

Using Open Source GIS for Development of Internet Geographic Information System: A Case study for Thai Herb Database in Phatthalung Province

Tavib Jungialern¹, Onjira Sitthisak¹⁺ and Waraporn Tanongsak²

¹ Department of Computer and Information Technology, Faculty of Science, Thaksin University, Thailand

² Department of Geography, Faculty of Humanities and Social Sciences, Thaksin University, Thailand

Abstract. A major problem facing the development of Geographic Information System (GIS) in higher education in developing countries like Thailand is a high technology cost of the necessary hardware and software and also vendor lock-in. As a result, an Open Source GIS was developed. This is one of the solutions for developing GIS application in developing countries. The objective of this research is to explore the use of open source GIS in order to create, implement and maintain the Internet GIS. In this research, Quantum GIS, PostgreSQL/PostGIS and GeoServer were focused. A GIS prototype for Thai herb database in Phatthalung province, Thailand was developed. The architecture of the system and the usability evaluation are discussed. The problem of join descriptive data using Thai in a CSV file with a geographic data in QGIS was discovered. However, we suggest one of the solutions for this problem by using PostgreSQL/PostGIS capabilities.

Keywords: Open Source GIS, GIS, Herb

1. Introduction

A major problem facing the development of Geographic Information System (GIS) in higher education in developing countries like Thailand is a high technology cost of the necessary hardware and software and also vendor lock-in [1]. As a result, an Open Source GIS was developed. The open source GIS is a viable prospect for anyone to access with a personal computer. The objective of open source is better quality, higher reliability, more flexibility, lower cost, and an end to predatory vendor lock-in [2]. This is one of the solutions for developing GIS application in developing countries [3].

We introduce the background to the pedagogical and technical issues involved in the development of Geographic Information System (GIS). A specific approach is described for Open Source GIS, GeoServer, PostgreSQL DBMS, Open Layer and QuantumGIS. A system overview of the proposed architecture is presented. The prototype system of Thai Herb GIS was developed by using these open sources. The prototype facilitates information management, visualization and illustration information in terms of geographic and descriptive data through the Internet. We consider an implementation and a usability evaluation. Finally, we present some discussion of a heuristic evaluation and conclusion.

2. Background

2.1. Open Source GIS

GeoServer is a popular Java-bases open source development environment for constructing spatially enabled Internet-web applications. It is fully compliant with the OpenGIS Consortium's web services specification; Web Map Server (WMS) and Web Feature Server (WFS). GeoServer is available under the

⁺ Corresponding author. Tel.: + (66827491831); fax: +(6674693995).
E-mail address: (onjira.sitthisak@gmail.com).

GPL 2.0 license [4]. GeoServer also supports Open Layers for making map generation quick and easy. Spatial queries in GeoServer are possible with the combination of PostgreSQL/PostGIS DBMS. There is a performance comparison between GeoServer and MapServer, another famous open source IMS [2]. Geoserver has a friendly administrator interface. This generic web interface is very interactive and easy to use. For MapServer, the user interface and mapping functions are limited because it is written in C and developed with CGI (Common Gateway Interface) program. Meanwhile, GeoServer is based on J2EE program.

PostgreSQL [5] is an open source object-oriented database management system (DBMS). It runs on multiple platforms including Linux, UNIX and Windows. It contains features and functionalities of object-relational database and also supports geo-spatial extension PostGIS. It also follows the OpenGIS Simple Features Specification for SQL. As a result, PostGIS has been certified as compliant with GeoServer.

OpenLayers [6] is a JavaScript library for displaying dynamic map data in any web page without server-side dependencies. This web page views the mapping services published by GeoServer using the OpenLayers web mapping library. The OpenLayer is open source, making it flexible and capable across standards as well as proprietary application programming interfaces (APIs). It allows to use any of the tile sets provided by Google, OpenStreet Map, Microsoft and Yahoo, all within the same programming API.

Quantum GIS (QGIS) [7] is a user friendly Open Source GIS that harnesses the power of distributed peer review and transparency of process. QGIS provides common GIS functions and features and supports a number of raster and vector data formats including shapefiles and spatial data in PostgreSQL/PostGIS. Moreover, it is easily added new format or feature using the plugin architecture and GIS enabled applications using Python or C++.

2.2. Usability Evaluations of Internet GIS Applications

Nowadays, many internet GIS applications are developed in many approaches. In order to enhance quality of development, usability evaluations are verified. Usability is one of the six fundamental parts of the classical FURPS model and in accordance with ISO 9126 [8]. One of many methods of usability evaluation is heuristic evaluation. Heuristic evaluation [9] is used for examining interface and judging its process of interactive design by experts. This method is classified into eight categories of heuristics: environment of user interface, used technology, error dilemma, user-friendly application, privacy, help and documentation tests, skills and usability control and freedom, and list of maps.

