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# Manual and Automatic Extraction of Lineaments From Multispectral Image in Part of Al-Rawdah, Shabwah, Yemen by Using Remote Sensing and GIS Technology

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***Abstract*— Lineaments extracted from satellite data have advantage of extracting lineaments which are not recognizable by the human eyes. Lineaments are considered as one of the most important topographic features used in exploring resources such as minerals, groundwater, oil and gas etc. beside they are indicators of structural and tectonics of a basin. Satellite data become useful for extract lineament feature especially in high resolution images. Lineaments have been extracted by manual and automatic methods successfully in parts of Al-Rawdah, Shabowh, YEMEN. Various image processing methods such as spatial filters and FCC applied in manual method whereas PCA technique and various default parameters have been applied for automatic technique. These, methods used for remove the noise, sharp the linear feature and enhance the image. Numbers of software have been used such as Erdas Imagine2014, Arc GIS 10.2.2, PCI Geomatica13 and Rockwork15. Four geospatial analyses have been applied for assess the extracted lineaments such as length, density, and intersection density and orientation analysis. The total length of manual and automatic maps after superimpose are 740km and 1978km respectively. The lineament density in all manual and automatic concentrate largely at NE &SW. The intersection density map for manual extraction concentrated largely at NW&SE of the study area, besides in automatic intersection density mostly concentrate in NE&W. Rose diagram indicated that the dominate trend of lineaments are NE-SW. The study area demonstrate the utilize of Landsat ETM+ for extract automatic and manual lineaments to assess and compare between them.**

***Index Terms*— Lineaments, Manual and automatic extraction, geospatial analysis.**

## I. INTRODUCTION

The most widely definition of lineaments is a linear surface features, which differ clearly from the pattern of adjacent features and assess, reflect subsurface phenomenon (O, Leary et al., 1976).It can be derived from remotely sensed data, geological and geophysical maps. Lineaments can be natural features such as fault, joint, line weakness, cliffs, terraces, and linear valleys or artificial features such as road, tracks, and buildings. Lineaments are one of the most important topographic features used in exploration of resources such as minerals, hydrocarbons (Dix and Jackson, 1981), hydrogeological researches and hot spring detection (Rowan and Lathram 1980, Sabins, 1996) as well as to solve certain problems in the area for instance, in site selection for construction a dams, bridges, roads, etc., for seismic and landslide risk assessment etc. (Stefouli et al, 1996). Lineaments extracted from satellite images by using digital image enhancement and filtering techniques (Chang et al. 1998).The purpose of this paper to use Landsat ETM+ data for extract manual and automatic lineaments to assess and compare between them.

## II. STUDY AREA

Al-Rawdah area is located in Shabwah provenance, southeastern central of Yemen between $14^o 20'$ to $14^o 40'$ N latitudes and $47^o 00'$ to $47^o 30'$ E longitudes (fig.1). The total area is about 1492km$^2$. It ranges from 15C$^o$-26C$^o$. The maximum and minimum elevations encountered in the basin are 1743 m and 594 m above main sea level MSL, respectively.

