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Spatial Map Geographic Information System for Mobile Devices

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ABSTRACT

The traditional approach of storing, accessing, updating and manipulating geographic data are done manually on filed maps which is time consuming, error prone and difficult to manage in our organizations or institutions for this work University of Ilorin was used as case of study. Most work on this area is just automation of some geographic data's, even if the geographic information's are fully automated; the database is centralized on a system in the office. This makes it very necessary to research on how to use a mobile device to access a GIS database which makes it easier to extent the automation from office level to field. Considering the familiarity and technology on mobile devices, mobile GIS applications need to be developed. Accessing GIS database via a mobile device was achieved using client server architecture; geographic data's were digitized, packed in to a spatial database and hosted on to a server. The database is accessed using a mobile GIS application running on a mobile phone. The proposed application was implemented through the use of Java programming language (Java ME).

Keywords: GIS, Digitized, Spatial Database, Java ME

Aims Research Journal Reference Format:
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1. INTRODUCTION

Organizations and institutions have specific geographic information such as coordinates; map, land space and master plan of their location to enable them know the size of the location and guide them to navigate within the area. Most of this geographic information is kept manually, the traditional approach is inefficient and time consuming there is need for Geographic Information System. For this paper University of Ilorin was used as case study. Geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. [1] In the simplest terms, GIS is the merging of cartography, statistical analysis, and database technology. According to [2] GIS application are tools that allow users to create interactive queries, analyze spatial information, edit data in maps and present the result of all these operations. Mobile GIS is the expansion of GIS technology from the office into the field. A mobile GIS enables field-based personnel to capture, store, and update, manipulate, analyze, and display geographic information.

Mobile GIS integrates one or more of the following technologies: Mobile devices, Global positioning system (GPS), Wireless communications for Internet GIS access [3]. GIS accuracy depends upon source data; GIS data represents real objects such as roads, land use, elevation, trees, waterways, etc. with digital data determining the mix. Real objects can be divided into two abstractions: discrete objects (e.g., a house) and continuous fields (such as rainfall amount, or elevations). Traditionally, there are two broad methods used to store data in a GIS for both kinds of abstractions mapping references: raster images and vector. Points, lines, and polygons are the stuff of mapped location attribute references. A new hybrid method of storing data is that of identifying point clouds, which combine three-dimensional points with RGB information at each point, returning a 3D color image. GIS thematic maps then are becoming more and more realistically visually descriptive of what they set out to show or determine [4].

GIS applications are software applications that process large amounts of geospatial data, involving heavy computations. Traditionally, these applications have resided on high performance workstations and servers equipped with the necessary resources: large amounts of primary and secondary memory, fast CPUs and graphics processors, and large screens for displaying the data. The recent decade, however, has seen a move of GIS applications onto smaller platforms, including mobile platforms such as personal digital assistants (PDAs), windows mobile and Smartphone's. These platforms offer a number of attractive features, primary among which are their extreme mobility because of its small size.

1.1 Statement of Problem

Traditionally the process of field data collection and editing have been time consuming and error prone, geographic data are on paper maps, fields edit were performed using sketching and notes on paper maps[3]. The traditional approach is inadequate; the increasing need of using maps to communicate and display geospatial information for locations GIS application for mobile devices need to be developed. Mobile GIS applications are developed to communicate geospatial information between human users and servers [5].

1.2 Aim of The Study

The aim of this research work is to develop spatial map geographical information system (GIS), for University of Ilorin accessible via mobile devices.

1.3 Research Objectives

The research sets out to achieve the following:

- Digitize paper map of University of Ilorin, Ilorin
- Develop geo-spatial database using the digitized map
- Devevelop GIS utility software for the database
- Port the software to mobile devices

2. GEOGRAPHICAL INFORMATION OF UNILORIN

University of Ilorin was established by a decree of the Federal Military Government in 1975 located in Kwara State North central Nigeria [6] the ancient city of Ilorin capital of Kwara state is about 300km from Lagos and 500km from Abuja.
University of Ilorin main campus (Permanent Site) is located about 16KM east of Ilorin township and occupies more than 15,000 hectares of land on sheet 223 Ilorin NW (scale 1:50,000). (University of Ilorin Physical Planning Unit, 2013)

2.1 Land Use

Within communities, Land use plays a critical role in development of the built environment. Urban planners must rely on knowledge of geographic space when deciding how best to manage growth. As the cities of the world grow and more rural land is developed, ensuring smart growth and practical environmental management are necessary goals. Designations for the use of land are provided in a master plan, which is usually intended to ensure the following:

- Transportation Flow
- Economic Development
- Historic Preservation
- Recreational Space/Parks
- Environmental/Wildlife Protection

According to the (University of Ilorin Physical planning unit, 2013) a land area of about 122.36 square kilometers and it is classified as Academic, Residential, Agricultural, Religious, Sports and Recreation. Other village's surrounding the institution are; Lajiki, Ile Apa, Sentu, OkeOdo, Jalala and Bolorundoro. The table on the next page displays the breakdown of University of Ilorin land use pattern.

