DEVELOPMENT OF GPS PHOTO DATABASE DISTRIBUTING SOFTWARE PACKAGE FOR LAND USE AND LAND COVER APPLICATIONS

An Ngoc Van*, Kyaw Sann Oo and Wataru Takeuchi
Sawada and Takeuchi Laboratory, Institute of Industrial Science, University of Tokyo
Ce 509, 4-6-1 Komaba, Meguro-ku, Tokyo 153-8505, Japan; Tel: +81-3-5452-6407; Fax: +81-3-5452-6408
Email: vanan@iis.u-tokyo.ac.jp

KEY WORDS: GIS, field survey, GPS Photo database, land user and land cover, distribute

ABSTRACT: An advanced Global Field Survey System (GFSS) has been developed for collecting the field survey data for 4 years, and the collected data is stored in the GPS Photo database on a server at The University of Tokyo, Japan, which includes photo, latitude, longitude, land cover type and other information. In order to distribute the GPS Photo database to the users, this study develops a software package running on Windows computers, allowing the user to use the GPS Photo database for LULC applications. Using this software, user can interact with the GPS Photo database to search for and download the desired field survey data. The software package can also help the user to check the accuracy of the user's land cover map based on the selected data, and the user can enhance the map with the Referenced Map database, including the maps shared by other users. As a part of GFSS, this software package allows the user freely use the field survey data from the GPS Photo database with nearly 6000 records, which have been collected in Laos, Myanmar and Vietnam since 2008.

1. INTRODUCTION

In LULC applications, field survey database always plays a very important role. The field survey data is one of the key inputs for design and training the algorithms. This data also is the vital reference for verifying the result. More and more such kind of databases have been developed by different programs and applications, but data sharing is still a big problem; not due to that data are not available, but data reuse for new applications and data sharing are daunting tasks because there are many barriers including technical, legal and administrative/political barriers (Devogele et al, 1998; Greg J. et al., 2004; Ling Y., 2003; Popescu A. et al., 2009; Taylor F., 2010). Currently, many data sharing services, such as GeoNames (GeoNames, 2007), Alexandria (Alexandria, 2004), Intergraph's Geomedia WebMap (GeoMedia, 2012), GE SmallWorld's Intenet Application Server and ER Mapper's Image Web Server (Zhang C., and Li W., 2005), offer various geographical data sources for sharing, but the shared data of these systems are only maps, the field survey data are not available for the users in those servies.

GFSS with GPS Photo database were proposed (Van et al., 2012) to create a field survey database for LULC applications. GPS Photo database is built based on both the existing data at the research institutions and the newly collected field survey data. Each item in the database includes the photo and the corresponding location information, land cover type, object description and other information. This database has been using for the LULC projects in Laos, Myanmar and Vietnam.

In order to provide a tool to share the field survey data in GPS Photo database with the users, this study develops a software package running on Windows computers, allowing the user to interact with GPS Photo database to search and download the field survey data, check the accuracy of the user's land cover maps with the downloaded data, enhance those maps and share their works with the other users. As a part of GFSS, this software package permits the user to freely use the field survey data in the GPS Photo database including nearly 6000 records, which have been collected in Laos, Myanmar and Vietnam since 2008.

2. SYSTEM DESIGN

This software package is designed to enable the users to share data in a win-win relationship: a user shares a land cover map with other users and gets the field survey data from GPS Photo database. For this purpose, the software package has two main functions: to be a tool to distribute the field survey data from GPS Photo database, and to be a tool for the users to share their land cover maps with the other users. Figure 1 shows how this software package works as a component of GFSS. As a tool to distribute the field survey data, this software package allows the user to select the field survey data from GPS Photo database and use those data to verify and enhance the user's maps, or export field survey data to use in other LULC applications. As a tool for the users to share their land cover maps with the

other users, this software package adds the user's land cover maps to the Referenced Map database so that the other users can use those maps as the referenced data for their works.

