GIS-based Web-Service Architecture

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ABSTRACT

The present research addresses the system design for building a geospatially-based web services application for mobile users. In recent years, geospatial information (GI) and Geographic Information Systems (GIS) are significant resources in decision-making analyses at various levels of society and activities. Recently, the integration of GIS and web services, called GIS web services, provides the wider implementation of GIS. At the present time, accessing, presenting, and manipulating updatedgeospatial information to locate geo-related facility services are real challenges related to application developers to implement for foot-travelers properly. The present paper investigates how the web services work in a GIS for discovering geo-related facility services such as a restaurant and post office in the user's vicinity. Thus, a prototype, with an architecture consisting of a windows application on the client side as well as facility services and geo-engineon the server side, were designed and implemented with the proposed GIS web services platform. On both the client and server sides, visual studio .Net technology was used. A geo-engine on the server side was also built with ESRI's MapObjects. Following successful implementation of the prototype presented in this study, the mobile user is able to invoke remote web services to assess the location of various facilities such as restaurants. Moreover, the present research demonstratesthat web services are not restricted only to web-based use, but can also be utilized by any web-connected application.

1. Introduction

In the past few years, a considerable amount of time has been spent to integrate GI and geo-related facility services to assist travelers' requirements. The recent technique related to this integration designated GISweb services, leads to the manipulation of GI service with independent language and platform. GI is an important resource in decision-making and policy support at various levels of private and public organizations. GIS allows storage, editing, maintenance, dissemination, display and access of GI. GIS is normally utilized related to the acquisition, storage, and analysis of information where geographic location is

important for the analysis or to make a model [1]. The combination of GI and GIS has improved the capability of GI for multiple applications [2]. During the last two decades, the geographic industry has faced interest and activity in the operation of web sites increasingly that provide access to geographic content. There are several drivers behind this activity. One is the advent of the World Wide Web and internet which can be observed as an infrastructure of shared computing resources and information [3]. At the same time, the GIS industry itself has come of age. This maturation has led to a new stage of growth related to the industry that concentrates on distribution of geographic knowledge and potentials.

Traditional GIS techniques were very difficult to meet the needs for all requirements of the application in order to locate the geo-related facility services for pedestrians with single GIS platform, the GIS based web service technologies have provided a new efficient solution. The geospatial web services are the software components that can supply the GIS data and functionalities that can be linked and integrated to the different customized geospatial applications. A web service is basically an application that represents a web-accessible application program interface. It keeps related source data and functionality on the server side and proposes the web access to it. Developers can apply the GISweb services to carry out geographical processing and return the results to the mobile user applications without maintaining the basic GIS system or the geographical data. Moreover, a web service is a set of standards that constitute applications to developinteroperability over the web. It has independent programming language and platform.

Although many studies have been applied the web services technology to GIS systems with different kinds of GIS web Services [4, 5], few studies have been reported on the design in order to build mobile application system with GIS web service technology by the use of existing software. The objective of the present research is to investigate the operability of geospatial web service components and to describe the implementation of a suitable prototype to help mobile users in the geospatial web services architecture in order to utilizefacility services such as restaurants and post offices in their vicinity.

2. Previous works

So far, many researchers have paid more attention to the application and analysis of geographic information rather than their access and publication. Previous efforts described the concepts and profits of geospatial infrastructure in the context of data standards and networking; however they were restricted in applying geospatial services related to mobile users. Moreover, actual implementations of the Web service recently has been emerged in such applications as Google Web APIs service [6] and OGC Web services initiative [7]. The World Wide Web Consortium (W3C) has successfully steered the SOAP's evolution from an HTTP-based RPC mechanism in XML to a leading interoperable technology with replaceable bindings[8]. The Web services technology is a practical engineering result in the software area. Designs of the Web services systems have received attention from both industrial [9, 10] and academic field [11, 12, 13]. Meantime, the Open GIS Consortium (OGC) has followed web

map services with interoperability of map servers and clients. The first specification on simple web map services was released in 2000. Currently, the web mapping services standards include the Web Map Service (WMS) and the Web Feature Service Implementation Specifications (WFS) [14].

