DEVELOPMENT OF A COMPREHENSIVE CITY STRUCTURE DATA BASE FOR THE PLACEMENT OF BASE STATIONS: A CASE STUDY OF MINNA, NIGERIA

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***Abstract*:** In this paper, a spatial database called "City Structure Database System" (CSDS) collection process is developed. This database is to represents situations in real-world by maps and digital data. With the use of the database, radio planners can access and get hold of relevant map information of a city easily. An effective data collection process is developed for the acquisition and collation of spatial data of the city. This database is required by an intelligent decision making process of base station placement. Experimental results of implementation in Minna town Nigeria, reveal the effectiveness of the method proposed in this paper.

Key words: Base station, City data base, GPS, Spatial data, Matlab programme,

1.0 Introduction

The explosion and rapid demand for wireless communication services has resulted in an increase in the number of base stations in our environment. While research is still on going to ascertain the medical impact of the base station within our living quarters efforts are still being made to make their presence less intimidating and acceptable. Many human activities require geographical information and the placement of base station is one of such. In wireless communication networks the choice for location for the network infrastructure is a tedious exercise usually carried out during the planning process. The availability of a comprehensive city data base proposed will go a long way to providing a more efficient

and effective infrastructure deployment process. The placement of base stations without adequate spatial and thematic information can be said to be optimally implemented. These lapses can be attributed to the non availability of such information and the dependence on their acquisition by government agency only. In other to locate a facility there is the need for comprehensive information of existing and potential structures which will be of concern to the infrastructure. In this paper we develop a user friendly process for the acquisition and collation of geographical data to be used in an intelligent decision making process for base station placement.

One of the key infrastructures of a mobile communication network is the base station. The base station is the facility placed to provide radio coverage for a given area referred to as cell. The optimally placement of base station has become a concern with the many constraints and contradicting factors to overcome [Alenoghena, 2012]. Some of these constraints include environmental aesthetics, safety, topography, demographic traffic distribution of users, interference between network cost, etc. The base station placement algorithm is a heuristic one genetic algorithm which will be searching a wide space.

In the remaining part of this paper, we discussed the need and significance of the study. The database organization and implementation is thereafter presented. Some data collected are presented before conclusions.

2.0 Need for the Study

In other to place base stations, site selection has to be carried out. The present manual exercise involved in site selection and survey process has been described as rigorous, inefficient and could be prone to errors as they are based on personnel experience and judgment [Job, 2008] This work is aimed at creating a detailed database of site information that will reduce the rigor and inefficiency prone in the usual way site surveys and selection process is done. The non availability of a Geographical information system database in most developing countries necessitated this research aimed at providing a template for digital data acquisition, storing and retrieval system that is user friendly and effective for radio planners. Information in the database can be used by other agencies, government and for developmental purposes.

Most developed countries have their cities/municipal supported by geobased online applications and being reffered to as ‘smart cities’. The City of Edinburgh for instance has developed a very modern and impressive internet presence with its services ranging from online maps, historic maps, catchment areas of school with detailed statistic. Information provided include road works, and traffic flow situation in

real-time [smartcities]. This proposed database will be of immense benefit for non smart cities.

2.1 Significance of this Study

The base station (BTS) is the most important section in the Global system for mobile communication (GSM) services as it is the link to the final consumer. Its proper location ensures quality service and interactions with the public. The agitation for more base stations and issues of non compliance of most GSM base station in the country to stipulated safety requirement by regulatory agencies in Nigeria necessitated this research work. In cellular telecommunication system deciding where to place the base station is a very important issue during the process of cell planning [Ajay, 2004]. The BTS for a given geographical area has to be well positioned for maximum coverage and minimal interference which are the indexes for measuring the quality of any mobile service [Kia et al, 1998]. However, if coverage is the only issue of contention in cell planning then the BTS would have been placed anywhere. However, if it were so, the issue of environmental safety violation as well as the quality of services provided would be compromised since the signal to interference ratio may be minimized. This is the actual scenario in the Nigeria mobile cellular communication industry.