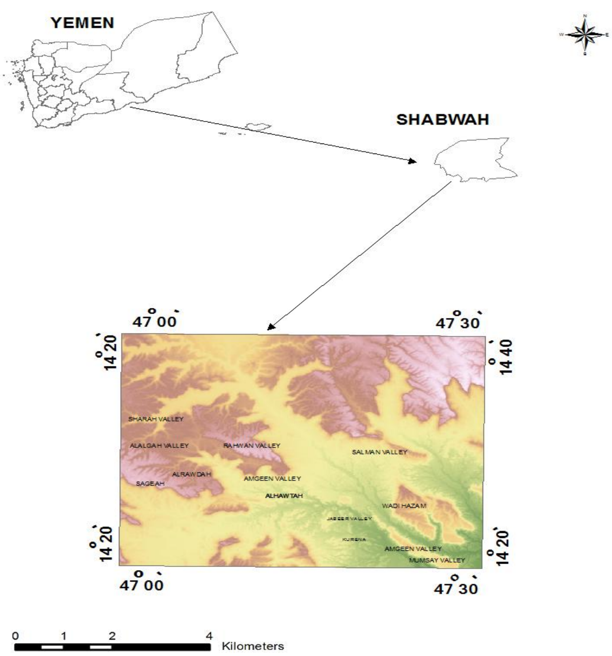


**Fig.1: Location map of the study area**

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## III. DATA PROCESSING

Landsat-7 ETM+ of 30m resolution 2005 which was downloaded from (GLCF) website and used for extraction lineaments in the study area. Various techniques have been used for determined the linear features in the study area such as manual extraction technique (visual interpretation) and automatic extraction technique. Various image processing enhancement have been applied for manual lineament extraction by using Erdas Imagine2014 software. Various image processing technique have been used for filtering operations (Suzen and Toprak, 1998; Chang et al. 1998; Mah et al. 1995), Principal Component Analysis (PCA) (Qari, 1991; Nama, 2004) and the false color composite is the most commonly used ones and will be applied in this study to smooth and remove the noise in the image. Lineament extracted automatically by using various parameters for edge enhancement and edge sharpening enhancement technique which gives the best result of lineaments that are not recognized by human eyes using the module line of Geomatica which extracted linear features from a single image and record the output as polyline with vector segments. Extracted lineaments statistically analyzed to determine lengths, density, intersections of the lineaments, generate rose diagram, lineament density map and lineament intersections map. Extraction lineaments have been plotted in Rockwork15 as rose diagram to show the direction/orientation of the lineaments. Arc GIS 10.2.2 has used for overlying, mapping, visualization and calculate different parameters.

## IV. RESULT AND DISCUSSION

### A. Geological setting

The geological set-up of an area comprises rocks dating from Mesozoic to Recent which show in (fig.2&table 1).

**Table 1: geological unit of the study are**

| Age | Geological Formation | Lithology |
|---|---|---|
| Quaternary | Alluvium | Sand, Silt, Clay, Gravel ,Conglomerate |
| Paleocene | Jiza | shale |
| | Jawl | Limestone |
| | Umm er Rdumah | Limestone |
| Cretaceous | Tawilah | Sandstone |

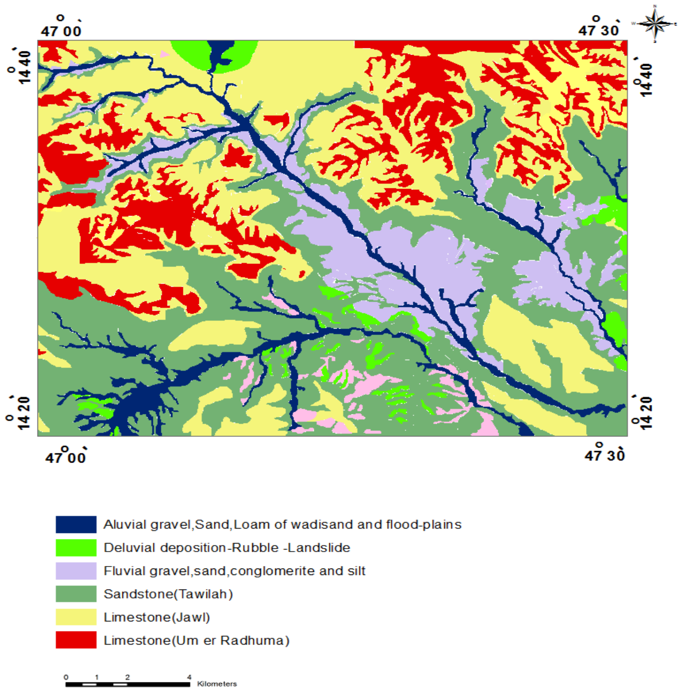



**Fig.2: Geological map of the study area (Derived from SOY geological map D 38-59)**

### B. Lineament extraction

There are two common methods for extraction of lineament from satellite data:

(1) Manual Extraction

Digitize the lineaments by user directly from the geological map either satellite data by using directional or non-direct filters such as the laplacian directional filter edge and sobel directional filter edge which make more enhancement then the lineaments are digitize manually. The visual extraction is mainly depending on the quality of the image and the proficiency of user. In the study area lineaments digitize manually from false color composition (FCC) image as showing in (fig.3), soble 3*3 and laplacian 3*3 filters technique (fig.4 A&B), and geological fault map (fig.4 C).

