EDGE DETECTION IN GEOLOGIC FORMATION EXTRACTION: CLOSE RANGE AND REMOTE SENSING CASE STUDIES

U.G.Sefercik [a, *], O.E.Gülegen [a]

[a] ZKU, Engineering Faculty, 67100 Zonguldak, Turkey – haritaci67@hkmo.net

PS YF

KEY WORDS: Analog, Non-metric, Camera, Geology, Automation, Edge , Extraction

ABSTRACT:

Edge detection is one of the most frequently used techniques in digital image processing. Its application area reaches from astronomy to medicine where isolation of objects focused on from the unwanted background is of great interest. Edge detection has also found application for photogrammetric purposes. In this study, edge detection has first been practiced on stratigrafic structures, which are crucial to geologic time scaling, using digitized images from an analog non-metric camera. The raw images have been low pass filtered in order to suppress the huge amount of unnecessary details. Four types of methods have been used and intercompared with each other. One of the problems encountered is long processing times due to gradient operations in both directions on the images. Natural layering of structure has been exploited in order to reduce computing time. Edge detection followed then from single direction. Taking over close grey values of linear edges with the non-required background leads to unclear detection of edges. Another practice of this study is to extract the faults in the western part of the north Anatolian Fault Zone on a digitized image taken by TK350 camera. A comparison of extracted details with geological maps has been undertaken. Here, the biggest problem is that the faults can be misidentified as geomorphological formations. Hydrological attributes such as streams, water lines, etc. exhibit same characteristics as with the faults. The joint problem of both applications is the quantization of linear details via dilatation. Automation is the last step of the entire edge detection process and has been still a difficult task.

1. INTRODUCTION

In our era, image processing and digital photogrammetry have been developing rapidly. These disciplines are used in studies with various objectives. In this research; firstly revealing stratigraphic construction is aimed at by applying edge detection used in image processing on a photograph which was taken analogously and transformed into a scanned digital image. In the second phase, by applying same techniques, discriminating the faults existing on the west extension of the northern Anatolian Fault Zone is studied by using TK350 satellite image that has 10m geometric resolution on the ground. Another target of research is explaining whether the detection techniques are applicable to all sorts of problems with the results obtained by these studies. In the sample applications defined, Edges being disclosed automatically in order to avoid any comment. That is automation is targeted.

2. METHODS

What's edge detection?

Edge detection is one of the subjects of basic importance in image processing. The parts on which immediate changes in grey tones occur in the images are called "edges". Benefiting from the direct relation between physical qualities of the materials and their edges, these qualities can be recognized from edges. Because of these qualities, edge detection techniques gain importance in terms of image processing.

Edge detection techniques transform images to edge images benefiting from the changes of grey tones in the images. Edges are the sign of lack of continuity, and ending (B.S Penn et al. 1993). As a result of this transformation, edge image is obtained without encountering any changes in physical qualities of the main image.

Objects consist of numerous parts of different color levels. In an image with different grey levels, despite an obvious change in the grey levels of the object, the shape of the image can be distinguished (Figure 1). The reason for this is the sensitivity of the eye to regional contrast. Contrast alteration can be observed by edge detection techniques. Edges can exist in various shapes. These are step edge, ramp edge, line edge and roof edge.

The mathematic display of edge detection, an example for difference operator with single dimension (1-D);

$$Dx = (\frac{1}{2})[1 \quad 0 \quad -1], \qquad Dy = (\frac{1}{2})\begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix} \tag{1}$$

Can be presented as "x" and "y" or horizontally and vertically.

The methods, that are used to obtain the edge image of introductory data of a digital image can be examined in 5 parts; Derivative methods, Local statistical method, Filtering methods, Stokastic Gradient methods and Morphologic methods.

2.1 Derivative Methods

Since these methods are highly sensitive to noise, edge detection algorisms form faulty edges and they fail to the physical features of the object correctly. One of the most

* Corresponding author.

productive methods of finding final edges is to designate the immediate changes of grey level. For f (i, j) grey level function, the first derivative of the image creates local maximum in edge areas. Consequently, edge image is obtained by taking the gradient of image and limiting it to an available threshold value. Another method is to determine zero possings by taking second derivative.

