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# DETECT AND ISOLATE THE LINEAR COMPOSITIONS IN SATELLITE IMAGES

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**Abstract:**

Remote sensing data is a source for deriving a spatial graph of the Earth's surface, which is mainly composed of linear faults, drainage systems, road networks, and other natural and artificial landscapes. Their appearance clearly and accurately often requires algorithms and image processing methods to detect edges. On this basis, the subject of the research included identifying and automatically isolating the spatial characteristics of the earth's surface, such as linearity, drainage systems, and the boundaries of the earth's coverings. Robert and Sobel filters were used for the purpose of edge enhancement. . In order to isolate the edges clearly from the rest of the image contents, the adaptive obfuscation method was used in order to obtain a binary image that can be used in post-processing operations. For the purpose of isolating the edges better and closer to their true shape, a new algorithm was corrected to join and slim the edges, and this algorithm included the processes of extension and stripping. The final algorithm has been applied to different scenes from Nineveh Governorate captured by satellite sensors and aerial photography, and the results have proven reasonable success in detecting linear structures.



**Keyword :** edge enhancement , nonlinear filter, dialation , erosion , remote sensing .

## 1. Introduction

The importance of remote sensing data is evident in the fact that it constitutes an important source of studies that target spatial information that represents the characteristics of the Earth's surface, such as geological genes (linearities, faults, drainage systems), road maps and residential complexes. The gray of the mock cell) relative to the background surrounding the edge[1]. The road, the faults, the branches of the drainage systems, and the borders of the buildings are all considered edges because their reflectivity differs from what is adjacent to them from the surface of the earth[2]. In most cases, spatial information does not appear clearly in satellite images for several reasons, including the height of the moon above the earth's surface and the poor discrimination power of the sensor mounted on the satellite, as well as the poor power of spectral discrimination represented by its poor efficiency in showing the low contrast between the gray levels that represent the reflectivity of the land cover This efficiency is largely reflected in the strength of the optical response function of the optical system used in imaging[3]. inspite of the clear improvement in the power of discrimination of the sensors of the current contract and the ability of the images of these sensors to show spatial information with fine details well the availability of these images does not dispense the beneficiary with the use of digital processing methods and edge detection algorithms for two reasons[4]. The first reason is that the power of high resolution often leads to showing the textures well at the expense of the edges that represent the lines and the borders of the covers[6]. The second reason is concentrated in the fact that these images do not cover large areas, as is the case in the images of the sensors of the past two decades, which provided images in huge quantities of the surface of the earth[6]. And for different periods, what makes these pictures an important source of information that cannot be dispensed with. The search for modern algorithms and methods to process these images to extract the necessary important information is important at the present time because this information is often not clearly visible in the raw image. These algorithms and methods were mainly limited to extract spatial and spectral information. Each type of information has its own algorithms. To show the spectral information, digital classification methods and interpretation of false-color images are usually used, which are composed of merging several images with different beams [5]. As for showing spatial information, algorithms are usually used that depend mainly on digital filters [4].

**2. Literature Survey:**

The interest of specialists in the field of remote sensing in the methods and methods of detecting edges began since the seventies with the beginning of the launch of the first series of civil satellites for the study of the Earth's surface in the year (1972). of data, which makes it an abundant field to extract spectral and spatial information. This has led to the interest of private companies and institutions in the manufacture of digital image processing software for the purposes of remote sensing by making edge detection methods and making them an important part of this software. These methods focused mainly on the use of filters using the spatial and frequency standpoint. Examples of such software are (VICAR), (ORSER, (LARSYS), (ILWIS), which were then implemented on mainframe computers[1]. After the success of this software, the attention of researchers in the field of digital image processing in general was directed towards developing these filters and adapting them to better fit the nature of the remote sensing data. The activity of the human entity and an example of these attempts is the use of a two-stage filter for rapid detection of edges by [11]. And used [12] non-linear filters to determine the linear characteristics of the different areas in the tissue through remote sensing data, and these characteristics included the surface landforms necessary to update the maps. He revealed edge visualization algorithms in computer vision programs [13]. new model is implemented to overcome the limitations and to correct the problems of the known and conventional techniques of urban feature extraction specifically road network. The major steps in the model are the enhancement of the image, the segmentation of the enhanced image, the application of the morphological operators, and finally the extraction of the road network[3].[8] used directional digital filters to determine the ancient trace of the course of the Niger River from remote sensing data captured by the thematic mapper sensor. And used [11] non-linear filters to determine the linear characteristics of the different areas in the tissue through remote sensing data, and these characteristics included the surface landforms necessary to update the maps. Digital filtering has also been widely used in the frequency sense to show the spatial characteristics of the remote sensing data. [4] used the Fourier transform to improve the edges of squares, road networks, buildings, and land cover borders using remote sensing data captured by the thematic mapper (TM) sensor carried on board the Landsat 5 satellite. Edge detection algorithms have also been used in computer vision applications by [9]. As for [3], he used the Fourier transform to extract the spatial characteristics (linearities) for different regions in Singapore, where he relied on the frequency principle in the digital filtering of a specific package of frequencies. The idea of adaptive filters was also used by [13] to improve geological characteristics such as faults and linears in general and topographical characteristics, as nonlinear filters were used, whose performance changes according to the change of the local statistical characteristics of the image regions. While the researcher [14] used Robert, Laplace, and Sobel filters, and the Kani algorithm to detect edges and corners.