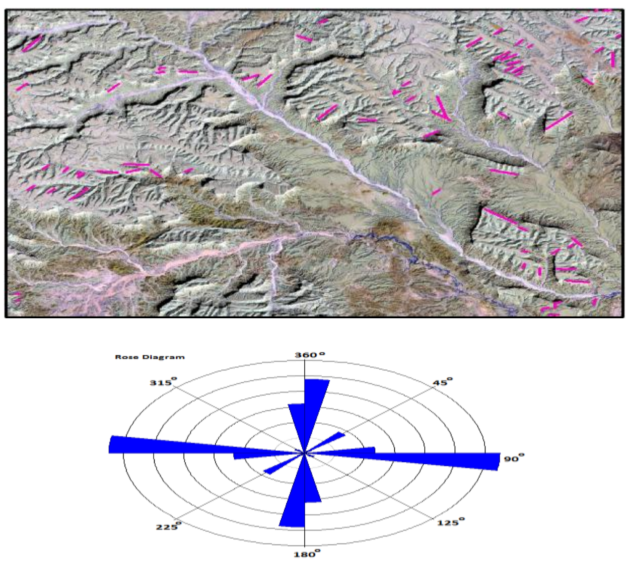
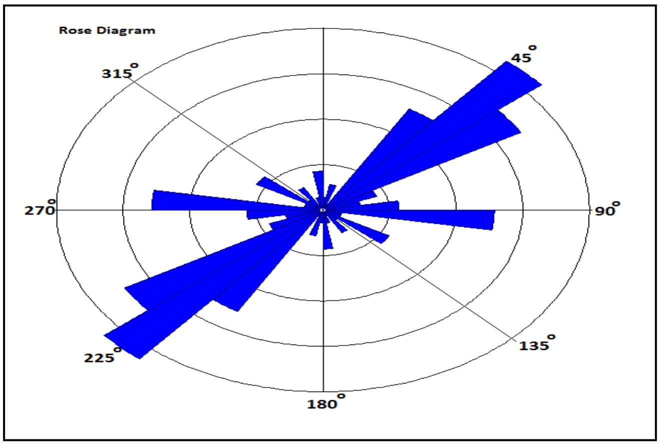
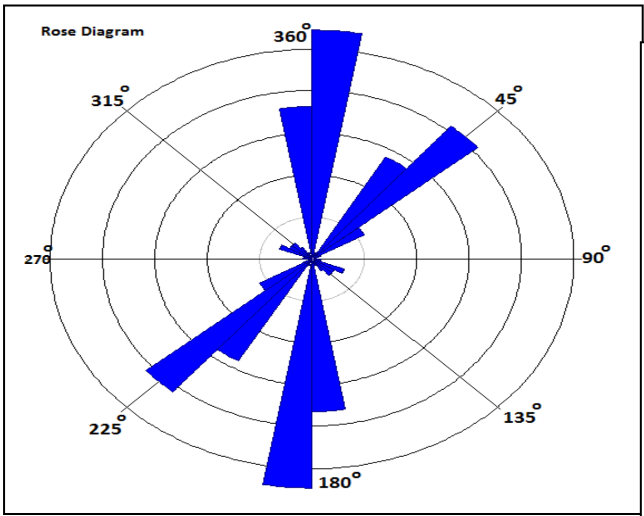
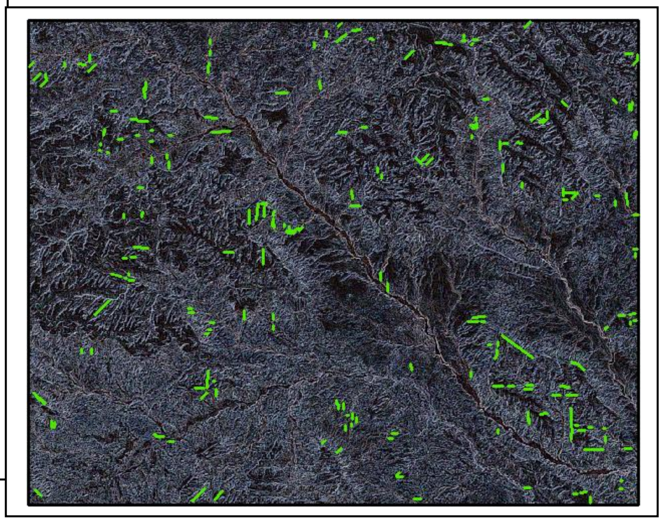



**Fig.3: FCC lineament map with rose diagram of the study area.**



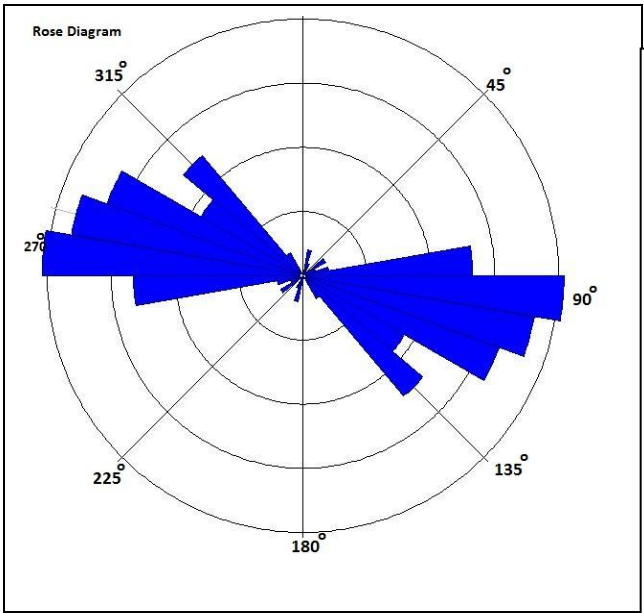

A.



