

Position Paper

The Need for Inclusion of Geomatics Engineering as a Programme in Nigerian Universities and Registrable by Council for the Regulation of Engineering in Nigeria (COREN)

Okonofua E. S.¹, Oladosu O. S.¹ and Ehigiator –Irughe R.^{1,*}

¹Department of Geomatics, Faculty of Environmental Sciences, University of Benin, Benin City, Nigeria

Corresponding Author: *raphael.ehigiator@uniben.edu

ABSTRACT

This paper presents the field of Geomatics as an evolving field, its relevance to other fields of engineering in general as well as other countries who have been practicing it. The rationale for teaching Geomatics Engineering courses in Nigerian Universities as well as making it COREN registrable is borne out of good intention to put it where it rightly belongs. In this work, previous researches on the relevance of Geomatics Engineering in other engineering practices and the advantages the profession has offered other fields of Engineering due to proper placement were reviewed. Geomatics Engineering has metamorphosed over the years and many countries have taken advantages of this development as a welcome idea and Nigeria cannot be exception. This article also revealed the need for the Council for the Regulation of Engineering in Nigeria (COREN), to urgently incorporate Geomatics Engineering into its structure as a field of engineering practice in Nigeria similar to what is obtainable in other advanced countries. This will help in harnessing the full advantage of the profession in the field of Engineering practices where the knowledge of Geomatics is required.

Keywords: COREN, Geomatics Engineering, Technological Advancement, Professional

1.0. Introduction

Geomatics a new paradigm comes from the French word “géomatique”. (Its roots are “geo” (Earth) and “informatics” (information + automation + “ics”) which is the accepted form for the name of sciences). Another description of Geomatics was derived from two words Geodesy + Geoinformatics. In the Latin language, the Geomatics correspond to Geomatica (Adeoye, 2010; Nwilo, 1999; Nwilo et al., 2000), and Russia is called Геоматика (Geomatika). Geomatics Engineering is the application of the knowledge of mathematics and sciences leading to the acquisition, processing (arrangement), and interpretations of ground and spatial data which is used for Engineering designs for the benefit of mankind (Junnilainen, 2006).

Junnilainen, (2006) describes terrestrial surveys with a much older history as being the fundamentals for determining size and shape of the earth, and of establishing country and continent-wide reference Networks. He also noted that in ancient time, the surveyor was called a person who uses geometry and primitive tools such as surveying rope, chain or tape in order to define the cadastral edge. A lot of words have been used in order to express Geomatics engineering from ancient time to today such as Geometrist, Surveyor, Survey Engineer, Geodesist, Photogrammetrist, Cartographer, Geoinformatiker, Geomatician etc. As the parallel to the technological development, surveying and mapping sector has improved itself and adapted to the new phenomena. This phenomenon has been synchronized into military and security architecture for the production of maps used in defense and combat. On a global scale, within the Last two centuries, the most affected engineering due to the revolution in computer and space technology is Geomatics Engineering. This is as a result of the sophistication of real time equipment in data capturing, preserving, analysis and presentation (Junnilainen, 2006).

Also, Geomatics as a department in Engineering that deals with all kinds of position-dependent measurement, calculation, analysis and visualization studies; has the advantage of sharing processed acquired data for engineering designs in Civil/Structural Engineering, electrical Engineering, Water resources and Environmental Engineering. Spatial information for hydrological and hydraulic designs are also acquired by Geomaticians for the design of hydraulic structures. The first beneficiary of acquired data are the Engineers, hence relocating Geomatics to Engineering is an added advantage to the college of Engineering as it is in most advanced countries. Geomatics Engineering is one of the vast engineering branches that are open to technological developments and best practices in contemporary technology (Cerba, 2012).

Geomatics, as a modern discipline, which integrates acquisition, modeling, analysis, and management of spatially referenced data, i.e. data identified according to their locations; its full advantage can be fully harnessed when it is domiciled in the faculty of Engineering for the purpose of share technical facility and ease of access to acquired data (Junnilainen, 2006). Based on the scientific framework of geodesy, it uses terrestrial, marine, airborne, and satellite-based sensors to acquire spatial and other data. It includes the process of transforming spatially referenced data from different sources into common information systems with well-defined accuracy characteristics (URL-1). Besides, Geomatics like other Engineering disciplines involves intersection of the physical, biological, business and social sciences with respect to mathematical and logical relationships as illuminated Fig 1 (URL-2).

