Geo-Log Mobile: Development of Mobile GIS Application Based on New Geological Database Framework for Eruptive History and Informatics

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***Abstract*— The ACRIFIS-EHAI (AIG Collaborative Research Institute for International Study on Eruptive History and Informatics, Fukuoka Univ., Japan), established from April 2012, aims to construct a new geological database system not only for academic purposes but also for general interests. Our first goal is to develop a database system for collecting information of outcrops and buried data that researchers have in their local computers. To achieve this goal, we have proposed a new framework that can manage outcrop data with manually added tags like keywords or key-phrases and automatically added tags like GPS information. Furthermore, our framework can also deal with the various types of files as the stored data and thus the database can manage many kinds of research materials, such as from raw data to research papers and so on. The framework also provides some API (Application Programming Interface) for easy constructing of database applications. In this paper we introduce our database framework and a mobile application based on this framework for sharing outcrop information.**

***Index Terms*— outcrop database, volcanic geology, mobile application, geo-information service**

I. Introduction

OUTCROP provides fundamental information for reconstruction of eruptive history (e.g. stratigraphy, faces, thickness and occurrence of analyzed samples). Such information are important resources for not only geological study but also outreach activity for reducing volcanic hazard. In urbanized and little flat country like Japan, however, it is difficult to collect such outcrop information because they tend to disappear or be covered due to land development. As well as other countries, many outcrops are threatened by permanently damages due to various reasons. Thus several researchers have tried to construct outcrop database up to the present [1], [2], [3].

On the other hand, geological information included in outcrops are essentially flexible and unformatted data because these are used for various purpose and by wide-area researchers. Thus database designers or editors use different expressions for their target data in each applications. In addition it requires much time and effort for editing many kinds of information and categorizing each data manually. This is the another reason why construction of outcrop database is so difficult [4].

To cope with these issues, we have proposed a new framework that can collect and manage outcrop information easily. This framework provides a management mechanism for various kinds of data with manually added tags like keywords or key-phrases and automatically added tags like GPS information [5]. It enables that not only researchers but also non-expert users register a new data easily because the database doesn't require a fixed input format and a limit of data notation at the entry of the data. Furthermore, it can also deal with the various types of files as the stored data and thus the database can manage many kinds of research materials, such as from raw data to research papers. In addition, the framework also provides some API (Application Programming Interface) for easy constructing of database applications. According to these features, we can build a new outcrop database for volcanic geology as a knowledge infrastructure for collecting various research data from a wide range of users and applying them for multi-purpose use.

In this paper, we introduce our database framework that we have developed and describe some features provided by the framework. Then, we show a mobile application based on this framework for sharing outcrop information as an example of our application.

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II. Design of Outcrop Database for Eruptive History and Informatics

A. Volcanological database and outcrop database

In volcanology research area, an online collaborative knowledge management system called Vhub [6] is known as the most succeed database. Vhub is a community platform designed for collaboration in volcanology research, education, outreach, it can serve not only various resources but also