3. GIS web service based methodology

The present research addresses a GIS web service based mobile architecture according to the following procedures. First, an appropriate architecture was developed to visualize the entities of the geospatial web services and their relationships. Second, a prototype of the geospatial web services application, based on proposed conceptual framework,was designed and implemented to access geospatial data and geo-related services. In the meantime, the operational method of web services in GI systems is considered, along with the type ofplatforms and technologies of geospatial web services needed to enable the mobile user to access the facility services in the vicinity of the user's location.

A web service is a software system designed to support interoperable machine-to-machine interaction over a network. The web service architecture enables the internet to function as a platform for distributing services, not just distributing data. The web services model typically relies on technologies derived from XML, a structured language that expands and formalizes HTML. In this regards, the W3C (2000) Consortium has created SOAP, an XML-based communication protocol. These days, SOAP is widely considered in most of the communication infrastructure offered for integrating applications and web services. Furthermore, languages in order to describe the web services have been developed, with the most well-known example being WSDL (Web Service Description Language), an XML-based language which allows developers to create service descriptions as a set of operations over SOAP messages. From a WSDL specification, a program can discover the specific services provided by a web site, and how to use and invoke these services. As a complement to WSDL, UDDI (Universal Description, Discovery and Integration) has been proposed by W3C (2001). UDDI provides mechanisms for searching and publishing services written preferably in WSDL.

Actually web services, whichcan be found, invoked, and executed over the web, is defined as a program which carries out a specified action. After that, it is relatively uncomplicated to define a geospatial web service. A geospatial web services is a web service which performs an action on geospatial data or information. The integration of GIS and web services supports the more significant implementation of the GIS architecture. Mapping,data and geo-processing services are accessible from numerous servers and can be integrated into a common environment. Moreover, the ability to interoperate and combine geospatial data makes GIS-based web services exclusive.

3.1. Geo-related architecture design

The geo-related web services architecture was designed and implemented to present the advantages of such a system over the traditional static systems in order to access the online geospatial data and geo-related services (Figure 1). In the client side of this structure a service

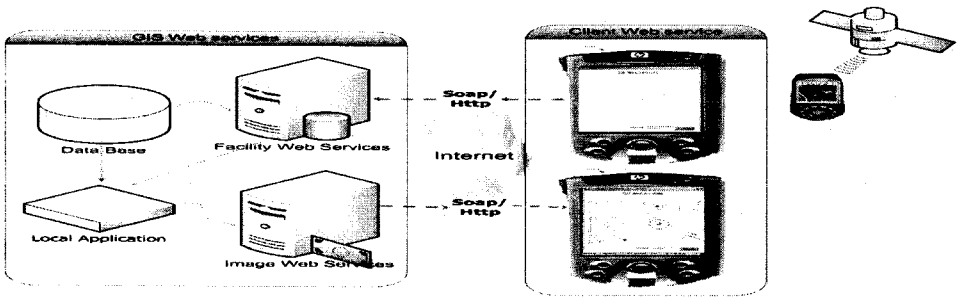

Figure 1: Geo web services proposed architecture

description and the access point to the WSDL file from a service registry such as UDDI can be searched and retrieved. The WSDL file is used to produce a client-side web service proxy. Then, the service consumer uses the service description to invoke the web service. The web service requester can send a SOAP message to the service provider to invoke a specific method of a web services and receive a SOAP response. The mobile users send their request to the web services to determine the favorite facility (e.g. supermarkets) in their vicinity. Then the user's position and the selected facility are sent to the geospatial web services to show where his favorite facilities are in his surroundings. In fact, the client architecture of the present research is so thin, thus it is more convenient for mobile devices. Since, the many types of mobile devices have serious limitations with respect to capacity and memory.