This fact was buttressed in the research carried out by Okonighene [2010], that in Nigeria, 98% of (GSM) base stations (cell sites) are sited within 20 meters from residences, offices, schools, business buildings, petrol stations and public arenas. According to the environmental regulatory body [nesrea.org] this is a violation on environmental safety. The presence of a BTS is always felt by the surrounding structures, human and material, irrespective of the fact that the BTS may stand alone on a space with the minimum space as specified by regulations. The need to handle public concerns on health effect of the BTS has been discussed by several researchers. [Julie, 2005; Biebuma, 2011; Danielle, 2005]. In recent times, the Nigerian environmental regulatory body (NESREA) have had course to shut down some base station that pose threat to public safety [guardiannews.com].

This research considered the provision of a digital city data base will aid the radio planning engineer to make a cost resourceful site selection. The data base together with the other radio network planning tools will provide the radio engineer an informed knowledge of the territory to be covered by a proposed base station. This will go a long way in ensuring the selection of suitable sites for BTS placements, taking environmental safety requirement into consideration. The

spatial data base generated will also serve for other facility placement decisions in the state.

3.0 Data base Organization

The city database will hold records on the land surface of the city identified by its geographic location. The city is divided into plots/units of 50m x 50m with the key field or field name being the Lat/Log as it is unique for every point in the universe. The city database has two other fields which are the elevation from sea level in meters and the class or nature of existing infrastructures if any. Table below shows the different fields for the proposed database.

Table 1.0: Data base fields.

Longitude	Latitude	Elevation	Class

The class refers to the type of feature on ground a specific location, for a comprehensive database the following range have been identified as class Residential, Commercial, Industrial, Civic/ cultural, Health/clinics, High ways, Vegetation and Open space. A ground survey has to be carried out to determination the class of each entry. The city database is organized following the tabular attribute format of data base management system. The database consist of a two dimensional table with the column indicating the attribute and the rows the records. The database has three main attribute which are the coordinates (latitude and Longitude) the elevation from sea level in meters and the class. The Class attribute is linked to a relational table where the class categories are defined. Table 2.0 shows the class categories and assigned class code.

Table 2.0 shows the different class categories

Class code	Class Category
1	Residential
2	Commercial
3	Industrial
4	Civic/cultural
5	Educational
6	Health /clinics
7	Highways
8	Vegetation

This class code is the major link between the two tables 1.0 and 2.0, developed following the relational DBMS model for storing attributes [Urisa, 1999]. The common and unique identifying attribute in this case is the 'class code'.

4.0 Implementation:

The implementation of the database collection is thorough but with proper organization the task was achieved in a short time. The entire city/territory was divided into pixels of units which are then subdivided into smaller units for better organization. The data upload was carried out using a programme written in Matlab. The entire city is sectioned into different regions with each regions cut out into several plots as depicted in the Minna city map shown in fig 1.0

Fig 1.0: Minna City Map showing area demarcation

The upload programme is so organized for adequate continuation and saving of data collected. The spatial data for small regions implemented were taken using a Germin handheld GPS device with a precision of 2 meters. The flow chart for the data upload is as shown in figure 2.0

4.1 Programme features

Unique features have been included in this programe to allow for a comprehensive data collection.

These include the data input template with the various field provided. A map data upload indicator that allows for indicating in the form of a black square the region within the uploaded map whose data has been captured.

