A Comparative Study Of Edge Detection Technique With MRI (Magnetic Resonance Imaging) Images

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Abstract

Edge detection is one of the most critical elements in picture interpretation. The edges of an image depict the object's outlines, which are the most fundamental elements of a picture. For example, image analysis and processing often use edge detection techniques. The edges may be detected using a variety of algorithms. Edge detection approaches such as Sobel, Prewitt, Roberts, and Canny using MRI images are studied in this work. Canny and Sobel edge detectors have been shown to operate better in experiments than the others. Matlab is used to carry out this project.

Keywords

MRI Image, Sobel, Prewitt, Roberts, Canny.

Introduction
The magnetic properties of individual atomic nuclei are exploited in MRI because image processing is now an essential stage in many aspects of life, including medicine. Image processing uses mathematical operators to analyze and manipulate digital pictures. Edge detection is a key stage in this process. Both sets of features describe the data of a picture as an input to image processing. When a picture has abrupt discontinuities, edge detection is the act of identifying and detecting the lines that separate them (L. Han, Y. 2020). Pixel intensity discontinuities describe the boundaries between items in a picture. An operator (a 2-D filter) developed to be sensitive to big gradients in the picture while returning values of zero in uniform areas is almost universally used for edge detection. The number of edge detection operators is staggering, and each one is optimized for detecting certain kinds of edges. Edge orientation, noise environment, and edge structure are all factors to consider when selecting an edge detection operator. The discontinuity in gray level values is what gives an edge its distinctive appearance. This means that an edge denotes the point at which one item ends and another begins. Many factors influence the appearance of picture edges, including: A digital image's luminance fluctuates suddenly at some spots, and the object's geometric and optical features, as well as mathematical algorithms for edge recognition, are used to identify these points (or put differently, has discontinuities). Researchers' attention has been drawn to it in recent years (R. Bausys, 2020; M. Ravi Kumar et al, 2020; P. Kanchanatripop and D. Zhang, 2020; S.K.T. Hwa, 2020; S. Bourouis, R. Alroobaea, 2020; Z.H. Naji,2020; A.K. Bharodiya and A.M. Gonsai, 2019; J. Mehena, 2019).

Various edge detection strategies are examined in these publications in order to identify the edges in a picture, and a comparison between these techniques is also done. Results and explanations are provided in sections 2 and 3, as well as a technique for detecting edges in part 4. To assist individuals recuperate, several sustainable project management systems use grayscale color and medical images to designate these locations.