B

B.



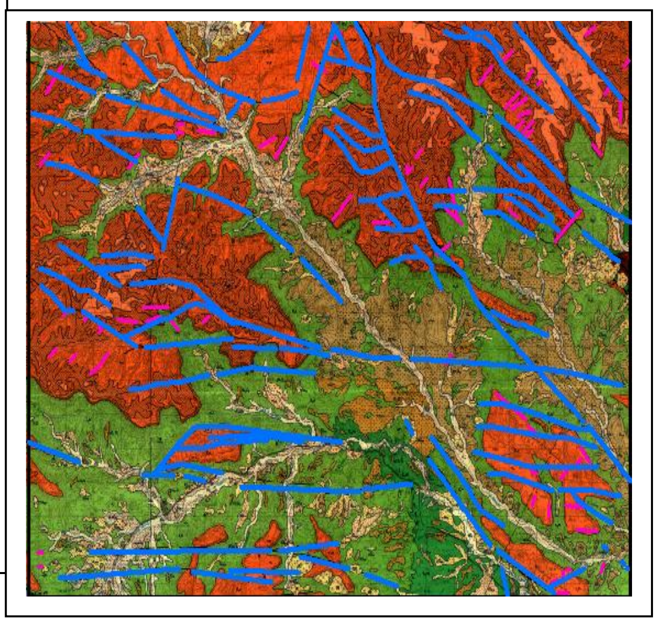
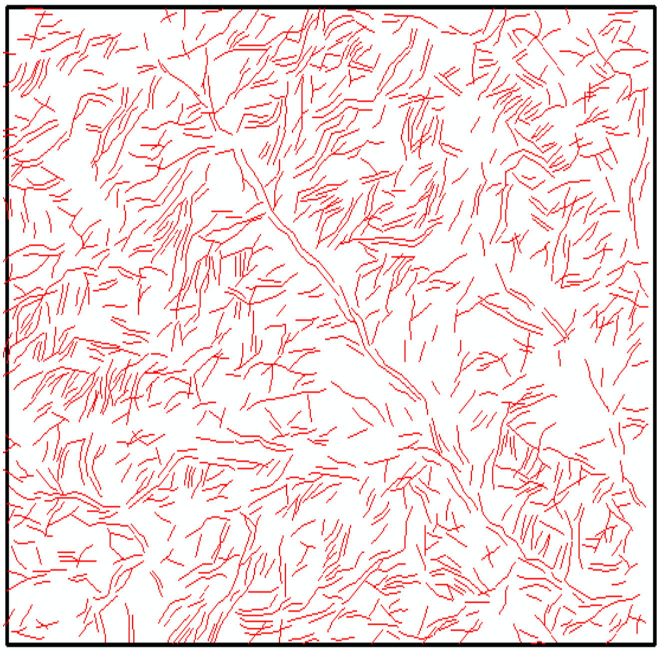



**Fig. 4: A&B: Sobel and laplacian filtering lineaments map with rose diagram C: geological faults map with rose diagram.**

(2) Automatic extraction

Lineament extracted automatically by using the module line of Geomatica which extracted the linear feature from a single image of PCA best band and record the output as polyline with vector segment. Various parameters control automatic extraction of the lineament process for more enhancements. These parameters are performed in a short time (Sarp et al 2005). In the present area lineaments extracted automatically from Landsat ETM+ after applied principle component analysis (PCA) technique for more enhancement as showing in (fig.5).



