Global Journal of human social science
Geography, Geo-Sciences, Environmental & Disaster Management
Volume 13 Issue 3 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-460X & Print ISSN: 0975-587X

Landsat ETM-7 for Lineament Mapping using Automatic Extraction Technique in the SW part of Taiz area, Yemen

By Anwar Abdullah, Shawki Nassr & Abdoh Ghaleeb
Taiz University, Taiz, Yemen

Abstract - The application of remote sensing technology may cover many fields of studies, especially in structure geology, and mineral exploration, where the remote sensing is a useful for lineaments and structure features extractions. Landsat ETM-7 satellite data were used and band -5 was found as the most suitable band in automatic delineation. The automatic lineament extraction process was carried out with LINE module of PCI Geomatica V9.1 based on automatic detection algorithms (canny algorithms). The comparison of the autom-atic lineament extraction and the published fault maps of the area in terms of total length, number of lineaments and directions. The number and the total length of the lineaments using automatic method were found to be more than the number and the total length of the faults in the fault map. The directional analysis of the automatic lineament map was done with the reference of fault map of the area and the structure features measured in the field.

GJHSS-B Classification : FOR Code : 291099, 291003

LANDSAT ETM-7 FOR LINEAMENT MAPPING USING AUTOMATIC EXTRACTION TECHNIQUE IN THE SW PART OF TAIZ AREA, YEMEN

Landsat ETM-7 for Lineament Mapping using Automatic Extraction Technique in the SW part of Taiz area, Yemen

Anwar Abdullah [α], Shawki Nassr [σ] & Abdoh Ghaleeb [ρ]

Abstract - The application of remote sensing technology may cover many fields of studies, especially in structure geology, and mineral exploration, where the remote sensing is a useful for lineaments and structure features extractions. Landsat ETM-7 satellite data were used and band -5 was found as the most suitable band in automatic delineation. The automatic lineament extraction process was carried out with LINE module of PCI Geomatica V9.1 based on automatic detection algorithms (canny algorithms). The comparison of the automatic lineament extraction and the published fault maps of the area in terms of total length, number of lineaments and directions. The number and the total length of the lineaments using automatic method were found to be more than the number and the total length of the faults in the fault map. The directional analysis of the automatic lineament map was done with the reference of fault map of the area and the structure features measured in the field. The results show extremely major trends in NE-SW. The pattern of the lineaments extracted from Landsat data suggests that some faults belonging to the Fault Zones were properly identified using this technique in the study area.

I. Introduction

In recent years, remote-sensing has been increasingly used for obtaining geoscientific data for both regional and small scales of investigations. Landsat Enhanced Thematic Mapper plus (ETM+) data in digital format were preferred data due to the availability of seven bands ranging from visible to mid-infrared with 30 m spatial resolution, and one thermal band with 60 m spatial resolution, this permitted a large spectrum of band combinations, useful in visual interpretation of different features. Studies of linear geologic features (lineaments) of both local and regional significance have been progressing rapidly. Lineaments have long attracted the interest of field geologists with remote sensing satellite imagery that the character and extent of these features have been realized, and lineament analysis of remotely sensed data, either by visual or automatic interpretation, is a valuable source of information for studying the structural setting. A lineament is any extensive linear surface on a planet, as a fault line or fracture line. The term "lineament" is one of the most commonly used terms in geology. Hobbs [1] first used the term lineament to define a "significant line of landscape within basement rocks. O'Leary et al. [2] described the term lineament as a mappable simple or composite linear feature of a surface whose parts are aligned in a rectilinear or slightly curvilinear relationship and which differ from the pattern of adjacent features and presumeeably reflects some sub-surface phenomenon. The purpose of this study was to test the automated lineament extraction method for detecting the lineaments over the study area, and to investigate the ability of this method in giving real results compared to the fault map.

Figure 1, shows the study area is located in the western part of Taiz state and extend between Jabal Habashi and Turbah Mawaset. It includes the highest mountains, about 2800m above the sea level.

