Develop a Spatial Information Management System: A Case Study for Faculty of Agriculture, University of Ruhuna, Sri Lanka

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Abstract

University Management Information Systems (MIS) are managing attribute (non-spatial) data of students. There is no facility to accommodate spatial data of the students in University MIS. Both spatial and non-spatial information together will leads to process of decision making much easier. This study is focused on introducing a Web based Geographical Information (WebGIS) System, which can be used to manage spatial data of students in a University MIS. This WebGIS System was initiated by Faculty of Agriculture, University of Ruhuna, Sri Lanka. Geographic locations of students were updated through MIS of the Faculty and then mapped using Google Maps Application Programming Interface (API). In this WebGIS System, students can add, view and update their locations on high resolution satellite images available in Google Maps. In other hand, university administration can visualize locations of students by different administrative levels, find shortest path and distance to students locations. Also they can visualize academic performance of students by different administrative levels. Based on these visual interpretations, decision makers can easily get their decisions.

Key words: Decision Support System (DSS), Google Maps API, Locational Data, MIS, WebGIS.

1. Introduction

Faculty of Agriculture, University of Ruhuna is located in Mapalana, Kamburupitiya, Sri Lanka. The Faculty is one of the premiers Agriculture Faculty in Sri Lanka which contributes to human capacity development and agricultural technology generation in the country. The Faculty is having seven academic departments and offering three undergraduate degree programs. Also, the Faculty is offering few postgraduate degree programs. Total number of courses offered by all the academic departments is more than 50. Total student population of the Faculty is more than 800 and the academic staff population of the Faculty is more than 100 (Student Hand Book, 2015). Therefore, it was very difficult to manage the academic program without having a Management Information System (MIS). To overcome the difficulty, the Faculty introduced a web based MIS which enabled the Faculty to manage the academic program smoothly and efficiently. The MIS is having modules for Student Information Management, Course Management and Examination Management. But, the MIS is managing only students' attribute (non-spatial) data. In other words, there is no provision to manage spatial information of students in the current MIS.

Students are entering to the faculty from various locations of the country. Therefore, it is very important to manage spatial data such as locational data of students other than their non-spatial data through the current MIS. Because, it will greatly helpful for university administration to visualize students locations by different administrative levels of the country, find shortest path to students locations from the faculty,

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calculate distance to students locations from the faculty and visualize academic performance of students by different administrative levels of the country. Also, this will help to compare locations vs. performance of students in different academic years and allocation of hostels among students considering distance to their locations. Therefore, this can be used as a decision support system (DSS) by analyzing spatial data of students.

There is no provision to manage locational information of students in the current MIS of the faculty. This is a problem for university administration. Therefore, development of a Locational Information Management System as a module of current MIS is required for the faculty. This can be used as DSS by analyzing spatial data of students. Also, this will be the first Locational Information Management System that can be used to manage spatial information of students' in Sri Lankan State Universities. Free and Open Source Software can be used for the development and integration of Locational Information Management System. It will provide easy integration, low cost and improve efficiency (Anderson and Moreno-Sanchez, 2003). Also, the spatial database can be used for further research studies. Finally, this model can be adopted by other educational institutes to manage spatial information of students in the institute.

Therefore, the main objective of the study is to develop a Locational Information Management System as a module of current MIS of the faculty. This is based on four specific objectives which are; 1) Link Spatial database system with Existing MIS, 2) Provide Spatial information for accurate Decision making, 3) Visualize student information online for better understanding on their admission and 4) Provide navigation facilities.

2. Study Area

For the case study, I selected Faculty of Agriculture, University of Ruhuna, Sri Lanka. University of Ruhuna is one of the recognized state university in Sri Lanka. Also, I selected undergraduates of the Faculty as my target group for the development of the locational information management system.

