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# Solving the Problem of Generation of Road Network Database for Minna and Environs Using Surveying and Geoinformatics Techniques

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***Abstract:*** *Roads are very important. Road network database of an area is also very important. A good road infrastructure is an essential basis for economic development. The study Area is Minna and environs. The study is aimed at creating road network database for Minna and environs. The objectives are to use GIS, Remote Sensing and Surveying techniques to gather data and create the road network database of the study area. Satellite images and existing road map of the study area were used. The satellite image was used to carry out field survey. ArcMap 9.2 software was used to digitize the road network. Road names were identified from the field survey. Then the creation or generation of road network database for the study area was done. In the database are the names of the roads identified in the study area and their types.*
***Keywords:*** *Road network, Database, Satellite images, Database management, Geoinformatics.*

## I. Introduction

A road is a specially prepared way, publicly or privately owned, between places for the use of pedestrians, riders, vehicles, etc.(Hornby, 2005). A road network system in any area provides a means of transportation of goods, services and interaction of individuals.

### 1.1 Importance or Significance of roads

Underdevelopment of a place, country or region etc, is associated with the fact that the place or region has not been opened up with required transport routes (Egunjobi, 1991). Few persons would dispute the proposition that a good road infrastructure is an essential basis for economic development.

### 1.2 Road Network database creation

For any GIS to work, the created database must be good enough for the end users. A research was carried out by Hazanike et al. (1998) in Asia, in which a database on road network such as existing spatial distribution of roads and their possible links to the roads of neighbouring countries was created and updated using remote sensing and GIS. The problem was the need to create a database on road networks, and to use it for Landslide risk assessment along the road. Data collected and used included existing maps, satellite images and data from field visits. Information such as contours from topographic maps was also incorporated in the database. GIS was used in creating the database by integrating information available in existing maps with current ones in satellite images.

A relational database creation is advocated. A relational database is a database that has a collection of tables of data items, all of which is formally described and organized according to the relational model. Data in a single table represents a relation, from which the name of the database type comes. In typical solutions, tables may have additionally defined relationship with each other (Wikipedia Encyclopedia).
The source of the data sets must be ascertained and current.

#### 1.2.1 Database Management

In any GIS, the database is the key to manipulation, processing, retrieval and analysis. There are two types of datasets, namely spatial and attribute. The spatial database is information stored in digital form and they are made from different types of maps relevant to a particular project. The attribute database is where the description of objects stored in the spatial database is stored.

### 1.3 The Study Area

Minna, the capital of Niger state is the study area. It lies between Latitude 9° 33¹ and 9° 40¹ north of the Equator, and Longitude 6° 29¹ and 6° 35¹ East of the Greenwich Meridian.
In the present political zoning system, it is within the North Central Zone, and occupies an area of about 884 hectares. It is about 145 Kilometers by road from Abuja, the Federal Capital of Nigeria. The Minna metropolis

has grown to engulf suburbs settlements such as Bosso, Maitunbi, Dutsekura, Kpakungu, Shango and Chanchaga.

**1.4 Problem Statement**

Getting data on roads manually or physically is time-consuming and tedious, yet it is very important to have this information. The problem is how these road network databases can be gathered efficiently, timely and accurately. This is the problem this study tends to solve using Surveying and Geoinformatics techniques.

**1.5 Aim and Objectives**

**Aim:** To generate road network database for Minna and environs.

**Objectives:** (1) to use remote sensing to gather more information on roads

(2) To combine the use of GIS, Remote Sensing and Surveying to create/gather road network database of the study area.

**1.6 Justification of Study**

A road network system in any area provides a means of transportation of goods, services and interaction of individuals. Database on existing road network is very important in order to keep track of the roads; it will help in the monitoring and maintenance of the roads. It is clear that without roads, economic activity would be drastically curtailed.

