Volume-7, Issue-3, May-June 2017
International Journal of Engineering and Management Research
Page Number: 155-159

Modelling a Web-Based Campus Geographic Information System for easy location of facilities within a University Campus

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ABSTRACT

Access to needed information about the geographical location of facilities within a University campus and it's environ could be tasking and frustrating without a well-articulated guiding mechanism, particularly to first-time visitors, due to the complex nature of the structure of a campus. This study models a web-based campus geographical information system for easy location and accessibility to facilities within Redeemer's University, Ede, Nigeria. The study employs the navigational development technique (NDT) with an integration of global positioning system (GPS) for determining the longitude and latitude of location of the required facility. The system was tested using a web technology as a presentation tool for information sharing. The system would ease navigation and access, and increase the efficiency of planning within the university campus.

Keywords-- Geographic information system, spatial location, road network, global positioning system, navigational development technique

I. INTRODUCTION

Access to needed location information about Redeemer's University and its environment has been a major issue, especially the access to spatial data of its location and utilities. Getting to a specific area in due time with limited knowledge on the shortest path available is always a challenge. In addition, information about the location of some basic facilities such as an ATM stand, banks, staff quarters and laboratories have generated concerns among visitors. Information related to departments, buildings, road networks and other facilities available has remained blurred and unclear. These needs have given rise to the quest for developing a web-based RUN Campus Geographical Information (RUNC-GIS).

The rest of the paper is organised as follows: Section II presents a literature review of related research works in the area. In section III, the modelling of the system was undertaken while in section IV the implementation is presented. Sections V and VI presents the result and conclusion respectively.

II. LITERATURE REVIEW

A geographic information system (GIS) has been described as a computer-based system which enables the displaying, processing, or storing of spatial data, with core functions of data creation, data management, data analysis and visualization. An exponential increase in the usage of spatial information in public health studies and an increased attention in understanding how place and spatial context are important for many public health issues has been reported in the past 20 years[1].The Santa Cruz Watershed Ecosystem Portfolio Model prototype (SCWEPM) was described in [2]. SCWEPM is an integrated water and land management and decision-making tool built with the intent to deliver predictive modelling and decision-support capability that can be used to forecast responses to policy and management decisions on natural resources based on changes in water availability, land use/land cover and climate scenarios. It uses "a multi-criteria evaluation framework that builds on GISanalysis and spatially explicit models that characterize ecological, economic, and societal endpoints and consequences, as identified by stakeholders that are sensitive to modifications to water and land management." In [3] an algorithm for determining road intersection using large taxi trajectories from GPS receivers was studied. Compared with the manually interpreted results, the detection results were found to be of high quality and provided enough detailed information for the construction of a routable map.

The use of GIS and the Internet has change the face of the usage of geographic information by organisations [4],[5]. The traditional GIS is an expensive, dependent and slow platform[4].Of recent, however, with different approaches of incorporating GIS on the Internet has been developed with various web technologies to enable the enormous amount of data and map image, software and data locations that are

imperative to create the most optimum system architecture. In the past years different architecture have evolved on the Internet and web-based GIS application. Technologies like ActiveX and Java has provided a lot of opportunities for web-based GIS. Environmental System Research Institution Inc. (ESRI) has develop many products such as ArcIM, ArcObject IMs, ArcGIS, and ESRI Cityengine which enable mapsto be easily copied and downloaded for more detailed use. As a result of these advancements, GIS has now become an inexpensive method to reach a wide audience on the Internet[6].SAS Institute Inc. describes a geographic information system as"a tool for organizing andanalysing data that can be referenced spatially; that is, it is data that can be tied tophysical locations. Many types of data have a spatial aspect, including demographics,marketing surveys, customer addresses, and epidemiological studies. A GIS helps youanalyse your data in the context of their location"[7].