3. Methodology

The purpose of the study is to introduce a WebGIS System that can be used to manage locational data of students in any educational institute. Most of the educational institutes are having MIS to manage non-spatial data of students. But, none of the systems are having a mechanism to manage spatial data such as locations of students. This is a problem for decision makers.

This WebGIS System has been initiated by Faculty of Agriculture, University of Ruhuna, Sri Lanka as a case study and which can manage student locations. Geographic locations of students updated through MIS of the faculty and then mapped on GIS Platform using WebGIS Technologies. Main objective of the case study is to develop a Locational Information Management System as a module of the existing MIS. The Locational Information Management System should facilitate to visualize locations of students, find shortest path and distance to locations of students and visualize academic performance of students attached to their locations.

There are several GIS technologies available to achieve the objectives of the study. Those are Desktop GIS, WebGIS and Mobile GIS (Biyanwila, 2014). Considering the problem domain WebGIS is selected as the best GIS Technology among other GIS Technologies available in the industry. Web GIS Development Life Cycle (Alesheikh, 2002) is used as the baseline methodology to develop the WebGIS System. Figure 3-1 shows the Web GIS Development Life Cycle. All the data sources used for the study are secondary data sources. The data sources are existing database of the MIS and GND (Grama Niladari Division) Survey Data (Map Scale: 1:10,000) from Survey Department of Sri Lanka. GND is the smallest administrative level of the country. For the implementation, I used most of the free and open source platforms on top of the medium level hardware platforms. Therefore, the implementation cost of the application was very low. Since the system was web based with thin client-server architecture, anybody can access the system from anywhere at anytime.

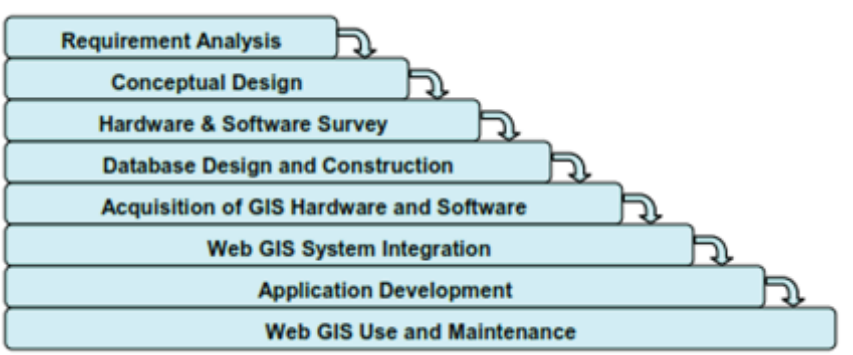


Figure 3-1. Web GIS Development Life Cycle.

