6 New Approaches for Integrating GIS layers and Remote Sensing Imagery for Online Mapping Services

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Abstract

This paper introduces a Web Mapping system, UrMap, which incorporates new approaches for integrating GIS layers and Remote Sensing Imagery. UrMap is an on-line location-based service (LBS) website developed by OleMap Inc. in collaboration with the FORMOSAT-2 Image Application Distribution Center at National Taiwan Normal University and the National Space Organization (NSPO) in Taiwan. The goal of UrMap is to provide electronic street map services and location-based information for the general public in Taiwan. This chapter also discusses the different types of map design strategies between western-style (Google Map) Web GIS applications and eastern-style (UrMap) Web GIS applications. Web GIS applications in different regions and counties are adopting different map design principles and having different strategies for map layouts even though they might use the same fundamental Web GIS technologies.

6.1 Introduction

The development of Internet Mapping and Web GIS applications is a global trend and becomes one of the major innovative tools for education and public affairs in the 21st century. This paper introduces a recent development of Web mapping applications in Taiwan, called “UrMap”, and discusses the different types of map design strategies between western-style (Google Map) Web GIS and eastern-style (UrMap) Web GIS. UrMap is an online electronic map (E-Map) developed by the OleMap Inc. with the collaboration of the FORMOSAT-2 Image Application Distribution Center at National Taiwan Normal University and the National Space Organization (NSPO) in Taiwan. The design of UrMap incorporates new approaches for integrating GIS layers and Remote Sensing Imagery with the focus of location-based

services (LBS). The general appearance of UrMap is similar to Google Map developed in the United States. However, the cartographic design of UrMap is more focused on value-added location-based service information and the integration of remote sensed imagery and GIS layers (such as roads and points of interests). The color schemes, fonts, and symbols of UrMap are quite different from the traditional western-style Internet mapping applications, such as MapQuest or Google Map. This chapter will also discuss the new approaches of integrating GIS layers and remote sensed imagery for Web GIS applications from an international perspective.

In many Asian countries, such as South Korea, China, Japan, Singapore, and Taiwan, the telecommunication and the Internet infrastructures are strongly supported by central governments. Most central governments in Asia provided a great amount of funding to establish necessary telecommunication infrastructures for Internet backbones and to facilitate the development of essential Internet applications. In Taiwan, the estimated Internet user number is around 9.6 million people (about 42% of the total population) in 2005. One major Internet infrastructure in Taiwan is the development of Taiwan Academic Network (TANet). TANet is created by the central government funding in Taiwan which is similar to the development of NSFNET in the 1980s in the United States. TANet is very important for Taiwan's education system because it provides free Internet access for all levels of public schools, including elementary schools, high schools, and universities.

Since the Internet accessibility rate is very high in Taiwan. Many Web GIS applications were developed by commercial companies to provide E-Maps for the interests of general public. Users can access daily needed location-based information, such as bus routings and schedules, house renting advertisements, traffic update, restaurant locators, etc. The needs of location-based services are providing a great opportunity to facilitate innovative development of Web GIS applications in Taiwan. UrMap is one of the most popular on-line map applications in Taiwan. UrMap is developed by the OleMap Inc. with the collaboration of the FORMOSAT-2 Image Application Distribution Center at National Taiwan Normal University and the National Space Organization (NSPO) in Taiwan. The National Space Program Office (NSPO) in Taiwan is the major governmental organization which has developed a series of satellite systems for the remote sensing purpose, including FORMOSAT-2 satellite system. FORMOSAT-2 is one of the very high resolution satellite systems, which can provide up to 2 meters panchromatic resolution and 8 meters multi-spectral resolution. One major feature of the UrMap is the integration of GIS layers (roads) with the FORMOSAT-2 satellite imagery. The total amount of FORMOSAT-2 imagery used in the web mapping application is over 60 GB in a GeoTIFF format. The UrMap system can update the satellite imagery twice per year. The following discussion will provide an overview of the technological development for UrMap and related Web GIS integration issues.

