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Development of a Mobile / Data Based Geographical Information System (GIS) for Federal Polytechnic Offa Main Campus

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ABSTRACT
The Federal Polytechnic Offa, Nigeria was established in 1992 with two campuses, and has graduated over fifty thousand (50,000) students since inception yet without being fully mapped though it appears on Google Map but the campuses are not digitalized. It is therefore worrisome that benefits associated with a well mapped institution are completely missing on the campuses. Geographical information system (GIS) provides spatial data and information that assist individuals and organizations in making the right decision; it provides crucial judgments about materials, infrastructure, space, and understanding cost structures amidst other benefits. In this article, a mobile / web based framework is developed for Federal Polytechnic, Offa Main Campus that enables visitors and or individual to navigate their way with ease on the campus; it also provides helpful features that will help students as well as workers to find the most effective and efficient destinations within and outside the campus.

KEYWORDS: Map, Spatial data, GIS, Digitalize, Mobile

I. INTRODUCTION

This paper reviews the development, capabilities, and utilization of geographic information systems (GISs) at Federal Polytechnic, Offa Main Campus. GIS technology enables individuals and even organizations to manage geo-referenced data and ensures proper mapping of positions in an area such that organizations may make wise judgments and fully comprehend the life cycle of a facility with the use of GIS and mobile devices for campus facilities. The issue of location, especially the geography of human activities, interactions between humanity and nature, and the distribution and location of natural resources and features, is one of the most basic elements of scientific inquiry. Conceptualizations and physical maps of geographic space have existed since the beginning of time because all human activity takes place in a geographic context. Representing objects in space, basically where things are located, is a critical aspect of the natural, social, and applied sciences. Throughout history there have been many methods of characterizing geographic space, especially maps created by artists, mariners, and others eventually leading to the development of the field of cartography [1].

The area of Mobile GIS was created as a result of the fusion of geospatial data and mobile devices in the field of Geographic Information Systems (GIS). The term "mobile GIS" refers to a system that combines hardware and software to enable mobile devices to access spatial data (maps) over a wireless network. Through geographical visualization and analysis, GIS is a technology tool for understanding geography and arriving at wise conclusions. GIS, for example, can be used to manage infrastructure both inside and outside of buildings, offering a thorough approach to maximize space, efficiently transfer personnel and classes, track the status of assets, and guarantee adherence to particular standards and laws. GIS can be used to investigate educational institutions at all geographic scales—a system, a campus, a building, or even a specific item. GIS, which is an integrated technology, collaborates with other toolkits (such as CAD, EAM, CAFM, CMMS, and related applications) to make better use of geographic and common facilities information.

The integration of context information in a Mobile GIS environment can add great value to the information that is displayed to an application user. This is due to the possibility of delivering personalized information to the user in combination with the display of geo-spatial data. This research presents the results of the development of a Mobile-based GIS application that is capable of managing context information within the campus of Federal Polytechnic Offa.

II. REVIEW OF PREVIOUS WORKS

The evolution of computer-based GISs began in the 1960s with the work of Roger Tomlinson in Canada [3]. Tomlinson's Canada Geographic Information System (CGIS) was a

mainframe-based system that was primarily designed to keep inventory of land use and other related natural resources such as soils, minerals, timber, etc.[4]. GIS utilization began to expand during the 1970s, primarily still using mainframe-based approaches. Although begun during the 1960s, the Harvard Laboratory for Computer Graphics and Spatial Analysis was one of the main academic groups focusing on developing mapping software for broader distribution during the 1970s [5]. This software, SYMAP, was originally developed for mainframe systems and provided access to thematic mapping, which provided rough map output on line printers. Started in the 1960s, but best known for its release with the 1980 US Census, geographic base file/dual-independent map encoding (GBF/DIME) files provided the basic geographic information for mapping [6]. These GBF/DIME files were matched to Census geography and provided a node and vector between nodes (i.e., arcs), representation that defines areas (i.e., blocks) with address ranges for each block face. These data representation was a major step forward for GIS use in demographic analysis when compared with the natural resource orientation of the CGIS.

Commercial GIS applications began to appear in the 1970s; most notable of these applications is the initial release of ARC/INFO by Environmental Systems Research Institute (ESRI) in 1981 [1].