Derivative methods are "gradient method" that uses first derivative and "Laplasyan method" that uses second derivative. (Erdon, 1992)

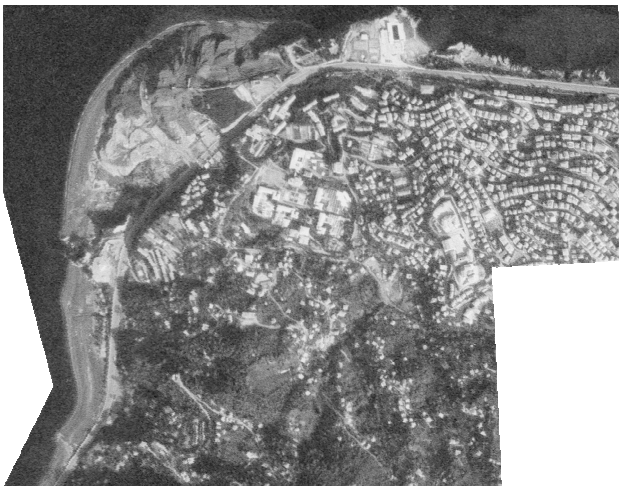
In this research; Sobel, Robert and Prewitt which are scalar edge operators among edge detection systems based on gradient methods involved in derivative methods are used. Scalar edge operators are not adjusted for any directions and supply outcomes that have equal spaces for all directions. For diagonal images Robert mask is more effective, but in the overall evaluation of Sobel mask forms more effective edge images.

In this study, broadcasting stratigraphic construction is targeted by the use of various edge detection operators of this kind. Similarly, the effects of derivative methods on determining stratigraphic construction which is one of the edge detection techniques are examined. The image used in such applications is taken by a non-metric ordinary camera and scanned by Scanjet 3c scanner with 300 dpi definition. On the obtained digital image; Sobel, Prewitt, Robert and LoG edge detection algorithms are applied successively to determine stratigraphic construction and the results are interpreted.

3. STUDY AREA

The study area is a part of Zonguldak city, located in Western Black Sea region of Turkey. It is famous with being one of the main hard coal mining field in the world. Area has a rolling topography and our stratigraphic construction area is shown in Figure 1.

Figure 1. Study area



4. GEOLOGIC APPLICATIONS USING EDGE DETECTION OPERATORS

4.1 Threshold value

As a result of the analysis of the sample grey tone values that are applied to the image, the value that shows the required sharpness as detail below the threshold value are eliminated automatically.

4.2 Dilatation

The purpose of this process is to clarify by filling the gaps on the main lines that set the stratigraphic construction. The reason for this process is that the high contrast lines that binary gradient pattern demonstrates, do not expose the main lines of stratigraphic construction totally.

That's why the lines are exaggerated and made visible through the process of dilatation.

4.3 Fill interior

On the extended stratigraphic image; although the lines become as clear as the image allows, some spaces exist in the line. This process enables the filling of these spaces.

These three main process steps are successively applied with Sobel, Prewitt, Robert edge detection operators and LoG filter on the image. The obtained images do not display the stratigraphic construction of the original image could not be revealed exactly, however stratification part lines of the specific parts of the picture have been determined. When these parts are examined, the length differences and contrast changes of the original construction prove to be effective in the clarification of this line.

When the original image is examined, stratigraphic line is observed to form a horizontal slope of approximately 30°. If the construction was horizontal, how would the process of revealing this line be with a scalar scanning at the horizontal direction at this image? To achieve this aim; the line is brought to an approximate horizontal position by spinning the image 30° clockwise and operators are applied horizontally.

By the result of horizontal detail removing made on that image, vertical details have disappeared; however, a clear image could not be obtained because of rock surfaces' being rough on the general image. In the direction of these results, as lines' not being able to become definite sharply, Medyan filtering method was applied to 30° spinned original image by taking the noise effect into consideration.

In the Medyan filtering process that has been done, filter dimension was selected as 25*25 and its effect to stratigraphic construction was tried to be designated by means of Sobel operators. 0,1 grey toning value was used in applying Medyan filtering on the image by the result of the investigation that was made.