6.2 The Integration of GIS layers and Remote Sensed Imagery in Web Mapping Applications

UrMap is an on-line, multi-functional E-map, which emphasizes street maps and location-based services, such as the locations of restaurants, bus stops, and business offices. The friendly mapping user interface and the Chinese-text query functions make the UrMap as one of the most popular on-line mapping applications in Taiwan. *Figure 6.1* illustrates the three major map display modes of UrMap (satellite imagery mode, hybrid mode, and street map mode).

One unique feature of the UrMap system is that the mapping service has its own satellite imagery source provided by the FORMOSAT-II satellite with the collaboration of the Image Application Distribution Center at National Taiwan Normal University (NTNU). The FORMOSAT-II satellite can provide high resolution imagery (2 meters in panchromatic mode) to overlay with street maps. The preparation of the satellite imagery for UrMap is handled by the Image Application Distribution Center at NTNU. The procedures of image processing are very complicated and time-consuming. The procedures involved with ortho-rectification, pan-sharpening, and mosaic/color – balancing tasks. These tasks will take two months to generate a new set of images for the UrMap server. The size of a completed image mosaic layer in UrMap is over 60GB by using a GeoTIFF format. Currently, the satellite imagery is updated twice per year in the UrMap server. The higher frequency of imagery updating is one advantage of UrMap for location-based services. The most updated imagery can provide more accurate geospatial references for identifying geospatial features.

The same spatial resolution (remote sensing) image source coverage is another advantage of UrMap. Most western E-Map applications, such as Google Map, are using a mosaic of images from multiple sources. Mosaic satellite imagery has various spatial resolutions from different parts of the electromagnetic spectrum. Also, many of these images are very old and out-of-date, often three to five years old. Different types of spatial resolutions and less-frequently updated image sources may cause problems in location-based services and geospatial reference functions.

6.3 The System Framework and the Technology Integration of UrMap

The system architecture of UrMap is based on the client/server framework similar to the general Web GIS applications (Peng and Tsou, 2003). The major technologies adopted in the UrMap include Asynchronous JavaScript and XML (AJAX), JavaScript Application Programming Interface (API), and XMLHttpRequest (XHR).