3. Objective

Three fundamental objectives have been followed: to explore the use of open source GIS in order to create, implement and maintain the Internet GIS, to study Quantum GIS, PostgreSQL/PostGIS and GeoServer with the development and applications of GIS, to test the technical feasibility of developing a prototype system and an affordable GIS for higher education, and to verify usability of this prototype with heuristic evaluation. It has been focused on the objectives of creating a GIS prototype for Thai herb database in Phatthalung province, Thailand. This research was considered appropriate to conduct an exploratory case study, undertaking hypothesis generation rather than hypothesis testing. This hypothesis generation is concerning the feasibility of community spatial data access through a web-based open-source GIS.

4. Methodology

4.1. Study Area and Data Collection

The study area is Phatthalung province. It is an ancient city in southern Thailand. It is a land of mountains. Phatthalung city is situated on the west bank of Songkhla Lake, about 846 kilometres from Bangkok, a capital city of Thailand. It has an area of 3,424.473 square kilometres or 2,140,296 Rai (Ground water 1,919,446 Rai 220,850 Rai). Height from sea level average 15-0 meters, medium. The geographical location of Phatthalung lies within Latitude: 7° 06 to 7° 53 N, Longitude: 9° 44 E. The length of the State from North to South is approximate 78 kilometers. For width from East to West, the distance is approximate 53 kilometers. Data in this research are collected from many local Thai herb philosophers in Phatthalung. These philosophers distributed in 10 districts and 1-sub-district. There are more than 200 type of Thai herb in

Phatthalung. These data collected in this proposed prototype are common name herbs, scientific name herbs, medical plants, herbal remedies and uses, herb pictures, topography and location.

4.2. Technical Feasibility and Functionality of the Prototype

The technical feasibility of developing the proposed system by using open source software was investigated by developing a prototype. The functionalities of the prototype are: to access descriptive and spatial information from a central database by local communities, to insert and update descriptive and spatial information collected by communities, and to display and query descriptive and spatial information over the web. The GIS can be used by communities in Phatthalung province to collect their own data. Through a user friendly interface, end-users can enter attribute data for selected areas. These data are then stored in the central database.

4.3. Architecture

The web-based GIS are designed in two parts as shown in Fig. 1. The first part is the server side, which was developed using GeoServer and Tomcat/Apache web server to augment point observations with other GIS data layer such as land, river and area boundaries. This is the basic function of web-based GIS system which allows users to navigate and visualize area of interest on map at different scales according to the selected areas. The generated GIS application is able to manage requests coming from the internet and switch them to either the GeoServer or PostGIS as required.

