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Development of A Mobile Data Collection And Management System

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Abstract

Mobile GIS applications are replacing more traditional ways of collecting field data. It is possible to collect data at the source and to upload it directly to a database server or a GIS. Field data collection and feature editing will be both easier and more accurate using mobile devices. In this study, we present a new mobile based data collection tool – ViGIS. The app enables field based personnel to capture, store, update, manipulate, analyze, and display geographic objects. It also allows users to flexibly load their own map layers from a server with a configuration file.

Keywords: Mobile GIS, Mobile based data collection, iOS, Geoserver, ViGIS;

1. Introduction

Field data collection is required for several reasons, such as collecting Ground Control Points (GCPs), ground truth data collection for result validation, collecting soil contaminated sites, plant or animal species in order to analyse the spatial distribution patterns of objects and information on their associated attributes. Accurate field data collection is also necessary for adequate spatial data analysis and proper decision making.

Traditional field data collection (i.e. pen-and-paper based) is a time consuming and bulky task. Firstly, collected data in field was being added to map with sketch. Afterwards, in result of checking them, they were manually transferred to GIS. As a result of this, GIS analysis and decision-making were late due not to be update GIS data. Nowadays, developments in mobile communication, Global Navigation Systems, the Internet and portable computational devices allow us to conduct field data collection in a timely manner. More-over, under the client-server setting for field data collection, a field user may take advantage of digital repositories prepared for data collection (i.e. base maps, satellite images and other ancillary data), as well as information resources more generally available via the Web. Data has timely been transferred the database in applications on account of implementing data collection and evaluating processes in field. As a result of accessing the update data and correct location information; analyse data presentation and decision-making processes have been applied

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rapidly.

Mobile GIS is the expansion of GIS from the office into the field. Wireless connectivity, geoservices, and Web mapping applications enable communication with and coordination of service technicians and contractors in the field. This increases efficiency and provides access to previously unavailable data for users who may have limited GIS experience (Looije, 2007). Another tool used for geographic investigation is the use of geospatial video which uses the combination of two approaches of geographic investigations: GPS and video. The technology has opened up the opportunity for field data collection of spatiotemporal phenomenon (Mills,2010).

In this study, we present a new mobile based data collection tool – ViGIS. ViGIS provides mapping, GIS, and GPS integration to field users via mobile devices. The app enables field based personnel to capture, store, update, manipulate, analyse, and display geographic objects. It also allows users to flexibly load their own map layers from a server with a configuration file. Wireless connectivity, geoservices, and Web mapping applications allow the field crew to complete database transactions in near real time. Surveyors rely on ViGIS application to collect spatial information within a GIS while in the field to improve the quality and accuracy of the data.

2. Design of the ViGIS

2.1. Architecture of the system

The mobile based data collection tool - ViGIS is developed using Mobile GIS technology. Architecture of the system is three components which consists of a Data server component, an ViGIS application component, and an Geospatial Data component. Figure 1 below illustrates the structure of the ViGIS architecture.

- The data server stores and manages different types of data, including vector and thematic data. A SQL database was used as the medium between offline vector or XML data and data collection work. There are many geo-services that help users store the captured data, manage data version, and execute of functions for data queries, editing and analysis.
- The ViGIS application component communicates with Geospatial Data via encoded documents (GML, JSON, XML and Tiles), transferred over HTTP, HTTPS. □Developers who want to develop their applications based on the aforementioned platforms are required to use the respective native Software Development Kit (SDK) that provide available tools, libraries, compilers, code samples, etc. In this study, we have used Apple’s iOS platform for developing the ViGIS application.
- The GeoServer provided open standards such as Web Feature Service (WFS), Web Map Service (WMS) for ViGIS application.

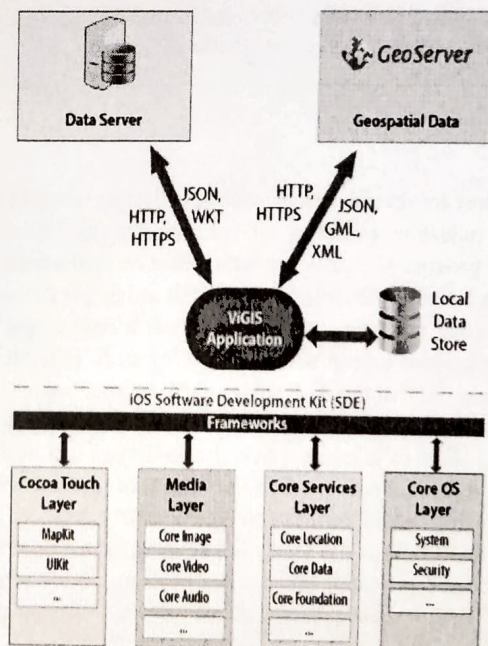


Fig. 1. Architecture of the ViGIS.

2.2. Module Partition

ViGIS is a system designed for spatial data collection. The idea is ViGIS provides functions for user to collect and manage spatial data from field. User can prepare their documents and data supporting for collection process, and upload them on ViGIS system. Then user captures spatial data by using ViGIS client (a function of ViGIS system) on the field. All the captured data is stored and managed on ViGIS system.

