UPDATES OF GPS PHOTOS DATABASE AND APPLICATION DEVELOPMENT ON APPLE'S iPHONE AND iPAD

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ABSTRACT: GPS Photos Database for land use and land cover applications was introduced in 2010 with thousands of GPS photos taken in Vietnam, Laos and Myanmar. Every GPS photo in the database coexists with the corresponding acquisition time, latitude, longitude, altitude, land cover type and description. The database went together with the GPS Photo application running on Apple's iPhone, which was the tool to update the database. In order to extend the use of GPS Photos Database, this study upgrades the database by adding more fields of data to the database, changing the way of description the objects of interest, and bringing the new tools for user to interact with the database using Apple's iPhone and iPad.

1. INTRODUCTION

In land use and land cover applications, well organized and correct field survey data collection always plays a very important role. The field survey data is one of the key inputs for design and training the classification algorithms. The collection of field survey data enables calibration of remote sensing data, and aids in the interpretation and analysis of what is being sensed. Field survey data also allows supervised classification to help determine the accuracy of the classification performed by the remote sensing software and minimize errors in the classification.

There are a lot of field survey databases existing. Most of the land use and land cover projects have their own field survey databases. However, these databases are either closed to the people working outside those projects or not well organized as a database to be effectively accessed by the computer software. There are also the open data sources on the Internet such as GeoNames (GeoNames, 2007) and Alexandria (Alexandria, 2004). Although these databases are well organized to be used by computer software, they are mainly updated by the normal users, who are not professional in land use and land cover study, and therefore the data are sometimes incorrect (Popescu, A. et al., 2009)(Ling Y., 2003)(Greg J. et al., 2004). Consequently, the available field survey databases are not always able to be used by land use and land cover applications.

GPS Photos Database was introduced in 2010 as a field survey database with thousands of GPS Photos taken in Vietnam, Laos and Myanmar (Van and Takeuchi, 2010). However, every GPS photo goes with only the basic data including latitude, longitude, land cover type and a short description of the place of interest. The lack of data fields and the way of specifying the object of interest sometimes make the data incorrect and limit the use of the database.

In order to extend the use the GPS Photos Database, this study upgrades the existing data by adding more fields of data to enrich the information in the database, changing the method to accurately specify the object of interest, and developing the new tools for user to efficiently interact with the database.

2. CURRENT GPS PHOTOS DATABASE AND ITS LIMITATION

2.1 Current GPS Photos Database

Figure 1 is the flow chart of a land use land cover application (Van and Takeuchi, 2010). In input data was processed by certain algorithms to produce the draft result. This draft result is then validated by using GPS Photos Database. The output of this step is final result. In land use and land cover applications, the role of GPS Photos Database is very important, because it is one of the main factors to determine the accuracy of the final result.

Every item in GPS Photos Database includes a photo, a longitude, a latitude, an altitude, a land cover type and a description of the place of interest. Figure 2 is an example of the information contained by an item in GPS Photos Database. The latitude, longitude and altitude describe the location of the user, when he took that photo. The land cover type and the description give the information about the land cover of the site. In GPS Photos Database, the definition of land cover type follows the International Geosphere-Biosphere Programme (IGBP, 2006), which defines 17 classes as shown in Table 1. Land cover type in the database is expressed by the corresponding IGBP ID.