It has been cautioned that "a GIS is more than the integration of computer hardware and software. It should be seen as the acquisition, management, analysis, and display of data that have geographic location as an important characteristic. Data that have a spatial character are usually displayed in the form of maps. For example, the level of nitrates found in a water sample by itself does not have geographic character. However, the location of the site where the water sample was obtained is important when viewed geographically relative to other features around the sampling site, such as proximity to potable water sources" [8]. The problem of locating clusters in aggregated health data had been studied in [9] while in [10] the framework for recognizing collinearand curvilinear building alignments from topographic data has been investigated.

Limitedstudies have been reported on GIS of communities and towns in Nigeria compared to even a relatively fewer number of Campus Information System. However, across the world, many institutions have studied and developed related systems and their suggested solutions have yielded many interesting results. We can view a GIS in different ways:

1. The Database View: A GIS is an independently distinct database of the planet earth, called a Geodatabase; i.e. a database containing information for the earth's geography.

2. The Map View: A GIS is a collection of maps that shows features of the earth surface. Set of maps on geographic information are created and used as access/windows into the database" to support analysis, queries, and manipulation of the gathered information

3. The Model View: A GIS as a model of a set of data transformation tool used in deriving new geographic dataset from an already existing dataset. It is a geo-processing function that takes information and implement analytic function that writes new results into a new derived database.

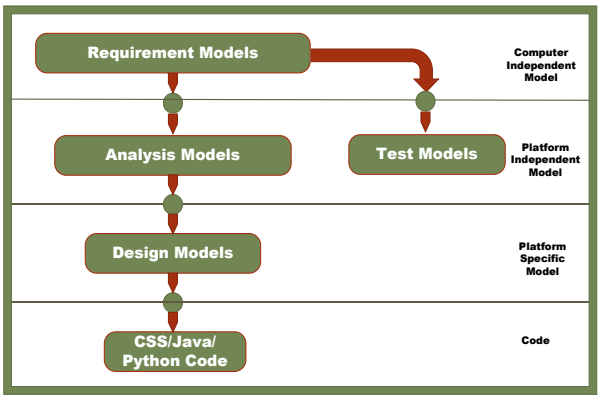

Figure 1 Model Development Diagram

III. MODELLING

A model driven approach has been adopted in this research (Fig.1). This is based on the Navigational Development Techniques (NDT), which is completely supported by a set of free tools grouped in NDT-suit, which include (ArcGIS 10.1).NDT is based on the model-driven archetype that processes a set of meta-models for each development stage (Information Gathering, Analysis, Design, Implementation, test and Maintenance)'

After gathering all information needed, a Geodatabase file was created in ArcCatalog for all layers required to prepare a representation model of the community. With the advent of feature class layers and feature data created in personal geodatabase a 2-D spatial information system (representation model) was created in ArcGis 10.1. All the attributes needed were digitized with the help of editor tool. The layers created were uploaded into the cloud-based ArcGIS online application to produce a web map. The web application was hosted locally using Internet information system (IIS) in order to run the application before deploying onto a web server.The method used in this research is depicted in Figure 2.

