

# Pattern Recognition in Medical Images Through Innovative Edge Detection with Robert's Method

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## Article Info

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## ABSTRACT

This research introduces an innovative approach for pattern recognition in medical images through the application of Robert's edge detection method. Pattern recognition in medical images has great significance in disease diagnosis and patient care management. Edge detection is an important stage in image processing which aims to determine the boundaries of objects in the image. Robert's edge detection method is one of the classic methods that has been used in image processing. However, improving edge detection performance is needed to improve accuracy in pattern recognition in medical images. In this study, we propose a modified variation of Robert's method to increase the accuracy in finding edges in medical images. The proposed innovative approach is tested using a large and diverse medical image dataset. Evaluation is carried out by comparing the edge detection results using the conventional Robert method with the results using the proposed modified method. Quantitative analysis is carried out to measure the performance improvements achieved. Experimental results show that the modified Robert edge detection method produces significant improvements in precision and accuracy in finding edges in medical images. These results indicate that the proposed innovative approach has the potential to improve pattern recognition in medical images and can make valuable contributions in the diagnosis and management of diseases.

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## INTRODUCTION

Currently, many real problems and scenarios require pattern recognition to help solve complex problems more quickly, especially problems that cannot be solved using traditional human heuristics.(Hasbi et al., 2022). Edge detection is an important pre-processing operation in image processing and pattern recognition. This operation involves identifying and tracing sharp and sudden discontinuities to extract meaningful information from an image(Junoh et al., 2017).

Pattern recognition in medical images is one of the important aspects in the world of modern medicine(Hauser, 2022). In computer vision and medical image processing, object recognition is a major concern today(Rani et al., 2022). Medical images such as X-rays, CT scans, MRI, and ultrasound are widely used for disease diagnosis, treatment planning, and

patient monitoring. However, to analyze medical images properly, it is necessary to have reliable and accurate techniques to recognize important patterns in the images (Djellali et al., 2020). Edge detection is a crucial feature in Computer Vision that aims to extract important information from digital images (Kumar et al., 2021). Grayscale shapes and shading were chosen with the aim of mimicking the structures and edges that appear in medical images (Urbaniak & Wolter, 2021).

As a part of image analysis, edge detection is often used for further segmentation or more precise measurements of various elements in an image (Nikolic et al., 2017). Robert edge detection is a gradient-based edge detection method used to find edge pixels in an image (Chaple et al., 2015). This operator processes light-density images in a convenient and fast solution (Selvakumar & Hariganesh, 2016).

Edge detection is one of the critical stages in medical image processing (Lv, 2023). The edges of objects in an image mark significant changes in pixel intensity, and determining these edges is important for separating the object from the background and determining the object's boundaries. A good edge detection method will help in identifying anatomical structures and pathological anomalies in medical images (Waili, 2023).

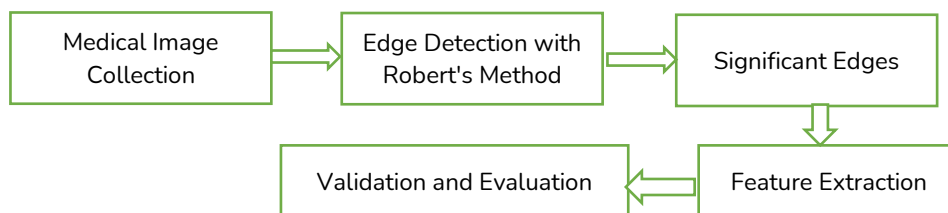
One edge detection method that has been widely used is the Robert method. This method uses convolution operators to detect sharp changes in pixel intensity (Wei & Xu, 2021). Although Robert's method has provided acceptable results in many applications, there is still room for improvement in edge detection performance, especially in the context of complex and diverse medical images.

## METHODS

Innovative edge detection refers to new techniques or methods developed to identify edges or sharp changes in digital images or signals. Edge in this context refers to the border between an object and the background in an image or signal, which is often the focal point in image processing and computer vision. More accurate pattern recognition or better identification of anatomical structures in complex medical images.

### Pattern Recognition

Pattern Recognition in Medical Images is a field in computer science and medical technology that aims to develop methods and algorithms for analyzing and interpreting medical images automatically or semi-automatically. The main goal of pattern recognition in medical images is to detect, classify, and extract relevant information from medical images, such as X-rays, MRIs, CT scans, ultrasounds, and others.