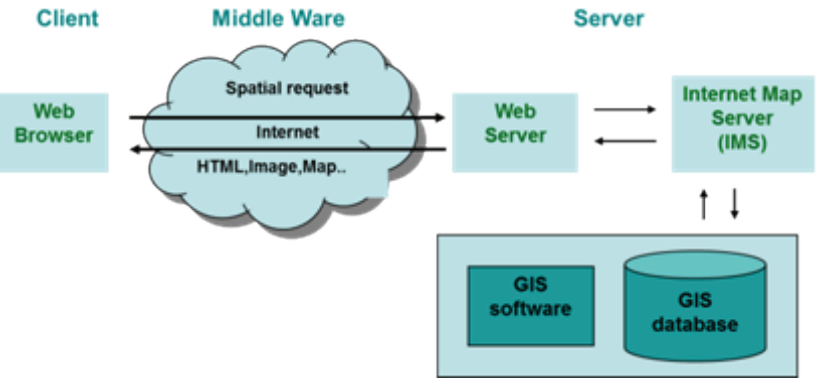


Figure 3-2. Client-Server Architecture

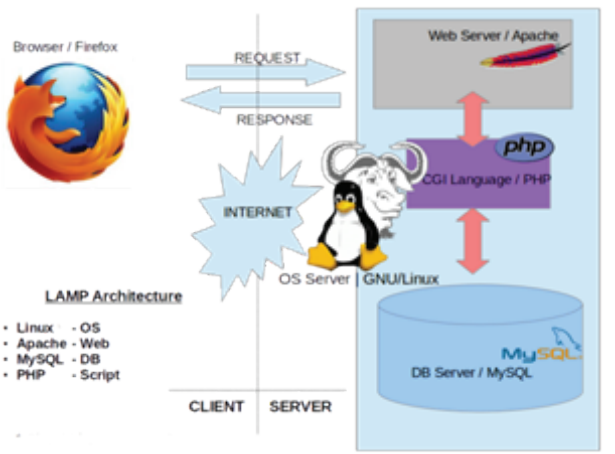


Figure 3-3. Components of LAMP Stack
Source: https://en.wikipedia.org/wiki/LAMP_(software_bundle)

Figure 3-2 shows the Client-Server Architecture (Alesheikh, 2002) used to implement the Web GIS Application. It shows the interaction with its different tiers.

LAMP (Linux, Apache, MySQL and PHP) stack is used to implement the client-server architecture with thin model. Figure 3-3 shows the different components of the LAMP stack. Since, the current MIS is also running on think client-server architecture with LAMP stack it is very easy for the system integration.

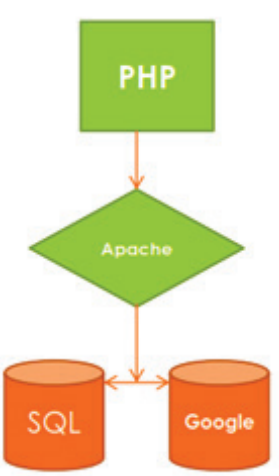


Figure 3-4. IMS Model

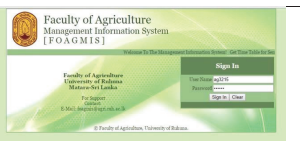
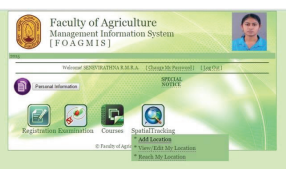
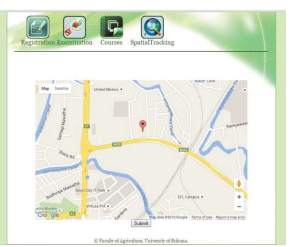
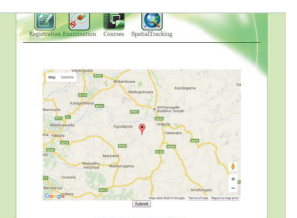
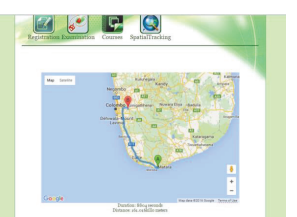
As IMS (Internet Map Server), Web Maps API was selected as the IMS Model for this project because which is fully compatible with the model of the existing MIS. Also, there won't be any additional hardware requirements to implement the model. Google Maps API was selected as the Web Maps API among available API in the industry because which is free, flexible and almost all web browsers are supporting it without any plug-ins. Figure 3-2 shows the IMS Model of the proposed system.

4. Result and Discusiion

Table 4-1 and Table 4-2 show the results and discussions based on the interactions of Students and Academic/ Administrative Staff with the implemented locational information management system.