In paper [12], on identifying the spots on the DNA microarray image, the particular image must be enhanced and its quality improved, so that the information of that image could be extracted. Thus, mathematical morphological-image processing is used for that work.

## 3. proposed algorithm:

### 3.1. pre-processing:

Due to the possibility that the remote sensing data may contain noise, which often forms false edges, it is necessary to remove it within the initial processing stages of the image. The Kaos filter mentioned in the second chapter was used for this purpose, as a window of size (3 * 3) and a standard deviation ($\sigma$=1) were adopted, and by applying the equation (2-2) The coefficients of the resulting mask were as follows[10]:

| | | |
|---|---|---|
| 0.37 | 0.6 | 0.37 |
| 0.6 | 1 | 0.6 |
| 0.37 | 0.6 | 0.37 |



Where the coordinate values for each of Xo Yo were considered equal to zero, the coordinates of the upper left corner (-1,-1), the coordinates of the lower right corner (1,1), and the value of K = 1.

### 3.2 Digital Filter Operations:

At this stage, one of the nonlinear digital filters Sobel and Robert was used, due to their ability to suppress texture edges and improve the edges involved in the installation of surface shapes such as lines, borders and drainage systems.

### 3.2.1 Robert Filter:

It is a nonlinear filter that depends on calculating cross gradients and is comparable to the partial derivative in the direction of X,Y. As in the case of the Sobel filter, the Robert filter is realized by applying the mathematical convolution process using two windows, as shown in Table (1)[8].

**Table (1): Represents the windows used in calculating the regression**

$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$

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The resultant regressions are calculated from the following equation:

$$S(I,J) = \sqrt{S^2_{1(I,J)} + S^2_{2(I,J)}} \quad \text{..........(1)}$$

Where:

S1: The value of the slope in the direction of X represents:

S1(I,J) = f(I,J) - f(I+1,J+1)

S2: the value of the slope in the direction of Y:

S2(I,J) = f(I+1,J) - f(I,J+1)

I, J: represent the x- and y-coordinates of the imaginary cell.

**3.2.2 soble filter** :

The Sobel filter is one of the nonlinear filters that aims to highlight the edges, especially the linear ones, at the expense of textures. It relies on calculating the slope in the X and Y directions, where the Sobel filter is achieved by applying the mathematical convolution process using two windows on each cell of the sham cells, as one of the windows aims to calculate the slope (edge strength) direction The x-axis, while the second window aims to calculate the slope towards the y-axis. Table (2) represents the windows used in the mathematical convolution process of the



**Table (2): Represents the windows used in the mathematical convolution process of the Sobel filter**

Sobel filter[6].

Row window

| | | |
|---|---|---|
| -1 | -2 | -1 |
| 0 | 0 | 0 |
| 1 | 2 | 1 |

Column window

| | | |
|---|---|---|
| -1 | 0 | 1 |
| −2 | 0 | 2 |
| -1 | 0 | 1 |

After calculating the value of the regression in both directions, the resultant of the two regression is calculated as follows:

$$S = \sqrt{s^{2}{}^{(I,J)}x + s^{2}{}^{(I,J)}y} \quad \text{.......(2)}$$

Where :

SX: represents the slope value in the direction of X.

SX(I,J) = [ f(I+1,J+1) + 2f(I ,J+1) + f(I-1,J+1)] - [ f(I-1,J-1) + 2f(I,J-1) f(I+1,J-1)]

SY: represents the value of slope in the direction of Y

SY (I , J) = [ f(I+1,J+1) + 2f(I+1,J) + f(I+1,J-1)] - [ f(I-1,J+1) + ( 2f(I-1,J) + f(I-1,J-1)]
S: represents the resultant regression, which represents the value of the edge.
I,J: represent the x- and y-coordinates of the imaginary cell.

