reference architecture in the Qarnot system was designed to process acoustic flows. Some experimental results were also presented on the recognition of alarm sounds [12].

It needs to manually change the location of the rough wood in the edge cutting process, and can its upper surface [13].

To solve this, a algorithm is developed and used in the cutting process of rough laminated wood edge. Next, a specification of the edge detection system is designed for detecting edge slicing. Second, the operator is used to detect the edges and the process of pattern recognition is used to detect the defect of the rough laminated wood [4]. Finally, the edge's width (pixel-wise) is measured and motor is guided to change the laminated wood's core. Experimental results showed that computer vision-based edge detection performs well in calculating and modifying the raw laminated wood angle deviation. Edge Cutting Processing [13] A SAR object edge detection method is proposed based on localization. First, the association of image with the 2 images is done. Detection is then taken with the ROA detector to the SAR image and, respectively, to the optical image with the detector [4]. Ultimately, end result is obtained using the optical edge image to calculate edge points in the SAR edge image which is on edge position. Computer simulation tests are used to check the validity of the proposed method. Localization of the edge is difficult to detect edge of SAR images. However, the proposed method resolves the problem to some extent [16].

III. MIXED APPROACH

This paper introduces and proposes the mixed approach. This method suggests two detection stages. First step deals with the development of Fuzzy system and second edge detection issue. This idea can be applied and the best results may be tried to be obtained. The following sub-sections address this proposed mixed approach method. Figure 1 demonstrates the basic flow and the same is explained in the next sections.

Fuzzy Rule Based System: After the application of the fuzzy based inference system or rules [14], the intermediate image is retrieved. It scans and fuzzifies the original image and adjusts the membership function of pixels after applying fuzzy laws. Then defuzzification is applied using the centroid method and the image is obtained in the centre.

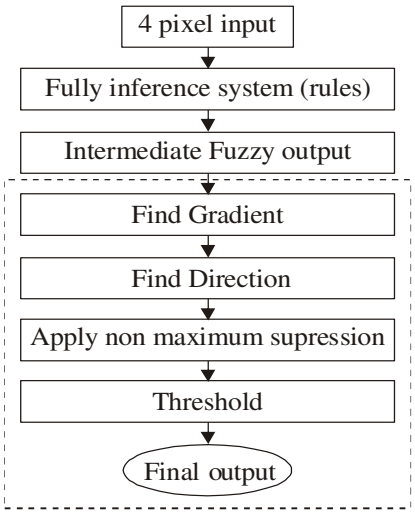

Fig. 1.

A. Scanning

2 × 2 window mask is used to scan an input object in this method. Here we obtain 4 pixel values that are used in FIS (Fuzzy Inference System) as data. The output pixel will be (X, Y) after applying the fuzzy inference rules.

B. Membership Function

Triangular membership function is used in this hybrid approach to express fuzzy property for input and output. Inputs are used as fuzzy sets of 2 types i.e. input is Black (or bit = 0) and White (or bit = 1) and 3 types of fuzzy sets *Black(B), White(W), and Edge(E)*. Pixel values in the gray image is in between 0 and 255, where 0 is for black and 255 is for white. In contrast the pixel value 1 (one) is considered white and the pixel value 0 (zero) is considered black in the binary image.

C. Fuzzy set and Fuzzy Inference Rules

Output pixels are categorized into 3 fuzzy sets as Black, Edge and White. Output range for fuzzy sets may be set as shown in Table 1 below [7].

Table 1.

Output	Pixel Name	Range
In,_out	Black	[0, 8, 16]
	Edge	[140, 144, 148]
	White	[245, 250, 255]

The Fuzzy System checks the conditions from the rules with defined input pixels and retrieves the output of the resulting pixel that is Black, Edge or White.

Stage-1:
Input: Raw input Image
Output: Intermediate fuzzy output Image
Step 1: Change to gray scale image
Step 2: Scan the above image with a 2 × 2 mask window.
Step3: The scanned pixels above are taken as a input for the FI System. By using the triangular membership function FIS converts it into a linguistic variable of black or white.
Step 4: Then, on the above fuzzy input, fuzzy rules are applied to obtain fuzzy output of either black, white, or edge.
Step 5: Defuzzification is applied to get the intermediate output using the centroid method.
End of Stage -1

Stage-2:
Input: Output from stage 1.
Output: Edge detected image
Step 1: The gradient and direction of the stage 1 output are determined.
Step 2: Thin line is obtained by suppressing weak edges by applying non-maximum suppression.
Step 3: The resultant output is obtained after double thresholding.
End of Stage -2

Here the 4-pixel input is used to get output fuzzy array, there are 32 rules. "In" for the input pixel, "Out" for the output pixel and X and Y are the pixel coordinates. A colored image is used as input and phase-1 output can be applied as an input to stage-2.

The output from the FIS is taken as an input to the technique. Shows a stage-2 algorithm. For canny edge detection method [9] steps are as below :

1. Determining gradient: In x and y directions, the gradient magnitude of an object is obtained which clearly indicates the edges. Object gradient is the process used to extract image data. It gives us two pieces of information, magnitude and direction [15].

The formula gives the gradient of an image:

$$\nabla f = \frac{\partial f}{\partial x}\,\hat{x} + \frac{\partial f}{\partial y}\,\hat{y}$$

2. Finding the direction: The edge direction can be determined using the gradient direction.

3. Method of Non-maximum Suppression:

When the position of the edge is obtained, this will be used for tracing in direction of the edge, along the edge and to suppress other which are not to be an edge. This gives the generated image a thin line.

4. Double thresholding method is used to eliminate stretching & takes into account the edges falling between these two values.

Fuzzy-Canny output will be generated after the steps are applied. The solution proposed can be applied in Matlab and can yield better results than the conventional method.

We may get better results in case of threshold, single or double. Yet threshold value is the hard thing. There are no general guidelines for the threshold value available.

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