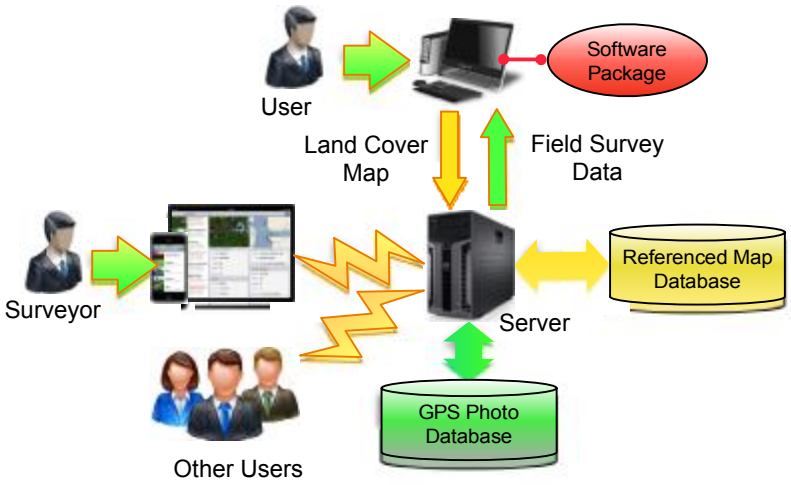
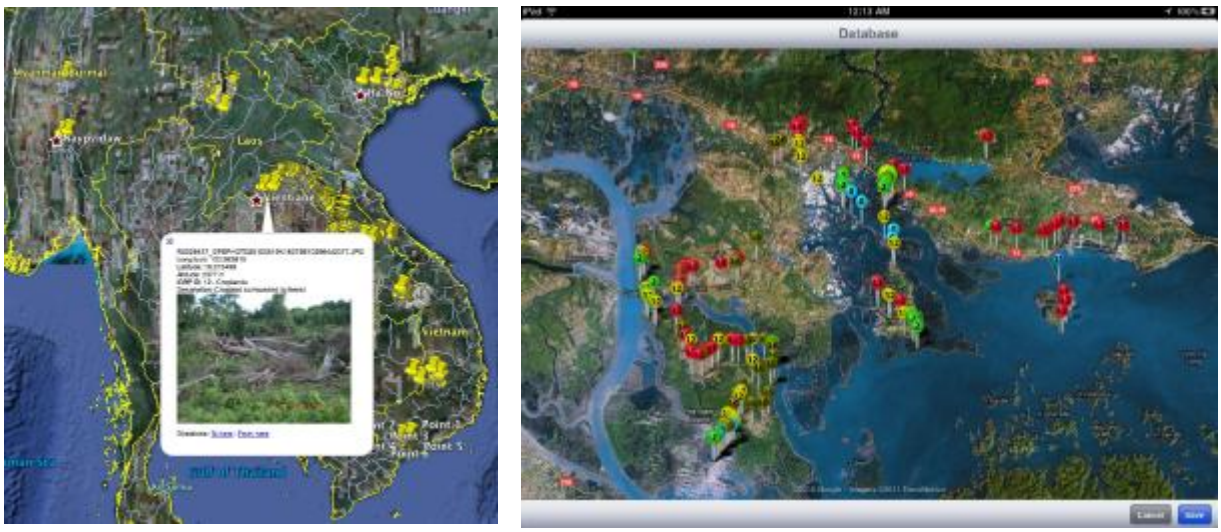


Figure 1. The software package works as a component of GFSS

Because almost all of the users' computers are running Windows, this software package is designed to work on Windows computers with Windows XP, Vista and Windows 7. The user needs Internet connection to interact with the databases on server.

3. GPS PHOTO DATABASE

GPS Photo database (Van et al., 2012) is a field survey database for LULC applications. Every record in the GPS Photo database contains information about one place of interest. This information is divided into 2 categories: the basic category includes photo, location information, and land cover information, and the extension category includes user-defined data. Photos are taken to show the visual characteristics of the place of interest. Location information is used to specify the position of the user at the time he collected the data as well as the position of the place of interest. The location information includes the latitude, longitude, altitude, and postal address. Information about the distance and bearing angle from the user to the place of interest is also included in the database. The land cover type indicates the land cover type of the place of interest at the time the data was collected. One of the default sets of land cover classification definitions is the International Geosphere-Biosphere Program, which includes 17 land cover classes (IGBP, 2006). GPS Photo database also contains the user-defined data, which is defined by the user and depends on the particular field survey. Figure 2a is the field survey data of GPS Photo database displayed in Google Map and figure 2b is the data collected in Yen Hung district, Quang Ninh province, Vietnam, displayed on the Apple's iPad.



