DEVELOPMENT OF AUTOMATIC GEOLOGICAL LINEAMENT EXTRACTION SOFTWARE FOR SUPPORTING CONSTRUCTION ACTIVITIES

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1. INTRODUCTION

Preliminary geological investigations have been conducted to find suitable construction site and to assess engineering geological characteristics before detailed in situ investigation for large scale construction activities such as highway, railroad, subway or underground cavern constructions. The geological stability is a very important and critical factor for safe maintenance of structures and facilities. Distribution of geological lineament is directly connected to geological stability of the area, but conventional wide area investigations as a preliminary investigation step were time consuming and labor intensive. Using remote sensing data and automatic analysis software can suggest quantitative standard processes for those analyses and improve working efficiency.

2. GEOLOGICAL LINEAMENT EXTRACTION

Geological lineament is a lineament is a mappable, simple or composite linear feature of a surface, whose parts are aligned in a rectilinear or slightly curvilinear relationship and which differs distinctly from the pattern of adjacent features and presumably reflects a subsurface phenomenon [1]. Geological lineament extraction and analysis is essential part in geological investigation reports for construction activities in Korea. Table 1 shows methods for geological lineament analysis using remote sensing data from various geotechnical site investigation reports. The analyses have been conducted by using naked eyes of geologists so inconsistent and qualitative results can be carried out according to analyst.

Table 1. Methods for geological lineament analysis using remote sensing data from geotechnical site investigation reports

type of construction	no. of reports	methods for geological lineament analysis using remote sensing data
highway	2	false color composite analysis, principal component analysis, Sobel filtering, rosette diagram display
subway	1	direction and length analysis using ASTER & ICONOS image, digital elevation model analysis
railroad	3	direction and length analysis using Landsat image, digital elevation model analysis, lineaments density map analysis, color synthesis analysis

3. DEVELOPMENT OF "TOPOLINER"

3.1. Algorithm of Topoliner

We designed and programmed automatic geological lineament extractor which is named Topoliner (fig. 1). Topoliner was developed by applying Hough transform with Matlab software to detect accurate and precise distribution of geological lineaments automatically. Hough transform changes data coordinate between image plane and parameter plane [2] with following formula.

$$x \cos\theta + y \sin\theta = \rho \quad (\theta: \text{angle}, \rho: \text{distance}).$$

Hough transform also use the parameters, accumulation cell size and cell accumulation numbers, to connect gaps between lineament segments. This software can overcome conventional geological lineament extraction methods which produce qualitative and subjective results according to analyst. Automated statistical analyses of extracted lineaments support quantitative estimation of geological structure of the bedrock. Hough transform has an advantage for connecting gaps from various objects such as vegetations and shades. The territory of Korea is covered with vegetation about 70% of its surface so Hough transform is useful to extract hidden and disconnected lineaments. Also Hough transform can extract complete line better than a simple set of pixels from edge enhancement techniques.

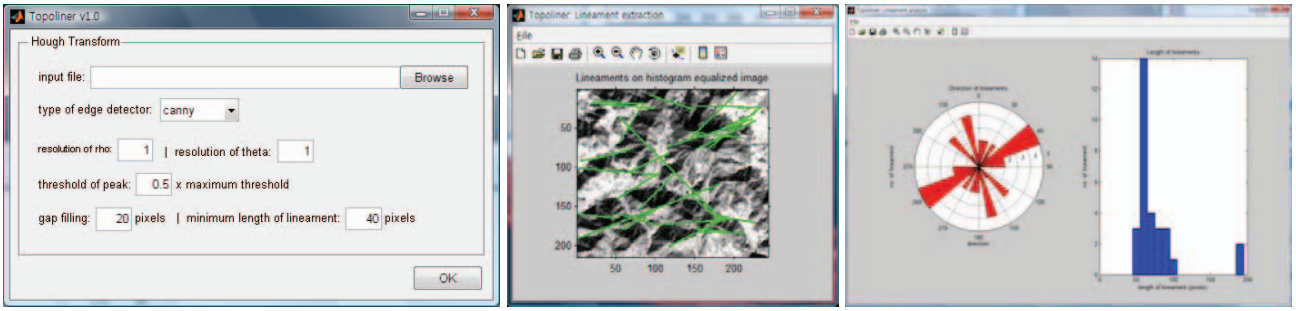

Fig1. Interface of Topoliner and an example of analysis result

3.2. Satellite dataset for case study

We constructed Landsat7 ETM+ dataset of fall season for whole South Korea and applied the developed software to south coast areas. A part of tree leafs is removed at the fall, so satellite images obtained at the fall season without snow were selected to minimize effects from vegetation occluding. Only one scene acquired in spring season is included in the dataset due to difficulties to obtain the data of fall.

4. CONCLUSION

We developed Topoliner software to extract automatically geological lineament and to analysis their distribution condition. Topoliner contains functions of histogram equalization, edge detection using various filters, Hough transform, automatic lineaments extraction, direction analysis, direction and length distribution analysis and lineament density mapping. This software can improve conventional geotechnical site investigation, especially subjective lineament extraction process, so quantitative standard process and analysis results can be carried out.

5. ACKNOWLEDGEMENT

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6. REFERENCES

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