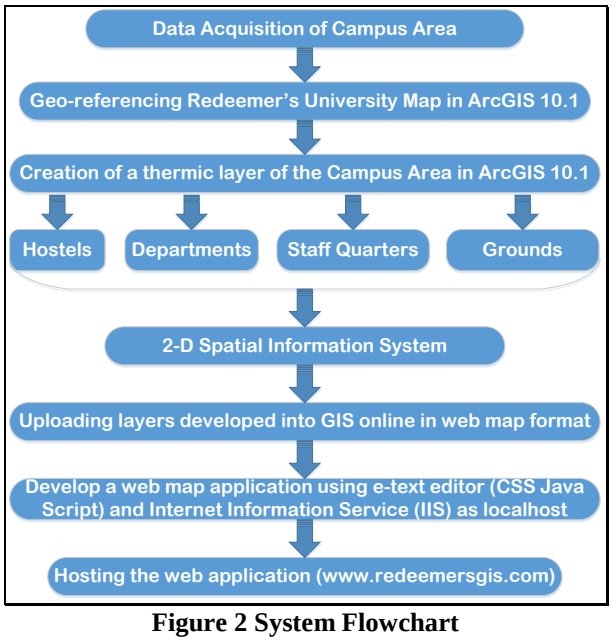

Figure 2 System Flowchart

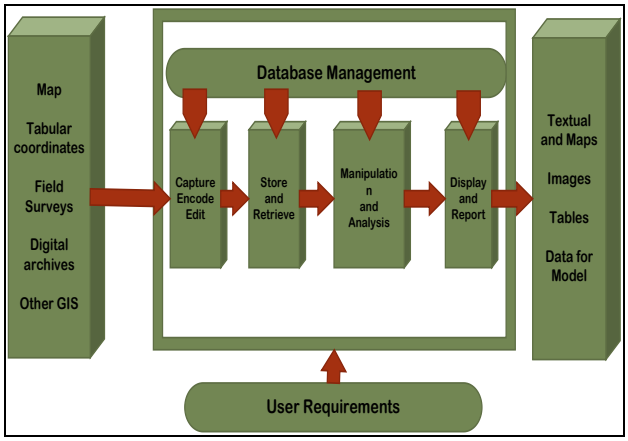

Figure 3 System Architecture

IV. IMPLEMENTATION

1. Development Environment

The design and implementation of this research was carried out within an ArcGIS development environment.ArcGIS is a geographical information system which functions by integrating maps and spatial data collected. It is used for; amassing geographic data, creating maps analysing mapped information; discovering geographic information and sharing, implementing maps and geographic data in a diverse applications, and managing geo-data in a database.

This platform provides a structure for maps and geo-information available to organisations and across the world made accessible through a web.

2.ArcGIS Components

ArcGIS packages product are available on Desktop GIS, and there are also GIS packages that run on a Server and on mobile devices.

3.Web Mapping

Web mapping is the process of linking maps extracted from a GIS to the Internet. Any web map on the World Wide Web is both served and consumed, hence, web mapping is more than mere cartography because it is both a service activity and consumer activity. Web GIS supports geodata processing which is more involved with design aspects such as data acquisition and server software architecture. Web GIS and web mapping are somewhat synonymous, web mapping usually involves a web browser or other user agent capable of client–server interactions.

The process of web mapping has been made simpler by using ArcGIS for desktop software. In the case of this research what is required is to upload the exported shape files into the cloud base ArcGIS online application and then publish the design.

4.Building the Web Map

In building the web map, the base layer for the web are obtained from the ArcGIS online application. The base map used in the case study are showing the road network and building. Thereafter, the exported shape files designed on ArcGIS wasthen uploaded to produce a multiple layer map which is saved online on the ArcGis making the web map accessible by the user online.

Figure 4Digital web map of the campus

5.Designing the Web Application

Data required: the data required are mainly image (picture images) of all facilities, digitalized on the web map. Image were taken with the following specifications: 4:3 aspect ratio, landscape picture orientation image, and a resolution of 245 pixels wide by 184 pixels.The web application design phase was divided into three major stages.

i. The GUI development stage
ii. Configuration stage
iii Publishing stage

6.ArcGIS Online

ArcGIS Online is a web application that allows uploading, sharing and searching of geo-information to users and authorized data providers. It allows the administrator to manipulate and implement data for testing.After uploading the shape files from the ArcGIS for desktop and comma-separated value (CVS) file created using Microsoft Excel to the version (ArcGIS Online), the representation model in Fig.4 was produced.

7.Basic System Requirements

(a) Minimum Hardware Requirements

The web-based RUNC-GIS will run on a system with the following minimum hardware configurations: an Intel Pentium IV system, 1 Gigabyte RAM, AMD or NVidia Graphic card (to support 3-D rendering), 20 Gigabyte hard disk space, GPS device or Scanner, Mobile device (running iOS, Windows or Android Platform).