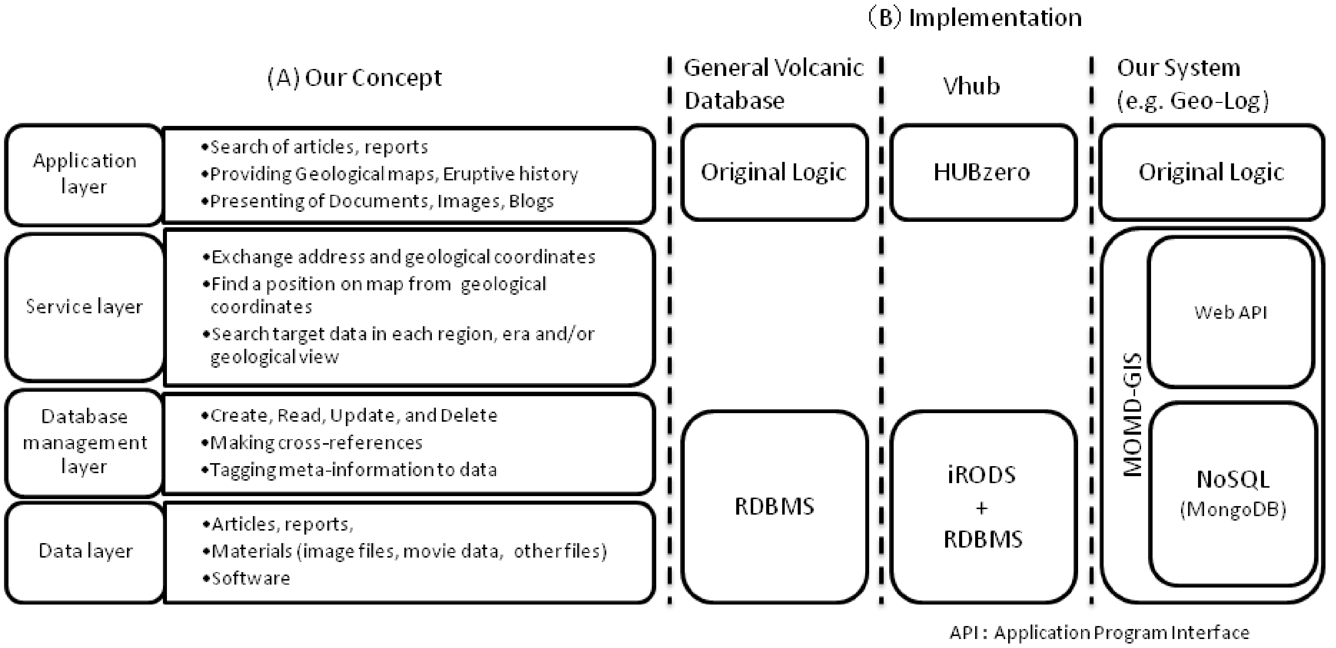

Fig. 1. Our concept of 4-layered model and implementation model for database systems. (A) Data layer stores various data including articles, reports, materials, software, and so on. Database management layer provides not only access to the data but making of cross-references and tagging of meta-information. Service layer provides various services for conversion of position and coordinates, finding of a position corresponding to coordinates, etc. Application layer provides actual applications implemented over the service layer. (B) Implementation models for some volcanic database that included our system.

virtual platform for computational tools. It is built using open-source platform "HUBzero [7]" and used by many researchers as a volcanology information integrated web site rather than outcrop database site.

On the other hand, several outcrop databases are already existed [2], [3]. The outcrop database SAFARI developed in Norway was collected from the late 1980s and continues to improve and expand [8]. Since the beginning of this century, a large amount of their outcrop dataset includes not only pictures and geometric measurement but also 3D virtual outcrop models using laser scanning techinques [9], [10]. This database, as shown in [11], has a lot of definition tables designed carefully with a great deal of effort. This tells us the database design is so hard task.

As another example, with the aim of collecting the important and magnificent geological outcrops, an online public database called outcorpedia has been published [3], [12]. Unlike the SAFARI database described above, the Outcropedia mainly targets outcrop pictures and does not require complex data-sheets for each outcrop. They have collected many outcrop pictures in the world, the number is still remainded below 1,000.

B. *New database framework based on NoSQL*

In conventional database construction approach, it is generally used Relational Database Management System (RDBMS). However, it has some weak points in terms of flexibility and scalability to target various data format or file types and manage them with complex and various features. To solve this problem we have proposed a new framework called MOMD-GIS (Metadata Oriented Multimedia Database for GIS) [5]. In this framework we use MongoDB [13], which is one of the NO-SQL database management systems. MongoDB is a JSON-style, document-based NoSQL database built for flexibility and scalability so we can deal with arbitrary data format and manage various kinds of document or image files. The MOMD-GIS provides APIs for not only general operations, that is registration, view, update and delete, but also a particular operation for GIS such as location search using MongoDB functions. Figure 1(A) shows our concept of this framework and (B) shows the relation between our proposed system and the other conventional approaches.

C. *Tag-based database*

As described above, the most difficult issue for constructing such a database system is that it requires much time and effort of editing many kinds of information and categorizing each data manually. To cope with this issue we have proposed a tag-based database management system built on our new platform [5]. This system can deal with various data not only by user-generated tags like keywords or key-phrases derived from comments but also by automatically added metadata like GPS information. So editors can add arbitrary keywords without being troubled by data format and can use automatic categorization using similarity calculation between tagged data. Figure 2 shows an example of tagged data.