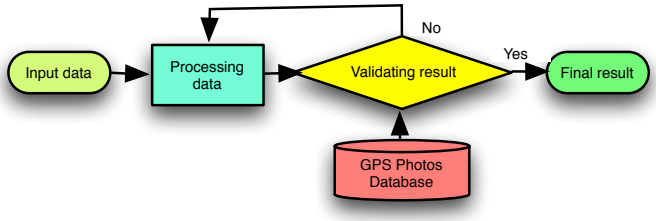

Figure 1. Flow chart of a LULC applications

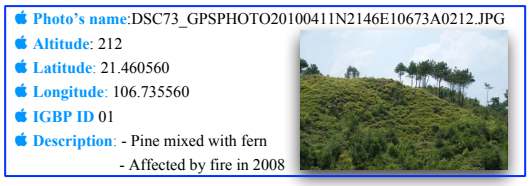

Figure 2. Data of an item in GPS Photos Database

Table 1. IGBP land cover classification classes

IGBP land cover classes			
00	Water	01	Evergreen Needle-leaf Forest
02	Evergreen Broad-leaf Forest	03	Deciduous Needle-leaf Forest
04	Deciduous Broad-leaf Forest	05	Mixed Forest
06	Closed Shrub Land	07	Open Shrub Land
08	Woody Savanna	09	Savanna
10	Grassland	11	Permanent Wetland
12	Cropland	13	Urban and Built-up
14	Cropland/Natural Vegetation Mosaic	15	Snow and Ice
16	Barren or Sparsely Vegetated		

2.2 Limitation of the current GPS Photos Database

Because GPS Photos Database was built up from the existing GPS Photos, it has some limitations. First, the location of the object of interest is incorrect. The latitude and longitude of a photo in the database locates the position of the user when he took that photo, and it is different from the position of the object in the photo, especially when the user zooms far from his position. Therefore, the land cover type attached with the photo is correct only when the user takes that photo in a homogeneous region. In other situations, the land cover type shown in the GPS photo is different from the land cover type at the user's position. For example, the land cover type in the photo of Figure 3 is water, but the correct land cover type at the position of the user (which is stored in the database) at that time is evergreen broadleaf forest. Second, GPS Photos Database uses only IGBP classification definition. Although IGBP is an international classification definition, every country or organization implements its own land cover classification definition, and normally different from IGBP. This brings the difficulty to the end-user, since he needs to convert the IGBP definition to another classification system. For example, the land cover is classified into 54 classes in Vietnam, so it is not easy for user to convert from 17 classes of IGBP to 54 classes of Vietnam's classification definition. Third, every item contains the data of only one geographical point. Normally, when user collects the data for one geographical point, whose position is specified by latitude and longitude. However, in many situations, that collected data can be used for a whole region. For example, in the mangrove forest shown in Figure 4, all the mangrove trees are the same; therefore, the data collected at a point of this mangrove forest can be used for all other points inside this forest region.

Figure 3. Incorrect land cover type of user's position

Figure 4. All positions are the same in a forest region

3. DATABASE UPGRADATION

Based on the above analysis, this study upgrades to GSP Photos Database to beyond the limitation, make the newly collected data correct, and enrich the data in the database. In the new version of GPS Photos Database, more fields of data are added to attach more information to every item in the database, a new method was built to help user specify the position of the object of interest more accurately, and an additional feature was also developed to bring the capability of update the data for a region.

3.1 New fields of data

The new version of GPS Photos Database comes with more fields of data, divided into 4 categories: location information, land cover type, object description, and environment data.

Location information represents the positions of both the user and the object of interest. Similar to the current version of database, the position of user, which includes latitude, longitude and altitude, is retrieved automatically by the device. The GPS location service inside the device can specify the location of user with 10-meter precision. Once the information about the user location is retrieved, the device automatically decodes that information into postal address and is stored to the database. This will make it easier for user to manage the database. In the new version of database, the position of the object is added. Figure 5 shows the locations of user (small blue pin) and object (big green pin) for an item in the database. After taking photo, user will touch on the map to select the position of the object of interest. With this method of specifying the object's position, the data is attached with more accurate position.