a) On Google Map b) Data of Yen Hung, Quang Ninh, Vietnam on Apple's iPad

Figure 2. Field survey data in the GPS Photo database

4. SYSTEM IMPLEMENTATION

Figure 3 shows how user gets the field survey data from GPS Photo database and shares his land cover map with other users. At first, the user needs to register an account and prepare a land cover map, which covers the region he wants to get field survey data. Next, the user selects the field survey data from GPS Photo database. After that, the software will verify the accuracy of the user's land cover map with the field survey data he selected. Based on the accuracy of the user's map, the user enhances the map and verify again until the user gets the best verification result. Finally, the user's land cover map will be uploaded and added to the Referenced Maps database on the server, and the user can export field survey data to use in other LULC applications.

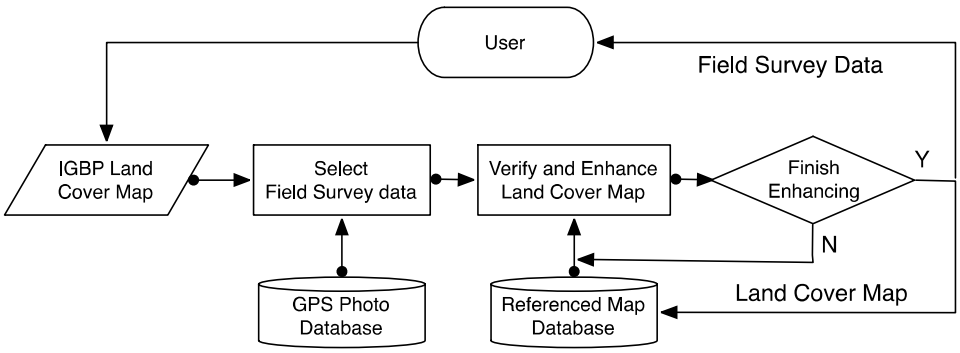


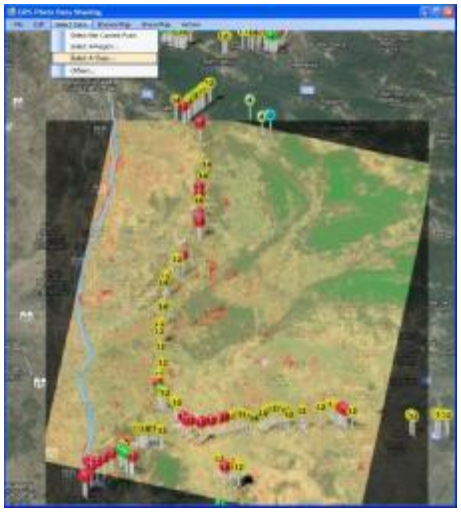
Figure 3. System implementation

4.1 Land cover map preparation

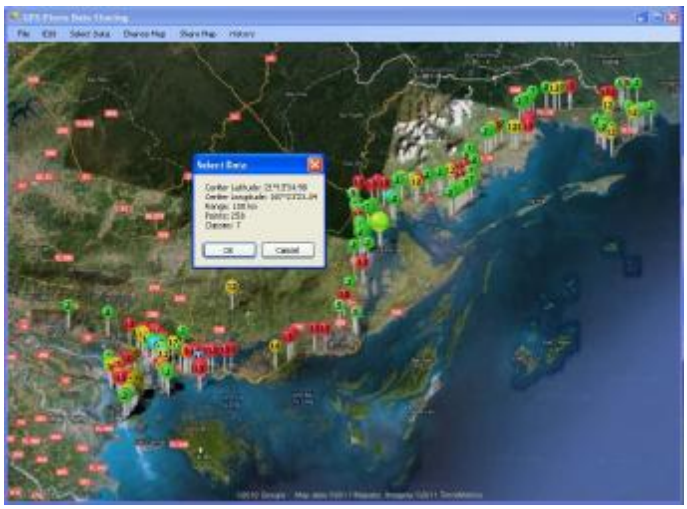
After registration to get user account, in order to get the field survey data from GPS Photo database, the user needs to share a land cover map by adding that map to the Referenced Map database on the server. The user's land cover map is in GeoTIFF format (GeoTIFF, 2012) and the land cover is classified by using IGBP definition with 17 classes (IGBP, 2006). The users can generate the land cover map by using the commercial software packages, or by using the LCMAP software package for Windows, which is a free and developed by the Institute of Industrial Science, The University of Tokyo, Japan (Takeuchi W., 2012), based on GRASS (GRASS, 2012).