**Brief Literature Review**

Sood, et al.(2000) created database for all the road sections in their study area. In their method, the road network of the study area was digitized from the map, using AutoCAD software. All the digitized data were exported into the Arc View software to build the spatial data. In the work of Pratap et al.(2006) titled 'Highway Information System And Management Using GIS', the road network of the study area was digitized from the Cadastral map of the Warangal City using AutoCAD software. All the digitized data were exported into the Arc Info software to build the spatial data. Lagunzad and Mcpherson (2003) were faced with the problem of creating road database for various purposes but which must have one reference system. Their work titled "GIS Applications for road Network of The Philippines: A new Technology in Road Management" is here reviewed. The original methods of locational referencing used by the department of Public Works and Highways (DPWH) were not suitable for comprehensive computerization of highway information. Many discrepancies were noted as to the exact position of the same features as recorded by the different offices in the DPWH. This is because different organizational units within the DPWH had carried out independent survey activities with little attempt at coordination. This led to extensive collection and duplication of the same data for different purposes.

To solve this problem, the Locational Referencing System (LRS) was used as the primary method to relate various types of road data. Global Positioning System (GPS) was used to survey the National road network, and combined with GIS to establish shape files describing that network.

## II. Methodology

**3.1 Description of Data**

The spatial data required for the study were acquired by (i) field method (ii) use of satellite images/ remote sensing method and (iii) a combination of remote sensing and GIS. The road map of the study area was used and also the satellite imageries covering the study area. These imageries are also showing the roads. Data from field work/measurements served as input data.

The data collection was done in such a way to meet up with the needs for achieving the aim and objectives of the study.

Source: National Population Commission

**Fig. 3.1:** QuickBird Satellite Imagery of the study area

The satellite imagery used is Quickbird imagery of 2006 covering Minna and environs, acquired from the National Population Commission. It has a resolution of 0.61 m, and is the best commercially available imagery then in terms of resolution. It is of scale 1: 3000. The imagery gives a resolution good enough for use in this study. The road map of the study area was acquired and used. It is the existing road map of the study area, sourced from the Ministry of Lands, Survey and Town Planning, Minna. It is drawn at a scale of 1: 50,000 and shows mainly the major roads.