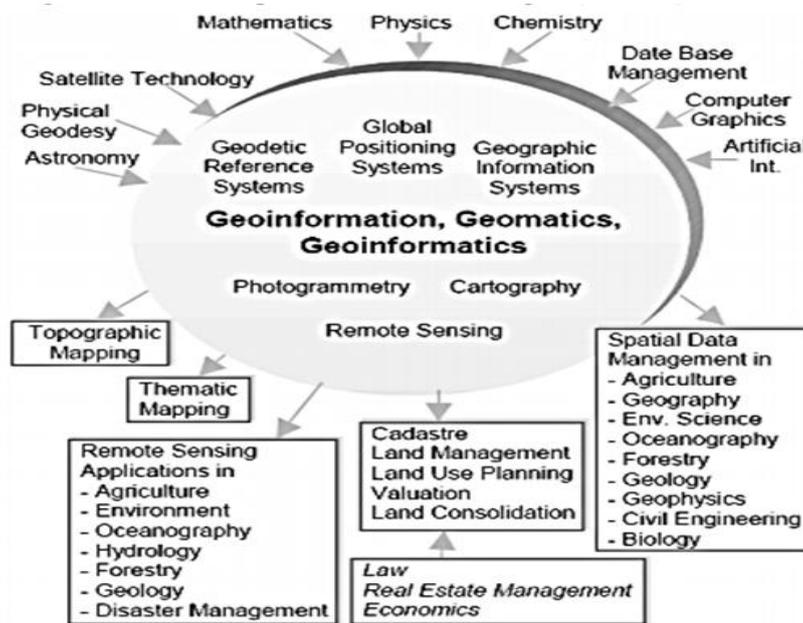


Figure 1: Geomatics at glance. Source: (Grun, 2008)

The aim of geomatics engineering according to Cerba, (2012) involves the development and use of various spatial techniques based on modern technology to better understand, plan, organize, monitor and manage the earth we live in, the production of various maps and spatial data /information for the needs of the country (planning, property, defense etc.) and determining precise position (horizontal and vertical) of any kind of space or land related to the earth. These are the basic details needed for the design of Engineering infrastructure hence to need to bring Geomatics closer to where the outputs are put applied.

1.1. Aim and Objectives

The aim of this paper is to unravel the need to teach Geomatics Engineering in Nigerian University, acceptable by Nigerian Society of Engineer (NSE) and to become registrable by Council for the Registration of Engineering in Nigeria (COREN). While the objectives are but not limited to:

- a. present the overview of Geomatics engineering at a glance.

- b. showcase the interdependency of major engineering fields with Geomatics Engineering.
- c. emphasize the application of Geo-data acquired by Geomatics Engineering to various engineering fields for solving societal problems.
- d. disabuse biasness and mediocrity against Geomatics engineering among Nigerians.

2.0. Justification for the inclusion of Geomatics Engineering in the Faculty of Engineering in Nigerian Universities

For the past years the polytechnics and universities in Nigeria, have been focused on producing cadastral surveyors and technicians. This was so because of the historical background of the country during the precolonial, colonial and postcolonial eras. The focus was on cadastral and boundary surveying as if it was the only discipline of surveying gave the profession a narrow perception in the eye of the public and making the practicing Surveyor the worse advertiser of their products. Emphasis was more on boundary delineation. The recent advancement in Technology has revolutionized the profession.

Over the last decade the Department of Surveying in most Nigerian University have transformed to the Department of Surveying and Geomatics. In University of Benin, the department was named GEOMATICS in conformity with international standard of nomenclature and because the department is domicile in the Faculty of Environmental Sciences. Most international Universities adopted the name GEOMATICS ENGINEERING or GEOSPATIAL ENGINEERING etc., depending on the Faculty housing the programme. Geomatics at the University of Benin was approved as a department to transform from the traditional surveying programme to one concerned with not just only ground survey data acquisition but also train students in processing the acquired data to produce designs of Engineering infrastructure. Courses in this program covers, highway geometrics, water resources and environmental Engineering, geotechnical engineering and fluid mechanics (Brimicombe, 2008). Increasingly, Geomatics is playing a central role in designing, building and managing the spatial information systems underpinning a modern society. The discipline builds on a strong measurement science base which is closely linked to its traditional land administration focus. The discipline has built on this strategic advantage to focus increasingly on the science, Engineering and management of spatial information.

