Application of Geographic Information Systems in Creating Smart Campus Map of Federal University of Technology, Minna Bosso Campus

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Abstract—**This project aimed at creating a smart campus map of Federal University of Technology, Bosso Campus, Minna Niger State, Nigeria. The advancement of technology with an attendant emergence of digital maps is gradually phasing out obsolete paper maps. One of the problems inherent with paper maps is the difficulty visitors face in navigating the campus. The study utilized ArcGIS as the main digital mapping software. It was used for digitization and simulation of map features. Google Earth pro 7.1 was used to extract and download satellite image of Bosso campus, which was geo-referenced to have the actual earth projection of the campus. The procedures employed include digitization, assignment of attributes to features, creation and editing of the map and finally, conversion of the map to KML format (the format that can be read by ArcGIS software), the utilization of Android Studio as an interactive software. The converted map is imported and overlaid with Google API 21. The Smart map is interactive software between users and various objects in the visual environment which further provides great convenience for the users to understand geographical environment and campus information of Bosso campus. The study demonstrates the potentials of digital mapping using GIS software and Android studio in creating and managing spatial data. Smart digital map can be used as a tool to formulate development plans not only in the campus but also for wider coverage areas.**

Keywords-digital mapping; geographic information systems; google earth; Android studio; campus map; digitization; smart map.

I. INTRODUCTION

Digital mapping (also referred to as digital cartography) is the process by which a collection of data is compiled and formatted into a visual images i.e. the creation and analysis of maps through the use of computers. As such, Geographical Information Systems (GIS) are an integral tool for cartography. The primary function of this technology is to produce maps that give accurate representations of a particular area, detailing major road arteries and other points of interest. The technology also allows the calculation of distances from one place to another and has made it easy to build sophisticated and interactive maps that can be disseminated (online) to a large number of people easily [1]

The roots of digital mapping lie within traditional paper maps. Paper maps provide basic landscapes similar to digitized road maps, yet are often cumbersome, cover only a designated area, and lack many specific details such as road blocks. In addition, there is no way to "update" a paper map except to obtain a new version. On the other hand, digital maps, in many cases, can be updated through synchronization with updates from servers. The development of mobile computing has recently (since about 2000) spurred the use of digital mapping in the sciences and applied sciences. As of 2009, science fields that use digital mapping technology include geology, engineering, architecture, land surveying, mining, forestry, environmental, and archaeology.

While there is a wide spectrum of specializations in digital mapping, the basic premise is that digital maps can accurately portray features as they actually appear to give "life-like experiences. Maps however, must be updated frequently to provide users with the most accurate reflection of a location [2]

FUT Minna Bosso Campus is located, between Latitudes 9°39'3.82"N to 9°39'25.90"N, Longitude 6°31'27.65"E to 6°31'27.65"E within Bosso Local Government Area of Niger State. Bosso Local Government Area is bordered by Shiroro to the North, Paiko to the East, Katcha to the South and Wushishi to the West. Federal University of Technology, Minna is a Federal Government owned University in Nigeria. It was established on 1st February, 1983 with the objective of giving effect to the Nation's drive for the much-needed self-reliance in Science, Engineering and especially Technology. It is a specialized University of Technology currently having two campuses (Gidan Kwano and Bosso) [3]. Figure 1 is showing the location of the study area.

In view of the advancement in technology all over the world, the use of paper maps has been gradually phased out giving rise to digital imagery or maps as the case maybe. Handheld GPS and ground based stations which are used in place of charts, these also coincide with;

- Students and faculty staff on campus having challenge to get around.
- Faculty staff and students finding it difficult when asked by people for direction to some obscure, remote or unfamiliar locations on campus.
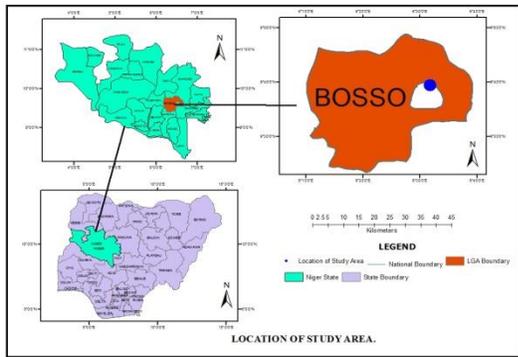- In addition, coming visitors can find difficulty to navigate the campus.