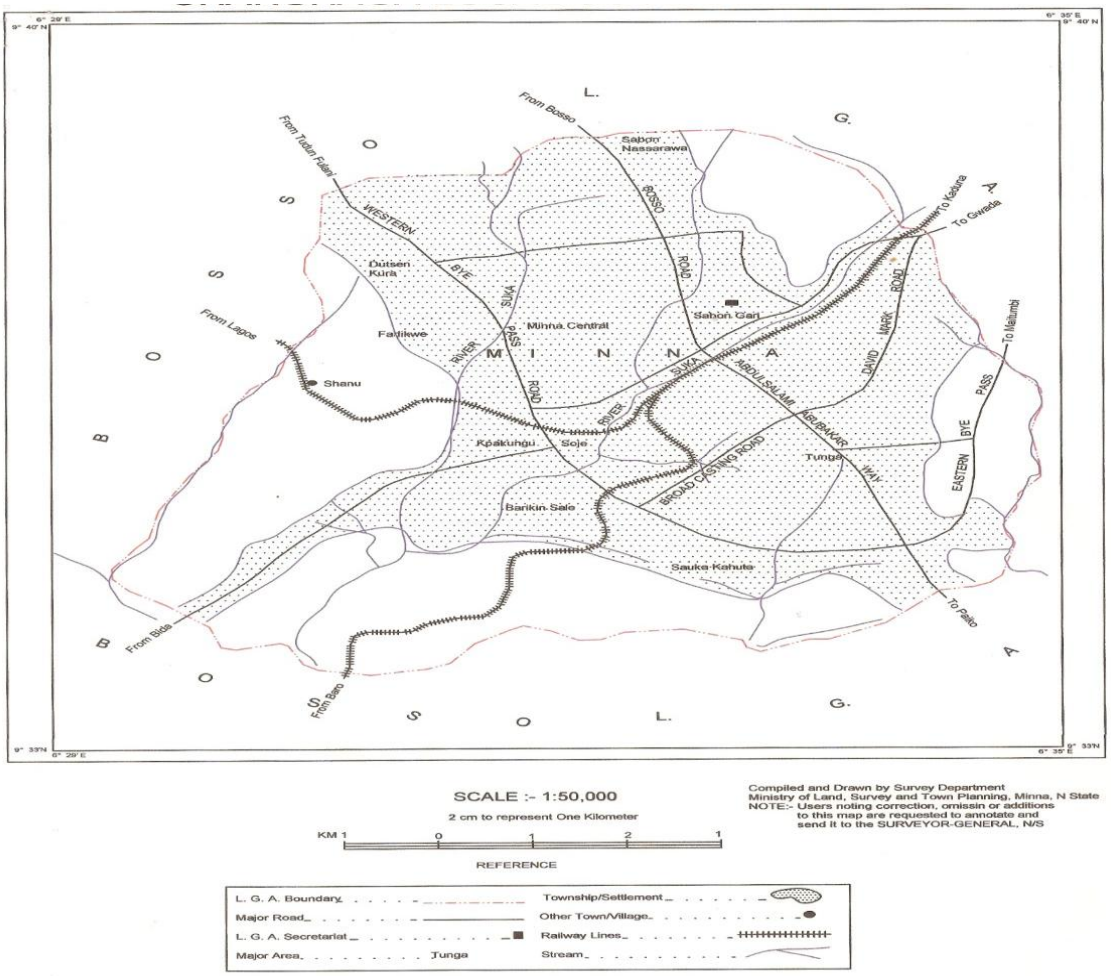



**Fig. 3.2:** Acquired road map of the study area

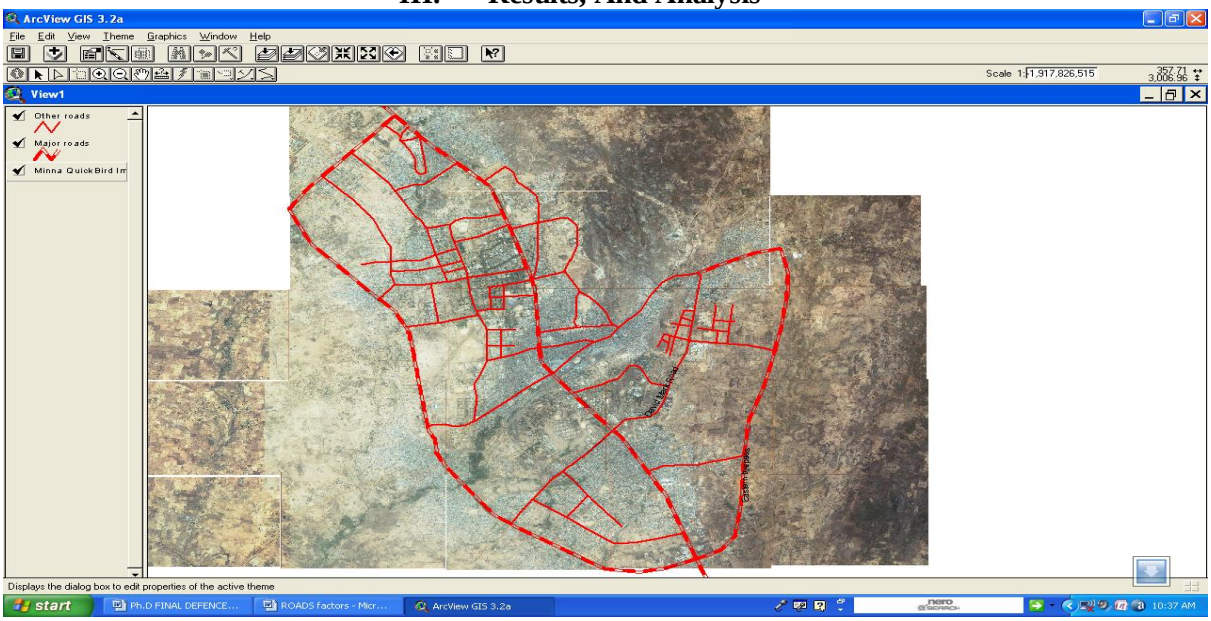
**3.2 Steps in the methodology**

The data collected and used included base maps, street guide maps and road network map.