(b) Basic Software Requirements

The software requirement for this research include:

i. ArcGIS version 10.1
ii ERIS Cityengine online cloud application 2013.1
iii Web browser (supporting OpenGL)
iv Google Earth
v. E-texteditor Software
vi. Microsoft Excel 2010
vii Internet Information System (ISS) webserver software (Windows 8 or higher)
viii. Windows Operating System version 7or higher.

V. RESULTS

In other to grant users easy navigation and location access, a GIS web view of the campus was created. This view comes in both desktop and mobile versions and also indicates the user's location over a mobile GPS device in real time. GIS on the web produces a friendly user interface which makes it easy for a person without sophisticated knowledge on ArcGIS toolkit to operate.The web-based information provides locations, images and details about buildings and road network within the campus.The features are categorised into different classes and sub-classes. An example in shown in Fig.5. For example, Departments are sub-classes of College and Senate Chamber is a sub-class of Administrative Building.

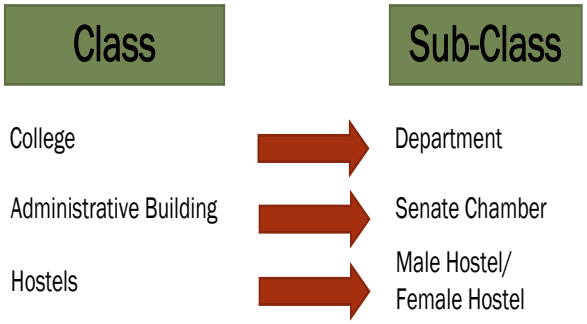

Figure 5 Classes and Sub-Classes

The RUNC-GIS has the ability to show the position of the class selected with the image and details about the selected class (Fig. 6).Both the desktop and mobile versions of the GIS web page allows the user to locate and share his or her actual position on the campus as at the time of use (Fig.7).

The system shows the details of Colleges by indicating the names of the staff occupying a particular room. All rooms are labelled according to their default labels (Fig. 8). The mobile version has a shortcut link thatprovides swift navigation from the web-based site to the Redeemers University Official website (Fig. 9).

VI. CONCLUSION

The RUNC-GIS provides students, academic and administrative staff and other users necessary information about the campus location and general campus facilities. The application consists of a database of geographic and related data of Redeemers University campus, coupled with the ability to display the data on maps, and analyse and query it.The ability of the system to query and analyse statistical data with "visualization and geographic analysis" distinguishes the GIS from other information systems and makes it highly valuable to explain a wide range of events. This application would be useful for anyone who is coming to the Campus for the first time or people who are not entire conversant with the entire campus.