**Figure 1.** Proses Pattern Recognition

## Edge Detection

Innovative edge detection is a concept in the field of digital image processing that refers to the development of new methods, techniques, or algorithms aimed at identifying edges or sharp changes in images in a more efficient, accurate, or adaptive manner than existing approaches. Edge in this context refers to the border or transition between an object and the background in an image.

## Medical Image

Medical Image refers to images or visualizations produced from various medical imaging technologies such as X-rays, computed tomography (CT), magnetic resonance (MRI), ultrasound, and others. Medical imaging technology allows healthcare professionals to view the internal structure of the human body in great detail without performing invasive interventions.

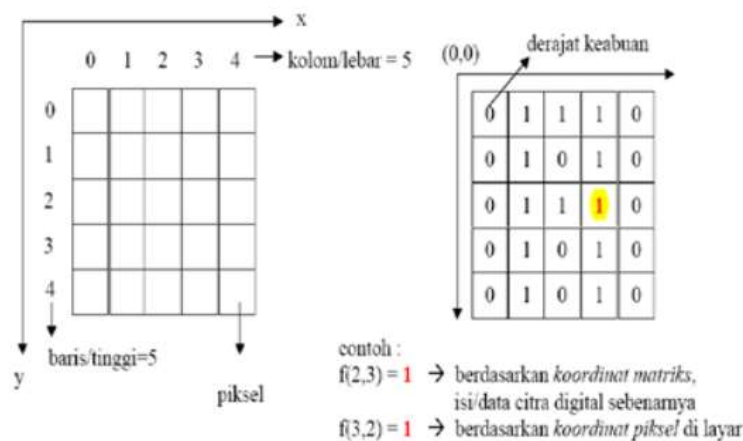


Figure 2. Image Pixel

## Method Robert

Robert's method is an edge detection technique used in digital image processing. This technique is used to find edges or sharp changes in images by identifying intensity differences between neighboring pixels.

Solving steps using the Robert Method:

Perform calculations using the 2x2 operator to perform edge detection in the image

1. Use a grayscale image with free resolution, and here I use 5x5 resolution

2. Find the value of Robert Horizontal ( $R_x$ ) =  $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$

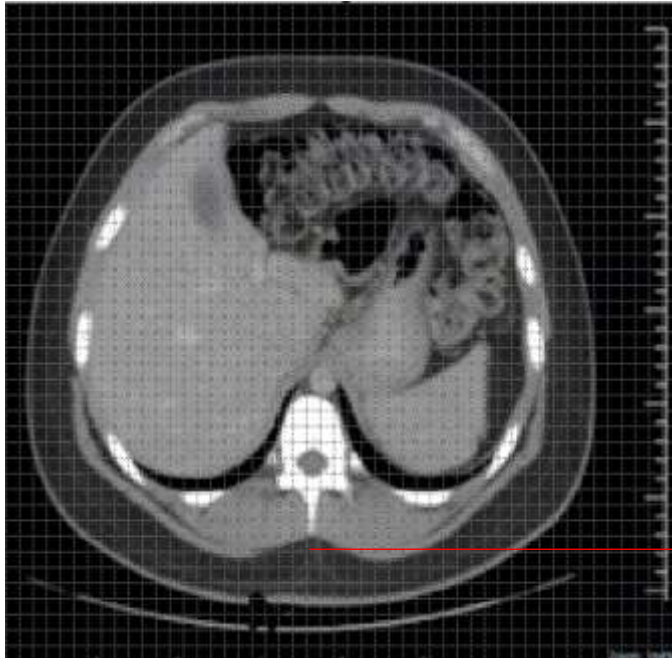
3. Find the value of Robert Vertical ( $R_y$ ) =  $\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$

4. Find the Gradient value ( $G$ ) =  $\sqrt{R_x^2 + R_y^2}$

## RESULTS AND DISCUSSION

The process of pattern recognition in medical images begins with image collection from various imaging modalities such as X-ray, MRI, or CT scan, followed by pre-processing steps

to improve image quality. Next, the image is separated into objects and background through segmentation, and important features of the objects are extracted.