Figure 1.   The Study Area

As a result of this, it has therefore become necessary to employ GIS and Remote Sensing for gathering information and data analysis in order to understand our immediate environment (FUT Minna campus). This will result into creating smart Campus map of FUT Minna, and convert to android and web application which can be used both within and outside the campus.

II.   LITERATURE REVIEW

This chapter does a review of the various literatures used in this research.

A.   Conceptual framework

- One of the most popular digital maps is Google Maps, which is useable for mobile devices and web applications. It offers satellite imagery, street maps, 360° panoramic view of street, real-time traffic conditions, and route planning for travelling by foot, car, bicycle, or public transportation.
- However, with using Google Maps application is not enough for searching or exploring some specific location on campus to get more details of information that user want to know.
- There are numerous researches focusing on creating and developing of FUT Minna smart campus map to benefit the users for exploring the campus.

The level of development in any university depends to a large extent on its state of utilization.

Geographic Information System (GIS) offers itself as a tool for effective mapping and management. It has many applications and promotes collaborations across a wide variety of disciplines. Therefore, mapping analysis and intelligence gathering using GIS have become very relevant today in Universities, as the rate of misallocating of places are much on the rise.

Since it have situational relevance, and hence have a positional element attached to them, GIS can be a very useful tool to display and apply spatial analysis to data, which reside in large databases, in order to obtain a strong visual appreciation of the patterns of locations and spatial activities.

Geospatial activities continue to be a major concern in contemporary society, causing headaches for the individual. Most universities are faced with displacement of students as a result of incorrect address location of places around the university. In many of the world's industrialized countries campus maps of universities are created as a software which is very accessible, portable and accurate because it also show the point location of student and the shortest routes to area of interest.

B.   Map design and development

Visualization of map attracts much of user's attention. Cartographic visualization is concerned with the representation of geospatial data and the spatial understanding of users [4].

A good map should be simple with objective and precise geospatial information. Besides, it should be well presented in such a way that can attract reader's attention to the significant information [5]. In order to meet the requirements of a good map, cartographers must keep certain goals of design in mind when planning a map. These goals include: orderliness, clarity, contrast, balance, unity and harmony [6].

[7] proposed his visual hierarchy for map design. In his theory, he stated that map elements and objects are organized in a logical manner by their relative utility depending on the communicative objective of the map. His visual hierarchy is not only focused on the useful for the traditional map but also for the web and mobile map. As a cartographer, it is important to know how to make certain map elements stand out. There is no doubt that designing each map element is the best way to highlight it in the visual hierarchy. Some common techniques include manipulating color value, hue, and intensity to establish contrast and styling objects to make them look different.

Color plays a major role in cartography. The importance of color exceeds the understanding of many mapmakers. A good color scheme should be attractive and match the nature of the data [8].

C.   Geographic Information System

GIS as one of the main supporters of education of the 21st century. A large number of options have been tested in order to find the perfect solution, by now it had become clear that GIS offers the best solution for these problems, and it can be used in educational applications too. Let's look into these methods with the help of a few examples, starting with the past, and at the same time, pointing ahead at the hypothetical, or rather to the probable options of the future.

III.   METHODOLOGY

This includes the various stages involved in generating the desired product; a review of the research method and instrument used. It also involves the procedure of the digital mapping and encompasses all the activities carried out from planning to the actual data acquisition and refinement.

A.   Study Approach

In carrying out this project, a digital approach to the study was embarked upon, making use of the internet, ArcGIS software, Google Earth pro, Handheld GPS, satellite imagery of study area and ArcGIS 10.2 were used. A survey of the study area, such as Federal university of Technology Minna

Bosso campus site was carried out. This was necessary so as to get acquainted with the study area with regards to what will be required for this study, materials and data used and enable them be compared in relation to what was gotten digitally. The methodology flowchart is shown in figure 2.

