AJLP & GS
African Journal on Land Policy and Geospatial Sciences

e-ISSN : 2657-2664, Vol. 6, Issue.2, March 2023

https://revues.imist.ma/index.php/AJLP-GS/index

https://doi.org/10.48346/IMIST.PRSM/ajlp-gs.v6i2.36856 Category of the manuscript : Articles

Received in: 31 December 2022 **Revised in:** 12 February 2023 **Accepted in**: 18 March 2023

Spatial Analysis of Control Points Distribution in Federal University of Technology, Akure.

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ABSTRACT

Context and background

As a result of advancement in Technology, the densification of Survey Control Points (SCP) has become very easy. There has been some Survey Control Points (SCP) that were established within the Federal University of Technology Akure (FUTA) campus, Ondo state, Nigeria with no intention for database storage.

Goal and Objectives: This study aimed at mapping of control points distribution within the University community. The objectives include to identify and re-coordinate all existing control points in the study area, compare the result statistically and create a database in a mobile application environment.

Methodology: Ground survey and Geographic Information System (GIS) methods were adopted in the study. All existing Survey Control Points (SCP) within the study area were re-coordinated with the use of South Differential Global Positioning system (DGPS) in static mode with minimum of thirty-minutes observation per station. The observed data were downloaded and processed using South GPS Processor, AutoCAD 16 and ArcGIS 10.3.1 software. Student's T-test was used in comparing some existing and the observed coordinates. The coordinates (Northings, Easting and Height), images of Survey Control Points (SCP) location, number and nearest identifying feature gotten from the ArcGIS environment were used in building the mobile application. Also, in the process of developing the mobile application, the following programming languages were used; JavaScript, HTML, CSS and Bootstrap. Notepad++ was used in compiling the codes while IntelXDK platform was used in building, testing and debugging the mobile application.

Results: The result reveals that the control points are evenly distributed within the study area. It has also contributed to the quality of geospatial data in the University environment, eliminate duplication of efforts, and provide an effective and efficient means of data accessibility through the creation of a mobile application database. The developed mobile application database is hereby recommended for adoption and update by the Department of Surveying and Geoinformatics, FUTA.

Keywords: *Surveying, Mapping, Control points, Database, Mobile application.*

1. INTRODUCTION

Surveying as the bedrock of sustainable development is solely dependent on a network of reference frameworks to which every survey job that is to be carried out on or beneath the surface of the earth and on water is tied (Tom, 2017). These networks of reference frameworks, which can be regarded as control points, must be established with very high accuracy based on the order of the survey job (first, second, and third). Various surveying techniques have been commonly used in the history of surveying to collect data from field measurements for various applications with different accuracy capabilities and requirements. (Ghilani and Wolf, 2012).

The establishment of a framework for horizontal, vertical, and gravity control is necessary at first when embarking on any survey work and mapping large expanses of land so as to make available a common reference for all surveying and mapping operations, (John, 1984; Olayanju, 2017).

There are several surveying methods used in establishing survey control points, these are traditionally made up of triangulation, trilateration, and traversing networks. These days, surveying with Global Positioning Systems (GPS) is used to strengthen the traditional network and to independently provide additional survey control (Tsuji, 1996).

The Global Positioning System (GPS) has been a very good digital instrument in the establishment of control points because it is very accurate, does not require line of sight, and saves time and energy. Also, considering the static method of GPS observation as the best method for control extension, it requires a minimum of thirty minutes per station of observation, (Ehigiator et al., 2017).

The Office of the Surveyor General of the Federation (OSGOF), Nigeria, has embarked on the establishment of control points in every part of the country, including zero order control points, usually called "COR stations," which were established in about fifteen locations in Nigeria. These COR stations can be used as base with a single GPS and can also be used to monitor the movement of the earth's crust within their vicinity, Corsmap (2020).

In addition, students and researchers in several institutions that offer surveying and geoinformatics in Nigeria and the Surveying Department, Ministry of Lands and Housing, Akure, Ondo State, Nigeria had also embarked on the establishment of several control points within their jurisdiction. Since the invention of the electronic computer, the stress involved in maintaining large volumes of data has been reduced to the barest minimum. Due to the technological development, it is commonly said, "Man thinks of his personal computer once but thinks of his mobile phone three times.". Mobile devices are employed more efficiently by the average man than his computers, that is, both desktops and laptops (Adedeji, 2016), So the need for a mobile database application becomes very imperative.