88	79	32	57	100
82	100	158	72	98
88	120	147	109	97
91	89	123	61	105
54	53	55	55	58

Figure 3. Medical Image Sample

Display the pixel value of an input image

88	79	32	57	100
82	100	158	72	98
88	120	147	109	97
91	89	123	61	105
54	53	55	55	58

### First Convolution

Perform calculations using the 2x2 operator to perform edge detection on the image which aims to find the Robert Horizontal (Rx), Robert Vertical (Ry), and Gradient (G) values.

a) Find the Robert Horizontal value of the first convolution with the formula:

$$R_x = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} 88 & 79 \\ 82 & 100 \end{bmatrix}$$

$$R_x = (1.88 + 0.79 + 0.82 + (-1.100))$$

$$R_x = 88 + (-100)$$

$$R_x = -12$$

The Robert Horizontal (Rx) convolution table is :

-12			

### Convolution

Perform calculations using the 2x2 operator to perform edge detection in the image with the aim of finding the Horizontal Robert (Rx), Vertical Robert (Ry), and Gradient (G) values.

a) Find the value of the fifteenth Robert Horizontal convolution using the formula:

$$Rx = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} 123 & 61 \\ 55 & 55 \end{bmatrix}$$

$$Rx = (1.123 + 0.61 + 0.55 + (-1.55))Rx = 123 + (-55)Rx = 68$$

The fifteenth convolution Robert Horizontal (Rx) table is:

-12	-79	-40	-41
-38	-47	49	-25
-1	-3	86	-93
38	34	68	

b) Find the value of the fifteenth Robert Horizontal convolution using the formula:

$$Ry = Ry = (0.123 + 1.61 + (-1.55) + 0.55)Ry = 61 + (-55)Ry = 6 \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} 123 & 61 \\ 55 & 55 \end{bmatrix}$$

The fifteenth convolutional Robert Vertical (Ry) table is:

-3	-68	-101	28
12	38	-75	-11
29	58	-14	36
35	70	6	

c) Looking for Gradient convolution values next with the formula:  $G = G = G = G = G =$

$$68\sqrt{Rx^2 + Ry^2} = \sqrt{68^2 + 6^2} = \sqrt{4624 + 36} = \sqrt{4660}$$

The convolutional Gradient Table (G) is:

12	104	109	50
40	60	88	27
29	58	87	100
52	78	68	

### Next Convolution

Perform calculations using the 2x2 operator to perform edge detection in the image with the aim of finding the Horizontal Robert (Rx), Vertical Robert (Ry), and Gradient (G) values.

a) Find the value of Robert Horizontal convolution using the formula:

$$R_x = R_x = (1.61 + 0.105 + 0.55 + (-1.58))R_x = 61 + (-58)R_x = 3 \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} 61 & 105 \\ 55 & 58 \end{bmatrix}$$

The next Robert Horizontal ( $R_x$ ) convolution table is:

-12	-79	-40	-41
-38	-47	49	-25
-1	-3	86	-93
38	34	68	3

b) Find the value of Robert Horizontal convolution using the formula:

$$R_y = R_y = (0.61 + 1.105 + (-1.55) + 0.58)R_y = 105 + (-55)R_y = 50 \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} 61 & 105 \\ 55 & 58 \end{bmatrix}$$

The Robert Vertical ( $R_y$ ) convolution table is:

-3	-68	-101	28
12	38	-75	-11
29	58	-14	36
35	70	6	50

c) Looking for Gradient convolution values above with the formula:  $G = G = G = G = G =$

$$50\sqrt{R_x^2 + R_y^2} \sqrt{3^2 + 50^2} \sqrt{9 + 2500} \sqrt{2509}$$

Gradient Table ( $G$ ) convolution next is:

12	104	109	50
40	60	88	27
29	58	87	100
52	78	68	50

### Looks up values and creates trashold tables

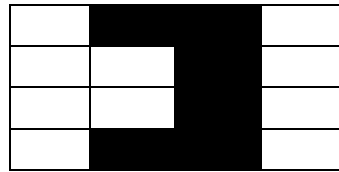
Finding the trashold value can be done by finding the minimum value and maximum value from the Gradient ( $G$ ) table first, then the two values are added and divided by 2, the formula is:

$$\begin{aligned} \text{Thrashold} &= (\text{min value} + \text{max value}) / 2 \\ &= (12 + 109) / 2 \\ &= 121 / 2 \\ &= 60.5 \text{ and rounded to } 61 \end{aligned}$$

So, values in the Gradient ( $G$ ) table that are greater than or equal to 61 will be changed to a value of 1, and values in the Gradient ( $G$ ) table that are smaller than 61 will become a value of 0.