B. Data Required for the Study

Hardware

Spatial Attributes were collected using the following**:**
- Handheld Germin GPS
- Pavilion M6 Hp Laptop

Software

The following software were utilized to perform data entry, storage, retrieval, manipulation and documentation.
- ArcGIS 10.2
- Google Earth Pro 7.3.1
- Google API
- Android SDK
- Microsoft office Excel 2007
- Microsoft office Word 2007

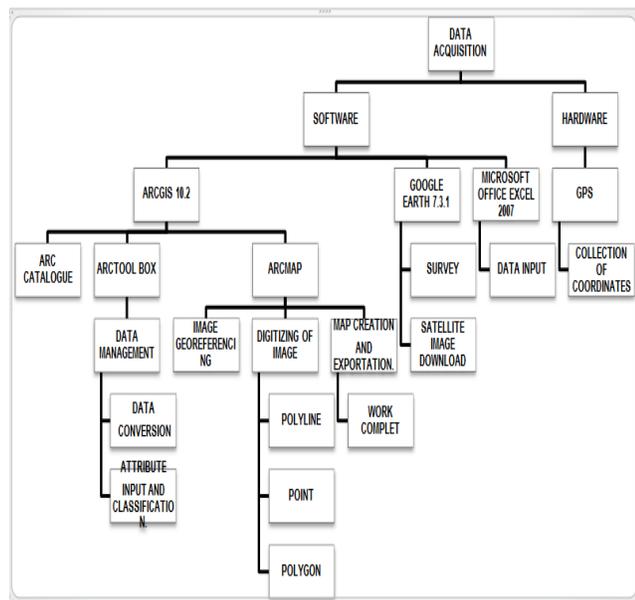### C. Presentation of Data Acquisition

Figure 2.   The Methodology Flow chart

D. Methods of Data Collection

Digital maps largely depend upon a vast amount of data collected over time. Most of the information that comprises digital maps is the culmination of satellite imagery as well as street level information.

The spatial data used include data on roads, buildings, streets, areas from the existing digital map collected, the Google Earth image used is indicated in figure 3. Also, the use of GPS to acquire the coordinate of some points of interest (POI). The attribute data (toponyms) of the spatial features

were collected. Other important components of data collection include:
- Primary Data sources
- Secondary Data sources
- Reconnaissance survey
- Preliminary data acquisition and field operations
- Actual Field operations/GPS Survey.
- Data entry and storage
- Geo-referencing
- Digitization
- Database Development

Figure 3.   Satellite Image of FUT Minna Bosso Campus

E. Map design.: Creating Android App FUT Minna Bosso Campus Map.

A decision was made to produce a map of FUT MINNA Bosso Campus, showing the buildings, sport facility, Faculties, laboratories, Residential (staff quarters), Hostels Foot paths, road network) at various scale. Each layer was converted to KML/.KMZ format for easy programming and transformation in Android studio. The methodology flow is indicated in figure 2 while the map of FUT Minna Bosso campus is indicated in figure 4 as digitized directly from the Google earth image in figure 3 and converted for further analysis in ArcGIS. The Android Studio IDE (Integrated Development Environment) comprised of a vast array of panels, tools, and functions to help users become as productive as possible at developing Android applications. I'll cover the most common panels, windows, and toolbars with which user interacts with. [9]

F. Creating New Project

When user opens up Android Studio and create your first new project in the IDE, user will notice that Android Studio introduces a new paradigm in regards to folder. Almost all files are located in the directory. The new file structure is in place in order to support the new Gradle build system. [10]