Here mentioned are few of related products and applications that are been delivered in the content of mobile campus navigation area.

A mobile application which helps people to locate buildings and roads in Osun State University campus has been developed. The application allows users to get necessary information about a building within the university main campus. The system was designed with the view of providing maximum simplicity, quality user experience, great user interface and most importantly accurate data. The application is an effective and efficient navigation system for the university. Navigation system architecture was designed using UML software engineering techniques. The implementation of the system was carried out using tools such as Eclipse ADT. Connection to Google play service was carried out and the implementation of the Graphic user interface of the system was done. The output of the various procedures is an android application was developed with eclipse and Android SDK implemented with Google map [2].

Similar to the above, Bowen University Campus mobile location map application provides users location and landmarks around them. Other features of the application include searching for places, checking nearby places and getting brief description of landmarks. The user interface is designed to conform to android design pattern which is aimed at providing users with friendly interfaces.

III. GIS IN FOCUS

GIS can be defined as a container of maps in digital form for spatial decision support system. It can also be described as a tool for performing operations on spatial data that are difficult, costly or mostly inaccurate if performed by hand. The definition given by ESRI which defines GIS as an integration of hardware, software and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information seems to be the best fit for this article. Thus GIS encompasses hardware and software tools that are used to facilitate the utilization of geographic information to analyze and model data, and for solving spatial problems.

GIS is a tool for conducting spatial analysis. Its crucial aspect is geography because every of its decision has a geographic components. Geographic data and information have connection to spatial aspects of the earth such as atmosphere, biosphere, hydrosphere and lithosphere. All geographic data are multi-dimensional which differentiate from many other types of data. Location requires some form of a spatial reference such as x and y coordinates, or latitude and longitude components, plus some associated characteristics or features, for example, location of a crime, elevation of a point, etc.

There are a number of ways by which spatial data can be stored and analyzed in a GIS application. The two most common methods of storing geographic information are Vector and Raster representations. While raster data usually are images represented by the number of pixels in a row-and-column format that compose the image, vector data representation is based on the exact location of geographic elements such as points, lines and areas. Data storage is usually more efficient for vector data because the geographic features can be represented by nodes (i.e. points) that are connected by arcs (lines) to form the features, whereas usually all of the raster cells need to be stored. Another feature of geographic data is that, it usually exists in a number of scales. Scale is the relationship between the actual size of an object and its representation in an abstract form.

Some of the key functions of GISs are highlighted thus[5]:

Adjacency and Distance - One main capability of a GIS is to measure distances between objects and to identify whether objects are adjacent to one another;

Geo-database – It is the term used to describe the database which contains the information required for a specific spatial analysis / application;

Geo-referencing – It is otherwise referred to as geo-coding, which is the ability to specify the location of geographic data;

Overlays and Queries – This is the ability to use GIS to overlay multiple layers of information and access these various layers simultaneously;

Reclassification – This is the ability of GIS to provide the capability of re-categorizing data in an automated manner. The reclassification function can be based on a simple re-categorization of the attribute's distribution or it could also be based on adjacency information.

Spatial Buffers - A spatial buffer identifies a specified area around a specific geographic feature. Buffers are useful for identifying neighborhood-related factors for decision making such as, how many business' customers are within a specified distance of a main road.

IV. METHODOLOGY

The design methodology employed for this paper is the software development life cycle (SDLC) technique and this can be denoted as Linear Sequential Life Cycle. This technology is utilized in building, designing and preserving information on industrial systems and computer software. It is a very common and the oldest software development architecture. The approach was selected for use because it is very easy to comprehend and mostly employed for minor projects in which their requirements are well-recognized. It involves series of phases in which the output of one phase provides the input to the next phase.

In our design, the requirement phase, the students, workers and management are interrogated to discover their aim and objectives, requirements, and expectations from the system. In the second phase (design phase), the system is designed to meet the end user's requirements. This entails the database design which is shown in table 1, flow chart depicted by figure 1 and the Use Case diagrams for the Admin is represented by figure 2. In table 1, the maps table structure consists of the primary key id, title, icon_name, slug, description, photo and timestamps fields. The fields are composite of a specific scanned map uploaded into the system with its title and description.