The satellite imagery used was printed out in A3 size paper and taken for demographic survey in the field. The selected roads were identified and noted on the image before digital interpretation of the imagery was carried out using ArcMap 9.2. The software was used to digitize and update the road network; road names were identified from the field work and were noted, other features like structures, streams, etc. on the image were identified and taken care of.

It is essential to convert spatial and attribute data collection into a form which can be used for a Geographic Information System (GIS) where it is not in that format. The satellite imagery acquired was in JPEG format and it enabled ArcMap software to recognize the data. The imagery was uploaded into Arc Map environment through the ADD DATA extension and a work directory was first setup to have a proper saving system. Digitizing started by using the line tools for roads, railway line, and then labeled with the text tools. The image was later geo-referenced using Minna coordinates. The image was geo-referenced using coordinates extracted from the road map of Minna and its environs with the process popularly known as map-to-spatial data registration.

## III. Results, And Analysis




Source: Author's work, 2008

**Fig. 4.1:** An Overlay of Digitized road network on imagery

Quickbird imagery of year 2006 at the resolution of 0.61 was used in the study. The roads are clearly seen and road surface conditions can be determined from the satellite image(s). Fig 4.1 shows an overlay of digitized road network on imagery. The roads were clearly identified on the imagies.GIS was used to digitize the roads and overlay them on the satellite imagery. This procedure brought out the roads clearly on the imagery. A good overview of the road network was obtained. These roads were then identified on the ground and their attributes obtained. Then the generation of road network database for Minna roads followed.

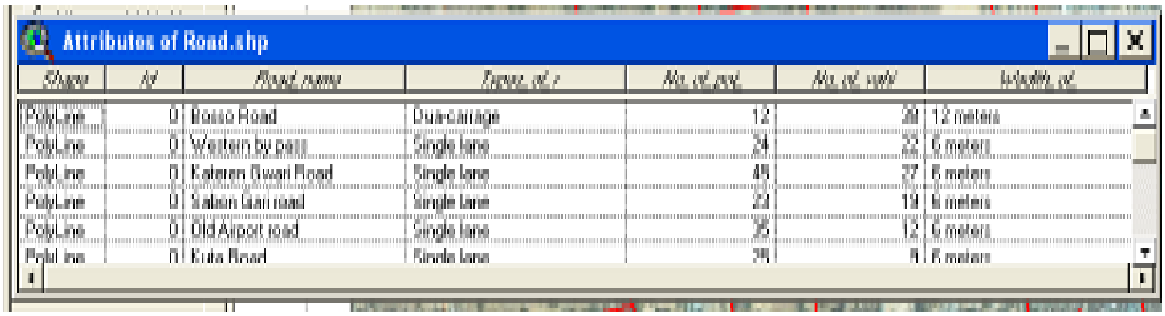



**Table 1.0: Road database (as at 2006 study time)**

| Road Name | Type |
|---|---|
| Bosso road | Dual Carriage |
| Western Bypass | Dual Carriage |
| Keterengwari | Single Lane |
| Sabon Gari | Single Lane |
| Old Airport | Single lane |
| Kuta | Single Lane |
| Tunga-Bosso | Dual Carriage |
| David Mark | Single Lane |
| Maitunbi | Single Lane |
| Bida road | Single Lane |
| Chanchaga | Dual Carriage |
| Okada road | Single Lane |
| Niteco | Single Lane |
| Broadcasting | Single Lane |
| Ebitu Ukiwe | Single Lane |
| Kolawole | Single Lane |
| Murtala Nyako | Single Lane |
| Zarumai | Single Lane |
| Ibrahim road | Single Lane |

| | |
|---|---|
| Yoruba road | Single Lane |
| Lagos | Single Lane |
| Musa Zogo | Single Lane |
| Ibo road | Ingle lane |
| Dr Sheikh Abdullah road | Single Lane |
| Peter Sariki road | Single Lane |
| Murtala Nyako road | Single Lane |
| Pateka road | Single Lane |
| El-Waziri road | Single Lane |
| Abbatoir road | Single Lane |

Road transport/network database for the study area was generated. In the database are the names of the roads identified in the study area; their types, and conditions. Road network database can be updated using satellite images; this has been done for the study area. The study attests to the fact that airphotos or remote sensing images can capture more information about roads than field surveys can, and can assist in a number of situations.