Trashold Table

0	1	1	0
0	0	1	0
0	0	1	0
0	1	1	0



**Figure 4.** Medical Image Edge Detection Result

## CONCLUSION

The use of Robert's method in edge detection in medical images provides promising results in pattern recognition. Robert's method, although belonging to the category of simpler edge operators, is capable of providing sufficient information to aid in the identification of important structures in medical images, such as the edges of tissues or organs. Innovative edge detection using Robert's method may have advantages in several aspects, such as faster computing speed or the ability to handle images with low noise. However, it is important to remember that its effectiveness depends on the application context and the characteristics of the medical images being processed.

## REFERENCES

- Chaple, G. N., Daruwala, R. D., & Gofane, M. S. (2015). Comparison of Robert, Prewitt, Sobel operator based edge detection methods for real time uses on FPGA. Proceedings - International Conference on Technologies for Sustainable Development, ICTSD 2015. <https://doi.org/10.1109/ICTSD.2015.7095920>
- Djellali, C., Adda, M., & Moutacalli, M.T. (2020). A data-driven deep learning model for pattern recognition for medical diagnosis, by using model aggregation and model selection. *Procedia Computer Science*, 177. <https://doi.org/10.1016/j.procs.2020.10.052>
- Hasbi, NH, Bade, A., Chee, FP, & Rumaling, MI (2022). Pattern Recognition for Human Diseases Classification in Spectral Analysis. In *Computation* (Vol. 10, Issue 6). <https://doi.org/10.3390/computation10060096>
- Hauser, F. (2022). Pattern recognition in medical settings. *ATH*, 2(6). <https://doi.org/10.47460/athenea.v2i6.28>
- Junoh, AK, Alshorman, MA, Muhamad, WZAW, Zakaria, MH, & Desa, AM (2017). Multi algorithms for improving leukemia images edge detection technique. *International Journal of Applied Engineering Research*, 12(18).
- Kumar, S., Upadhyay, A.K., Dubey, P., & Varshney, S. (2021). Comparative analysis for edge detection techniques. Proceedings - IEEE 2021 International Conference on Computing, Communication, and Intelligent Systems, ICCIS 2021. <https://doi.org/10.1109/ICCIS51004.2021.9397225>
- Lv, HCYDCSY (2023). A Method for Weak Edge Extraction of Complex Medical Images Based on Visual Sensors. *International Conference on Power, Electrical Engineering, Electronics and Control (PEEEEC)*, 765–770. <https://doi.org/10.1109/PEEEEC60561.2023.00152>.

- Nikolic, M., Tuba, E., & Tuba, M. (2017). Edge detection in medical ultrasound images using adjusted Canny edge detection algorithm. 24th Telecommunications Forum, TELFOR 2016. <https://doi.org/10.1109/TELFOR.2016.7818878>
- Rani, S., Ghai, D., Kumar, S., Kantipudi, M.P., Alharbi, A.H., & Ullah, M.A. (2022). Efficient 3D AlexNet Architecture for Object Recognition Using Syntactic Patterns from Medical Images. Computational Intelligence and Neuroscience, 2022. <https://doi.org/10.1155/2022/7882924>
- Selvakumar, P., & Hariganesh, S. (2016). The performance analysis of edge detection algorithms for image processing. 2016 International Conference on Computing Technologies and Intelligent Data Engineering, ICCTIDE 2016. <https://doi.org/10.1109/ICCTIDE.2016.7725371>
- Urbaniak, I., & Wolter, M. (2021). Quality assessment of compressed and resized medical images based on pattern recognition using a convolutional neural network. Communications in Nonlinear Science and Numerical Simulation, 95. <https://doi.org/10.1016/j.cnsns.2020.105582>
- Waili, AR AL. (2023). Using Convolutional Neural Networks for Edge Detection in Medical Images to Determine Surgery Instrument Tools. Journal of Artificial Intelligence, Machine Learning and Neural Networks, 34. <https://doi.org/10.55529/jaimlnn.34.13.25>
- Wei, Y., & Xu, M. (2021). Detection of lane line based on robert operator. Journal of Measurements in Engineering, 9(3). <https://doi.org/10.21595/JME.2021.22023>