Table 1: Map Table Structure

Name	Type	Collation	Attributes	Null	Default
id	bigint(20)		UNSIGNED	No	None
title	varchar(191)	utf8mb4_unicode_ci		No	None
icon_name	varchar(191)	utf8mb4_unicode_ci		No	None
slug	varchar(191)	utf8mb4_unicode_ci		No	None
description	text	utf8mb4_unicode_ci		No	None
photo	varchar(191)	utf8mb4_unicode_ci		No	avatar
created_at	timestamp			Yes	NULL
Updated_at	timestamp			Yes	NULL

Figure 1 shows the system flowchart, which is a diagrammatic description of the algorithm for the design and implementation of the application [2].

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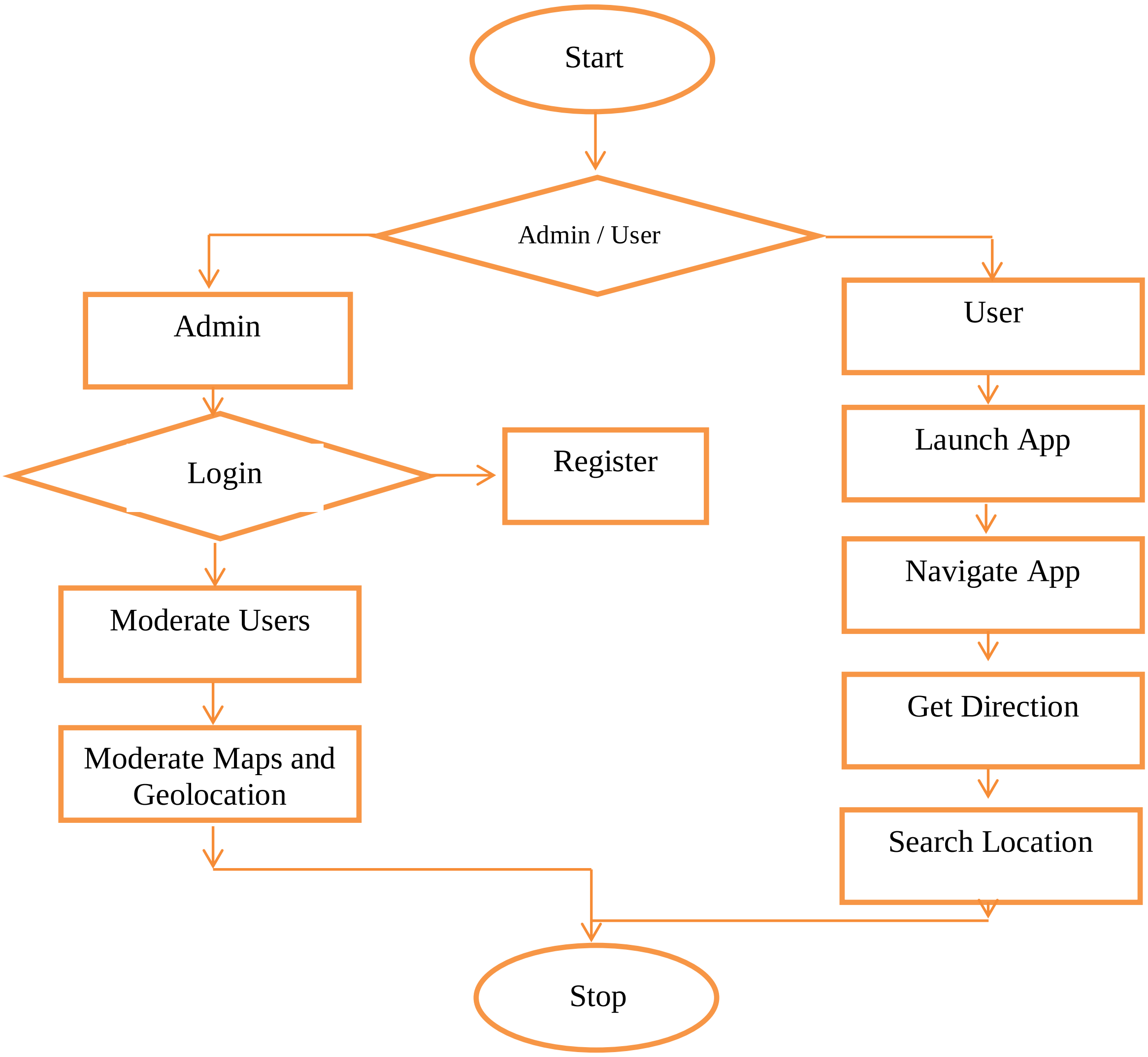

Figure 1: The System Flowchart for the Application

The Use Case diagram is a tools for showing the relationship between the users and the system, that is, it identifies all possible actions to be performed on the system by the user. Figure 2 shows the Use Case diagram for the Admin, who manages other Users of the Application. The Admin moderates the Users by granting roles and privileges, moderating items and various transactions.