### 3.3 Image Thresholding:

At this stage, the image resulting from the digital filtering was tarnished, and an automated method was used to calculate the threshold value, called the Adaptive Thresholding method. Squares of deviations from the value of the image cell that corresponds to the center of the window using the following mathematical equation[9]:

$$T = \sum_{i=1}^{3} \sum_{j=1}^{3} (X(i,j) - \bar{X})^2 \quad ......(3)$$

$\bar{X}$ : The center cell value represents (x (2,2)).

X: The adjacent cells (i) represent the coordinates of the cells within the window (3 x 3). 53

### 3.4 Morphological Operations:

They include extension and stripping algorithms.

#### 3.4.1 Dialation Algorithim:

In this algorithm, the gaps within the edges resulting from either the inefficiency of the image blaming process, or the inefficiency of the filter, or both, were filled. The algorithm includes testing the value of the zero-value image cell in the binary image, whether it represents part of the edge or not. As a window of size (3 * 3) was used and passed over the image, as is the case in the Mathematical convolution process, and at each site a Fill the gap if the dummy cell with a value of (0) is located between two cells, each of which is loaded The value of (1) has been taken into account six possibilities [11].

#### 3.4.2 Iterative Erosion algoritghm :

Step 1: insert the image resulting from the I1 extension process.

Step 2: calculate the number of image cells included in the structure of the edges with the value (1) and put them in M.

Step 3: Perform horizontal stripping on image I1 and place the resulting image in the X matrix.

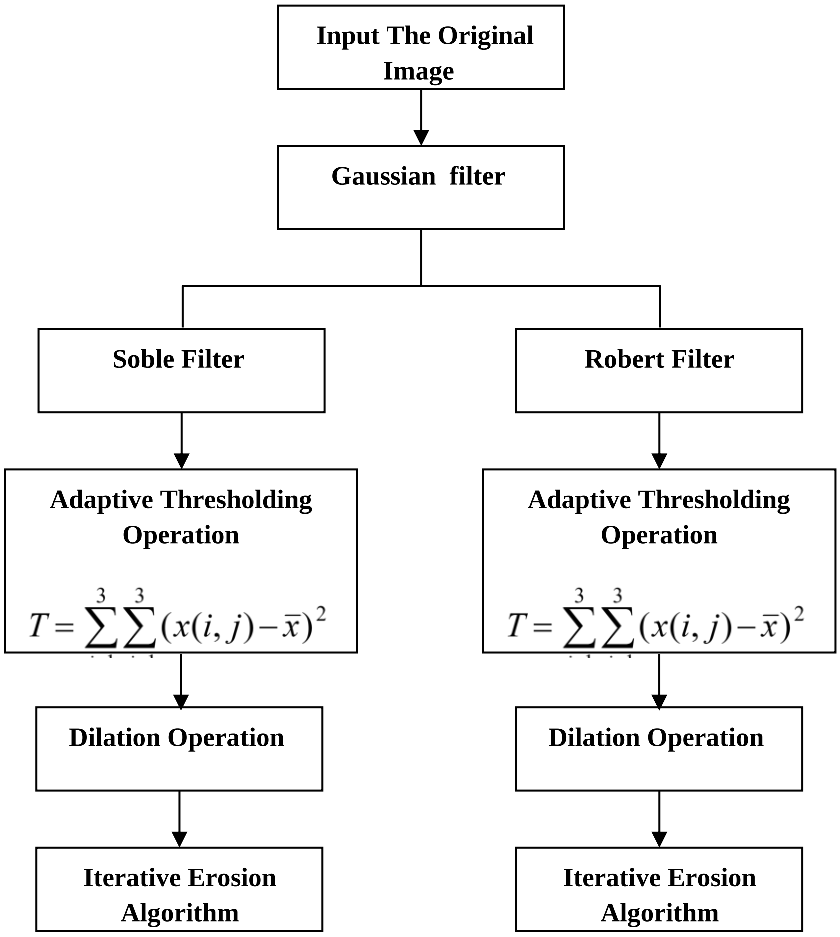
Step 4: Perform a vertical stripping operation on image I1 and place the resulting image in a Y matrix.

Step 5: Perform the logical addition operation (AND) between X and Y and put the output in I2.

Step 6: Calculate the number of image cells included in the structure of the edges of I2 whose value is (1) and put them in N.