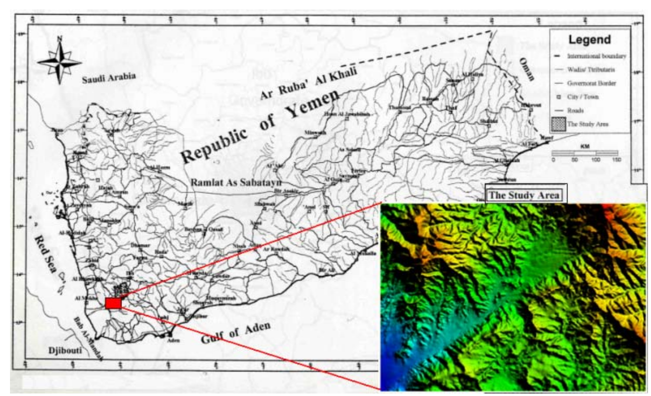


Figure 1 : Location of the study area

According to GSY [3] classification, the rocks in the study area divided into three groups as follows:

1. Proterozoic sediments (Paragneiss meta-sediments)
2. Mesozoic sediments (Cretaceous sandstones beds)
3. Cenozoic rocks (Tertiary Granitoid intrusives and volcanic rocks)
4. Recent sediments (Quaternary alluvium sediments)

The structural map of the study area (Figure 2) was digitized from geological sheet map of Taiz with scale 1:250,000.

Author α σ ρ : Geology Department, Faculty of Applied Science, Taiz University, Taiz, Yemen. E-mail : alhrani@gmail.com

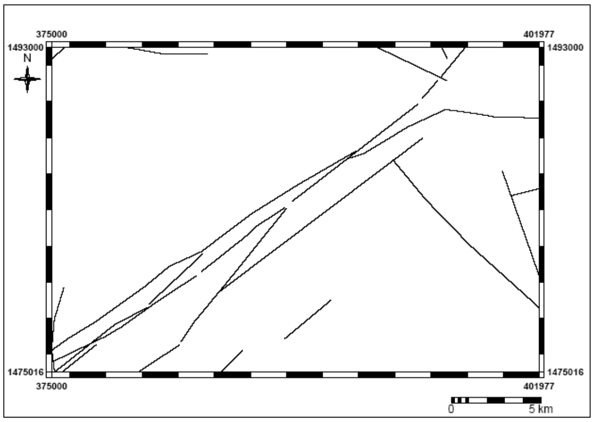


Figure 2 : Fault map of the study area

II. Materials and Methods

There are several techniques that were developed for determine the linear features and geomorphologic characteristics of the terrain. According to this paper the automatic lineament delineation was based on decision of the most appropriate band for edge enhancement, followed by edge sharpening enhancement technique which gives the best result of lineaments that are not delineated by human eyes, and apply LINE module of PCI Geomatica V9.1 for recognized lineaments. Landsat ETM-7 satellite data were used and the first step was to select the band that should be used for lineament extraction (Süzen and Toprak [4]; Madani [5]). Visual inspection of the individual bands was carried out, based on the ability to identify features, and band 5 (1.55 - 1.75 μm) (SWIR) was selected and it was stretched linearly to output range 0 to 255 (Figure 3). The second step was to select the filter type. For this purpose, different types of filters are tested. Edge sharpening filter was the best which convolved over band 5. Edge sharpening enhancements make the shapes and details for analyses (Richards [6]). Edge sharpening was applied using PCI Geomatic software package. And finally the final image of the study area was used for automatic lineament extraction. According to Abdullah, A et al. [7], the lineament extraction algorithm of PCI Geomatica software consists of edge detection, thresholding and curve extraction steps. These steps were carried out over band 5 image under the default parameters of the software as follows:

RADI = Radius of filter in pixels, GTHR = Threshold for edge gradient, LTHR = Threshold for curve length, FTHR = Threshold for line fitting error, ATHR = Threshold for angular difference, and DTHR= Threshold for linking distance (PCI Geomatica [8]).

According to the six parameter above. Several lineament maps were generated using different threshold values. The most suitable threshold values were selected (below) considering these lineaments as fault lines. General properties of faults were taken into consideration such as the length, curvature, segmentation, separation and so on in order to determine the threshold values. The parameters in this application are selected as follows:

•RADI=12, •GTHR=80, •LTHR=30, •FTHR=10, •ATHR=30, •DTHR=15.