The introduction of the B.Eng. programme in Geomatics Engineering is justified at this time in Nigeria because in spite of the huge potential for geomatics engineers to provide the needed engineering mapping services for all phases of environmental engineering and management, there are currently few universities offering this programme in Nigeria. The surveying education currently being offered in Nigeria is aimed at practicing as land surveyors and being largely skill and rule based, it does not meet the knowledge-based requirement for Geomatics Technology.

The new geomatics engineer will provide all mapping and engineering surveying services for engineering, scientific and military applications which include: mining and underground engineering works, highway engineering, tunnel engineering, deformation studies, water supply engineering, feasibility studies, erosion modelling & remediation, flood prediction, refuse evacuation engineering, irrigation & precision agriculture, navigation and tracking of moving vehicles or objects, Geotechnical Engineering, land surveying for cadastral, mapping for the production of township maps, establishment of geodetic control networks for establishment of national or state plane coordinate systems, establishment of national geodetic datums and linkage with international datums, precise positioning of scientific structures, space exploration, study of earth dynamics, measurements and predictions of earth tremors and quakes, rocket launching, military engineering and intelligence gathering, pipeline engineering, power line engineering, optimal route selection, environmental systems modelling, automated mapping and facilities mapping (AM/FM), contextual analysis of spatial features, etc. (Brimicombe, 2008). The table below show list of some selected leading Universities in the world offering Geomatics Engineering and the equivalent degree certificate compared to B.Eng. certificate issued in Nigerian Universities offering Engineering, accredited and registrable by (COREN). The

advantages enjoyed by these institutions include; shared facilities, ease of access to acquired data, robust knowledge in data (point and spatial) acquisition and design using the acquired data etc. The Nigerian University Geomatics Engineering graduates also stand the chance of benefiting from the above listed advantages and in addition be acquitted with the type of data details to acquire for specific projects. Table 1 is list of Universities oversea offering Geomatics Engineering.

Table 1: Some Universities offering Geomatics Engineering Programme

S/N	University	Degree Offered	Faculty	Location
1	Imperial College of Science, Technology and Medicine	B.Eng. Geomatics Engineering	Engineering	UK
2	University College, London	B.Eng. Geomatics Engineering	Engineering	UK
3	De Montfort University, Leicester	B.Eng. Geomatics Engineering	Engineering	UK
4	Moscow State University of Geodesy and Cartography	M.Sc. Engineering Geodesy and Geomatics	Engineering and management	Russia, Moscow
5	Siberian State University of Geosystems and Technology	M.Sc. Geodesy and Geomatics Engineering	Engineering	Russia, Novosibirsk
6	University of Melbourne	B.Eng. Geomatics Engineering	Engineering	Australia
7	University of New South Wales (UNSW)	B.Eng. Geomatics Engineering	Engineering	Australia
8	University of Queensland	B.Eng. Geomatics Engineering	Engineering	Australia
9	University of South Australia	B.Eng. Geomatics Engineering	Engineering	Australia
10	Ohio State University	B.Eng. Geomatics Engineering	Engineering	Columbus, USA
11	University of Wisconsin	B.Eng. Geomatics Engineering	Engineering	Wisconsin USA
12	University of Maine	B.Eng. Spatial Information Engineering	Engineering	Orono, USA
13	California State University, Fresno	B.Eng. Geomatics Engineering Department	Engineering	California
14	University of Tehran,	B.Eng. Department of Surveying and Geomatics Engineering	Engineering.	Iran
15	British Columbia Institute of Technology.	B.Eng. Department of Geomatics Engineering Technology.	School of Construction and the Environment	British Columbia, Canada.
16	University of Calgary	B.Eng. Geomatics Engineering	Engineering	Canada
17	University of New Brunswick, Fredericton	B.Eng. Geodesy and Geomatics Engineering	Engineering	Canada
18	University of Toronto	B.Eng. Geomatics Engineering	Engineering	Canada
19	Dublin Institute of Technology	B.Eng. Geospatial Engineering	Engineering	Republic of Ireland
20	Purdue University	B.S. (LSE) and B.S. (LSE & BSCE)	Engineering	West – Lafayette, USA
21	Kwame Nkrumah University of Science and Tech. Kumasi	B.Sc. (Geodetic Engineering)	Engineering	Ghana
22	University of Mines and Technology, Tarkwa	B.Sc. Geomatics Engineering	Mineral Resources Technology	Ghana
23	University of Nairobi	B.Sc. (Geospatial Engineering)	Engineering	Kenya
24	University of Stuttgart	B.Eng. Geomatics Engineering	Engineering	Germany
25	University of Twente	M.Sc. Spatial Engineering	GeoInformation Science and Earth Observation (ITC)	Netherlands