Step 7: If N=M go to the eighth step, otherwise store the matrix I2 in I1 and go to the third step.

Step 8: stop.




**Figure(1): represent the proposed method stages**

## 4. Results :

The proposed system was applied to remote sensing data to extract spatial information such as lines, drainage systems, boundaries and ground covers. Several scenes were selected for different regions of Nineveh Governorate captured by satellite sensors and aerial imaging devices. These areas are distinguished by the presence of various morphological characteristics such as faults and fractures, which appear in the form of linear lines and drainage systems, which appear in the form of dense, short and intersecting lines. Mostly, in addition to containing these images on different ground covers, which makes them suitable to show the efficiency of detection algorithms from the edges.

1. The results of applying the system to the first scene (Mount Sheikh Ibrahim area):

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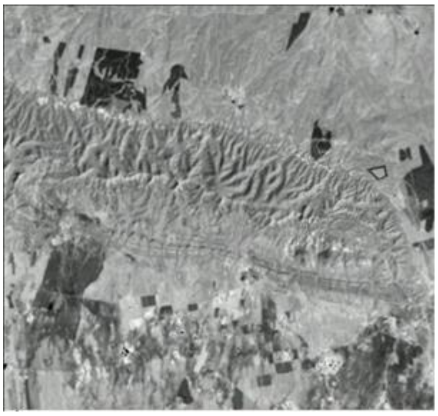
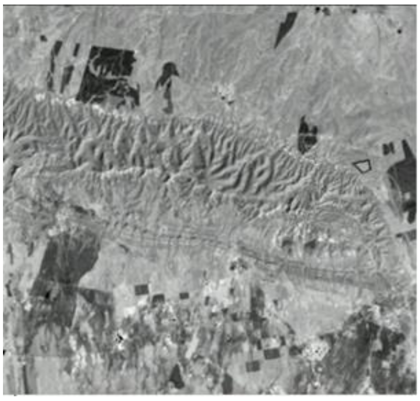


b. Original image

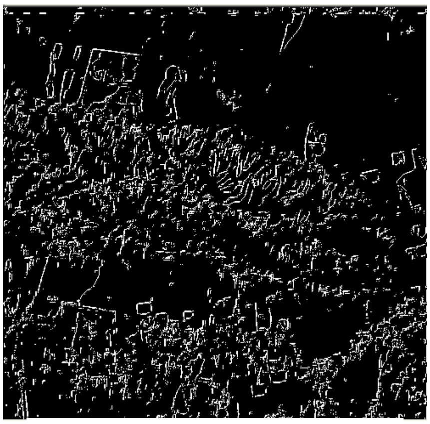


a. Gaussian filter

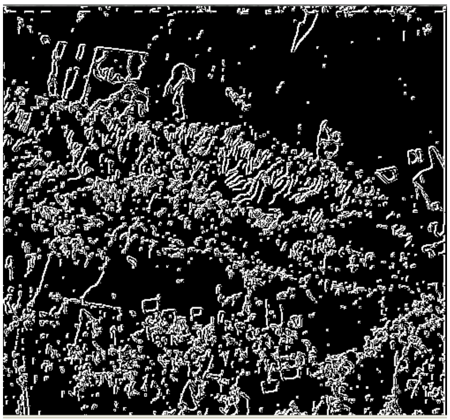
**D .Binary Image For Soble Filter**

**C. Image Soble Filter**





**f. image after nested erosin**



**e. image after dialation**

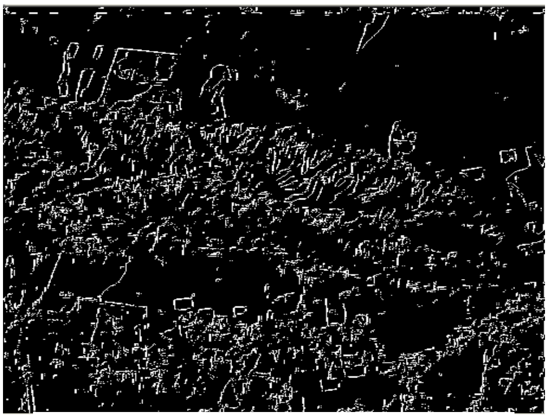
In the case of using the Sobel filter in the digital filtration process, the results will be as fo

