DIGITAL FIELD DATA SYSTEM FOR GEOLOGICAL MAPPING AND GEOHAZARD MANAGEMENT

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ABSTRACT

Data acquisition is an important branch of Geoinformatics as the Geoinformatics system starts with the process of data acquisition, database construction, and ends with the tools and models that will help define the processes of our earth system. The practice of geological mapping and geohazard evaluation requires field data collection as the results heavily base on good geological field data. Field data collection includes the identification of the geological features, structural data and other parameters. Final products of beautiful maps or imposing models are nonsense if these input field data are not correctly collected.

The study aims to develop a Digital Field System for the acquisition, processing, management, analysis, and presentation of geospatial data. The primary objective of the research is to design and implement an information technology-based system for geologic mapping and geohazard management where the relevant information will be processed and communicated effectively. Its main components include: 1) A data management tool in GIS-based environment to facilitate the acquisition, visualization and storage of large amounts and widely varying types of data from various sources, 2) A data collection tool for site investigation through Personal Digital Assistants (PDAs) or laptops, which provide the built-in forms for data acquisition, 3) A digital imaging and analysis tool using close-range photogrammetry for rapid, semi-automatic geologic mapping of rock exposures, 4) A fracture projecting tool of structural data in combining with digital imaging for constructing adaptive 3D models with analytical procedure for real-time analysis at the field.

The designed system would expedite the process of updating preliminary interpretations and production of databases for analysis. The effectiveness of the system is in the efficiency and precision of field data capture, the handling of enormous amount of data and time saved from data transcription work and the compatibility of field data and final output models.

Keywords: digital field system, field data collection, geohazard management, geological mapping, information system.

1. INTRODUCTION

Field information constitutes the primary data input for a field mapping research. Field data collection involves checking the earlier made interpretations and collecting more detailed information about a number of observations such as geologic boundaries, fault evidences, failure activities and possible causes can only be described from field surveys. The application of observational methods is more difficult in the complex geologic conditions.

The laborious and time-consuming methods of data handling in geologic mapping and risk assessment on paper can be avoided by designing well-structured field databases to incorporate all spatial information. The main goal of this research was to establish a system that can be used to capture data digitally in the field for geologic mapping and geohazard management studies. Hours of data entry time in the field or in the office are reduced to a few minutes of transferring. Since data is collected digitally in a GIS environment, the researcher is in a position to visualize field results and start analysis in the field. With the basic analysis, patterns can be observed and planning of subsequent field days be executed effectively (Njagih, 2003). The system uses advances in IT, particularly in data management, digital imaging, and computation power to enhance the safe, efficient and economical use of field data.

2. FRAMEWORK OF A FIELD DATA SYSTEM.

The determination of geological mapping and geohazard management with respect to the recognition and management of geologic features and hazard activities are primarily concerned for a field data system. It must demonstrate a balance between high-quality understanding of geology and a sufficient appreciation of engineering to ensure that the relevant information will be processed and communicated effectively (Knill, 2002). Base on this concept, the flow of the field data system includes:

- A data management tool based on GIS-based environment must be initial be built. It is important that the data be recorded from the field in a structured and complete way and be readily retrievable by anyone who dig in it. The most appropriate way is to capture it digitally in a structured database from which the data can be retrieved and analysed.
- A PDA/laptop data collection tool to collect outcrop information and provide fast analysis of structural data.
- A close-range photogrammetry tool to perform face mapping and identify structural features if rock exposures are available.
- A borehole projection tool in combining with digital imaging for constructing adaptive 3D geologic models.

The data management tool is the heart of the system comprising a property maintenance database.

2.1 Data management tool of field data.

A large amount of geological and hazard information data can be acquired during the fieldwork process. This data can be fully utilized to understand the geologic model or the site condition depends on how quickly and smoothly the data can be processed and analyzed. An integrated relational database is therefore should be established and used in every step of field data gathering, from the preparation to the final stages.

Data from different sources will be stored in tables in the database and these tables are to be related through primary keys to maintain data integrity and all the records will be associated with master records.