2.1. Some Equipment Used in Geo-Data Acquisitions in Geomatics

Some of the equipment used in Geomatics shows that some professionally trained persons can understand and handle them successfully. These devices are used to acquire data which form the basis of Engineering designs. Various data such as: one dimensional, two dimensional, three dimensional, even four dimensional are products from Geomatics engineering work which are needed for various engineering design purposes.



Figure 2: Some modern Geomatics Engineering Equipment

Fajemirokun et al., (2002) affirmed that with the enlarged tasks of surveying, the need for new or modified curricula in the tertiary institutions in Nigeria has become paramount. In view of this, the curriculum of Geomatics department, University of Benin and that of other institutions like University of Lagos have been revisited and review severally as occasion demands by many capable hands to reflect the internationally accepted best practices. Geomatics as identified by most engineering professionals as also the case observed in Nigeria is closely related to the disciplines listed in Table 2.

Table 2: Closely related disciplines to Geomatics Engineering

1	Computer Science	9	Geotechnical Engineering
2	Information Science	10	Metrology
3	Civil Engineering	11	Coastal Engineering
4	Geophysics	12	Disaster/hazard Engineering
5	Environmental and Natural Resource Management	13	Applied mathematics
6	Instrumentation Engineering	14	Space Engineering
7	Hydrology	15	Navigation Engineering
8	Glaciology and Sea Level	16	Railway Engineering

As in all disciplines of the engineering profession, Geomatics Engineering is influenced by: Global trends, Regional needs and trends, National needs and trends, State needs and trends as well as Ethical concerns, Social responsibilities and Independence. In Figure 3, Laser scanner and Total station equipment can be seen at glance in industrial application work. Starting from inventory survey to capture and update, the plant inventory as the solid basis for planning and the subsequent creation of plans, factory information systems and 3D models, setting-out and control measurements are carried out during the alterations and new constructions. Post construction surveys, deformation monitoring

and as-built surveys carried out by Geomaticians have saved a lot of damages to engineering infrastructure in recent times (Kufonyi, 1999).



Figure 3: Laser Scanner and Total station in industrial application (Source: GEODATA, 2015).

Thereafter, machines and tools are positioned and accurately aligned and calibrated and inspected to ensure the quality of the finished product as well as all the necessary control and monitoring measurements during ongoing operations; for instance, on crane tracks, rolling mill frames, etc. Measurement data with high precision for accurate information on the size, shape and position of objects on site with pinpoint accuracy using the advantage of the latest technology are now possible Figure 3 shows a total station being used for alignment in an industrial setup (Kufonyi, 1999).



Figure 4: Application of laser scanner on bridge and pipeline (Source: Mills et al., 2004)

2.2. Geomatics View of Societal Needs

What the society needs from the perspective of a Geomatics Engineers are specified as follows.

- a. The need to have a place to live and work;
- b. The need to manage our cities with this being an increasing requirement;
- c. The need to manage the land and marine environment which is on the increase;
- d. The need to continue to build and increasingly maintain our physical infrastructure.

All these activities are central to the role of a Geomatics Engineer. As a result of the above, there will be increasing needs within society for the management of spatial information (Mills *et al.*, 2004). Specifically, society will require Geomatics Engineers to among other things to engage in the following services.

- Design, build and manage spatial data infrastructures such as the geodetic framework, the various base mapping systems, the new spatial data collection technologies such as high-resolution satellites and spatial data measuring systems such as the global positioning system.

- Society will increasingly need to design, build and manage the spatial business systems concerned with the natural and built environment which build on this spatial data infrastructure. This will include all the systems to manage utilities and services, geographic information systems (GIS), land administration systems and all the natural resource information systems including the marine environment.
- Society will continue to require Geomatics Engineers to design, build and manage the urban and rural habitation which has been a traditional function of survey engineers. This includes the development of residential, commercial and industrial land developments.
- Finally, within this more complex society, Geomatics Engineers will increasingly be required to design and apply the measurement systems which will control much of the construction and management of the above development and management of the environment for the benefits of mankind.