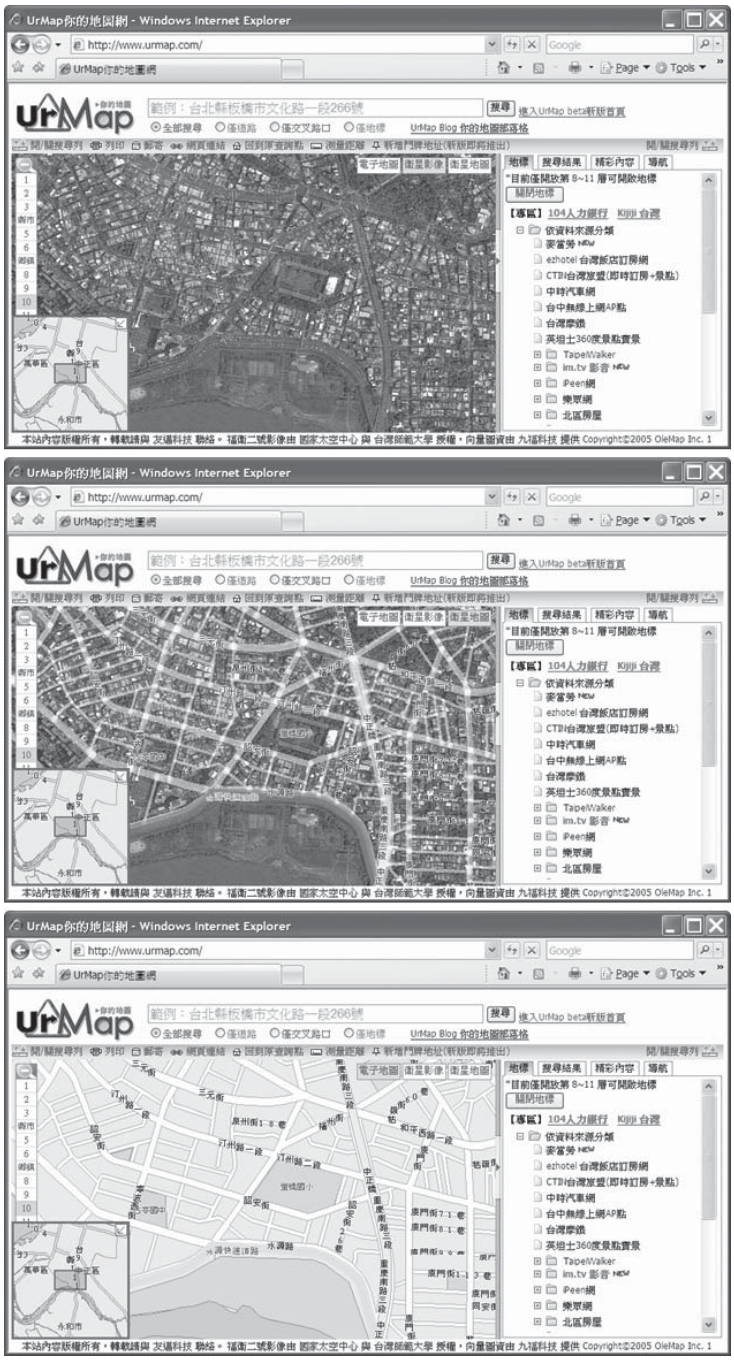

Fig. 6.1 The three display modes of UrMap – satellite imagery (top), hybrid mode (middle), street map mode(bottom). (http://www.UrMap.com).

The server side of the UrMap system consists of multiple application servers and database servers. The UrMap application servers provide interactive user interface functions on the web mapping pages and play a connector role between the web browsers and the UrMap database servers. The UrMap database server will process and generate geospatial information and images from the GIS databases and remote sensed imagery. The client side of UrMap adopts AJAX and JavaScripts to create customized mapping services and interactive web pages.

One important feature of the UrMap service is the development of the UrMap APIs, which can provide comprehensive web service integration and the communication mechanisms between the client-side web browsers and the UrMap application servers. There are three components of open API services provided by the UrMap system, API servers, Map servers, and Utility servers. The API servers are used for the authentic verification of all mapping requests (API calls) from the client-side browsers. All incoming API calls will be processed by the API servers first, and then be passed into the Map server. The Map server will generate new maps (images) according to the API calls. The Utility server will provide extended mapping services, such as routing, geocoding, and georeferencing functions.

The API services can also provide three different map display modes for end-users (satellite imagery mode, hybrid mode, or street map mode). The satellite imagery mode and the street map modes can be processed directly by the Map server because the Map server only needs to generate one layer (image) for each API call. The request for hybrid maps is more complicated because the Map server needs to combine both the street layer and the remote sensing layer together. The Map server will need to generate a transparent street layer image first and then overlay the transparent layer above the remote sensing imagery layer for the hybrid map. Both images (streets and satellite images) need to be georeferenced in order to match the map extends with each other.

The powerful UrMap API services can provide convenient tools for the development of “Mash-up” web mapping applications. Various web pages and applications can add the UrMap functions into their own web pages and applications directly. For example, a hotel website can use the UrMap API to display its locations inside the reservation web page. *Figure 6.2* illustrates an example of the Mash-up application by using UrMap API services to provide the location of famous restaurants in the city of Hsin-Chu.

The major technologies adopted in the UrMap including Asynchronous JavaScript and XML (AJAX), JavaScript Application Programming Interface (API), and XMLHttpRequest (XHR). The development of AJAX is a promising Web technology (Garrett, 2005). Traditional Internet GIS applications and Web-based mapping tools are suffered from slow response time and the lack of high resolution imagery layers because of the limitation of image data sizes and the slow client/server communications. The new AJAX technologies can improve the system

Fig. 6.2 The Mash-up web application by using UrMap API services (lower right corner). This is a restaurant locator application.

performance and reponse times of Internet GIS application significantly. [HTTP://maps.search.ch] and [HTTP://maps.google.com] are the two early examples of AJAX Internet GIS applications.