More information was obtained from the Quick bird satellite images about roads in the study area (see figs 4.1). A reasonable amount or number of information about roads in the study area was also obtained from the Google satellite images in appendix. New roads not existing in the hard copy road map were identified on the satellite images and used to update the map of roads in the study area.

## IV. Discussions / Conclusion/And Recommendations

### 5.1 Generation of Road Database for Minna

Quick bird high resolution satellite imagery was used. The high spatial resolution (0.61) played a great role in image identification and interpretation of features. The integration of the satellite image data and other road data collected from field measurements, such as maps, etc., into GIS environment made it possible to generate the road network database for Minna and environs. GIS is used to display and analyse spatial data which are tied to databases. Various field investigations were carried out to obtain details of the roads. The database was also populated with field photos showing the conditions of roads. The satellite images were used to facilitate the identification of roads.

The total number of roads (main) identified as of then (2006), is fifty, which includes five major roads (dual carriage), twenty five minor roads (single lane), and twenty others (minor roads). The longest is the Nnamdi Azikiwe Way, followed by Tunga-Bosso road (Abdusalam Abubakar Way). There are many other connection roads both tarred and untarred. Field work was carried out to get the names of the roads, their types, width, etc. The satellite images helped to have an overview of the roads in the study area, and then field visits were used to get details of the roads.

Without the satellite images that gave the overview of the roads, which guided the field visits, it would have cost much more, taken much longer time, and required much more man power to be able to get the database of all the roads in the study area. These data were integrated with GIS to generate the road database for Minna. This system of using GIS and remote sensing for generation of road database is faster, more economical, safer and modern.

Effective data correction/updating remain themes of prime importance to ensure the proper maintenance of databases. When a database is updated, the associated map can be updated as well. The road network database for the study area was generated. The database was generated from field measurements, observations, and remote sensing data. The names and types of roads are indicated, etc. They are stored in the GIS database.

GIS was used in creating the database by integrating information available in existing maps with current ones in satellite images. Newly constructed roads do not exist in the existing maps, so an updated database was created using satellite data combined with field visits. Digitized satellite images were geo-referenced to map's coordinates. With the help of high spatial resolution data, mapping and updating of road network can be accomplished. Field observations, measurements and records were all used in combination with the satellite images and GIS in updating the road map of the study area.

For the base year, 1988, when the existing road map of the study area was produced, there were only five (5) main roads. As at 2006 when the satellite image was acquired for the study, thirty – tthree roads (main) were identified on the image. This implies that between the base year 1988 and the year 2006, a period of eighteen years, twenty – eight new (main) roads were added in the study area. That shows a significant 84% increase in the number of roads – a sign of development. All the new roads are normal /minor roads of single lane. Of the former five main roads, three have now become dual carriage way.GIS is used to display and analyze spatial data which are tied to databases. Maps can be drawn from the database and data can be referenced from the maps. Relational database was created and the road data base was updated.

## V. Findings

1. Data correction and updating are important tasks to ensure that accurate and timely information is available.
2. Database creation using GIs and remote sensing is possible. In the database are the attributes of the roads which include names, width, type, etc.. A comprehensive road database has been created for the study area using remote sensing and GIS.
3. Road database creation can be continuous and accurately done. It is necessary to have an update at any given time.

## VI. Conclusion

A format for creating a comprehensive road database has been developed. The digital database created in the form of tables, maps, etc. would help in monitoring and maintenance.

Different types of operations such as retrieval, insertion, updating and deletion of data can be done on the database created. The results obtained in the study have shown that high resolution satellite data could play an important role in the updating of road network maps. Once a base line map has been established, further updating can be done as more recent imagery is acquired – this can be done.

The results obtained in the study have shown that high resolution satellite data could play an important role in the updating of road network maps. Once a baseline map has been established, further updating can be done as more recent imagery is acquired – this can be achieved by directly overlaying the base line digital map information to more current, geometrically corrected satellite imagery.

## VII. Recommendations

1. Creation of road database should be done using Surveying and Geoinformatics techniques.
2. Updated comprehensive road data base should always be available.

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