**Related Work**

Watermarking works on medical imaging data authentication. Embed (R. Singh, 2019). This work proposes an efficient invisible and resilient watermarking approach based on Edge Detection in Double Density Discrete Wavelet Transform (ED3WT). The suggested technique decomposes the input cover picture into wavelet coefficients using DWT. The Sobel edge detector calculates the decomposed image sub band edge. The double density DWT is resistant to noise and filtering assaults. To increase picture resilience, a scaled morphologically dilated high frequency edge coefficient is employed as a key. Edge Detection in Double Density discrete Wavelet Transform (ED3WT) domain is offered as an effective undetectable and resilient watermarking approach. The suggested technique decomposes the input cover picture into wavelet coefficients using DWT. The Sobel edge detector calculates the decomposed picture sub band edge. A watermark is added to the
decomposed image's high frequency sub-band coefficients. GMAW (gas metal arc welding) is frequently used in industry (P. Zhai, 2019). The usage of pulsed GMAW outperformed typical DC welding in terms of spatter, welding performance, and all-position welding adaptability. The suggested monitoring system and image processing algorithm offer a novel technique for investigating mathematic descriptions of droplet flight trajectory and constructing an accurate automated welding system. Color picture edge detection is a newer area in pattern recognition research. We provide an excellent color picture edge detection method. The approach uses a canny edge detector. (Bora, 2018). This study introduces an effective color picture edge detection method. The approach uses a canny edge detector. Medical image processing is a new and hard area. (Zotin, 2018). The study outlines the suggested methods to identify the borders of brain tumors using patient MRI scan pictures of the brain. Technique for balancing contrast (BCET). The output is then segmented using Fuzzy c-Means (FCM) clustering. It is then used to identify the tiny edges. Reading and analyzing DICOM images is described in “Nghian cu khoa häc vc, 2018” where software integrates Insight Toolkit (ITK), Visualization Toolkit (VTK) and Qt software development environment. Comprehensive edge detection analysis (M.A. Ansari, 2017) With picture, numerous edge detection algorithms like Prewitt and Sobel are applied. Experiment shows that Canny edge detector works better than others. Image processing requires edge detection (A. Kushwah, 2017). This work compares Canny, Prewitt, and Sobel edge detection approaches, which are frequently used in image processing. This stage of digital image processing is called segmentation (S. Jeyalaksshmi and S. Prasanna, 2016). This study reviews several edge detection methods for picture segmentation. This study compares several edge detection operators in image processing (P.P. Acharjya, 2012). The work of canny edge detection operator is superior than Sobel, Roberts, Prewitt, zero crossing, and LoG. (Laplacian of Gaussian) This article compares several image edge detection approaches (R. Maini and H. Aggarwal, 2009). The program is MATLAB 7.0. In practically all cases, Canny's edge detection technique outperforms all other operators. In noisy situations, Canny, LoG, Robert, Prewitt, and Sobel outperform. This work (M. M. Radha, 2011) compares the performance of the most widely used edge detection algorithms for picture segmentation. Using satellite photos from the Indian Remote Sensing Satellite (IRS) sensors LISS-III, LISS-IV, and Cartosat-I as well as Google Earth, S. K. Katiyar and P. V. Arun (2014) compare several edge recognition methods. This study (M. Sharifi, 2002) classifies the most widely used edge detection algorithms, notably ISEF, Canny, Marr-Hildreth, Sobel, Kirsch, Laplacian of Gaussian, Cany, Sobel and Robert. This work (M. Sharifi, 2002) classifies the most widely used edge detection algorithms, notably ISEF, Canny, Marr-Hildreth, Sobel, Kirsch, Laplacian of Gaussian, Cany, Sobel and Robert. In this study (A. Sharma and S. Jaswal, 2015), Sobel edge detection is utilized to extract edges from facial photos. UTeM UAV photos were used to evaluate these edge detection algorithms (Z. Othman, 2018). During their research, the Prewitt process outperformed other methods in terms of accuracy, precision, sensitivity, and f-measure. (Muktneja, 2015) Edge detection techniques used in image processing such as Prewitt, Laplacian of Gaussian, Canny, Sobel and Robert are covered in this study.
Edge Detection Method

Edge detection is a critical step in image processing that is used to analyze images by locating the boundaries of objects within them. It works by detecting discontinuities in brightness of object in image. Edge detection is used for image segmentation and data extraction in areas such as medical image, security and agricultural so on. Edge Detection filters are commonly used as a first step in procedures to define discrete objects within image. Common edge detection algorithms include Sobel, Canny, Prewitt, Roberts, fuzzy logic methods, etc. The work of the edge detection methods, it calculates the image intensity gradient for each pixel inside the image. The result indicates how abruptly or smoothly the image changes at each pixel, and thus how probable that pixel is an edge. The Gradient and Laplacian filters are convolution filters that use sets of kernel coefficients (weights) to process values in the filter window. The objective of the present study is to comparative various edge detection operators and analyze their performance and also performances of such techniques is executed for MIR image by using MATLAB software.

1. Sobel Operator

The Sobel–Feldman operator (or Sobel filter). To generate a picture that highlights edges, the Sobel edge detection technique was invented by Sobel in 1970. Sobel operator is a pair of 33 convolution. The gradient is computed using the Sobel edge detector using discrete differences between rows and columns of a 3X3 rectangle. The gradient's magnitude is determined by

$$|G| = \sqrt{G_x^2 + G_y^2}$$

With the Sobel operator, the picture is convolutionally filtered using small integer-valued filters. The Sobel technique of picture edge detection employs the derivative approximation. Using a 2-D spatial gradient quantity on an image, the Sobel method accentuates high spatial frequency areas near edges. It's used to measure the absolute gradient magnitude in a grayscale picture. Figure (1) depicts the operator as consisting of two 3x3 complex kernels. The two kernels are 90o rotated. This is the Roberts Cross operator.