UrMap adopted AJAX to improve the performance of transferring high resolution satellite images between the web browsers and the UrMap Servers. One important aspect of AJAX is the function of XMLHttpRequest (XHR). XMLHttpRequest can update a portion of the web page without reloading the contents of the entire web page. This function is also called "refresh without reload." XHR is the major communication mechanisms between the web servers and the client browsers. Therefore, the performance of web mapping can be improved significantly on client-side applications with the AJAX technology.

6.4 The Location-Base Services provided by UrMap

This section will introduce several on-line location-based services provided by UrMap, such as searching for restaurants, apartment rentals, and hotel reservations. Location-based services focus on business-oriented location management func-

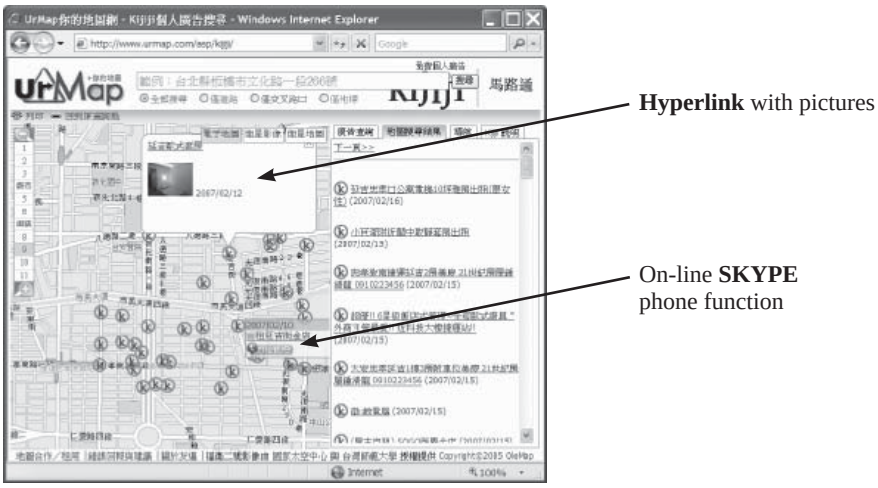

Fig. 6.3 The hyperlink pictures and SKYPE functions in the UrMap.

tions, such as navigation, street routing, finding a specific location, or tracking a vehicle (Jagoe 2002; Tsou 2004). There are more than twenty different categories of Points-Of-Interests (POIs) stored in the UrMap system. *Figure 6.3* illustrated one of the POI examples, apartment rental information, shown in the UrMap viewer. The example demonstrated that the UrMap viewer can provide hyperlinked pictures for advertisements (apartment renting) and the on-line communication tools (SKYPE) to talk to the apartment owner.

Another major LBS function of the UrMap system is the routing service. Users can type in their start point address and the end point address on the UrMap browser. The map engine will automatically generate the shortest or fastest routing lines. Users can also decide whether they would like to drive a vehicle by themselves or take the mass transportation systems (such as bus lines or subways). The routing service can calculate various combinations of bus schedules and routing functions to come up a best solution for users (*Figure 6.4*). The mass transportation routing function is very unique because most western E-maps applications (such as MapQuest) mainly focus on the individual vehicle-driving directions rather than public transportation systems. The reason behind this difference is that the mass transportation systems in Taiwan and Asian regions are much better developed and popular compared to most cities in the United States.

Another interesting function of the UrMap system is allowing multiple users create their own landmarks (placemarks) and the capability of uploading these to the UrMap POI database. These uploaded POIs become the public information for sharing and exchanging experiences. The UrMap member users (with valid registration) can create their private or public placemarks by using the UrMap system

Fig. 6.4 The routing functions of UrMap. Users can choose the options by either driving their own cars or taking the mass transportation systems (bus lines).

and exchange the information with other users on-line. *Figure 6.5* illustrates an example of adding a famous Chinese restaurant into the landmark databases in the UrMap with pictures and contact information by a regular user.