Table 1 Land Use of University of Ilorin Permanent Site (Physical Development Unit University of Ilorin land use plan adapted since 1981, 2013)

CAPTION	HECTARES
Academic Area	152
Medical School Area	28
Senior Staff Housing Areas	508
Senior Staff Housing Schemes	452
Junior Staff Housing	300
Student Housing	104
Service Industry Area, Sewage Treatment, Booster Stations and Water Tower	28
Sports Center	20
Religious	12
Communal Center	16
University Staff School Area	36
Reservoir and Dam	88
Observatory	04
Tree Nursery	16
Teaching and Research Farm	184
Sugar Cane Research Institute Farm	196
Commercial Farm	396
Green Revolution Farm	356
Small Staff Holding Areas	112
Community Health Care Center	24
Animal Farm and Building Area	312
Zoological Garden	260
Botanical Garden	212
Forest Research Area	500
Medical Research Institutes Treatment Facilities and Medical Industries	340
Engineering Research and Training Institutes	348
Agro Research and Training Institutes	380
Forest Reserve	1744
Natural Landscape Along Oyun River	1628
Landscaped Area Along Roads	1500
Reserve for Villages Falokun, Jimba and Ile Apa	188
Animal Farming Area (North-East)	1944
Animal Farming Area (East)	2184
PHCN Tracks	424
Oil Pipeline	80
Zone for Fence	280
TOTAL (APPROX.)	**15,356HA**

2.2 Geographic Coordinate

Coordinate systems enable geographic datasets to use common locations for integration. A coordinate system is a reference system used to represent the locations of geographic features, imagery, and observations, such as Global Positioning System (GPS) locations, within a common geographic framework. Each coordinate system is defined by the following:

- Its measurement framework, which is either geographic (in which spherical coordinates are measured from the earth's center) or plan metric (in which the earth's coordinates are projected onto a two-dimensional planar surface)
- Units of measurement (typically feet or meters for projected coordinate systems or decimal degrees for latitude-longitude)
- The definition of the map projection for projected coordinate systems
- Other measurement system properties such as a spheroid of reference, a datum, one or more standard parallels, a central meridian, and possible shifts in the x- and y-directions

A geographic coordinate system (GCS) uses a three-dimensional spherical surface to define locations on the earth. A GCS is often incorrectly called a datum, but a datum is only one part of a GCS. A GCS includes an angular unit of measure, a prime meridian, and a datum (based on a spheroid). The spheroid defines the size and shape of the earth model, while the datum connects the spheroid to the earth's surface.

A point is referenced by its longitude and latitude values. Longitude and latitude are angles measured from the earth's center to a point on the earth's surface. The angles often are measured in degrees (or in grads). According to Land Set Aside for the use of the Government of the Federal Republic of Nigeria Ilorin Local Government Kwara State of Nigeria Bearing and distance of University of Ilorin Start from "KWP 1327 to KWP 1328 = 14.4M at 67^{o} 27" and ends at "KWP 18848 to KWP 18847 = 140.2M at 68^{o} 21" (on Topo sheets 02 S.W and 223 N.W) (University of Ilorin Physical planning unit, 2013)

2.3 Description of Mobile GIS

The mobile GIS do not have a concrete definition, the same thing happened to GIS many years ago. There are many disciplines and technologies that can be related to mobile GIS, such as LBS (Location Based Services), and telegeoinformatics [7][8]. Mobile GIS will be defined as the ability of mobile device to display geospatial data, and receive, process, and retrieve the GIS requests of mobile user. The most common framework for mobile GIS is to be considered as an extension to Web-GIS, where the GIS requests of the mobile user are processed via internet web browser. This framework was extended and tailored to display geospatial data and perform GIS operations on mobile device.

3. METHODOLOGY

Through extensive survey of various works on GIS application the approach, method, concept and teaching. Geographic data's such as paper map, land use and master plan were collected from the University physical and planning unit (Works Department). This research develops GIS application for mobile device, software development process and object oriented modeling were used to model the proposed system and relational database approach was used to store data. The model was implemented using java programming language (JAVA ME)
Mobile devices are becoming more popular and powerful with improved functionalities, there is need to develop mobile application. In this research a GIS application was developed using the above steps and finally deployed to a mobile phone

3.1 Proposed Mobile GIS Framework

This section describes the approach adopted in developing the overall framework for the Geospatial Information System. The framework synchronize data from three platform; spatial database, web server application and mobile client