Functions implemented in ViGIS can be divided into four main modules: basic GIS function module, data collection module, system setting module and wireless data communication module, according to their functionality.

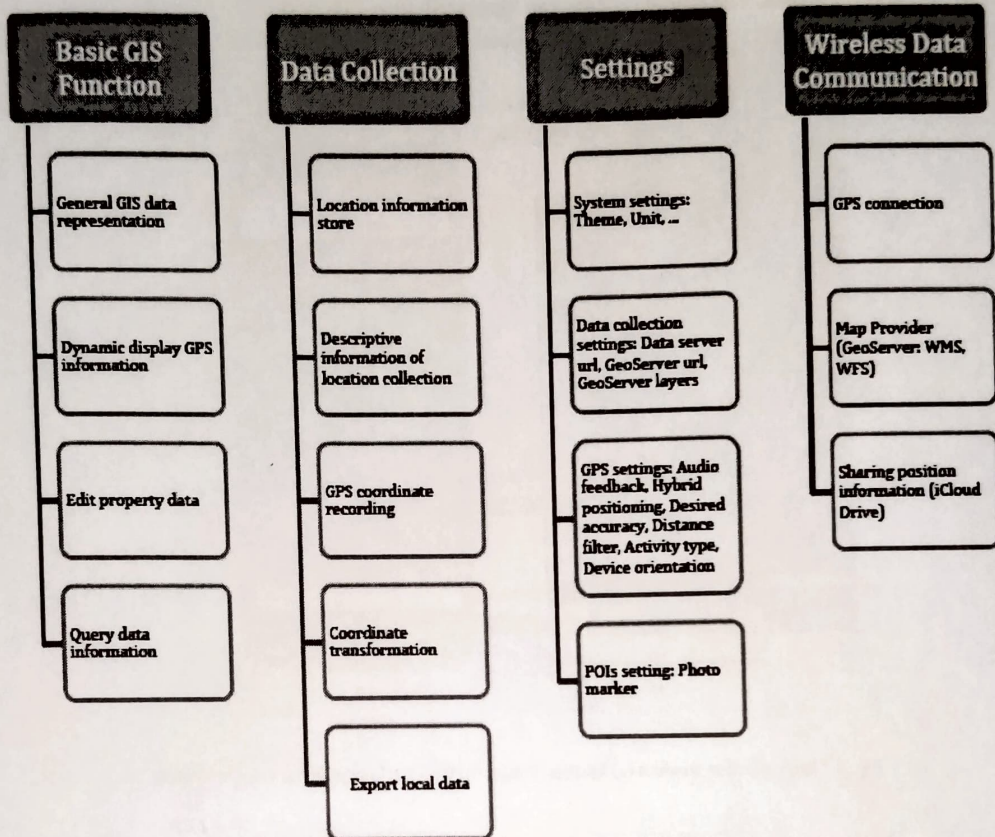


Fig. 2. Module structure of the ViGIS

- **Basic GIS Function Module:** In this module general GIS functions used in desktop GIS software, such as digital map representation, dynamically show the received GPS location information on loaded map, zoom in, zoom out, zoom to full extent, zoom to active theme and panning of a map, are implemented in mobile environment. Location information and location image are stored as attribute data of a map, and can be edited.

- **Data Collection Module:** Data collection module is the core of the whole system. It is responsible for gathering GPS information and related data. Before any collection operation, the system must ensure GPS connection is established and location information can be read from serial port stably. At a place, where we investigate, the system will record its latitude and longitude information automatically when an image is taken (See Fig. 3). The name of the image and its saving location will be saved in iCloud Storage. The default coordination in the ViGIS is the WGS-84 coordination in the longitude, latitude and altitude format. In some cases, users may need GPS coordinates to be located in a local coordinate frame. The ViGIS provides a tool for coordinate reference transformation. The tool covers most of the available coordinate reference systems and their parameters.

- **System Setting Module:** System setting must be accomplished at data collection target place. It mainly set the project, photo maker and GPS connection. Making out the GPS signal situation, and set a proper location information record and show time gap is very important to improve data gather efficiency. The main mission of

the system (setting phase is to ensure GPS availability and set an appropriate location information gathering interval. The process of system setting is generally shown in Fig. 4.

- Wireless Data Communication Module: Wireless data communication module including GPS data receiving, map provider and sharing location information.

The user can send a map download request to map server (Web Map Service). Web Map Service (WMS) provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. A WMS request defines the geographic layer and area of interest to be processed. The response to the request is one or more geo-registered map images to the mobile client.

- The user also can access geographic features from your map or geodatabase through a WFS service (Web Feature Service). Web Feature Service returns actual features with geometry and attributes that clients can be use in any type of geospatial analysis. WFS service also support filters that allow users to perform spatial and attributes queries on the data. The whole process can be described in Figure 5.

- Location sharing service is designed for investigators to share their locations and communicate with each other in data collection process.