In general, the location-based services provided by the UrMap are very diversified and business-oriented. The icons and symbols displayed in the UrMap Browsers are also customizable with hyperlinks associated with telecommunication functions. Most of POIs are provided by business providers or private partners directly. The UrMap development team did not create the contents of POIs. The display of POIs has a great business value and can be used for promoting many local businesses and stores.

Fig. 6.5 A user-created place mark in the UrMap can be share with others as public Point-of-Interests (POI) information.

6.5 User Interface Design Comparison between UrMap and Google Map

The user interface design of UrMap has some similarities and some differences compared to Google Maps. This section will discuss these issues through a side-by-side comparison between the two popular on-line mapping systems and also highlight their different cartographic design strategies.

Figure 6.6 illustrates side-by-side screen shots from the UrMap and the Google Maps. The mapping technologies between the two systems are very similar. Both utilize AJAX technology and the XMLHttpRequest function, which can provide excellent mapping performance and interactive map search functions.

However, the map layout and design of the two systems are quite different. The UrMap arranges the map display window on the left side and the search results with POIs categories on the right side of the browser. The Google Map reverses the design and puts the map display window on the right side. Also, the Zoom-In/Zoom-Out functions are different between the two systems. The Google Map puts the Zoom-In function on the top of scale line and the UrMap put the Zoom-Out function on the top of scale bar. UrMap also added the context of the scale bar (as Street level, City level, and County level). The query results window in the UrMap include four tab functions, including search advertisement, map search result, navigation, and the POIs category. The Google Map search results are more simplified without using multiple-tabs page display.

Comparing the keyword search function for both systems, the UrMap has the "free text searching" function, which can search for both street names and landmark labels. The Google Map search engine will only focus on the place-mark (landmark) label

Fig. 6.6 The comparison between the UrMap (left) and the Google Map (right).

Fig. 6.7 The keyword search function comparison between Google Earth and UrMap.

search. *Figure 6.7* illustrates the search result of "101" in both UrMap and Google Map in the Taipei region. The UrMap search results are more organized and classified into both "roads" and "landmark" categories. The Google Map search results include the user-created contents only.

For the location-based services, users can enter the keywords (such as "pizza") in the Google Map search engine (text query box) for the business search function. However, UrMap does not provide a free-text query function. The search of business locations in UrMap are based on the pre-defined category of POIs. Users can check out the categories of POIs (such as Coffee shops, Steak houses, Banks, etc.) and search for the requested business locations. The Google Map provides more freedom and flexibility in the searching function. UrMap provides a more systematic search mechanism.

6.6 Conclusion

The development of the UrMap System is a unique example of Web GIS applications that focuses on location-based services and the integration of remotely-sensed imagery. The UrMap system is currently one of the most popular on-line E-maps in Taiwan. The average usage of the UrMap service is ten million maps per month. According to the web logs, UrMap averages 1.2 million unique visitors per month with an average usage time of 15.5 minutes per visitor. With powerful API functions and the UrMap objects, a single web page can include multiple map windows for different purposes. These functions are user- and LBS-oriented. The similarity and differences of UrMap and Google Maps can provide a valuable lesson for the future development of on-line mapping services in regard to principles of western-style map design and eastern-style map design. One finding is that the design of routing functions in each map application reflects the actual transportation infrastructure in each society. Most people in U.S. rely on individual vehicles and most people in Taiwan rely on the mass transportation systems and bus lines. Therefore, the routing functions in UrMap and Google Maps are quite different.

This chapter provided an overview of the UrMap system and introduces its location-based services. There are many other similar Web GIS applications in Asia, such as YPMap in Hong Kong (http://www.ypmap.com), Japan's Mapion (http://www.mapion.co.jp). The fundamental technology of these Web GIS mapping applications are all similar, but the actual design principles, mapping functions, and the layout of maps are quite different in different counties. By illustrating the variety of Web mapping applications, this study enriches the body of knowledge in Cartography and provides more useful guidelines for the future development of Web mapping tools.

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