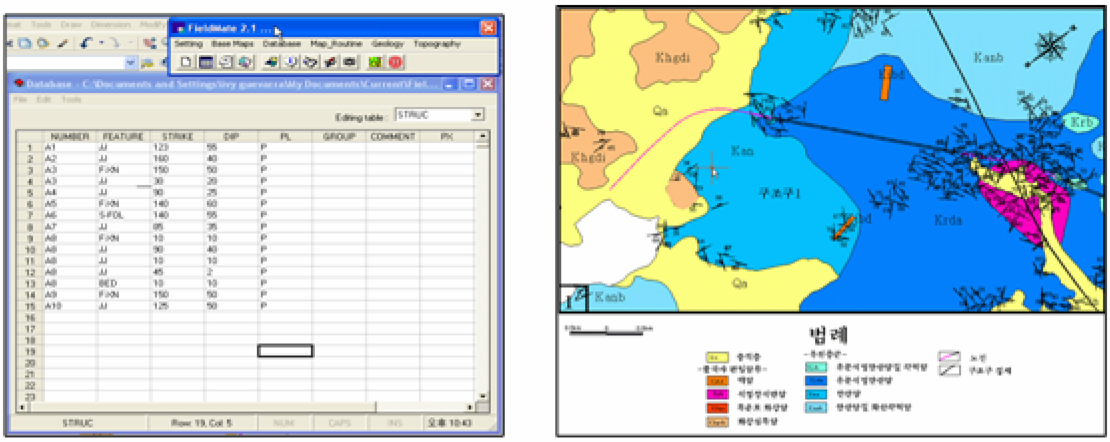

Figure 1. Central database for data storage and visualization

The designed tool can help in generating AutoCAD-based environment that contain field data for querying, structural analysis, map making and integrates with various field equipments.

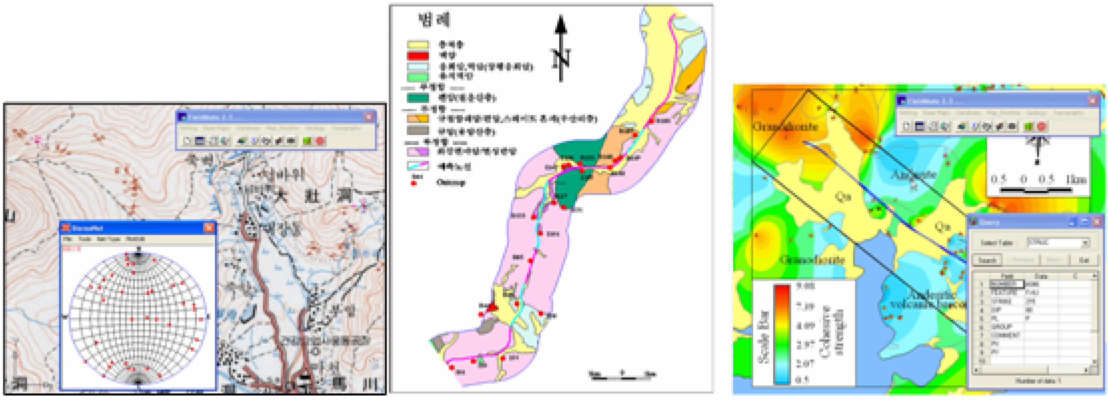

Figure 2. Data presentation and initial interpretation at the field condition.

The central database facilitates the acquisition, analysis, visualization and storage of large amounts and widely varying types of data from various sources.

2.2 Data collection tool for geologic/hazard characterization.

The data collection tool is developed on PDA as a self-explanatory data input form to record geological data based on visual/manual observations. It uses texts and pictures as standard formats to minimize personal biases.

Figure 3. Data collection using PDA

The tool can collect outcrop location by reading GPS information, record the information of lithology, structural properties. It can also perform some simple analysis such as stereonet plotting or rose diagram. For aerial photo interpretation and field mapping of landslides, checklists are used since it makes the interpreter to use a clear set of guidelines for identification and description of mass movements (van Westen, 1993). The collected data can then be transferred to the main computer for further analyses.

Recently, new models of pen-based computers are appearing that offer features that make mobile computing in harsh field conditions possible while maintaining the functionality of desktop computers. A pen-based laptop can gives the readiness of data for instant analysis in the field if require. Normally, the system consists of an input data device (e.g. laptop) and its accompaniments (camera, GPS, compass…) for data gathering.