Surveying as the bedrock of sustainable development is solely dependent on a network of reference framework on which every

This study is aimed at spatially analyzing all the existing GPS control points distribution within FUTA Campus, thereby filling the gap by creating a database application in a mobile environment which will make the geospatial data available for students and researchers.

1.1 STUDY AREA

The study area is the Federal University of Technology Akure (FUTA) campus (Figure 1, **Appendix A**). It is located within the latitude 7° 18' 55" to 7° 17' 42" and longitude 5°07'01" to 5°08'30" of the WGS84 Zone 31N coordinate system. It is bounded in the north by Akure-Ilesa highway, in the south by Aule village while in the East and West by Alejolowo and Apatapiti community respectively. As at 2017, the total population of students and staff in FUTA include Male 13,928, Female 5,213 which makes a total of 19, 141 and 2321(Directorate of Academic Planning, 2017). The average weather condition in FUTA during the wet season is warm, oppressive, and overcast and during the dry season is hot, muggy and partly cloudy. During the period of the year, the temperature changes from 65°F to 88°F and is rarely below 58°F or above 93°F. Based on the beach/pool score, the best time of the year to visit Akure for hot weather activities is between early November and mid-February. Liquid equivalent precipitation has about 0.04 inches on a wet day. There is significant variation in the occurrence of wet days throughout the year. The wetter season lasts 6.7 months, between April 7 to October 28, with about 43% greater chance of having a wet day and by September 10, the peak of wet day is attained at 83%. The drier season occur within 5.3 months, between October 28 and 7th April of each year while barest chance of having a wet day occurs on 28th December at 3%, Weather Spark, (2020).

2. MATERIALS AND METHOD

The data used in this study involved primary and secondary data. The primary data consist of the coordinates acquired using Differential Global Positioning System (DGPS) while the secondary data involved the available coordinates of the existing pillars and a survey plan showing FUTA boundary in AutoCAD format acquired from the Department of Surveying and Geoinformatics, FUTA. During the field reconnaissance, all the existing and new control points to be coordinated were located and their total number were forty-nine (49). The existing pillars were used in the course of this study and only those that are yet to be numbered were capped and numbered serially according to the pillar numbers allotted from the department of Surveying and Geoinformatics (SVG G15/18 to SVG G15/27).

The list of the equipment and accessories employed for the successful execution of this study include both the hardware and software. The hardware includes a pair of South Differential Global Positioning System single frequency (H66/H68) and its accessories which was used for the acquisition of the coordinates of the control points while Prismatic Compass and Measuring Tape (100meters) was used for station description.4Gig Ram HP Laptop Computer with its accessories serves as the necessary component of GIS and programming while the software includes South GPS Processor which was used for processing of the GPS acquired data. AutoCAD 2016 and ArcGIS 10.3 were deployed for processing and presentation of results and production of the digital map while Notepad ++, was used for programming of the database application. The programming languages used include HTML, CSS, JavaScript and Bootstrap, Google Chrome, for code debugging.

The control check was carried out to determine the reliability and the genuineness of the control point used during the course of this study. The Control points used in this process are: FUTA/GPS 01, FUTA/GPS 02 and SVG/G13/03. A 30 minutes static method of GPS surveying was used in the field observation for four days while following all necessary precautions.

After the observation, the data was downloaded and was processed and the backward computation of the coordinates extracted from the result and the coordinates of the control points acquired from the surveying department was performed and their result were compared. The difference between the two coordinates is insignificant which shows that the control points are in-situ, that is, they are reliable for use.

For future sake, a witness survey was also carried out with prismatic compass and Measuring tape so as to be able to locate the control points in case they cannot be found in their respective locations. This was achieved by taking offset from each control points to at least two prominent features of permanent nature within the vicinity of the station and the bearing and distances were recorded in the station description sheets. Observations were made to features like edges of building, electric poles, street lights and trees. The following details were clearly written on the description sheet for each station: Station Identity (Pillar Number, location of the station, Feature identity, coordinate of the station, bearing and distance to the nearest features, Signature of the observer and the date of observation.

Plotting of the coordinates was done with the use of AutoCAD Software to show the locations of all the control points. Specifically, the survey control network was plotted on the survey plan showing FUTA boundary. Thereafter, the digital mapping was carried out by acquiring the Google earth image of the study area using the Google earth software via Internet. The image was geo-referenced using the coordinates of four control points from the Differential Global Positioning System (DGPS) processed result. After this, all the existing features on image some of which include Building, roads were digitized. Also, the following further processes were performed on ArcGIS environment which include plotting of the observed coordinates of the control points on the digitized map to produce a digital map of FUTA showing all nearest details and the control points (Figure 2, **Appendix A**). The images of each control points with nearest features which were gotten from the digital map was used in the building of the mobile application.