Using Android SDK (Software Development Kit) Configuration, smart Bosso campus map is inputted as the name of the application, company name was left as default, selection of the form in which the application is created with lower android API which will make the application run faster. The application interface was created, which include the navigation menu, Font, theme, colour etc. also the operational function which include the software creation and map

integration. Each of the map layers exported in kmz format was imported into the program to have a distinct functionality, it was overlaid with Google map. Google API 21 was downloaded, editing activities was carried out, see figure 5.
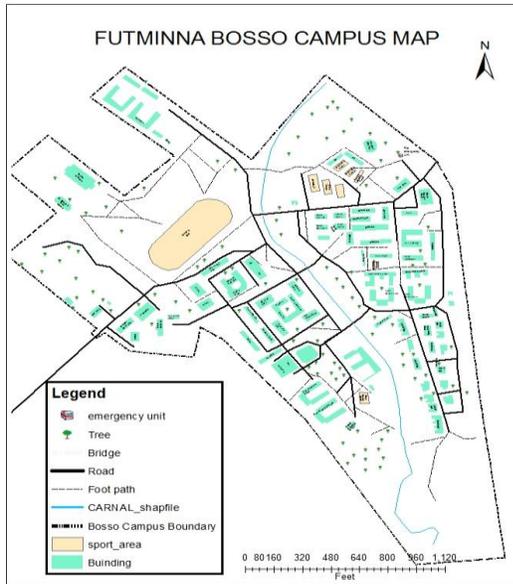

Figure 4.   FUT Minna Bosso Campus Map

G. Steps in Generating an Android Package Kit (APK)

Generating an APK in Android Studio is a snap. The steps includes:

- Select/Generate Signed APK from the Build menu. This will display the Generate Signed APK Wizard.
- Select your module and click next.
- Either supply the path to your keystore that you're currently using for your Android application, or create a new key store.
- Click Next.
- At this point you can define the destination for your APK. You can also specify whether you'd like to run ProGuard, and where the ProGuard configuration file is located.
- Click Finish and your APK will be generated in the destination folder

H. Features of FUT MINNA Smart Bosso Campus Map

- It will give users a friendly interface and overall view of the campus and also tell the position of the user.
- FUT MINNA Bosso campus Map will provide a smart option for a key search for any specific remote around the campus.
- It will also provide directions to a chosen destination.
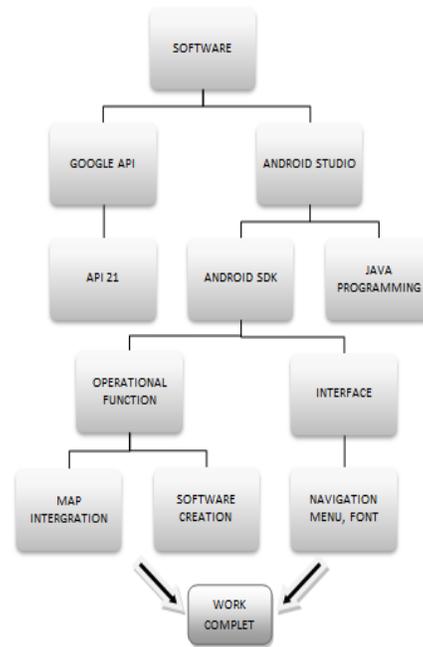- It will provide information about targeted search item

Figure 5.   Smart map methodology flow

IV.   RESULT/DISCUSSION

The use of ArcGIS and Google maps for developers in Android studio provides an opportunity for establishing a hybrid android application that aids the process of developing mobile map. Designed ArcMap can be integrated into mobile maps. Figure 6 on the last page of this paper gives an outlook of smart map of FUT Minna Bossso campus map showing different interfaces of the map application including a splash screen, main activity. When running the app, the splash screen comes up and it links to the main activity automatically in few seconds. The smart map launches and displays FUT Minna Bosso campus in 2D Format. It shows the buildings, roads, bridges, car parks and Bosso campus boundary in a colourful way. Users can find path ways or route to destination by adding markers from point of location to the point of destination. The smart map finds the possible and easiest route to such destination. A search bar is also added to give user access to search for places easily without much stress, few point marker are displayed to show few point of interest. At the top left corner of the screen is the menu bar. The menu gives other activities apart from map navigation, once clicked it opens up with categories which gives user access to select other activities that they are most interested in according to such categories. The menu has five categories which include search, Bosso campus map, e-portal, e- result portal and a gallery which displays the great structures and other activities of the Federal University of Technology, Minna, Bosso campus.