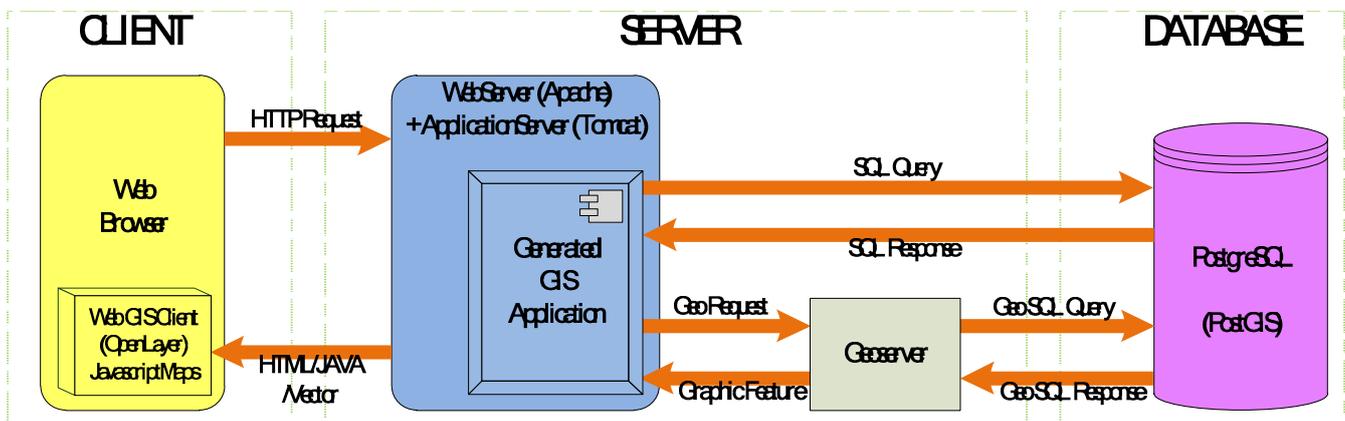


Fig. 1: Architecture of Web-based GIS

The second part of the system is web client interface which will be developed using JAVA, PHP and PostgreSQL which could establish a web database connection that enables users to integrate web based map browsing, spatial query, data services, and map overlaying capabilities. At run-time, actions performed by the user are translated into HTTP request by JAVAScript code and raster data. Based on the selection of parameters by the user, a PostgreSQL could be built and sent to the database server for execution. The results of the execution can be obtained by the web application server and converted into JAVA format to display in the client-side web browser. In detail, a GIS query is transmitted as a GET or POST request. The request is captured by the generated GIS application and forwarded to GeoServer which interprets the query, composes the SQL statement according to the PostGIS and send it to the DBMS. When the DBMS compute the query, results are gathered by GeoServer to create the answer. This answer is sent it back to the client side in HTML format. Lists all the applications used in the creation of the proposed prototype are PostgreSQL/PostGIS V.9.1, GeoServer V. 2.1.1, Apache V.7.0.21, JAVA V.1.6.0, OpenLayers V.2.1.0, and QGIS V.1.7.0. The software chosen for this research was chosen following a period of research into each component.

4.4. Internet-Based GIS Implementation

The prototype system was developed as a series of components in Fig. 1. End-users access the system by logging in the internet GIS client. The client runs inside a web browser, as illustrated in Fig. 2, and required no additional software or plug-ins. The user interface of this prototype contains two main focused features: GIS and MIS modules. From Fig. 2, the layers of GIS data can be overlaid on the map which is the middle of

screen by mouse-clicking on the left side menu list. The GIS operations are controlled by computer programming tools that are in the map. User can select various processing parameters such as common name herbs, scientific name herbs, medical plants, herbal remedies and uses, topography and location above the map. When selecting a data layer on the left side menu, the user also selects certain parameters which are specific to that layer such as Province layer, District layer, Road layer and Village layer. The user would like to search all herbs in Phapayom District, thus a district name feature such as Phapayom District has been clicked. A listing of all herbs in the District is presented. Then, the representation of non-geographical information processing which are in all MIS operations appears on the new windows.

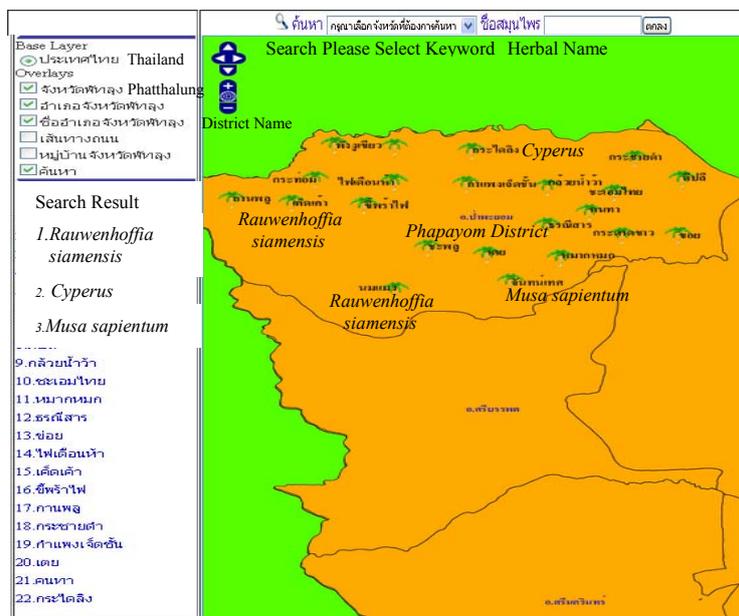


Fig. 2: Screenshot of the internet GIS and search results page showing all herbs in Phapayom District

5. Evaluation

5.1. Technical Feasibility and Functionality of the Prototype

The design and implementation of the prototype show that it is feasible to develop a system such as the one described in this paper using open source GIS software. However, the problem of join descriptive data using Thai in a CSV file with a geographic data in QGIS was discovered. Excel encodes this CSV file using ANSI (American National Standard Institute) character set. In QGIS, text features from outside QGIS cannot be pasted to a layer within QGIS. As a result, there is a language error for the join descriptive data. We suggest one of the solutions for this problem by using PostgreSQL/PostGIS capabilities. First, we have to convert an ANSI CSV file to a UTF-8 CSV file by using Notepad or EditPlus. UTF-8 is appropriate for writing code for cross-platform software. Second, we import an Unicode CSV file into PostgreSQL/PostGIS. Then, Descriptive data in the CSV file can be joined with a geographic data by using the joins Tab in PostgreSQL/PostGIS.