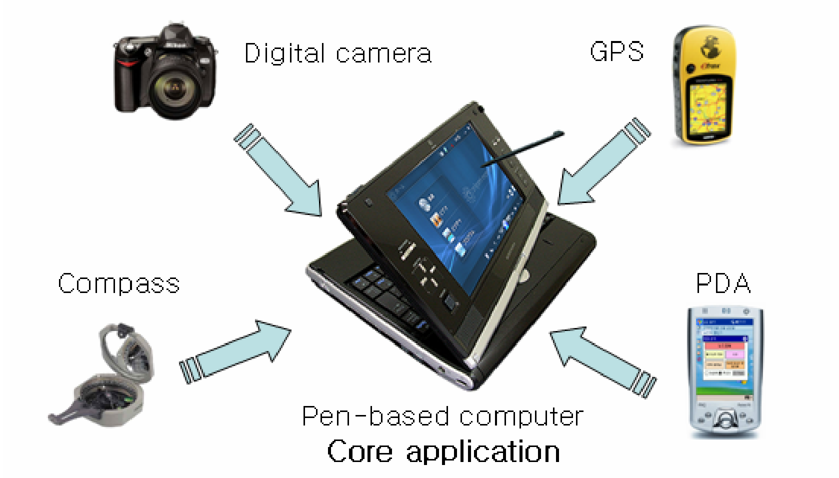

Figure 4. Components of a real-time pen-based data collection system

2.3 Digital image acquisition and interpretation tool using photogrammetry.

When the rock exposure is available, detail mapping of the rock surface can be done, especially to understand the structural condition that controls the failures. The tool composes of a camera equipment along with a software provides a new way of measuring planar and linear structures on the rock surface remotely. This tool follows the concept of close-range photogrammetry which uses two overlapping photographs for measuring 3D coordinates.

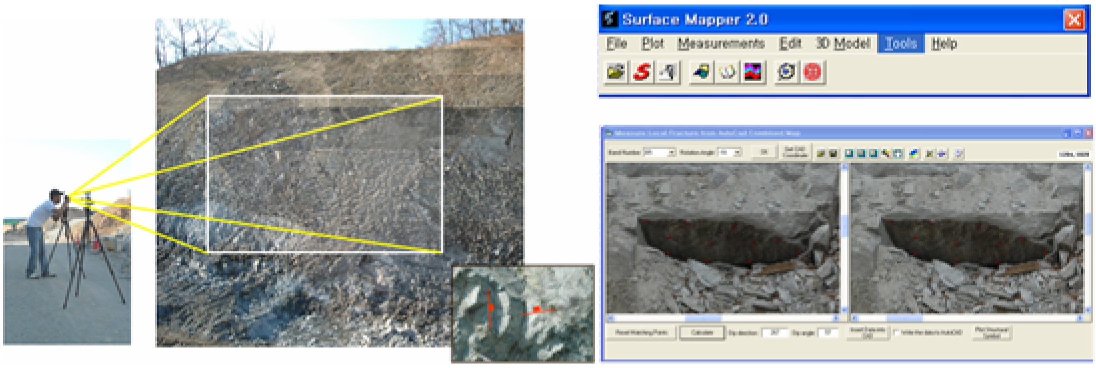

Figure 5. Measuring structural data on rock surface using photogrammetry.

The concepts are expanded to measure orientations of features, model three-dimensional view at reasonable quality as close-range digital photogrammetry offers distinct technical and economic advantages over competing technologies such as 3D laser scanning.