From the list above, it can be concluded that society will have an increasing requirement for an engineering profession which is responsible for ground data acquisition, spatial information acquisition, post construction survey, infrastructure deformation monitoring and managing 3D Geospatial dimensional space of our natural and built environment.

3.0. Geomatics Engineering Curriculum Design

The design of curriculum for Geomatics engineering in Nigeria has been advocated by renowned academician and professional stake holders. The training initially offered in the institutions discussed by Fajemirokun, et al., (2002) on Geomatics education in Nigeria was geared towards training in the field of surveying from where students may be exposed to the basic rudiments of computer hardware and software, and taught some of the programming languages. Courses on the various divisions of surveying were offered. Such divisions include Plane Surveying, Engineering Surveying, Geodetic Surveying, Photogrammetry, Remote Sensing and Hydrographic Surveying.

The activities of geomatics are included in, but not limited to, Surveying and Mapping, Cartography, Digital mapping, Geodesy, GIS, Land Information Management, Digital Photogrammetry and Remote Sensing. Geomatics can also be regarded as the integration of the traditional survey techniques and applications with the modern methods of Global Navigation Satellite System (GNSS), Remote Sensing and Geographic Information System Fajemirokun, et al., (2002).

Due to the change of emphasis from Surveying to Geomatics, the training of surveyors in Nigeria is being modified to meet the training needs of geomatics education. Many institutions at the University and Polytechnic levels are now modifying their curricula so as meet the training needs for the geomatics education. It has indeed become very important for every higher institution in the country to change or modify their curricula in order to produce the needed man power to meet the current needs in the private and public sectors.

Many professionals in allied fields like engineering, sciences, health and social sciences and even in education and business administration are now embracing Geomatics. The higher institutions offering surveying are now saddled with the task of developing new curricula to train Geomatics Engineer and professionals from other fields of study (Fajemirokun, et al., 2002). In the light of this, several institutions of higher learning previously offering Geomatics as surveying, or surveying and Geoinformatics have seen need to upgrade to the internationally acceptable best practices of upgrading to full Geomatics training. Table 3, is a sample of the designed curriculum currently being run in the Department of Geomatics, University of Benin (UNIBEN).

Table 3: Sample of curriculum design and courses taken by Geomatics students UNIBEN