4. System implementation and discussions

After designing the architecture, the GIS web services architecture was implemented by a component-based prototype. It is a modular and self-contained architecture which can be easily changed. The geospatial web services prototype was implemented by the use of two technologies: Microsoft's .Net (Vb.Net and C#) and ESRI's MapObjects. The .Net and MapObjects are combined to allow the multi-user system to develop as separate and single server-based units. The former provides the user interface, the network communicationsand the component framework to hold the whole system together. The latter provides three basic components of GIS: data storage, map rendering, and spatial analysis. MapObjects is an ActiveX component that lets the developer add specific spatial functions within an application, after which the geo-engine can be invoked by the facility web service and can obtain the users' position and the facility type, which are normally saved in image file format. In the currentpaper, the implementation of the web services geospatialbased prototype produced several results. In the GIS web services requester side, the client side after connecting to GIS web services can easily invoke the web services to use data and services. The facility web service is taken as the main part in the GIS web services.

As noted earlier, the GIS web service provider architecture encompasses three different sections: facility web service, geo-engine and image web service. The geo-engine was built by ESRI's MapObjects, which is a collection of GIS components. It has been widely used to create specialized GIS desktop applications.

Moreover as the inability of the facility web service to convey an image file to the web service client side directly, the image file has to be sent to the client part through another web service. The image web service keeps the image file in a memory stream, and encodes the stream to a string, a kind of text format (Figure 2).

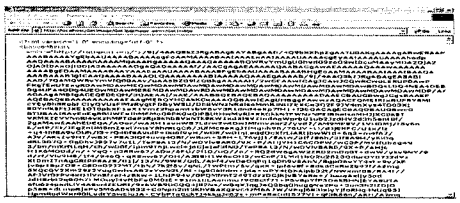

Figure 2: Encoding image file to text format

The web service client converts the encoded SOAP message into an image, which allows the users to easily obtain their geo-related requirement on the client side without needing any spatial data or GIS software. Actually all spatial data processing is computed on the server side and only the SOAP message, which is a kind of text format, is sent back to the client. Figure 3 shows the results of geo-related user request on the client side. Actually, the user can find the facility (e.g. supermarket) in the vicinity without having any GIS data or function in his device. For this, this is one of the best architectures for mobile device which does not have enough memory space to install GIS software and store geospatial dataset.

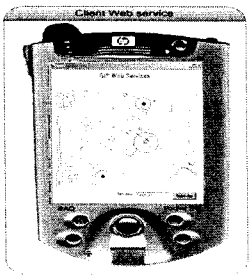

Figure 3: Client side includes final map

According to the determined GIS web service building architecture, this research implemented a GIS Web Services in order to help application developers to easily design the client side for mobile users. Generally, the capability of evolving a system largely depends on the system architecture. In addition, a simple client side application is built to evaluateimplemented GIS web services. It has been found that web services is a very appropriate architecture for practical implementation of distributed GIS, and Microsoft .NET and ERSI's MapObjects are apt components for such web services architecture. In this work, the .Net which executes the method employing the appropriate protocols was used. Microsoft's .Net is a kind of toolkit offering the user interface, the network communications, and the component structure to connect the whole system together. Most web services toolkits are comparatively new, and some are not exclusively functional.

5. Conclusions

The presentresearch examined how geospatial functions work in the web services environment. In this regard, a prototype, with architecture consisting of a Windows application on the client side as well as geospatial web services and geo-engine on the server side related to mobile users, was designed and implemented. The web service was confirmed to be a very capable structure for practical distribution of GIS implementation. Microsoft .Net and ERSI's MapObjects are appropriate structural components for such geospatial web services architecture. Additionally, this study featured the following versatile advantages. The present work confirmed the transferability of GIS functionality and data

to other computers, including those with no installed GIS softwares.

In general, the geospatial web services prototype supports architecture through which any mobile user with any platform and any programming language can utilize GIS tools in the vicinity of geo-related facilities. In addition, the mobile client in the present architecture does not need to store geospatial data or geoprocessing functions which are a critical requirement of the most mobile computing environments. Overall, although this prototype only encounters the surface of the geospatial web services, it reveals the simple and efficient combination of the web services with GIS applications.

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