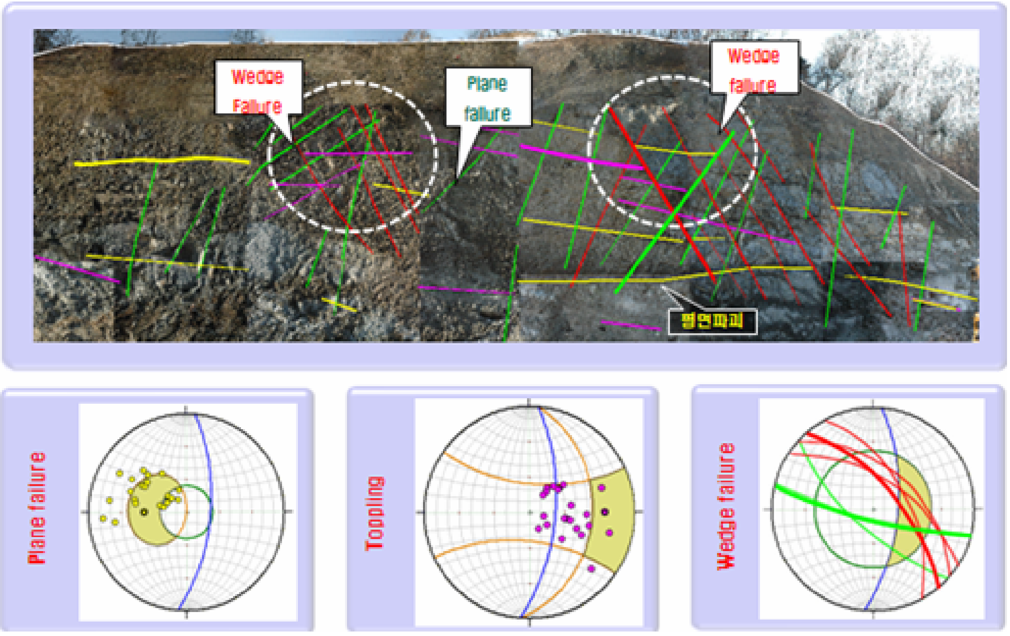

Figure 6. Failure analysis of structural data.

2.4 Borehole projection tool for constructing 3D conceptual models

The development of conceptual model requires 3D representation of the lithology and structural pattern. The information of lithology and structural features from surface or borehole data can be used to generate this kind of model.

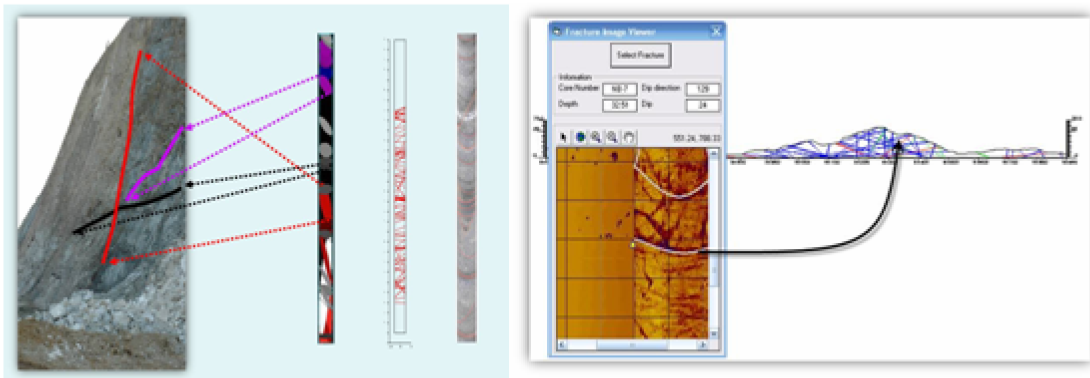

Figure 7. Projection of structural features from borehole data.

Data from digital imaging and remote measurements are used to update the geologic model of the excavation.

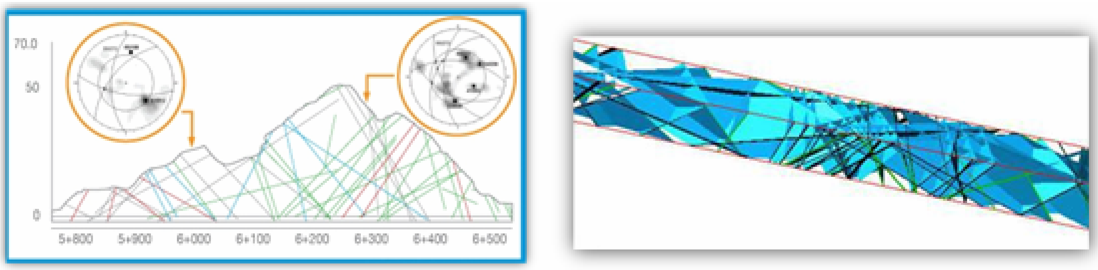

Figure 8. Structure projection on a cross section view.

3. DISCUSSION AND CONCLUSION

This research introduces a framework of a field data collection system for geoscientific studies as a contribution for the development of geoinformatics. By integrating the data of field investigations into one platform, the designed system has the capabilities of improving the mapping quality towards safe, efficient and economical ways. The system composes of different components and each of these components reflects the development in geoinformatics and will be a major contribution to data investigation, management, analysis, and presentation of geospatial data.

However, digital applications are suitable for process with well-defined and agreed field description attributes. Digital mapping seems to be a more complicated procedure than the pen and paper method since there are many details must work together like the batteries, cables, data transfer and back-up methods (Njagih, 2003). The effectiveness from digital data collection is in the enormous amount of time saved from data transcription work and the compatibility of digital field maps and final output maps.

The proposed framework has been applied and examined in the several geologic and hazard mapping projects in Korea since the initial element has started from 2001. Additional modules and analytical procedures are under developing within the framework.

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