2.1 Mobile Application Design

There are several steps involved in producing the required output of the mobile application starting from applications design development to deployment stage. From the algorithm, HTML, JavaScript, Bootstrap and CSS codes were derived which are then packaged in Notepad++ software. The coordinates (Northing, Easting and Height) and the station description arranged in Microsoft Excel and the images of the beacon locations were linked in the program. The package used for deploying these codes on mobile platform is the IntelXDK platform which was developed to leverage HTML, CSS, JavaScript and bootstrap skills in developing hybrid mobile applications to be installed on major multiple platforms which include the Android, iOS and Windows phone operating systems.

2.1.1 Application Building and Testing Platform

The android application building platform used for this study was Intel XDK. The Intel XDK is a comprehensive cross-platform development environment for cost-effectively creating, testing (Figure 3, Appendix B), debugging, building, and deploying HTML5-based hybrid mobile apps and web apps (IntelXDK,2017).

3. RESULT AND ANALYSIS

In this study, a total number of forty-nine (49) control points were observed and database was created using the processed coordinates and their location images on the map as well as all nearby features. For an example, Figure 4 (**Appendix B**) shows the map which consist of the plotted control points within the FUTA boundary while Figure 5 (**Appendix C**) shows the digital map of the study area which consists of the control points and existing features as well as their identification labels. From Figure 4 (**Appendix B**), it is evident that the control points are evenly distributed within the study area.

3.1 Analysis

The analysis of the observed and existing coordinates was performed to show the level of accuracy between them. Thirty-one (31) out of forty-nine (49) coordinates were selected for the analysis using Student's t-test as shown in Table 1 (**Appendix D**).

Number of observations (n) = 31

Using a two-tail student t- test to compare the means:

H_0: EN = ON, EE=OE

H_0 – There is no significant difference between Existing Eastings and Observed Eastings.

H_0 – There is no significant difference between Existing Northing and Observed Northings.

H_1: EN ≠ ON, EE ≠ OE

H_1 – There is significant difference between Existing Eastings and Observed Eastings.

H_1 – There is significant difference between Existing Northing and Observed Northings.

Statistical Comparison between the Coordinates:

Existing Eastings (EE) and Observed Eastings (OE):

T_{cal} = 0.00000160237

T_{tab} = 2.000

Decision Rule

Reject H_0 if Tcal > Ttab, otherwise accept the alternative hypothesis.

Conclusion

$T_{cal} < T_{tab}$

Statistical Comparison between the Coordinates:

Existing Northings (EN) and Observed Northings (ON):

T_{cal} = 0.0000209296

T_{tab} = 2.000

Decision Rule: Reject H_0 if $T_{cal} > T_{tab}$, otherwise accept the alternative hypothesis.

Conclusion

$T_{cal} < T_{tab}$

The result reveals that there is no significant difference between the means because Tcal < Ttab, therefore, there was enough evidence to accept the claim of null hypothesis and conclude that at least one mean is not significantly different from the other at 95% confidence level.

3.2 Discussion of Results

From the result of the differences between the observed and the existing coordinates shown in the analysis (section 3.1), It is evident that, there is no significant difference between the two sources of data which means that both results are reliable and very accurate.

It is therefore recommended that the results of the observed coordinates should be used for the purpose of this research and to be accepted for further survey jobs within the study area.

3.2.1 Mobile Application Database

Having installed the mobile application on a real phone, the interface is as shown in Figure 6 (**Appendix E**). The window 1 (Get information) of the application gives already stored coordinates (X,Y,Z) and locational attributes of all the observed control points based on any of the beacon number selected from the drop down arrow by the user. Also, the window 2 (Search) accept search to be made in a specified format by the user in which the beacon numbers were stored and the details (coordinates and locational attributes) of any control point searched for will be displayed (Figure 7, **Appendix E**) and this can be copied and paste on any Microsoft package for further use.