COURSE CODE	COURSE TITLE 100 Level	COURSE CODE	COURSE TITLE 200 Level
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CHM 111	General Chemistry I	GEM 221	Introduction to Geomatics Engineering
CHM 113	Organic Chemistry I	EMA 281	Engineering Mathematics I
MTH 111	Algebra and Trigonometry	GEM 231	Introduction to Computer Programming
MTH 112	Calculus and Real Analysis	MEE 211	Applied Mechanics I
PHY 111	Mechanics, Thermal Physics & Properties of Matter	MEE 221	Engineering Drawing, I
PHY 113	Vibrations, Waves and Optics	EEE 211	Electrical Engineering, I
GST 111	Use of English I	GEM 211	Basic Environmental Geomatics I
GST 112	Philosophy and logic	CVE 211	Strength of Materials
CHM 122	General Chemistry II	LAB 201	Laboratory/ Field Work I
CHM 124	Organic Chemistry II	EMA 282	Engineering Mathematics II
MTH 123	Vectors, Geometry and Statistics	GEM 212	Basic Environmental Geomatics II
MTH 125	Differential Equation and Dynamics	GEM 232	Engineering Computer Graphics& CADD
PHY 109	Practical Physics	GEM 252	Computer Application to Geomatics Engineering
PHY 124	Electromagnetism & Modern physics	MEE 212	Engineering Mechanics II
GST 121	Peace Studies and Conflict Resolution	GEM 222	Mathematical Cartography
GST 122	Nigerian Peoples and Culture	CVE 212	Element of Architecture I
GST 123	History and Philosophy of Science	EEE 212	Electrical Engineering II
	300 Level 1st Semester	LAB 202	Laboratory/Field Work II
EMA 381	Engineering Mathematics III		500 Level 1st Semester
MEE 351	Thermodynamics	PRE 571	Engineering Management, Economics and Administration
CVE 341	Engineering Geology I	GEM 531	Engineering Geodesy I
GEM 331	Geomatics Engineering Networks	GEM 521	Space Geodesy
GEM 311	Cadastral and Land Information Management	GEM 531	Digital Image Processing
GEM 341	Engineering Statistics	GEM 541	Digital Terrain Model
GEM 361	Geospatial Information System I	GEM 501	Project
GEM 351	Photogrammetry & Remote Sensing I	CVE 521	Civil Engineering Hydraulics
MEE 361	Fluid Mechanics I	GEM 511	Geo-Environmental Engineering
GST 300	Entrepreneurship	GEM 581	Lab/ Field work V
	300 Level 2nd Semester		OPTIONAL COURSES (Choose two Courses only)
EMA 382	Engineering Mathematics IV	GEM 551	Applied Building Information Modelling
GEM 317	Engineering Geophysics	CVE 523	Engineering Hydrology I
GEM 312	Operation Research in Engineering	CVE 553	Non-Topographic Photogrammetry
GEM 322	Hydrology and Water Resources Engineering	CVE 555	Positioning, Navigation and Wireless location
GEM 362	Photogrammetry and Remote Sensing II	CVE 541	Geotechnical Engineering
GEM 392	Hydroinformatics Engineering I		
GEM 332	Mining and Special Geomatics Engineering		500 Level 2nd Semester
GEM 352	Geometric Geodesy	GEM 528	Water Resources and Environmental Engineering
GEM 372	Adjustment and Least Squares	GEM 516	Mapping Laws and Code of Professional Practice for Civil and Geomatics Engineering
ELA 302	Swimming/Field Camping	GEM 514	Marine Geodesy
	OPTIONAL COURSES (Choose one Course only)	GEM 522	Physical Geodesy
GEM 342	Geodetic Astronomical Methods	GEM 532	Engineering Geodesy II
GEM 342	Engineering Geology	GEM 524	Adjustment & Mathematical analysis
MEE 362	Fluid mechanics II	GEM 552	Health, Safety and Environmental Management system
	400 Level 1st Semester	GEM 502	Final Year Project
EMA 481	Applied Engineering Mathematics		OPTIONAL COURSES (Choose two Courses only)
CVE 441	Soil Mechanics	GEM 592	Sensor Web and Internet of Things
GEM 421	Engineering Surveying	GEM 562	Environmental Remote Sensing and GIS
GEM 461	Geospatial Information System II	GEM 572	Environmental modeling
GEM 451	Advanced Remote Sensing and GIS	GEM 556	Environmental Monitoring and Management
GEM 411	Hydroinformatics Engineering II	CVE 522	Engineering Hydrology II
CVE 423	Environmental Engineering		
GEM 471	Potential Theorem and Spherical Harmonic		
GEM431	Geodetic Engineering		
CVE 431	Introduction to Transportation Engineering		
LAB 401	Laboratory/field work IV		
	OPTIONAL COURSES (Choose one Course only)		
CVE 421	Hydraulic and Hydrology		
CPE 481	Numerical Computation		
	400 Level 2ndSemester		
	SIWES (Industrial Training)		

Table 3 reflects the summation of courses offered in the department of Geomatics, university of Benin. The programme contains 53% Engineering courses covering Civil and Mechanical Engineering; and 47% Surveying courses. The more than 50% Engineering courses give the students leverage in Engineering practices and profession. We therefore recommend Table 3 to National University

Commission (NUC) and COREN as the minimum requirements by students offering Geomatics engineering to pass before graduating from Nigeria Universities. It is a reflection of the evolvement and revolution of the discipline of Geomatics over time and over the world.

5.0. Conclusion

Geomatics Engineering in higher education around the world used to be in a perilous condition because of student low turnout and lack of proper awareness of what the programme entails. Recently, this narrative is changing globally as there is a holistic marketing approach in ensuring that the advantages of geomatics engineering is appreciated in nearly all fields of engineering and Nigerian universities cannot be exception. The change in the discipline has been dramatic and exciting and here is a great deal of demand for the graduates and very good support for sponsored-research in the Geomatics Engineering discipline. Therefore, this study has added immensely to the clarion call of geomatics engineers for the inclusion of geomatics into Nigerian Universities curriculum and also a division in Nigeria Society of Engineers which is registrable by the Council for the Regulation of Engineering in Nigeria, COREN.

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