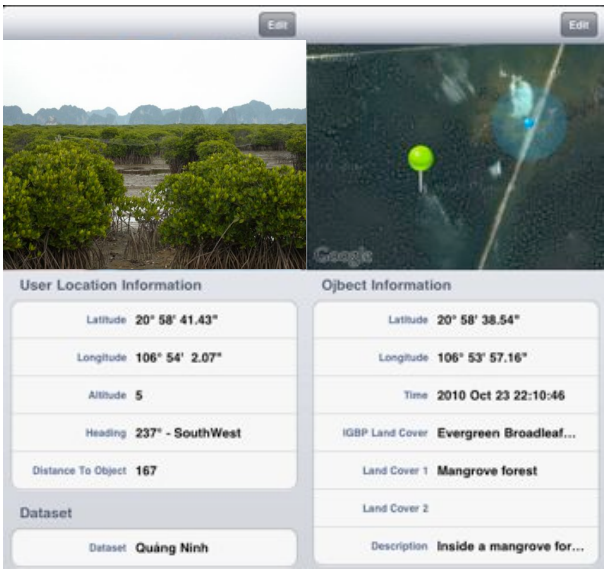

Figure 5. Specifying object's position on map

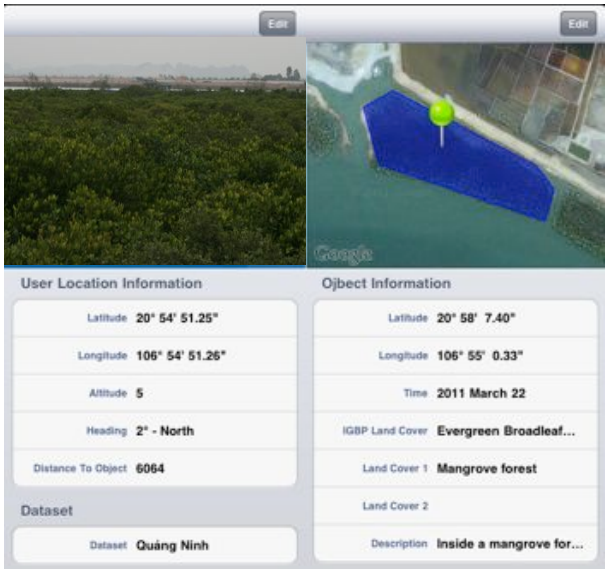

Figure 6. Update data for a polygon

As mentioned before, every country or organization implements its own land cover classification definition rather than IGBP. In order to make the database more flexible, new fields of data are added allowing user to select the land cover types and multiple definition. At this time, the user can select up to three types of land cover classification for the same object.

In the new version of database, the information to describe the object is much more detailed than just the single description in the old version of database. The objects in described as the forested or non-forested object. User now can enter the information about the main species and the status of plant, or store other information such as the average height, average diameter, average crown diameter and so on in the database.

In addition to the information about the object, the environment parameters are added to the database. These parameters include wind speed, air and soil temperature, relative air humidity and volumetric water content. The information about the environment will provide more detail about the status of land use and land cover at the place of interest. Of course, user needs the extra devices to get the values of these parameters.

3.2 Describing a region with polygon

Normally, in the field survey, user collects the data for one geographical point whose position is specified by latitude and longitude. In the new version of database, user can even update data for a region by using update with polygon feature. Figure 6 shows the feature which updates database with polygon. After selecting the polygon representing the region of interest on the map, user can edit the relating information of that region as he does when updating the information for a new GPS photo. This feature helps user to update the information for a homogeneous region without moving around and take photos.

4. SOFTWARE UPGRADATION

With the new version of GPS Photos Database, a new application called Field Survey, running on Apple's iPhone and iPad, was developed as the tool for conducting field studies and also as the tool for user to interact with the database. Compared to the GPS Photo software, Field Survey has a lot of new features.

4.1 Display information

Field Survey software manages data by using SQLite, the free library of database management engine (SQLite Team, 2010). The database is displayed in two view modes: map view mode and detail view mode. Figure 7 is the map view mode and Figure 8 is the detail view mode of a database. The map view mode shows the data on the map, which provides the traditional view to the user. Each item in the database is displayed as the annotation with corresponding classification identifier. User can select an annotation to get the information about the corresponding item. Field Survey software also let user overlay the custom maps in the map view mode. In Figure 7, the land cover map on ALOS AVNIR2 data of Khammouane province of Laos was overlaid.