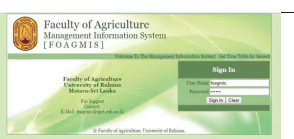
4.1 Interactions of Students

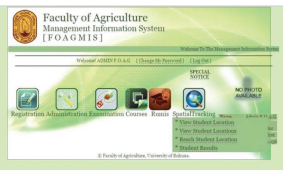
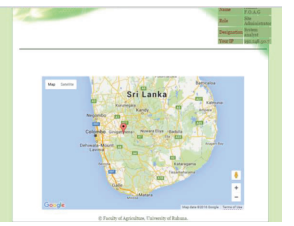
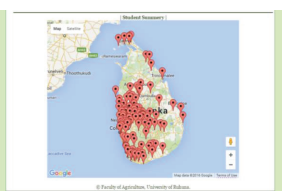
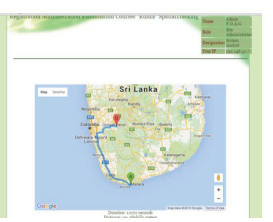
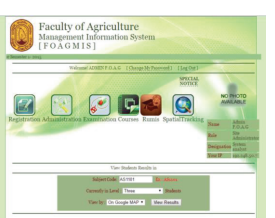
Table 4-1. Interactions of Students.

Interaction	Result	Discussion
Student Login		A student should provide his/her user name and password to login into the MIS
Menu Options		Menu options of Spatial Management Module, those are allowed to access by a student
Add Location		A student should select his/her Province, District, DSD and GND respectively. Then the system will generate the approximate location of the student based on the centroid of his/her GND and display the location. Now the student can move the marker into his/her correct location and save the location
View/Edit My Location		A student can view his/her location. Also his/her can select a new location and submit the new location to save in the system
Reach My Location		System is generating and maps the shortest path to student location from the Faculty. Also it will display the distance and time taken to reach his/her location

4.2 Interactions of Academic and Administrative Staff

Table 4-2. Interactions of Academic and Administrative Staff.

Interaction	Screen	Description
Academic/Administrative Staff Login		An Academic/Administrative Staff should provide his/her user name and password to login into the MIS

Menu Options		Menu options of Spatial Tracking Module those are allowed to access by an Academic/Administrative Staff
View Student Location		Academic/Administrative Staff can search a student to find out the location of the student
View Student Locations		Academic/Administrative Staff should select the stream, level and view by options. The output is according to View by Google Map, Province and District. View by DSD and GND are not properly displaying due to increasing number of polygons
Reach Student Location		Academic/Administrative Staff can search a student to find out the shortest path to the student home location from the Faculty
Student Results		Academic/Administrative staff should type Subject Code, select Level and View by Options. The results will display as markers attached to student locations in different colors according to the grades they achieved

Since the existing MIS is web based, it was very easy to use WebGIS to integrate the spatial information management system in to the MIS. Further, both systems are using free and open source software for the implementation, which provides easy integration, low cost and improve efficiency. The WebGIS system can access from anywhere, at any time and from any device. System users can use any web browser to access the system, because the system architecture uses thin client architecture. Further, development of this kind of system will enhance the interaction in between employers, undergraduates and graduates in future. Because, this system can further enhance to provide access to employers to get the locational information of graduate or undergraduate students in a particular region for their recruitments for company or projects. At this stage of the system considered spatial information of undergraduate students only. Next, stage it will consider other students of the faculty. This is a limitation of the spatial information management system.

5. Conclusion

According to the results the of the study, students can add, view and update their locations on high resolution satellite images available in Google Maps where they can identify their home locations clearly. Also the students can easily find out shortest path to their locations from the institute. In other hand academic and administrative staff can easily track locations of students. Also they can find out shortest path to student locations from the institute. Further, they can overlay locations of specific target group of students by Provincial, District, DSD and GND levels. Finally, they can analyze student performance (results) by Provincial, District, DSD

and GND levels based on students' home locations. Finally, all these features can be accessed through a module of the existing MIS.

As a result of the system, academic/administrative staff can take decisions based on the spatial data of students. Therefore, this system leads to decision supports of any educational institute based on spatial data of students.

The system can be incorporated to MIS of the other faculties of the University as well. Also, this system can be introduced to other universities and educational institutes to manage locational data of students. Therefore this system can be used as a decision support system by accessing locational data of students in national level. Further it is possible to develop a mobile application to ease of access as a further study.

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