D. *Main features of MOMD-GIS*

Main features of our database system based on MOMD-GIS are as following:

1) Management of content data with metadata: enable to

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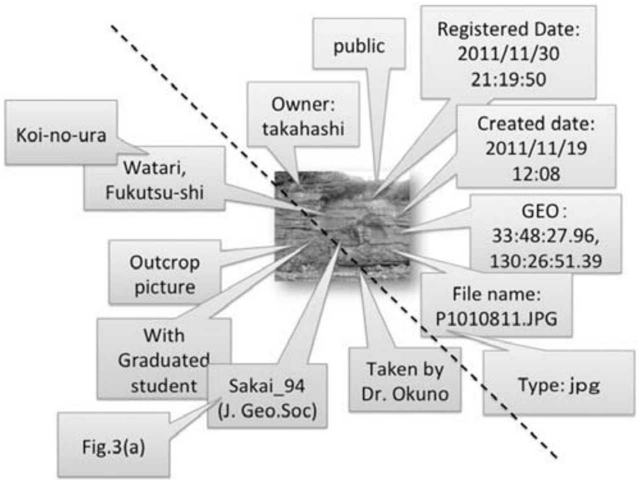

Fig. 2. An example of the posted image with tags, which is so-called meta-data. The tags on the right side of the dashed line can be added automatically by extracting some meta-data included in the original image. The left side tags stand for user-generated keywords or key-phrase.

categorize primary information (raw data) formalized difficult.

2) Management of various file type without pre-processing: enable to register easily from primary raw data to secondary or tertiary data.

3) Adding fixed format meta-data by application: enable to define fixed information except for user-generated tags for conventional or multi-purpose use.

4) Setting of public or private for each data.

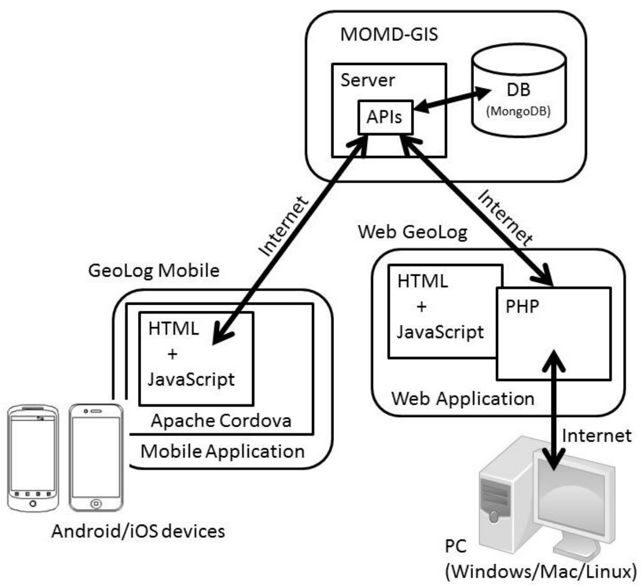

Fig. 3. Our approach for developing a mobile application using APIs provided by the MOMD-GIS framework.

5) Automatic metadata generation: generate some metadata like file type, created date and location information which can be extracted automatically.

By using our framework that can manage various file types with automatically or user-generated tags, it enables to construct outcrop databases easily by not only expert users but also non-expert users and to mitigate effectively the load of database construction. These advantages are useful for collecting much more data and expanding the number of users. In addition, our framework can provide various services for multi-purposes with categorizing automatically corresponding to each target. This means that our database can be used as a new knowledge infrastructure for providing flexible data from unstructured database differing from conventional database system.

III. Development of Geo-Log Mobile

A. Basic approach for making mobile application

Based on the framework described above, we developed a mobile application to collect outcrop information. We have already developed a web-based database application named "Geo-Log [14]" for the purpose of collecting and sharing of outcrop information from expert and non-expert users. Taking into account for usability on field, it is inevitable to expand to a mobile application.

In developing, we target the Android OS and iOS devices (smartphone and tablet) and built as hybrid mobile application using JavaScript and HTML5 with Apache Cordova [15]. Figure 3 shows our approach for development of web and mobile applications. The applications are implemented using the APIs provided by the MOMD-GIS. This approach enables easy development. Actually, in this case, it took approximately one man-month to develop the mobile application. The reason we could shorten the development time is because we used not only the hybrid approach but also the APIs provided by our framework. This means our framework has a high flexibility and high scalability.