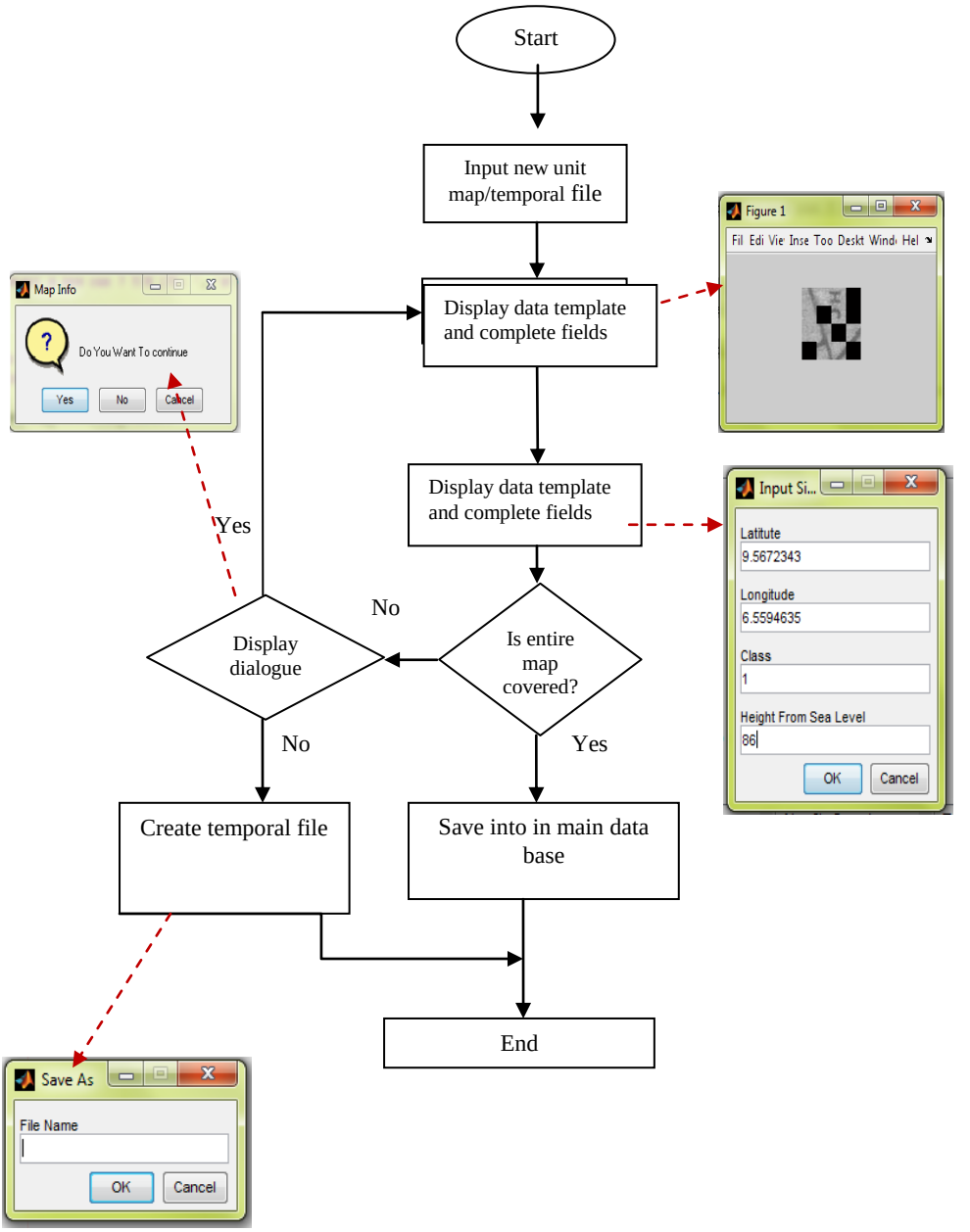

Fig 2.0 Flowchart for data upload in Matlab environment

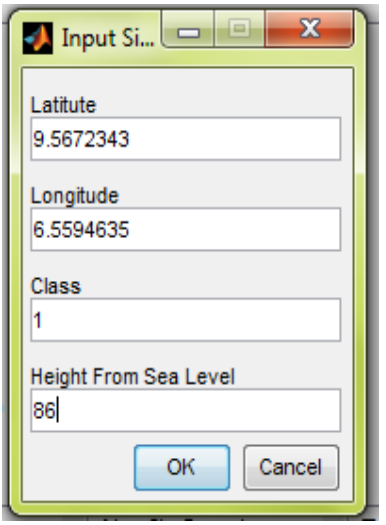

Fig 3.0 Data input template

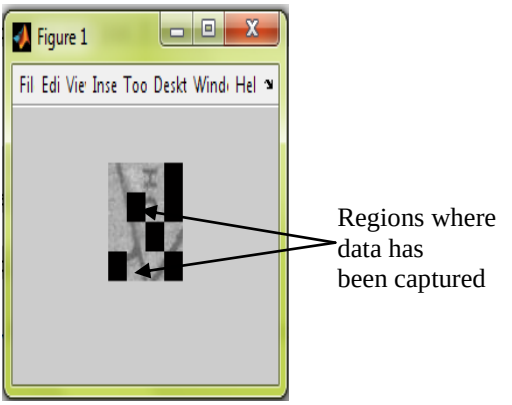

Fig 4.0 Map data upload indicator

The data saving and continuation process is automated in line with modern GIS database repository format for storing databases. Figures 5.0 a, b, and c show the graphical user interfaces for saving, and retrieving of the spatial data.