4.2 Field survey data selection

Based on the user's land cover map, the user can select the field survey data to verify the map. The user can use some criteria to filter out the field survey data he needs such as the interest region, the time or land cover type. The selected data will be downloaded to the user's computer. Figure 4a shows the options for selecting data while the user's land cover map of Khammouane province, Laos, is overlaid on the field survey data from GPS Photo database. Figure 4b is the result of a search, which is the field survey data of Quang Ninh province, Vietnam, in the range of 100km from the center point at 21°13'34.98N and 107°23'23.04E.



a) Options for selecting data



b) Search data by distance to the center point

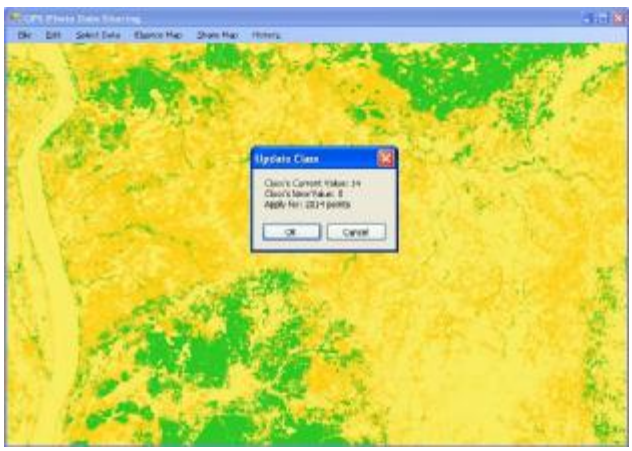
Figure 4. Select the field survey data from GPS Photo database

4.3 Verifying user's land cover map

The accuracy of the user's land cover map will be verified with the selected field survey data. The average accuracy, average reliability and the overall accuracy are calculated by using confusion matrix. The overall accuracy, the spatial resolution and the area of the user's map are considered by the data provider to decide how much field survey data the user can download at his next login. The more accurate the user's land cover map is, the more field survey data he can get from GPS Photo database in the next download.

4.4 Enhancing user's land cover map

In order to get more data from GPS Photo database, the user needs to enhance the user's land cover map. The user can use any software to edit the land cover map and verify again with the selected field survey data. This software package also provides the tool to enhance the map. With this tool, the user can edit a pixel, a region or a whole land cover class to generate a higher accuracy map. Figure 5a is the interface of the tool for enhancing map, where a user converts all points of class 14 (Crop land/Natural Vegetation Mosaic) to class 0 (Water). Besides the traditional map enhance tool, this software package also offers a special map enhance function that allows the user to refer to the referenced maps from the Referenced Map database, which are shared by the other users. The user can compare his map (the overall accuracy, percentage of overlaying, number of points in the overlaying regions, the list of the classes in the overlaying region) with the referenced maps and decide which map will be selected for enhancing. After the referenced map is selected, the user can manually enhance the map by cross checking (by point, region or class) or let the software package enhance the map automatically. In the figure 5b, the user is selecting a map from the list of the referenced maps that are available for his land cover map.



a) Update the class value b) Referenced maps with accuracy and percentage of overlay

Figure 5. Enhance the land cover map with the tool of this software package

4.5 Sharing the user's map and exporting field survey data

After enhancing the land cover map, the user can share it with other users. This software package will add the user's land cover map to the Referenced Map database on the server. Once the user's map has been added to the Referenced Map database, other users can use it as the referenced map. By this way, not only GPS Photo database but also Referenced Map database helps the user to generate better land cover map. As mentioned before, based on the overall accuracy, the spatial resolution and the area of the user's land cover map, the system will decide more or less field survey data the user can download at his next login. When the user's land cover map has been added to the Referenced Map database, the user can export the field survey data to use in other LULC applications in various formats such as text Google's KML (Google, 2011) and ESRI's Shape file (ESRI, 2010). Figure 6 shows the working history of a user and the amount of the downloaded data and the data his can download at his next login.