B. Implementation of Geo-Log Mobile

Figure 4 shows the example views of our application. We implemented some functions as the following:

1) To display outcrop information on the map (Fig. 4 (b)): a function for displaying registered data near the central of the map. To tap a marker jumps to a detail page (Fig. 4 (e)).

2) To submit outcrop information (Fig. 4 (c)): a function for posting user's pictures with title, comments, category and location information shown on the map .

3) To search outcrop information (Fig. 4 (d)): a function for searching recent posts or search results with some query.

Each function communicates to MOMD-GIS API with

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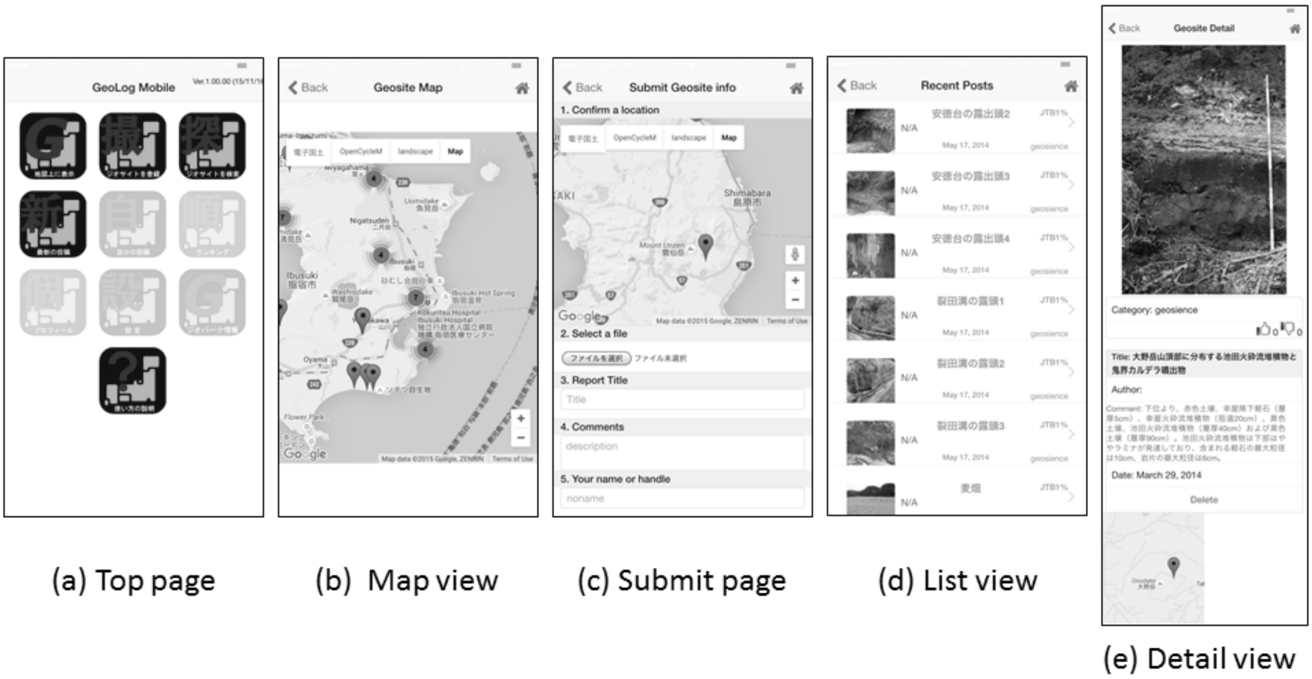

Fig. 4. Example views of our application. (a) shows the top page of the application. Users can select to some functions by tapping icons. (b) shows an example of map view. Markers on the map show posted information from users. (c) shows a page for submit outcrop information. (d) shows an example of list view. Users can check recent posts or the result of search. (e) shows an example of detail information view.

asynchronous JavaScript and displays results using HTML5.

IV. Conclusion

In this paper, we introduced a new framework for easy construction of Geo-Information database and a mobile application based on our database as one of application example. Thorough the short development process we could show the efficiency and usefulness of our framework and database. In future plan we intend to improve our application through feedback from users on field. Moreover we intend to develop another mobile application using our database, e.g. an application for geopark, etc.

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