5.2. Usability Testing

A heuristic evaluation [9] was used to investigate usability in this research. This evaluation involves testing the ability of a system to allow users to complete their task effectively, efficiently and enjoyably. This preliminary evaluation was focused on six categories of heuristics. These categories were Environment of user interface, Used Technology, Flexibility, esthetics and design, User friendly application, Skills, user control and freedom and List of maps. The participants were voluntary 4th year undergraduate students. Instruction sheets were distributed to all participants and asked the participants to rate the prototype system against the criteria on a 5-point Likert scale (Strongly disagree, Disagree, Neutral, Agree, Strongly agree, coded as 1,2,3,4 and 5 respectively) that best described their opinion.

6. Result and Discussions

The study gathered data from 20 students. A one-sample t test was used to test differences between the observed sample means and an expected sample mean of 3.0, being mid-way on the measurement scale. As can be seen in Table 1, the mean rating was significantly higher than 3.0 for 6 of 9 measured variables.

The students did not think that descriptions of all fields were familiar, brief, polite and descriptive (DescriptPolite). This may be because the students never used the GIS application before testing this application. The students also did not think that layers were sorted into thematic groups (LayerSorted). This suggests that the layers need to be arranged into new groups and be more descriptive. For AccessQuick, the students did not think that the map list was accessible quick and easy. This suggests that loading of the map or the map list need to be adequately quick. The results of the remaining t-tests were straightforward: the students agreed that all text were readable (TextReadable). Used terms were commonly known (TermCommon). It was not necessary to have installed plug-in (InstallPlugin). Good contrast, brightness and color was harmony between pictures and background (Good Color). Results of searching were linked back to the map list (SearchLinked), and a searching was easy (SearchEasy). This experiment shows that this prototype was acceptable to students. Hence, it was feasible to develop a system by using open source GIS in order to create, implement and maintain the Internet GIS.

Table 1: t-Test

Measured Variables	Test Value = 3.0			
	t	df	Sig.(2-tailed)	Mean Difference
Environment of user interface				
TextReadable	5.107	19	0.000	0.900
TermCommon	3.577	19	0.002	0.650
Used Technology				
InstallPlugin	4.000	19	0.001	0.800
Flexibility, esthetics and design				
GoodColor	2.854	19	0.010	0.600
DescriptPolite	2.027	19	0.057	0.400
User friendly application				
LayerSorted	2.236	19	0.038	0.500
SearchLinked	2.773	19	0.012	0.550
Skills, user control and freedom				
SearchEasy	2.703	19	0.014	0.500
Lists of maps				
AccessQuick	1.710	19	0.104	0.400

7. Conclusion

Results achieved with the initial implementation of the above described interface indicate that the proposed architecture is feasible to develop GIS in higher education for developing countries. Using open source GIS; Quantum GIS, PostgreSQL/PostGIS and GeoServer are feasible to develop an application of GIS. The technical feasibility of developing a prototype system and an affordable GIS for higher education are acceptable. In addition, usability of this prototype with heuristic evaluation is acceptable to students.

However, the problem of join descriptive data using Thai in a CSV file with a geographic data in QGIS was discovered. We suggest one of the solutions for this problem by using PostgreSQL/PostGIS capabilities. This internet GIS application has an advantage. This prototype is just an example of how open source GIS can provide capability and features of commercial GIS software. Thus, the methods and software used in this prototype can be used to create, implement and maintain any prototype in any field with an end to predatory vendor lock-in.

8. Acknowledgements

This work was supported by Thaksin University under the Higher Education Research Promotion, Office of the Higher Education Commission in the year 2011.

9. References

- [1] J.T. Fadahunsi, A Perspective View on the Development and Applications of Geographical Information System(*GIS*) in *Nigeria*. The Pacific Journal of Science and Technology, 2010. **11**(1): 301-308.
- [2] Ming-Hsiang Tsou and J. Smith, *Free and Open Source Software for GIS education*. 2011, National Geospatial Technology Center of Excellence.
- [3] Sreejit S. Nair, *Web Enabled Open Source GIS based tourist information system for Bhopal city*. International Journal of Engineering Science and Technology. 2011, **3**(2): 1457-1466.
- [4] GeoServer, *GeoServer*. 2012. from <http://geoserver.org>
- [5] PostgreSQL, *PostgreSQL*. 2012. from <http://www.postgresql.org/>
- [6] OpenLayers, *OpenLayers*. 2012. from <http://openlayers.org/>
- [7] QuantumGIS, *QuantumGIS*. 2012. from <http://www.qgis.org/>
- [8] ISO, *ISO/IEC 9126 : Software engineering-Product quality*. (2001): International Organization for Standard.
- [9] Hub, M., O. Víšek, and P. Sedlák, *Heuristic evaluation of Geoweb: case study*, in *Proceedings of the 5th European conference on European computing conference*. 2011, World Scientific and Engineering Academy and Society (WSEAS): Paris, France. 142-146.
- [10] *tial Geometry*. CRE Press, 1998.