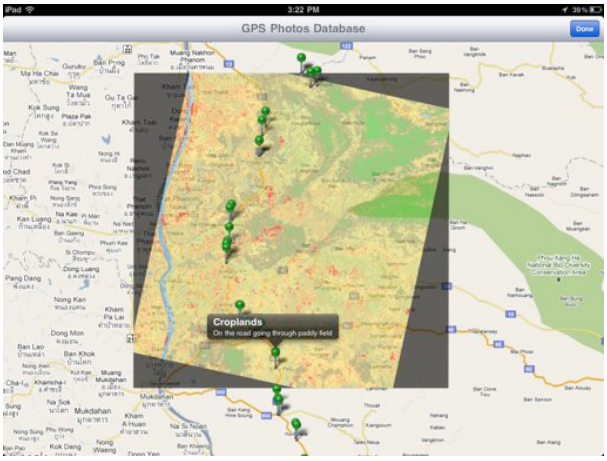

Figure 7. Map view

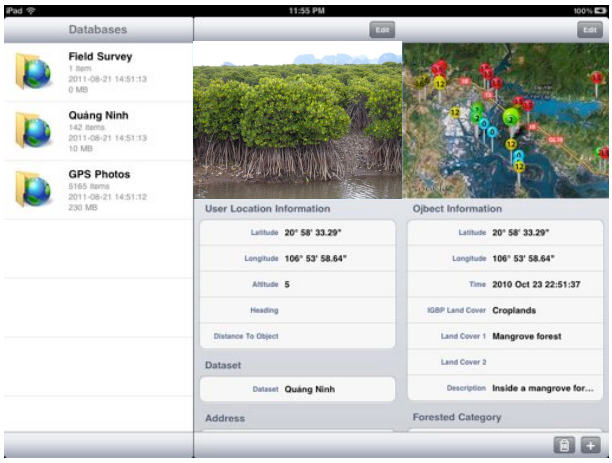

Figure 8. Detail view

4.2 Searching and extracting information

In order to be the interface between the GPS Photo Database and the land use land cover applications, Field Survey software can provide data to user by the search feature. User can search for the items in a certain region, which is specified by the distance from a center position or by the name of the region. User can also search for the items based on the time they are collected, or based on the land cover type of the items. Figure 9 show the place within 30 kilometers from the position (N20°58'48", E106°54'5"), which is in Quang Ninh province, Vietnam. In order to get this result, user call the search menu or just open the map mode and touch on the position he wants to search from. Another important feature of the Filed Survey software is data extraction. The data in the database or the result of a search can be extracted in some formats. First, data can be extracted in the format of text to be used by other software. Second, the data can be pull out in the Google's KML (Google, 2011) and ESRI Shapefile format (ESRI, 2010), which can be shown in Google Map, Google Earth and ArcGIS. Third, the detail information about an item can be provided to the user in the format of a report. Figure 10 is the database presented in Google Earth in KML format. Finally, Field Survey software can synchronize the database on the mobile device with the database on the server. This feature enables users to share the field data. Whenever a mobile device connects to the server, all the change on that mobile device and on the server will be synchronized.

Figure 9. A result of a search in GPS Photos Database

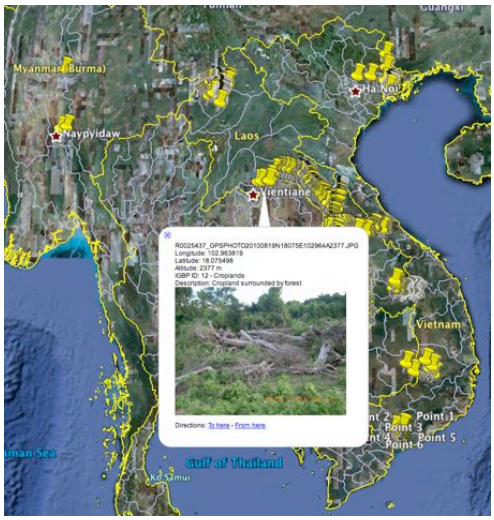

Figure 10. Database on Google Map

5. CONLUSION

This study upgraded the GPS Photos Database by adding more fields of data to enrich the information in the database, changing the method to accurately specify the object of interest, bringing the capability to update the data for the homogeneous region by using polygon, and developing the new tools for user to efficiently interact with the database. The GPS Photos Database was stored on the server in Institute of Industrial Science, University of Tokyo, Japan and contains over 5000 of GPS photos, which have been collected since 2009. This database has been using in the land cover classification projects in Vietnam, Laos and Myanmar.

In the future, new features such as tracking, data sharing, field trip planning will be added to the database. A version on Android, the open source operating system for smartphone, will also be developed.

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