The interfaces of the interactivities illustrating the menu interface on Bosso campus smart map was displayed on Figure 5. It allows the users to navigate between different categories. Clicking on any of categories gives users access to its activity.
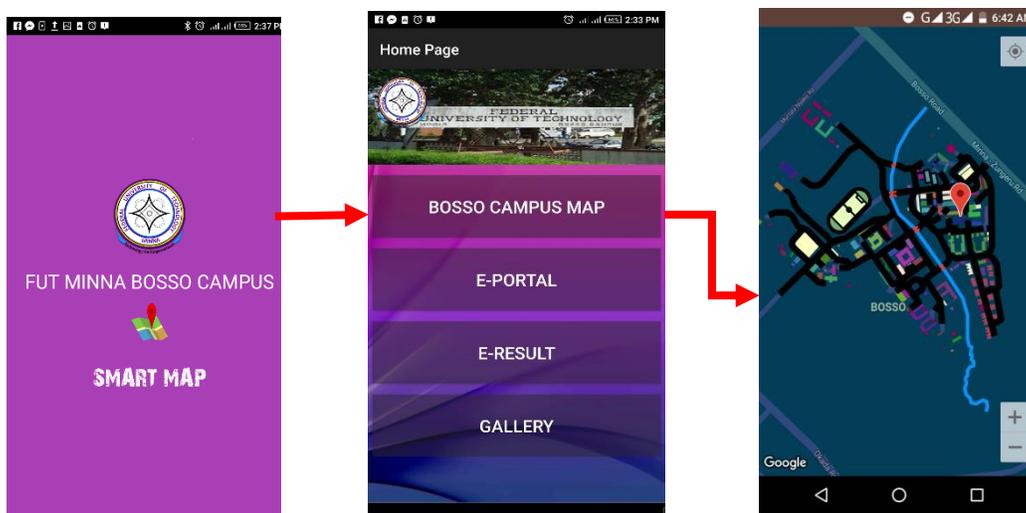
Figure 6.   The mobile App Flow

The age of paper map is phasing out already giving rise to the age of smart mobile map inform of the smart campus map developed here. This can be substantiated by the views of [9]where these authours acknowledged to the fact that the age of personal computer (PC) is coming to a close with the emerging age of mobile computers (MC), a situation where smart phones or tablets function in a way that resembles the laptops. This is very true because we have seen a revolution whereby laptop overcame the former desktop, in like manner, the smartphone revolution will soon overcome the laptop and in that, the smart maps on the smart phones will definitely overcome the paper maps to a greater extent.

V.   CONCLUSION AND RECOMMENDATION

A. Conclusion

The smart Bosso map demonstrates a way of creating an interactive mobile for showing maps based on open source platform. The study of modern trend of mobile mapping is grasped by recent studies. As for implementation part, there are two aspects-design of using ArcMap and developing this mobile map app. Google map is useful for online mapping tool that makes design for mobile mapping, whereas Arcmap is also a key tool in both offline and online mapping activities. The background map was designed by setting various related properties and customization of Google API for the map activity. The individual layers, colours, and labels were done using ArcMap. All the manipulation can be shown in a user friendly interface.

B. Recommendation

The following recommendations should be considered:
Smart digital mapping of F.U.T. Minna Gidan Kwano campus should be carried out.
For both campuses (Bosso and Gidan Kwano) this mobile application should be made available to staff, students and visitors for easy access to various places on campus.
- One of the value of digital map that made it different from paper map can be found in its ability for easy upgrade and update besides access, therefore F.U.T. Minna smart maps should be updated from time to time.
- Such maps like this should also be extended and implemented for use in other places other than campuses.

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