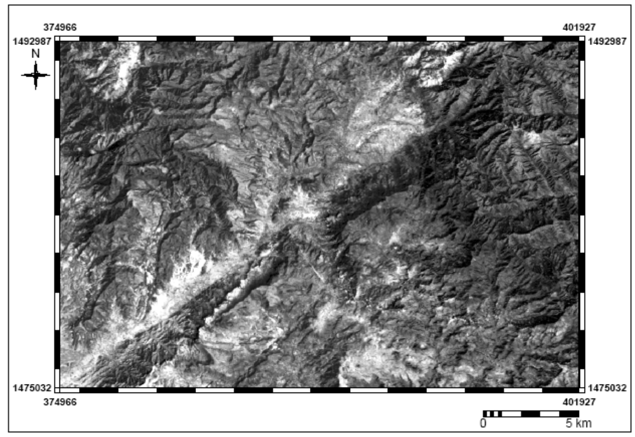


Figure 3 : Band 5 of Landsat ETM-7 after contrast enhancement

III. Results and Discussion

Lineament maps are generated using different values. The most suitable values were selected as mentioned in the above section considering these lineaments as fault lines (Figure 4). In order to test the ability of this method to extract the lineaments. The results obtained from automatic lineament detection need to be checked (Abdullah, A et al. [9]). For this purpose, the fault map of the study area was used in this work.

As seen in Table 1, it was noticed that the automatic lineament map has the higher lineaments number compared with the fault map. The highest score of the lines number was recorded in the automatic lineament map as 362 and whereas the lowest score of the lines number was recorded in fault map as 25.

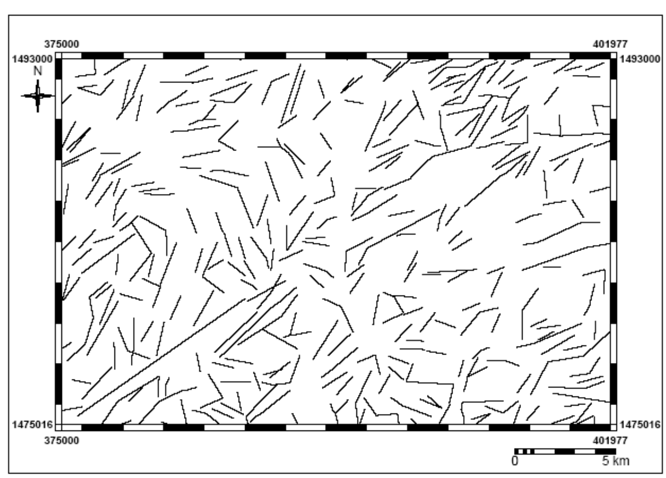


Figure 4 : Automatic lineament map over the study area

Table 1: Basic statistics of the automatic lineaments map and fault map

Variables	Fault map	Automatic lineaments map
No. lineaments	25	362
Max. length (Km)	21.345	17.05
Min. length (Km)	0. 711	0.855
Total length (Km)	154.590	539.815
Avg. length (Km)	6	1
Std. length (Km)	4	0.8

The total length of lineaments was (539) km for automatic map, and (154) km for fault map. And the average length of lineaments was (1) km for automatic map and (6) km for fault map. The total length of lineaments was 539 km which was the highest value. The maximum length of lineaments was (17) km for automatic map, and (21) km for fault map. And the minimum length of lineaments was (0.855) km for automatic map, and (0. 711) km for fault map.

The number and the total length of the lineaments using automatic method were more than the number and the total length of the faults in the fault map. This result was possibly due to the fact that the automatic lineament extraction method approach does not discriminate man made features during the analysis, as well as the automated lineament extraction method was worked successfully over the hilly area (topography might be the main reason for this problem which was eliminated in the data bands and easy to extract by using automatic method). This leads to increases the total number and length of the lineaments.

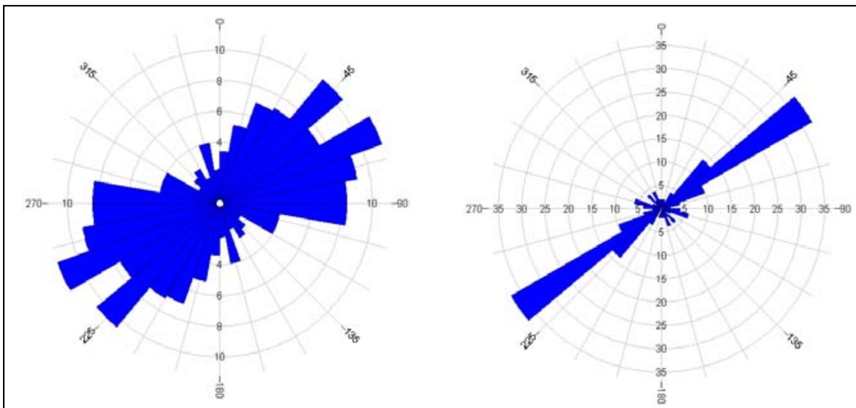
The most important factor for this was that the lineaments in an automated one were shorter in length so that a few of them could be combined to form one long lineament.