a. Original image

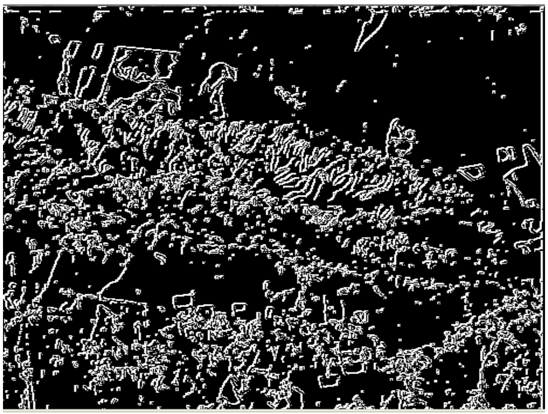
b. Gaussian filter

**d. binary image for Robert filter**

**c. image after Robert filter**

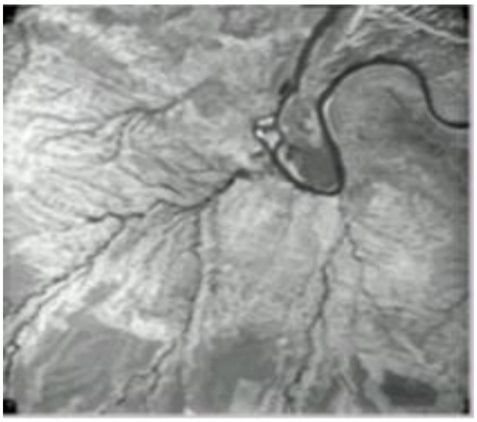


**f. image after nested erosion**



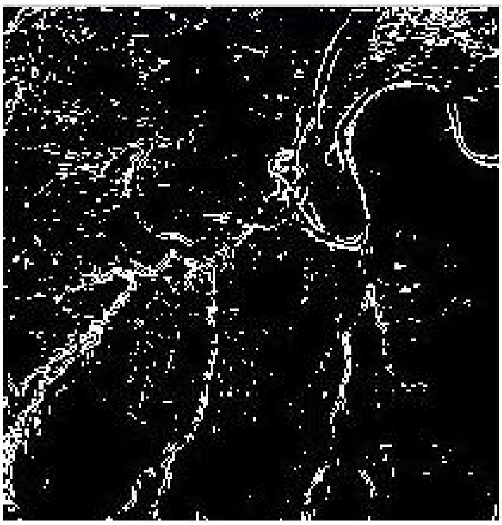
e. image after dilation

2. Results of applying the proposed system to the second scene (Maqloub Mountain area):



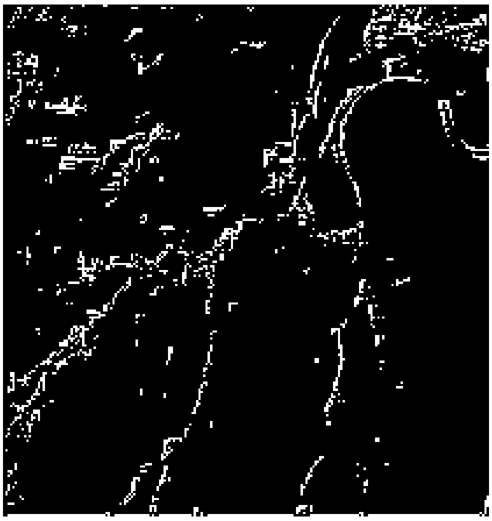
a. **Orginal Image**

**b. Gaussian filter**

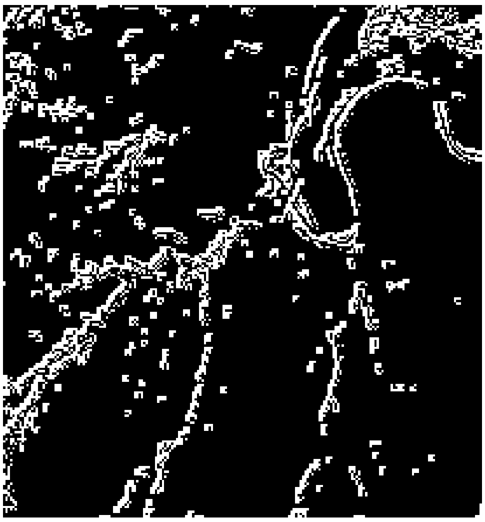


d. binary image for Robert filter

c. Robert filter



f. Image after nested erosion



e. Image after dialation

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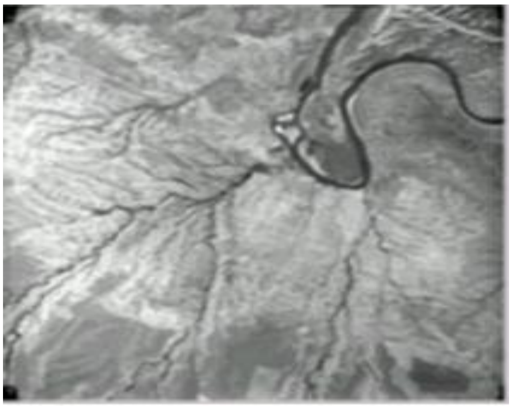
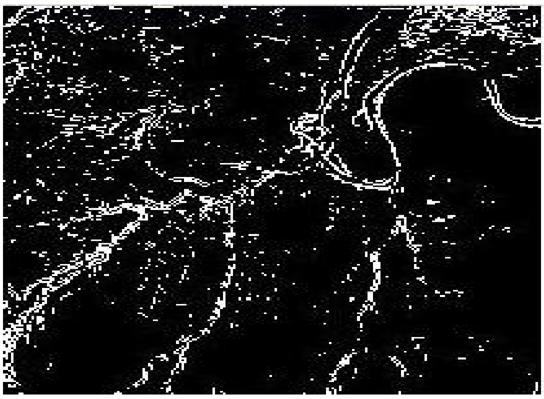
2. In the case of using the Sobel filter in the digital filtration process, the results will be as follows:

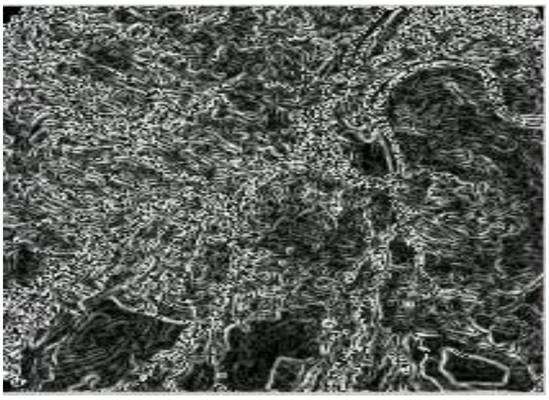


a. Original image

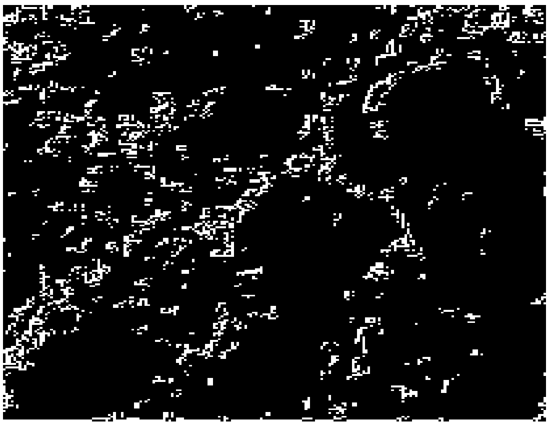
b. Gaussian filter



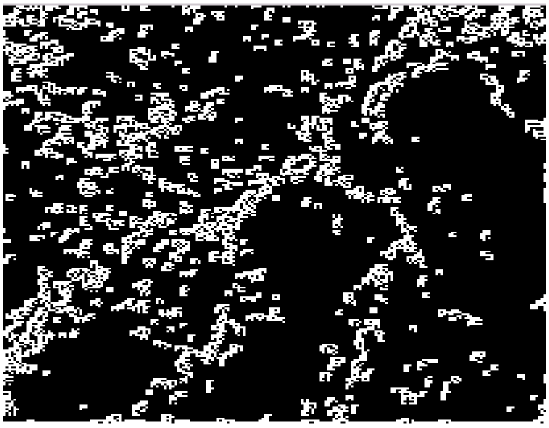
d. binary image for soble filter



c. image after soble filter



f. image after nested erosion



e. image after dilation

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## 5. Conclusion

It is possible through the results drawn from the application of the proposed system for the purpose of improving the edges and making the image better prepared for the complementary and complementary algorithms, it was found that the Robert and Sobel filter are the best. Improve strong rims at the expense of weak rims. The iterative expansion and stripping algorithm used in this research has proven its effectiveness because all the possibilities that lead to the existence of an edge have been taken into account. In the expansion process, the gap is filled if the values of the two cells, in any direction, are equal to one.As for the repeated erosion process, the use of more than one mask and the use of the logical tool leads to thinning the edges effectively and in all directions without canceling a specific direction.

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