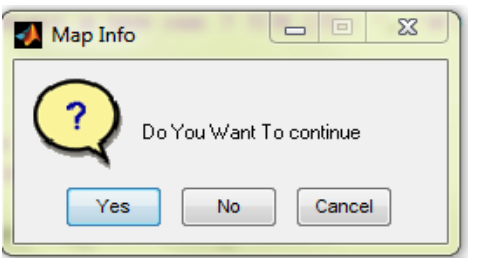

Fig 5.0 (a) Inquiry for contuation of data up load

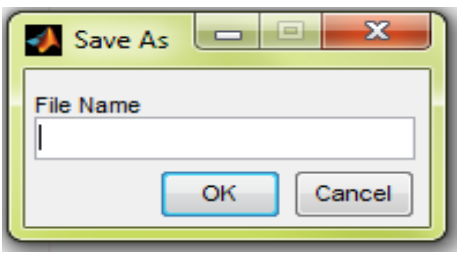

Fig 5.0 (b) Creating a tempoary file name

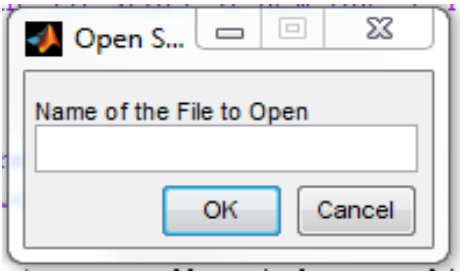

Fig 5.0 (c) Opening a previously saved file

4.2 Area of Implementation

The developed template and image map building was implemented in Minna, the capital of Niger state, Nigeria. Minna is located at approximately between latitude 09^0 25'N and $09^0$45'N; and longitude 06^0 15'E and 06^0 35' E with an average elevation/altitude of 299 meters [Ojigi 2012]. The terrain in Minna can best be described as asymmetrical with surrounding hills. The inhabited regions in the town however are flat, with very scanty habitation in the hilly regions. Sample of some data taken in Minna is given in table 3

Table 3: Raw field data of data in Kpakungu Minna

Longitude	Latitude	Elevation	Class Code
6.533167	9.597778	239	2
6.532694	9.597639	240	1
6.532361	9.597444	240	2
6.531805	9.597306	235	4
6.531333	9.597083	236	5
6.531833	9.597000	234	2
6.531055	9.596278	239	2
6.531333	9.596778	234	2
6.531138	9.596806	235	6
6.530666	9.596833	237	1
6.530361	9.596583	234	1
6.529305	9.596361	232	1
6.529472	9.595833	233	1
6.530722	9.596889	233	1
6.529583	9.595333	232	1
6.529638	9.594583	231	1

6.530083	9.594556	231	1
6.530416	9.595000	230	1
6.530888	9.595500	232	5
6.531083	9.595833	232	6
6.531500	9.596333	230	1
6.531777	9.596083	230	1
6.531944	9.596194	230	1
6.532138	9.596583	231	1
6.532694	9.596722	230	1
6.533305	9.596861	231	1
6.516888	9.596250	232	1
6.517166	9.596889	234	1

Conclusion

Spatial data collection is a GIS base activity with accuracy achieved through the use of high precision GPS facilities. In situations where this information is not available as is the case in Minna, Nigeria, facility locations such as the base station placement has been a challenging task. The easy access and retrieval of this information are very necessary. In this paper a comprehensive data collation process have been presented, with fields relevant to the information required by radio planners. The generated database will be used to test an ongoing work on base station placement using genetic algorithm. The accuracy of data collected will be verified in future work with the development of a digital map displaying ground features.

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