The orientations of lineaments and faults lines were created by using rose diagrams (Figure 5) and the results mostly showed great similarities. The main trends observed in the structural truth map (fault map), field features and the lineament map could be recognized in these diagrams, showing strongly major trend in NE-SW, and the subdominant directions were in E-W, NW-SE and N-S. All these lineaments directions were coincide with the major faults directions.

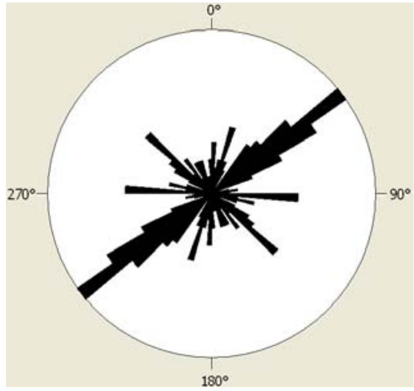
Generally, the pattern of the lineament maps extracted from Landsat ETM-7 data suggests that some faults belonging to the some areas were properly identified in the study area. Lineaments in other parts especially in the central and southern sections display a typical pattern of the faults such.

There were some of lineament lines in the lineament map could not matched any fault line in the output map of the fault map, also there were some fault lines in the fault map could not matched any lineament lines in the lineament map. This means the algorithm of the automated lineament extraction method does not work successfully to identify all the linear features existing in the area, and it needs some mathematical enhancements and applying it with different satellite images, different resolutions, and different geological environments. Anyhow, this technique may be still a good technique in the moment but, expert knowledge is always required to evaluate the extracted lineaments.

Automated methods require an inordinate amount of computer processing of the image and adequate algorithms for lineament identification which at the present time are still being develop and would still not produce an accurate map devoid of cultural effects. This means that the machine method still requires some interaction to eliminate cultural effect.



Dominant directions of lineaments   Dominant directions of faults



Dominant directions of features measured in the field

Figure 5 : The dominant directions of lineaments, faults and field features

IV. Conclusions

Landsat (ETM-7) imagery has higher spatial resolution (30 m) was providing us a powerful for lineament study and analysis especially in the semi arid area. The image enhancement was one of the useful tools to improve the interpretability or perception of information in images for human viewers, or to provide better input for automated image processing techniques, one of those enhancements is edge sharpening enhancement technique for enhancing the edges in an image. Automatic lineament delineation was developed for minimizing the power and saving time. Whereas, non-geological and artificial lineaments may be added to the final lineament map due to the nature of algorithms used. Automatic methods needs advance mathematical algorithms and proved this enhancement by applying it with different satellite images, different resolutions, and different geological environments to improve this technique.

References Références Referencias

1. Hobbs, W. H., 1904. Lineaments of the Atlantic Border Region. *Geological Society* .American Bulletin, 15: 483-506.
2. O'Leary, D. W., Friedman, J. D., & Pohn, H. A. 1976. Lineament, linear, lineation: Some proposed new standards for old terms. *Geological Society America Bulletin* 87:1463-1469.
3. Geological Survey of Yemen (GSY). 1990. Geological Map of Taiz area, 1st edition, scales 1:250,000.
4. Süzen, M.L. & Toprak, V. 1998. Filtering of Satellite Images in Geological Lineament Analyses: An Application to a Fault Zone in Central Turkey. *International Journal of Remote Sensing* 19(6): 1101-1114.
5. Madani, A. A. 2001. Selection of the Optimum Landsat Thematic Mapper Bands for Automatic Lineaments Extraction, Wadi Natash Area, South Eastern Desert, Egypt. *Asian Journal of Geoinform-atics* 3(1): 71–76.
6. Richards, J.A. 1986. *Remote Sensing Digital Image Analysis*. New York: Springer- Verlag.
7. Abdullah, A. Akhir, J.M. & Abdullah, I. 2010. Automatic Mapping of Lineaments Using Shaded Relief Images Derived from Digital Elevation Model (DEMs) in the Maran-Sungai Lembing Area, Malaysia. *Electronic Journal of Geotechnical Engine-ering* 15(J): 949-957.
8. PCI Geomatica. 2001. *PCI Geomatica user's guide version 9.1*. Ontario. Canada: Richmond Hill.
9. Abdullah, A. Akhir, J.M. & Abdullah, I. 2010. The Extraction of Lineaments using Slope Image Derived from Digital Elevation Model: Case Study: Sungai Lembing-Maran area, Malaysia. *Journal of Applied Sciences Research* 6 (11): 1745-1751.