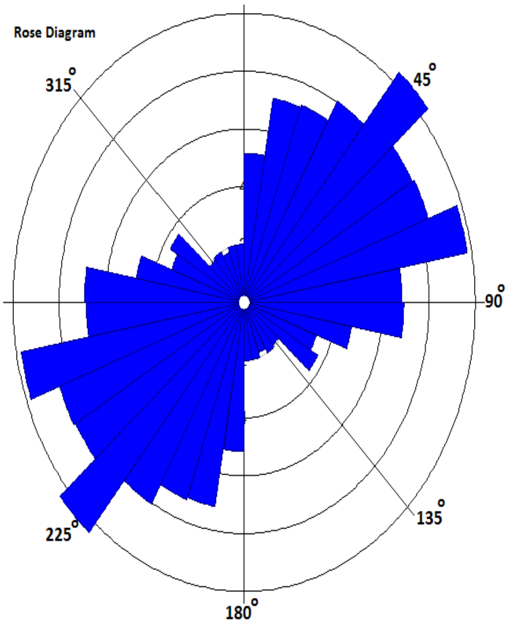



**Fig.5: Automatic lineament map with rose diagram of the study area**

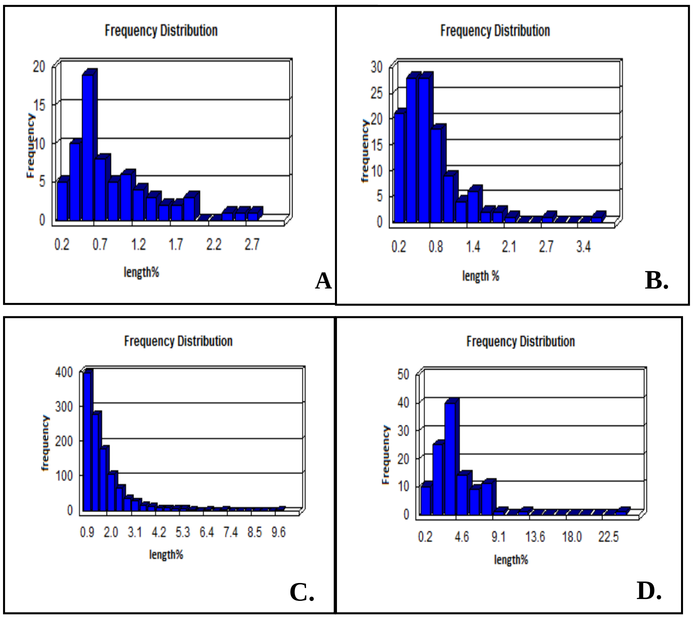
C. Geospatial analysis

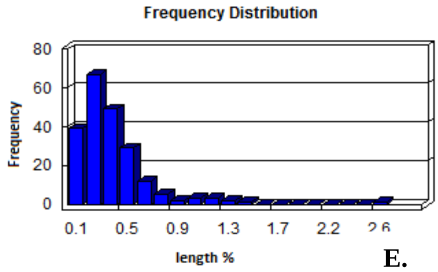
(1) Length of lineaments

Length of lineaments is a total length of all demarcates lineaments divided by the area under of interest. Lineaments length is considered as one of the most important characteristics for interpreting lineament map. Length analysis has been applied on the both manual and automatic extracted lineaments of the study area. Parts of Al-Rawdah basin contain lineaments length 79.6km for sobel lineaments map, 94.8km for laplacian lineament map, 66.6 km for FCC lineaments map and 499km for geological fault map which have been calculated digitally by using Arc GIS 10.2.2 and show lineament of automatic extraction was highest value as showing in table 2.whereas total length manual and automatic maps after superimpose are 1978km and 740km respectively table 2. Frequency distribution in whole Al-Rawdah demonstrated in (fig 6&7). The basic statistics analysis of manual and automatic extraction is show in table 3.

**Table 2: basic statistics of the manual and automatic lineaments map and fault map**

| Variable | Manual lineament map | | | | Automatic lineament map |
|---|---|---|---|---|---|
| | Soble filtering | FCC | Geological fault map | Laplcian filtering | PCA |
| NO. Lineament | 121 | 70 | 112 | 213 | 1143 |
| Max. length(km) | 3.7 | 2.68 | 24.9 | 2.68 | 9.7 |
| Min. Length(km) | 0.1 | 0.2 | 0.18 | 0.10 | 0.9 |
| Total length(km) | 79.6 | 66.6 | 499 | 94.8 | 1978 |
| Mean (km) | 0.80 | 0.95 | 4.4 | 0.44 | 1.7 |
| Std. length(km) | 0.52 | 0.5 | 3.0 | 0.28 | 0.8 |





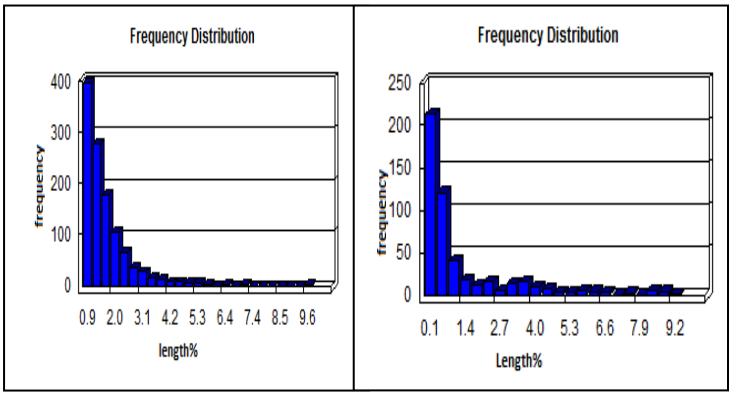

E.