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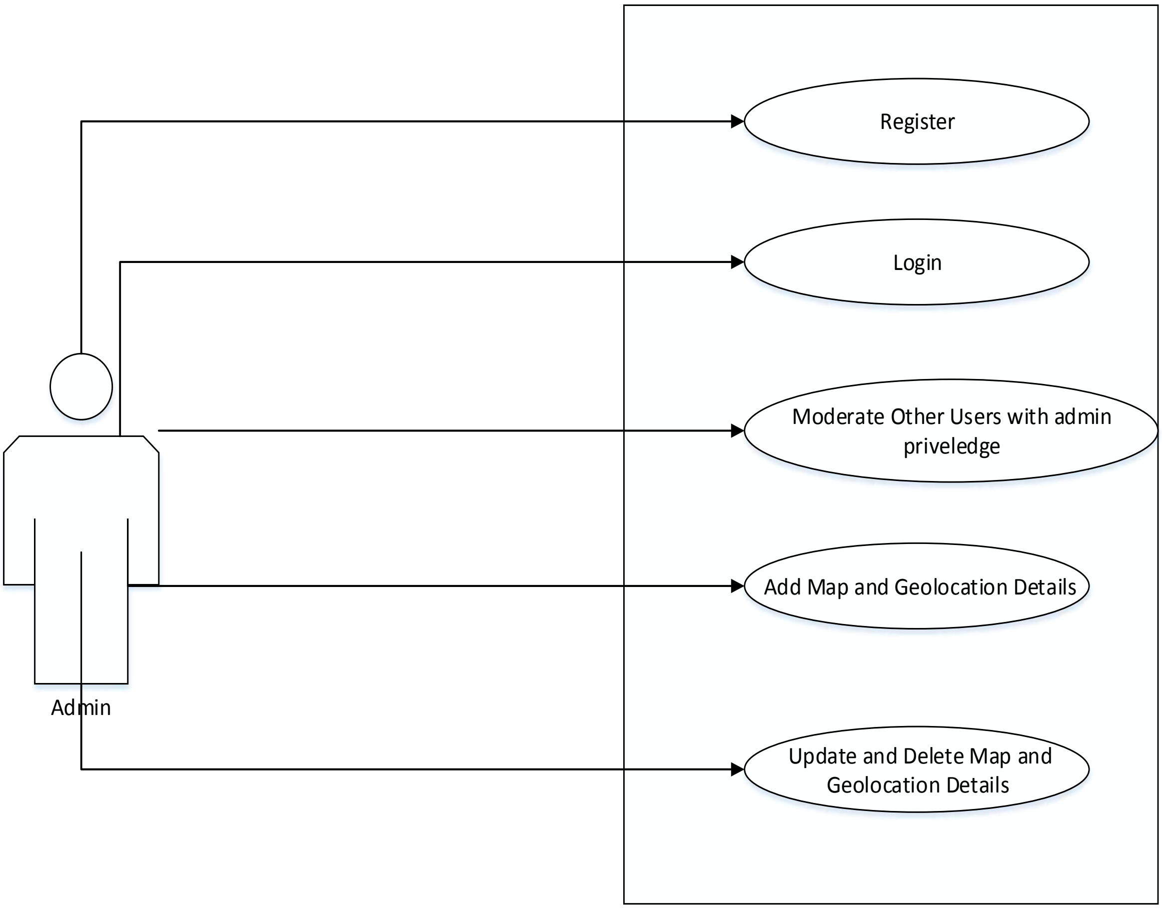

Figure 2: The Admin Use Case Diagram

V. SYSTEM IMPLEMENTATION AND RESULT

In order to implement the developed application, various tools are deployed. For the frontend graphical user interface, HTML5, CSS and Bootstrap Mobile Framework, Vue JS and JavaScript tools are used, while LARAVEL is deployed for the back-end design. The system interconnects with the database located on a remote server which serves over an application programing interface REST (representational state transfer) API which is consumed by the Vue JS and compiled to native application via the Vue Native. Finally, the system is developed to accommodate changes for continuing the system after deployment.