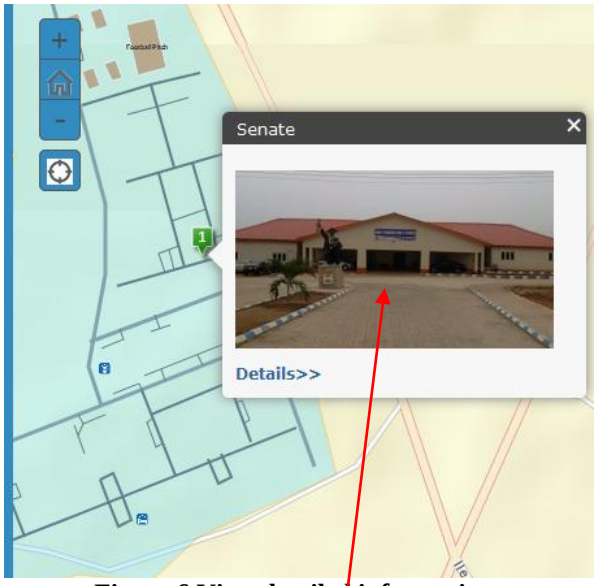

Figure 6 View detailed information

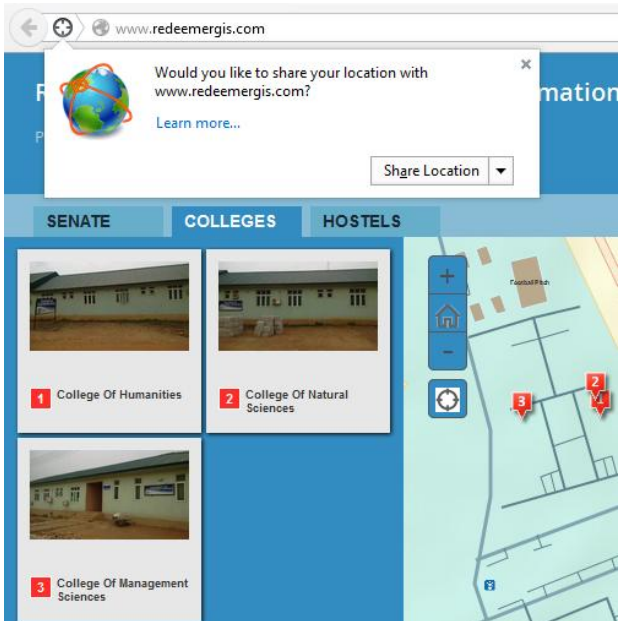

Figure 7 Find and share user's location

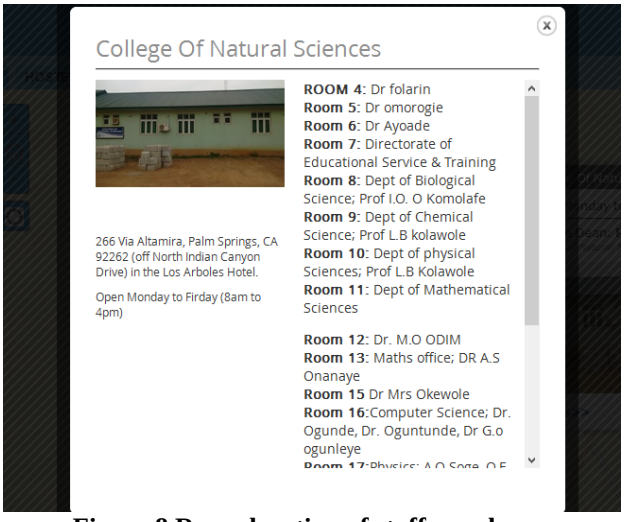

Figure 8 Room location of staff members

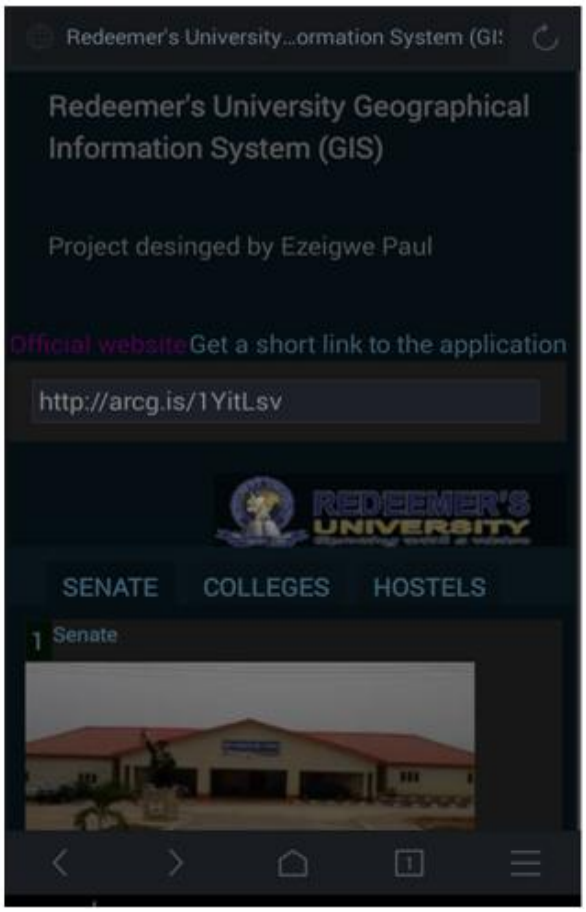

Figure 9Navigation to RUN Official site via a web mobile

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