A: Sobel 3*3 B: Laplacian 3*3
C: FCC D: Geological fault
E: Landsat PCA

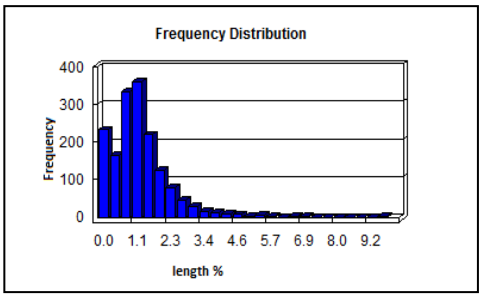
**Fig.6: frequency distribution of manual and automatic extraction lineaments**

**Table 3: basic statistics of total manual and automatic extracted lineament map**

| Variable | Automatic lineaments | Manual Lineaments |
|---|---|---|
| NO. Lineament | 1143 | 516 |
| Max. length(km) | 9.7 | 9.4 |
| Min. Length(km) | 0.9 | 0.10 |
| Total length(km) | 1978 | 740 |
| Mean (km) | 1.7 | 1.41 |
| Std. length(km) | 0.8 | 1.8 |




A. B.

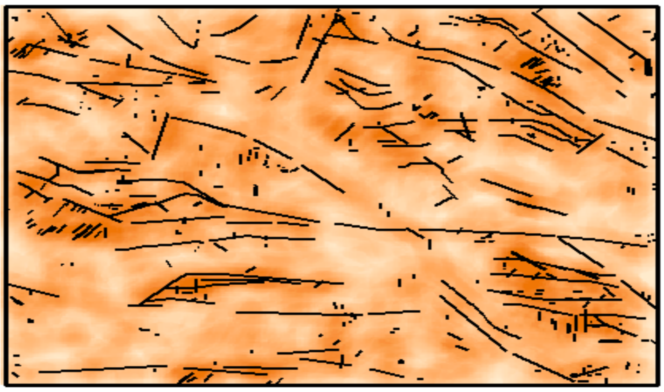



C.

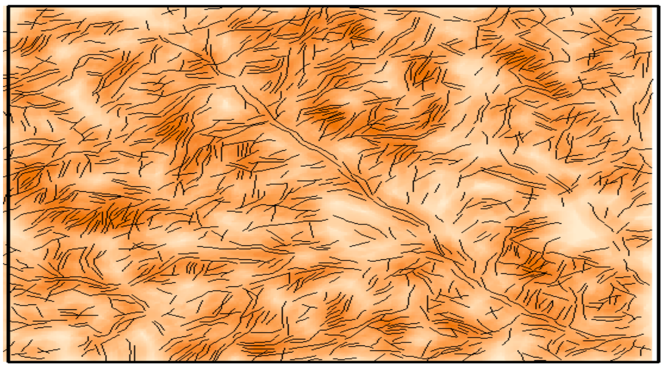
**Fig.7: Frequency distribution of total A: Manual lineaments, B: Automatic lineaments and C: Superimpose both manual and automatic lineaments**

(2)Density of lineaments

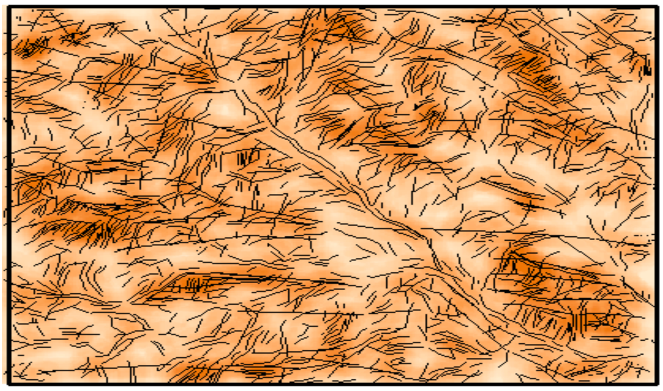
Lineament density map is become another method to analysis the extract lineament which refers to the length of lineaments per unit area (Cosford et al 2013). The lineament density is created by spatial analyst tool in ArcGIS10.2.2 software by counting lines digitally per unit (number/km$^2$) area and then plotted in the respective grid centers and contoured using the same tool. The analysis of lineaments will demonstrate a map showing concentrations of the lineaments over the area. (fig.8a, b&c) show lineaments densities of all manual and automatic and superimposed them which show the lineaments concentrated at NE&SW. These lineaments observed where there are higher elevations and less overburden, while the lowest densities are found in the central of the study area



A.