![Fig. 1 Show the table of Sobel](http://www.webology.org)
These kernels are designed to react to edges. One kernel for each of the two perpendicular pixel grid orientations (vertical and horizontal). They may be applied to the picture independently. As a consequence, the gradient component measurements vary (call these $g_x$ and $g_y$). These may be used to calculate the gradient's absolute magnitude and direction.

2. Prewitt

In image detection, Prewitt operator edge detection masks are one of the most often used approaches. Prewitt originally presented them in 1970. The Prewitt edge detector employs the mask illustrated in figure (2) to approximate $G_x$ and $G_y$ digitally.

![Fig. 2 Show the table of prewitt](image)

Prewitt is the way to go to identify an edge's size and direction. It receives the direction from the kernel with the greatest response, unlike other gradient edge detection techniques that need to calculate it.

3. Roberts

Lawrence Roberts invented edge detection (1965). It quickly computes a basic 2-D spatial gradient measurement on an image. This method emphasizes high spatial frequency areas near edges. This technique is most often used to provide the operator a grayscale representation of the output. Pixel values reflect the estimated total magnitude of space at each output point. The operator is made up of two 22 convolution kernels, as illustrated in the graphic (3).

![Fig. 3 Show the kernel of Robert’s operator](image)
These kernels, one for each perpendicular orientation, are intended to react maximally to 45° edges. The kernels may be applied independently to the input picture to measure gradient components in each orientation (call them Gx and Gy). These may then be combined to calculate the gradient's absolute magnitude and direction.

Canny

In 1983, at MIT technology John Canny introduced the canny edge detection. It is the most common and widely used edge detection approach. It isolates the noise from the image before excreted the feature. The Canny operator can manipulate a variety of edge picture details and effectively suppress noise. This technique Canny is a multi-step procedure that is implemented.

1. Gaussian smoothing is used to remove noise.
2. The edge direction and local gradient are determined at each site. It is the point having the highest local strength in the gradient direction, according to the edge point.
3. As a result, these two thresholds are employed to distinguish between strong and weak edges. Thus, the parameters can be used to change their effectiveness. Figure 1 shows a 3x3 convolution mask used in the canny edge detection approach (4).

![Convolution Masks](image)

Fig. 4 Show the table of Cannys

Results And Analysis

In this paper, Sobel, Prewitt, Roberts Canny edge detection operators have been implemented on a MRI images and 3 slices of MRI image (brain, bone, liver) and the results are presented in Figure 5, Figure 6 and Figure 7, respectively.
Fig. 5. (a) original image, (b) Brain image with canny, (c) Brain image with prewitt, (d) Brain image with Roberts and (e) Brain image with Sobel
Fig. 6. (a) original image, (b) Bone image with canny, (c) Bone image with prewitt, (d) Bone image with Roberts and (e) Bone image with Sobel
Fig. 7. (a) original image, (b) liver image with canny, (c) liver image with prewitt. (d) liver with roberts, (e) liver with sobel.
image with Roberts and (e) liver image with Sobel, (c).

For image processing, most edge detectors rely on a collection of convolution masks. Canny extracts edges better than other techniques presently available and delivers decent results. In addition, it has superb location and reactivity. However, there are certain drawbacks. Because of its intricacy, it takes a long time to compute. The Sobel operator's merits include its simplicity, as well as its ability to identify edges with high spatial frequencies and certain orientations. The Sobel method yields a quantity that is proportional to the gradient magnitude. The Prewitt detector is significantly easier to build in terms of computation than the Sobel detector, but it produces noisier results. Robert's edge detection extracts vertical and horizontal edges independently, then combines them.

Conclusion

Edge detection is a critical component of image processing specially in medical image, machine vision, and computer vision, which all aim to recognize points in a digital image. A variety of methods have been presented for extracting the contour properties of an image.

References