Fig. 3. Data collection services (a) location image; (b) GPS tracking point on Google satellite.

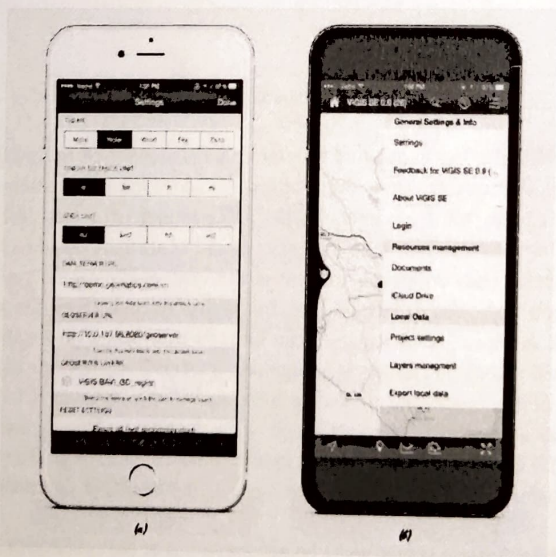


Fig. 4. System setting module (a) General setting; (b) Project setting.

3. Field data collection mobile GIS implementation

The data collection application in Mobile GIS consists of five main phases: initial planning, data preparing, system setting, data collecting and collected data processing. Collection content planning and data preparing phases are the basis of the whole process, which can make a clear goal of what information, is to be collected and what kind of supplementary data is needed.

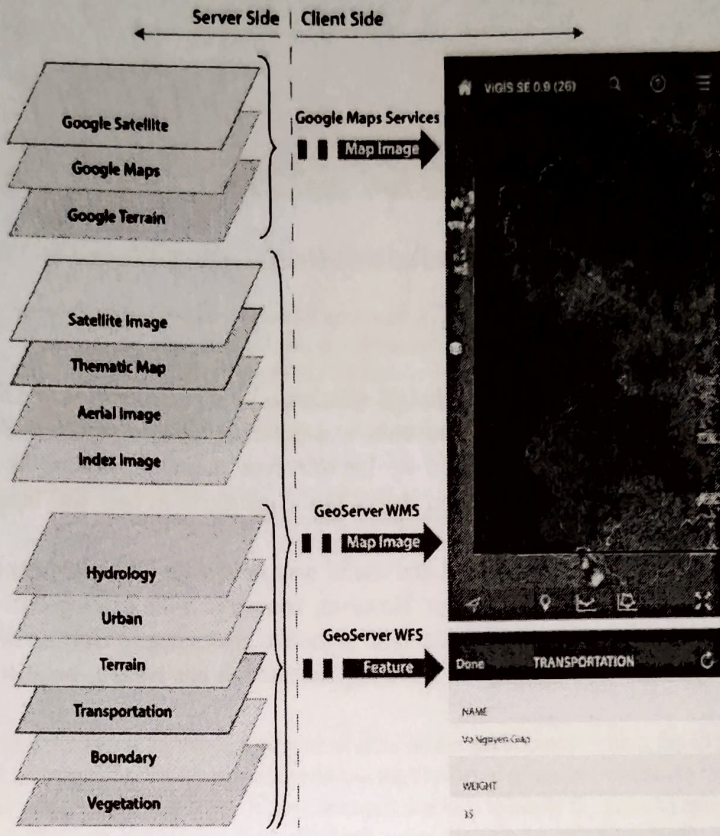


Fig. 5. Collection and Display function in ViGIS.

System setting phase must be accomplished outdoor. Because, GPS signal intensity although global positioning systems have high positional accuracy and ability to log "real-time" to a computer and great potential in many application areas.

Field data collection is the most important phase, which involves a combination of GPS data and digital camera data. The ViGIS application allows user to mark the geographic location of the incident based on the inbuilt GPS and associated information. Thematic map service published from Geoserver renders and the location information can be shown on map in real-time. During data collection process the surveyor can further submit his survey observation using the predefined form and attaches a picture of a certain place using the smart phone in built camera. The information collected by the surveyor is uploads to the central geodatabase server.

Collected data processing is the last stage of field data collection. In this phase the user need to export collected data to a desktop computer and the data can be opened in ArcGIS directly to do some advanced spatial or statistical analysis if necessary.



Fig. 6. Collection and Display function in ViGIS.

4. Conclusions

In this paper, a field collection oriented Mobile GIS solution – ViGIS is presented. ViGIS application allows viewing feature service from the content of Geoserver and provides tools to perform editing or adding new information based on the information collected by the surveyor during inspection to the GIS data. The information uploaded by the surveyors saved and shared to the managers in near real time. The managers can view this information using ArcGIS Desktop.

In the process of system, we find an efficient and useful way in Mobile GIS implementation, which can be used as an example for other mobile GIS design. However, compared with desktop GIS development, many more complicated factors need to take into consideration in mobile environment. Only some basic functions and services, which are very common in desktop GIS, are implemented in our system, we still have a long way to go.

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