Edge detection techniques applied in this application was utilized in determining the west wing of the North Anatolian Fault Zone from TK350 satellite image as a different research.

Figure 2. Original image

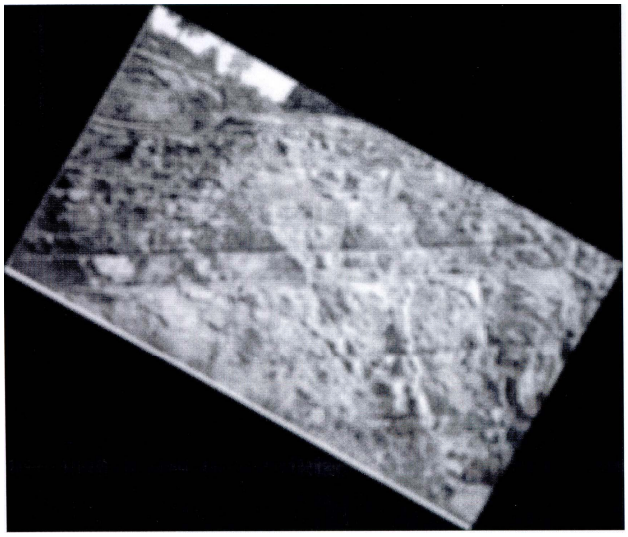


Figure 3. Rotated and Medyan Filtered image

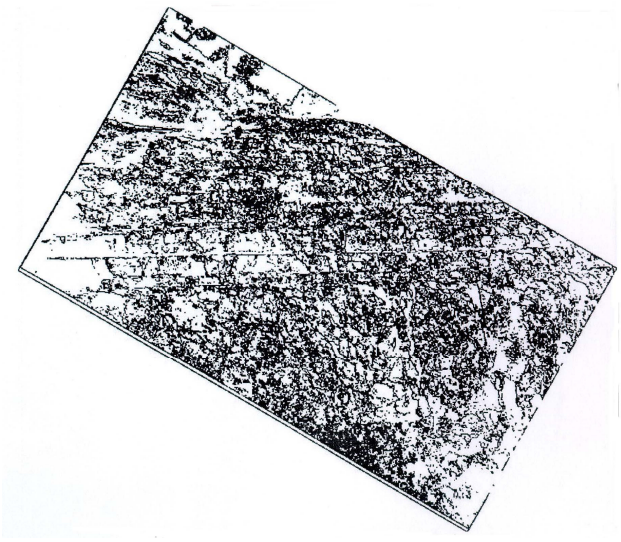


Figure 4. Dilatation at Sobel

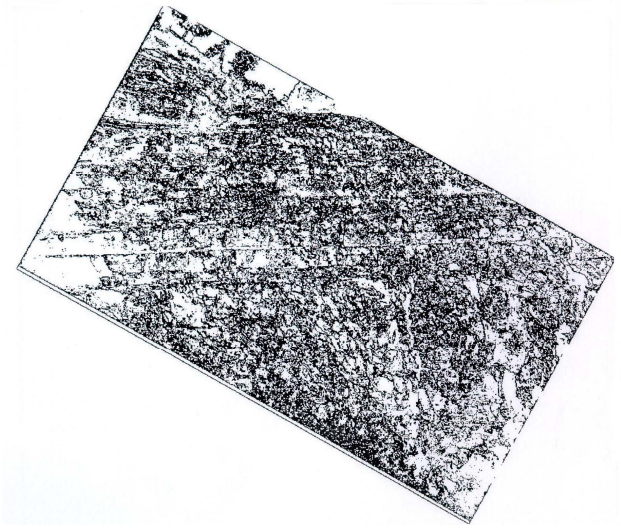


Figure 5. Dilatation at Robert

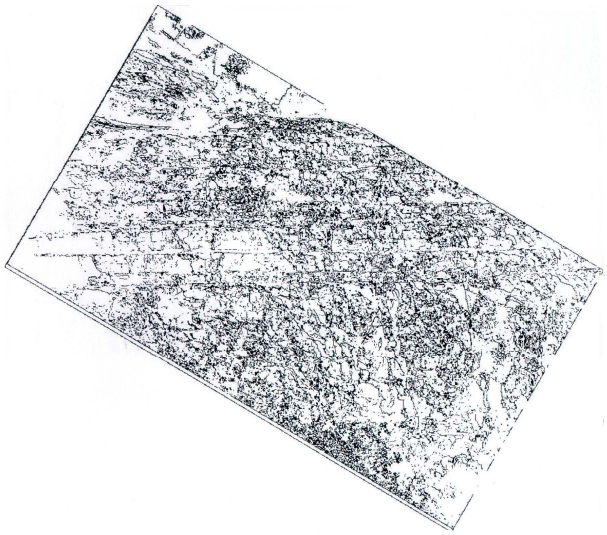


Figure 6. Dilatation at Prewitt

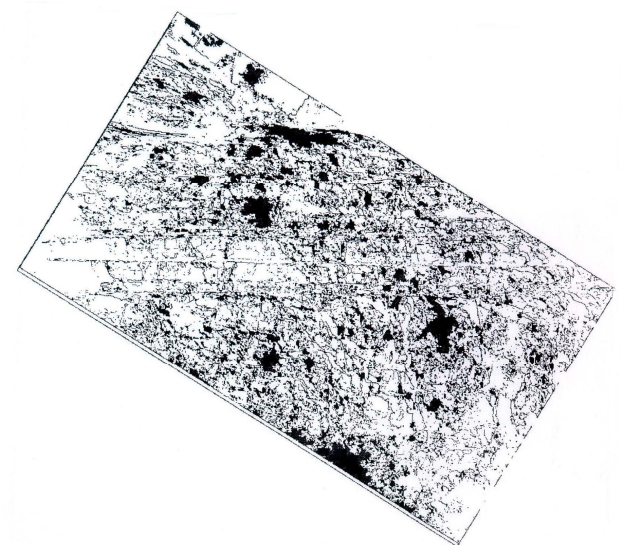


Figure 7. Fill interior at Prewitt

5. COMMENT

When the obtained images are analyzed, the images are thought to reveal the expected line not clearly but at a beneficial degree. If the human intervention could be decreased to the least in this kind of research, could better results be reached? Developing a program that would decrease the human intervention to the least was targeted to be able to response of this question and our studies on this subject are going on. If a complete automation can be provided by using this type of program in the future, good results can be taken in different areas by doing this kind of studies.

6. CONCLUSION

In this research; on the selected example constructions, desired lines are tried to be determined by using derivative methods on traditional edge detection methods. The first point that must be careful at this method is the edges' to be proved to slip from their places. Another point is, these methods are too sensible against noise. Its reason is that they define edges by the help of differences between two grey levels. At the original rock image that is utilized at the research, edges' changing slowly and at a wide area, roughness of rock surface and noise effect cause edges' to slip or not be fixed clearly.