4. CONCLUSION AND RECOMMENDATION.

In conclusion, the application of geospatial technology and programming has been efficiently utilized in achieving the aim of this research which attempt to spatially analyzing and create a mobile application database for all the existing control points distribution within the study area. Also, the digital map produced and the mobile database application will in no small way help in making the spatial and non-spatial data of these survey control points which forms a fundamental aspect of surveying and mapping operations available to the students, researchers and the department of Surveying and Geoinformatics, FUTA at large.

For future research, it is recommended that this study should be extended to cover the control points in Akure South Local Government Area, Ondo state and whole of Nigeria.

5. ACKNOWLEDGMENT

The authors expressed their profound gratitude to Mr. Aremu Gbamila, Mr. Jauro Barnabas, Surv. E.A Aje, Mr. Ifeoluwa, Miss. Blessing and Mr. Ewenla Korede for their immense support towards the success of this study.

6. FUNDING

NO FUNDING

7. AUTHOR CONTRIBUTIONS:

Titilade Adedeji Samuel contributed to this study as the researcher and writer.

Ijaware Victor Ayodele contributed to this study as the reviewer.

Aniyikaye Kehinde Ruth also contributed to this study as the reviewer.

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9. KEY TERMS AND DEFINITIONS

Surveying: is an art of positioning.

Mapping: is a process of making maps.

Control points: a precisely surveyed location that can be identified on the ground which can be used as reference point for other survey projects to be carried out.

Database: is an information gathered for easy accessibility, managing and updating.

Mobile application: is a software application designed to work on a mobile device, e.g Phone.

AJLP&GS, e-ISSN: 2657-2664, Vol.6 Issue 2, DOI :10.48346/IMIST.PRSM/ajlp-gs.v6i2.36856