B.

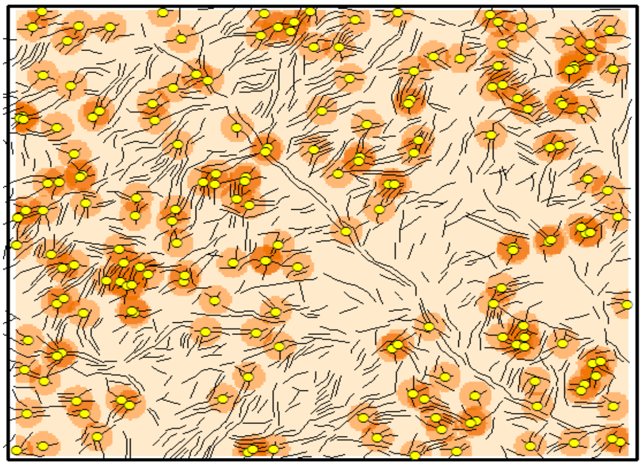


C.

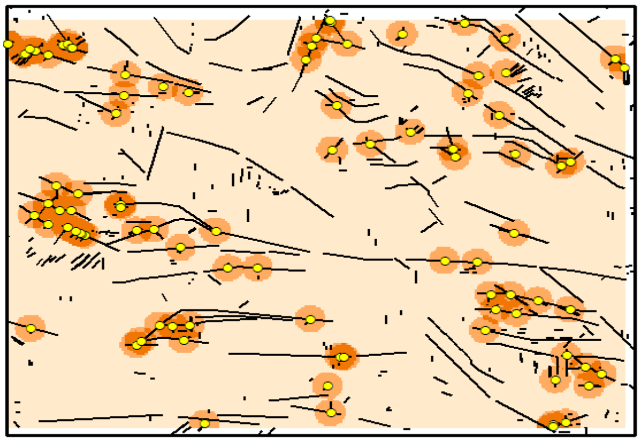
**Fig.8: Density maps of A. all manual lineaments, B. Automatic lineament C: Superimpose all manual and automatic lineaments.**

(3)Intersection density analysis

Lineament intersection density is defined as map showing the frequency distribution of intersections lineaments that occur in a unit area (Sarp et al 2005) which purposed to estimate the areas of diverse lineament orientation (Gulcan Sarp and Vedat Toprak). If the lineaments don't intersect in an area, the result map will be represented by a plain map with almost no density contours and the lineaments almost parallel or sub parallel in an area (Hassan et al 2014). The lineament intersection map of study area indicates high and very high intersection in the same areas where there is very high density of lineaments. The zone of high lineament intersection over study areas is feasible for various sources. Other purpose of use intersection density map is to estimate the areas of divers lineament orientation (Hassan et al 2014).In the automatic intersection density, the highest intersection densities show in NE&W of the study area whereas highest intersection densities in all manual density map is indicated in NW-SE of the study area (fig 9.A&B).



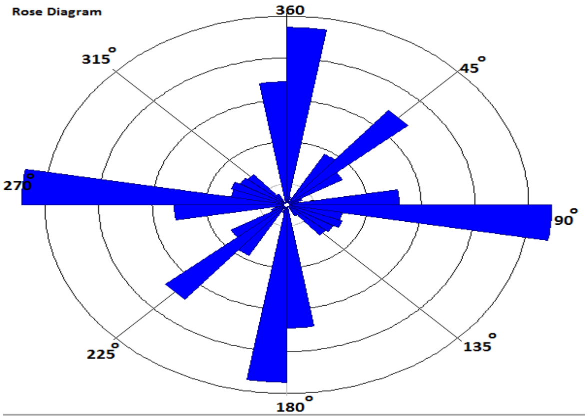
A.