By the result of Sobel, Prewitt, Robert operators from derivative methods and LoG filter are practiced to the original image; when the obtained images are compared and the whole image is considered, Sobel operator was proved to be more effective in defining the lines; however, by Prewitt and Robert operators, the images that have similar features with the reasons sourcing from image's specific construction is proved to be obtained. Because of being too sensible against noise, in practical operations, especially 'Laplasyan Method' was not used; LoG filter was used as it introduced effective results by being utilized with filters; at the result images, edges could not be determined as expected level because of the causes explained below.

In addition, at the fault line fixation some difficulties are confronted because of the other geomorphologic features.

At these studies, edges were revealed partially by edge detection techniques and only the demanded lines could not be revealed completely. The next research can be an automation that confirms a suppression of other minor details by revealing the main lines clearly. The distinction of lines has always been done by commenting by eyes up to now (qualitative).

7. REFERENCES

Schenk, T., 1999. *Digital Photogrammetry*. Terra Science, Laurelville, Ohio, USA.

Erdon, A., 1992. Edge detection methods in digital images. Msc. Thesis, ITU., Istanbul, Turkey.

Penn B.S, Gordon A.J, and Wendlandt R.F., 1993. Using neural networks to locate edges and linear features in satellite images. *Computers & Geosciences*, 19: 1545-1565.

Gupta, R.P., 2002. *Remote Sensing Geology*. Springer-Verlag, Berlin.