Figure 6. User's Information

5. CONCLUSION

This study developed a software package for distributing the field survey data from GPS Photo database to the users in a win-win relationship: the user gets the field survey data from the database and shares his land cover map with other users. With this software package, the user can use the data from GPS Photo database to generate and verify the land cover map; the user can also enhance his map based on the maps from Referenced Map database, which is built from the maps shared by all users; the user can add his map to the Referenced Map database to share with other users as well as extract the field survey data to use in other LULC applications. The more accurate the user's land cover map is, the more field survey data he can get from GPS Photo database. This data distributing method not only allows the users to freely use field survey data from GPS Photo database, but also provide users a good source of the referenced maps. Since LCMAP for Windows is now available (Takeuchi W., 2012), this software package can also be used with LCMAP as a tool for training, where the user launches LCMAP to generate the land cover map and carries out the map verification as well as enhancement with the tool provided by this software package. This software package will be available for the users to get field survey data and share land cover maps from 2013.

6. REFERENCES

Alexandria, 2004. Alexandria Digital Library. Available online at: http://www.alexandria.ucsb.edu/adl/

Devogele, T., Parent, C., and Spaccapietra, S., 1998. On spatial database integration. In: Int. J. Geographical Information Science, 1998, Vol.12, No.4, pp. 335-352.

ESRI, 2010. ESRI Shapefile technical description. Available online at: http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf

GeoMedia, 2012. Intergraph's GeoMedia Service. Available online at: http://www.intergraph.com/sgi/products/product-family.aspx?family=10

GeoNames, 2007. GeoNames geographical database. Website: http://www.geonames.org

GRASS, 2012. GRASS GIS. Avaiable online at: http://grass.osgeo.org

GeoTIFF, 2012. GeoTIFF format. Available online at: http://trac.osgeo.org/geotiff/

Greg J. et al., 2004. Issues in Georeferenced Digital Libraries. In: D-Lib Magazine,Vol.10, No.5.

Google, 2011. KML Documentations. Available online at: http://code.google.com/apis/kml/documentation/

IGBP, 2006. International Geosphere-Biosphere Programme. Available online at: http://www.igbp.net/page.php?pid=250

Takeuchi W., 2012. LCMAP software package for Windows. Available online at: http://www.eorc.jaxa.jp/SAFE/TOP/html/tools/LCMAP_software_guide_p0.html

Popescu A. et al, 2009. Mining a Multilingual Geographical Gazetteer from the Web. In: International Conference Web Intelligence and Intelligent Agent Technology, pp. 58-65.

Taylor F., 2010. Global Geographic Information Management: Some Institutional and Data Sharing Issues in Integrating Geospatial and Statistical Data. In: Second Preparatory Meeting of the Proposed United Nations Committee on Global Geographic Information Management, New York, May 10-11, 2010. Available online at: http://ggim.un.org/2nd%20Prep%20Meeting/UN-May-10-Global%20Geographic%20Information%20Management-FINAL-1.pdf

Van A.N., Oo K.S., and Takeuchi W., 2012. Development of an Advanced Global Field Survey System (GFSS) for Terrestrial Monitoring and Mapping with a Demonstration for Agricultural Cropland Mapping in Asia. In: Photogrammetric Engineering & Remote Sensing, Vol. 78, No. 8, August 2012, pp. 875-884.

Ying L., 2003. Geo-referenced Digital Libraries: Experienced Problems of Purpose and Infrastructure. In: Library Philosophy and Practice, Vol. 6, No. 1.

Zhang C., and Li W., 2005. The Roles of Web Feature and Web Map Services in Real-time Geospatial Data Sharing for Time-critical Applications. In: Cartography and Geographic Information Science, Vol. 32, No. 4, pp. 269-283.