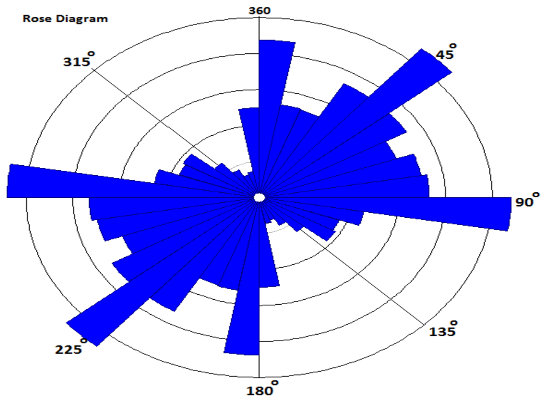
B.

**Fig.9: The lineament intersection density map of A. automatic and b. manual extraction.**

(3) Orientation of the lineaments
Lineaments orientation (azimuth) is considered as one of the most important characteristics for different purpose such analyzing dominant lineaments trends. Orientations of the lineaments have been analyzed by rose diagrams which display lineaments length by using rockwork15 software. The rose diagram shows NE&SW direction for automatic lineaments (fig.5) whereas NW-SE for manual lineaments (fig.10.A) respectively. Superimpose all manual lineaments map mostly at NE-SW (fig.10.B).




A.




B.

**Fig.10: Rose diagram of total A: Manual lineaments and B: Superimpose both manual and automatic lineaments**

## V. Conclusion

Remote sensing and GIS technology become a good technique for study various geological application. Lineaments have been extracted manually and automatically successful in part of Al-Rawdah, Shabwah, Yemen. Digital image processing has been carried out for enhancement different themes. Four geospatial analysis have been analyzed the lineaments which is length, orientation, lineament density and lineaments intersection density.

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## REFERENCES

[1] Beydon R. Ziad, Alsaruri L. A., El-nakhal Hmed, Al-Ganad N. Esmail, Baraba S. Saleh, NaniO. AbdullSattar, Al-Aawah H. Mohammed (1998) International lexicon of Stratigraphy-Geological of Yemen, IUGS.3(34): 48-229

[2] Chang, Y., Song, G., HSU, S.( 1998) "Automatic Extraction of Ridge and Valley Axes Using the Profile Recognition and Polygon-Breaking Algorithm", Computers and Geosciences, Vol. 24, No.1, 83-93.

[3] Dix. O.R., Jackson, M. P. A (1981) statistical analysis of lineament and their relation to fracturing, faulting and halokinesis in the east Texas basin. Burea of economic geology, the University of Texas at Austin TX, report 110, 30.

[4] Gulcan Sarp (2005) **"**Lineament Analysis From Satellite Images, North-West of Ankara**"** Msc theses Middel east Technological University pp2.

[5] Jason Cosford and L.A. Penner (2013) Lineament interpretation, NWMO REPORT NUMBER, page 39 APM-REP-06144-0054

[6] Mah, A., G.R. Taylor, P. Lennox, and, L. Balia., (1995) Lineament analysis of Landsat thematic mapper image, Australia, photogrammetric engineering and remote sensing, 61(6), pp 761-773.

[7] M.L.. Suzen, V. Toprak (1998) Filtering of satellite images in geological lineament analysis: An application to fault zone in central Turkey, international journal of remote sensing 19.6pp, 1101-1114.

[8] 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, Vol.87, 1463-1469.

[9] M. Hassan, S. Adhab(2014) Lineament automatic extraction analysis for Galal Badra river basin using landsat satellite image Iraq journal of physics 12:44-55.

[10] Rowan, L. C. and E. H. Lathram, (1980) Mineral Exploration. Chapter 17, in Remote Sensing in Geology (B. S. Siegal and A. R. Gillespie, editors), John Wiley and sons, New York, pp. 553- 605.

[11] Sabins, F. F. (1996) "Remote Sensing: Principles and Interpretation, 3rd Ed.: W. H. Freeman and Company", New York, 494 pages.

[12] Stefouli, M., A. Angellopoulos, S. Perantonis, N. Vassilas, N. Ambazis, E. Charou, (1996) "Integrated Analysis and Use of Remotely Sensed Data for the Seismic Risk assessment of the southwest Peloponessus Greece". First Congress of the Balkan Geophysical Society, 23-27 September, Athens Greece.

[13] Qari, M.Y.H.T. (1991) "Application of Landsat TM Data to Geological Studies, Al- Khabt Area, Southern Arabian", Photogrammetric Engineering and Remote Sensing, Vol.57, No.4, 421-429.

[14] Nama, E.E. (2004) "Lineament detection on Mount Cameroon during the 1999 volcanic eruptions using Landsat ETM", International Journal of Remote Sensing, Vol, 25, No.3, pp.501-510.