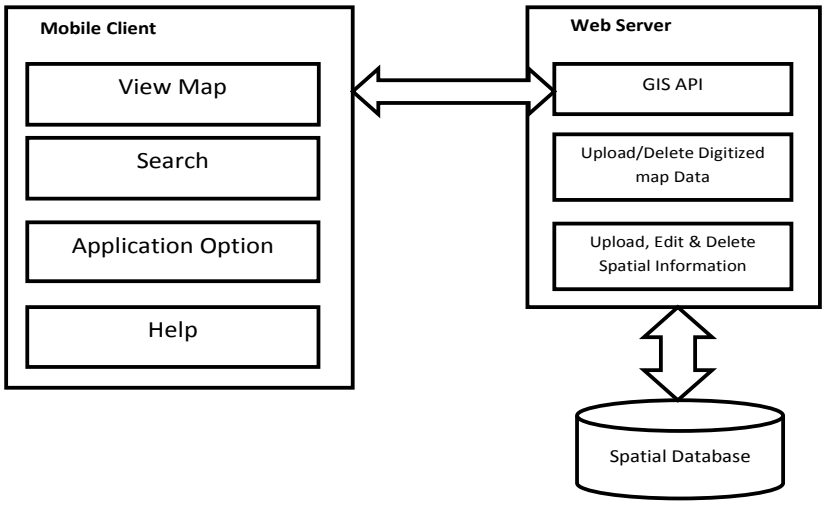

Figure 1 Frame Work

3.2 Map Digitization

The process of representing an analogue signal or an image by a discrete set of its points is known as Digitizing. This data after conversion is in the binary format, which is directly readable by computer. The data to be converted can be a text, an image, audio or a video. The analogue signals are variable whereas the digital format is the discrete one. These discrete units are called as bits.

These bits (8) organized in groups are known as byte. The digital signals are mainly represented in the form of sequence of integers. These integers can be converted back to analogue signal that are approximately similar to the original analogue signals. In case of this research google maps were used in the digitization process of which not all structures are there on the maps, more mapping were done and the structures were included.

Figure 2 Digitized University of Ilorin map

3.3. Spatial Database

A spatial database is a database that is optimized to store and query data that represents objects defined in a geometric space. Most spatial databases allow representing simple geometric objects such as points, lines and polygons. Some spatial databases handle more complex structures such as 3D objects, topological coverage's and linear networks. While typical databases are designed to manage various numeric's and character types of data, additional functionality needs to be added for databases to process spatial data types efficiently. These are typically called geometry or feature. The Open Geospatial Consortium created the Simple Features specification and sets standards for adding spatial functionality to database systems

3.4 Hardware and Software Requirements

The hardware requirement is the physical component of the computer that is necessary for the effective functioning of the system. These include;

- PC with at least 2GB of RAM.
- 250GB hard disk capacity
- Intel Pentium IV Microprocessor
- VGA monitor or compatible of at least 640/480 resolution.
- A Multi-media GPRS enabled Mobile phone

One more important subsystem of a computer system, without it, the system cannot function and it is a predefined logical set of instruction for achieving a task on the computer system. Therefore, the following software is needed;

- Apache Server (Wamp)
- Java Standard Edition SDK
- MySQL database
- Standard mobile device OS running on the mobile phone for testing
- Operating system (Windows) i.e. Windows , 7

4. RESULT

Implementation is a realization of a technical specification or algorithm as a program, software component, or other computer system through computer programming and deployment. Many implementations may exist for a given specification or standard. At present on Personal Digital Assistants (PDA's) there are three different operating systems (OS) which are Windows Pocket PC, Palm OS and Linux. Symbian, Android, iOS and more devices specific are been the OS(s) for mobile phone. Thus, the programming language for these devices should be as much independent as possible. For this research work Java is the appropriate programming language satisfying the proposed requirement considering the fact that JAVA applications suites most platforms.

Figure 3 User Interfaces (a & b)

Figure 3 User Interface (c)

5. CONCLUSION

In accordance with the trend of ubiquitous computing and development of wireless telecommunication technologies [9,10 11]. GIS extended its application into mobile domain. It is expected that mobile GIS applications will completely substitute thematic maps which are today widely used. Mobile devices are becoming more popular and powerful with improved functionalities, there is need to develop mobile application. In this research a GIS application was developed using the above methodology and finally deployed to a mobile phone.

6. LIMITATIONS

The limitations on the proposed system are those associated with mobile phone and client server architecture approach [12,13 14]. Device limitations affect GIS application, although not all applications of Mobile GIS are limited by a device. This limitations are applicable to smaller devices such as mobile phones and PDA's such devices have short battery life, limited memory and processing power compared to larger devices and small screens with a poor resolution. Additional limitations related to the architecture include poor graphical user interface, device integration, network problem and limited offline web client cache.

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