Figure 3 shows the Mobile App Welcome Screen, figure 4 depicts the App with side bar Navigation while figure 5 is a representation of the Federal Polytechnic Offa Main Campus.

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Figure 3: Mobile App Welcome Screen

In figure 4, the side navigation bar shows all the routes to the page and fetches all data from the JSON API data relating to each item on the page. The navigation bar routes the home page, digital map, scanned map, navigation through individual routes.

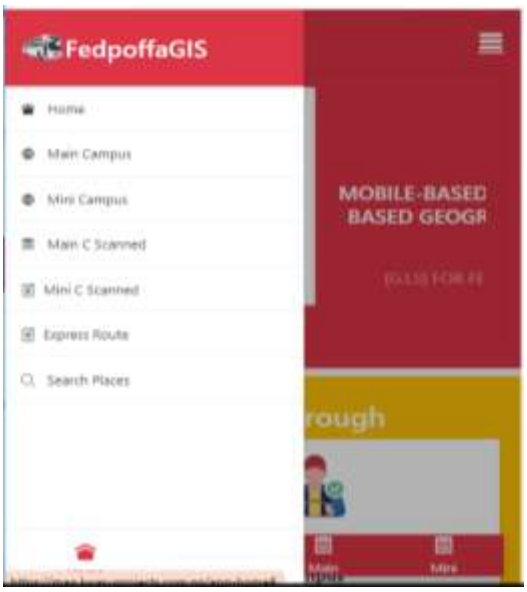

Figure 4: Mobile App with side navigation

The digital map navigates the location of the Federal Polytechnic Offa Main Campus on the Google map with the satellite and terrain view. Figure 5 shows the digital map of the Main campus of the institution.

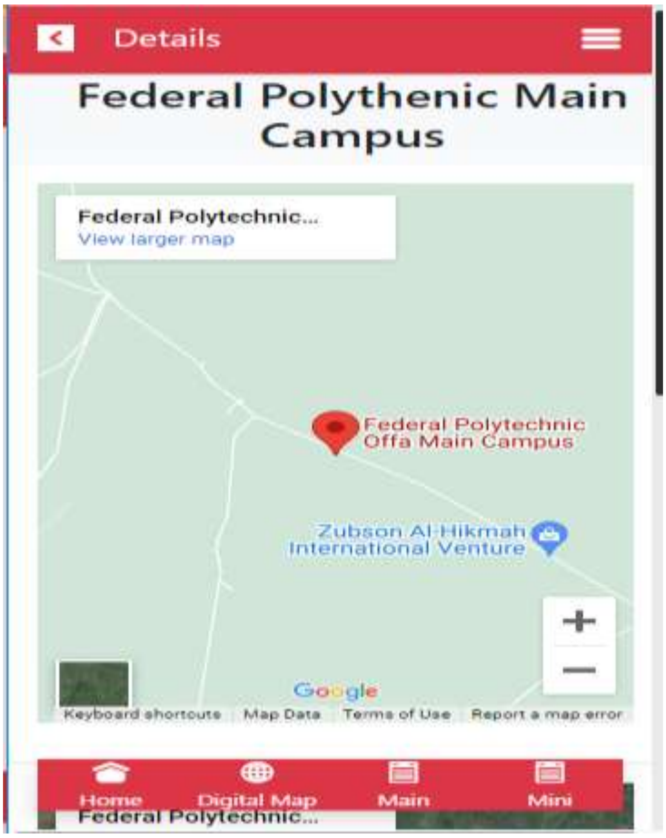

Figure 5: Federal Polytechnic Offa Main Campus

VI. CONCLUSION

The technologies used for the implementation of the application include Google Map, Vue JS, Vue Native, LARAVEL and MySql. The resulting application from the research enables users to find paths to specific locations within the main campus and provides location-based information on class rooms, lecture theatres, hostels, clinic, roads and other facilities on the campus. This system eliminates frustration usually experienced by visitors on the campus and provide easy escape route during disaster and emergency situations.

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