10. APPENDEXE

- Appendix A

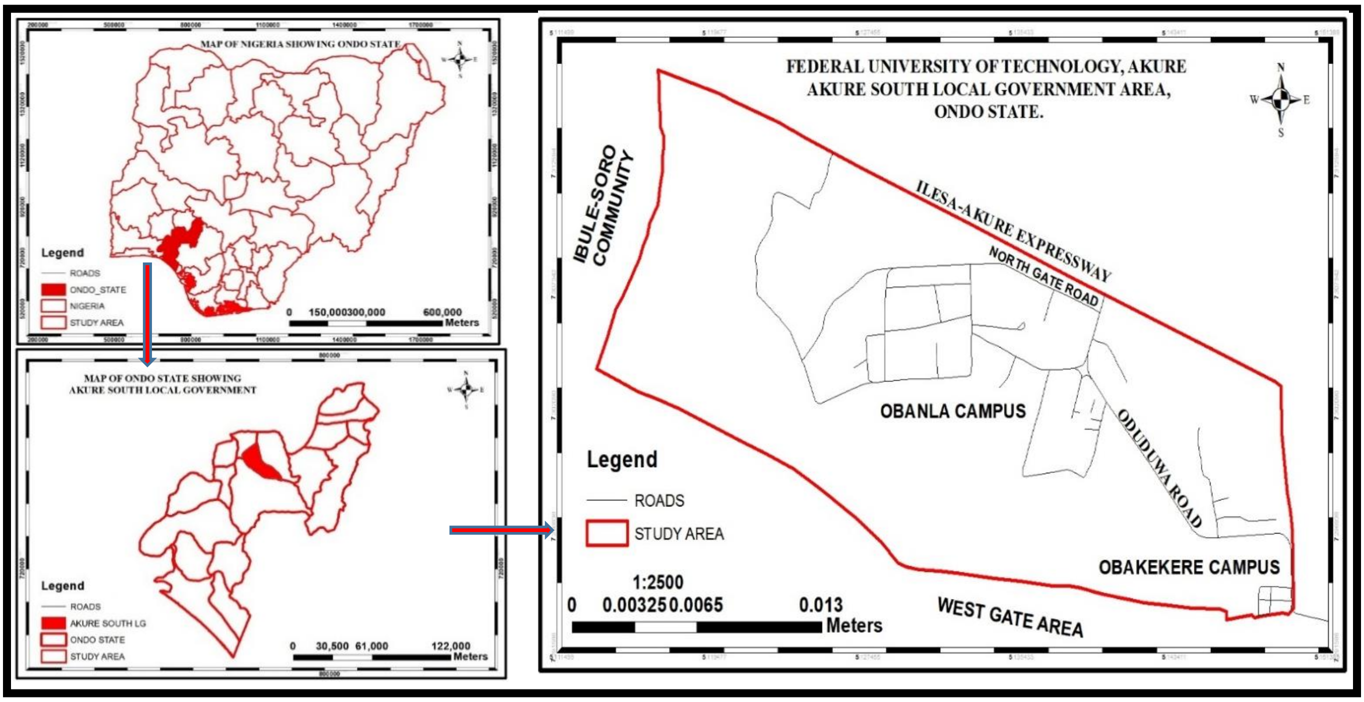

Figure 1: Map showing study area

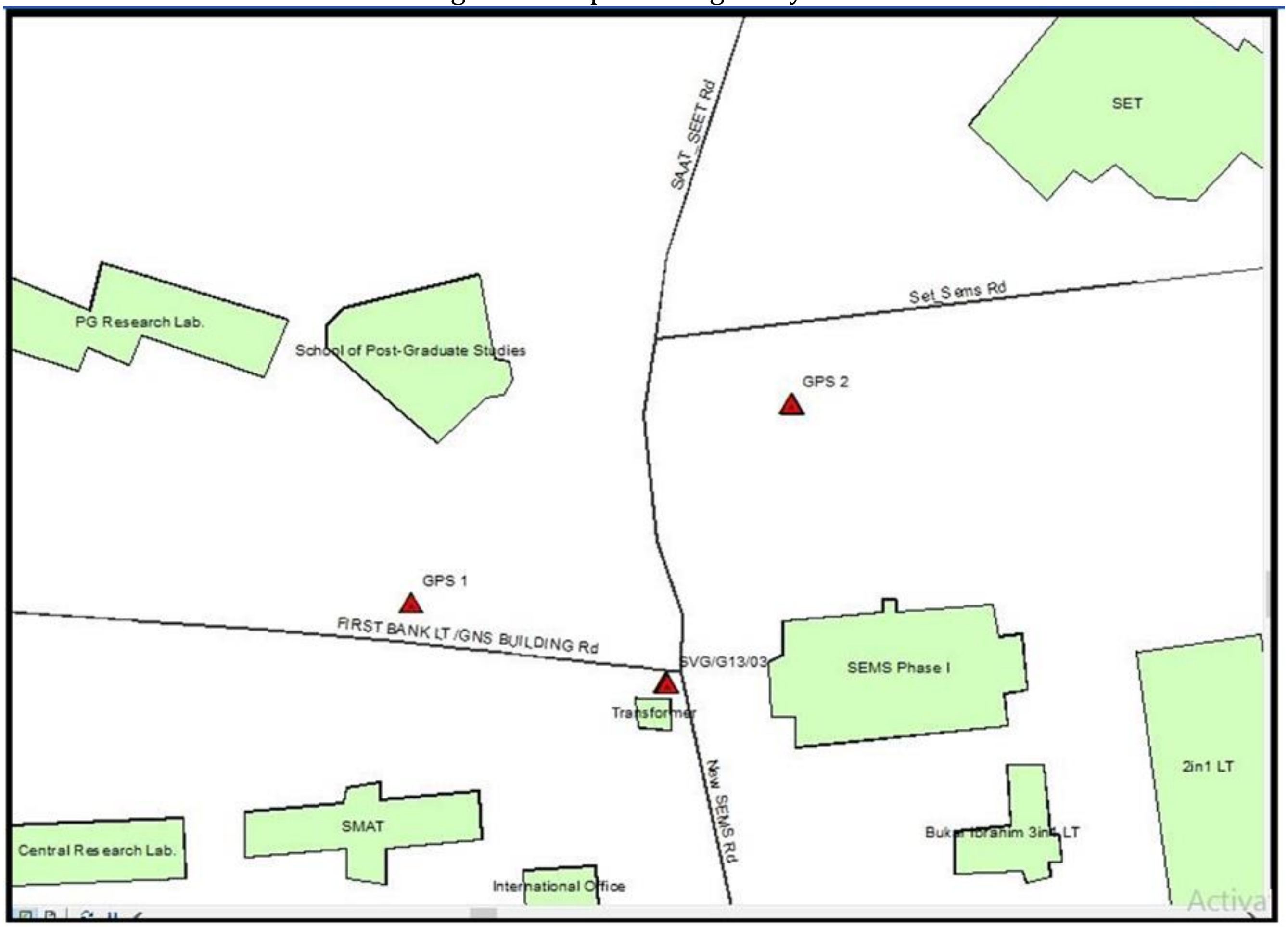

Figure 2: the location of some of control points and nearest feature in the study area.

- **Appendix B**

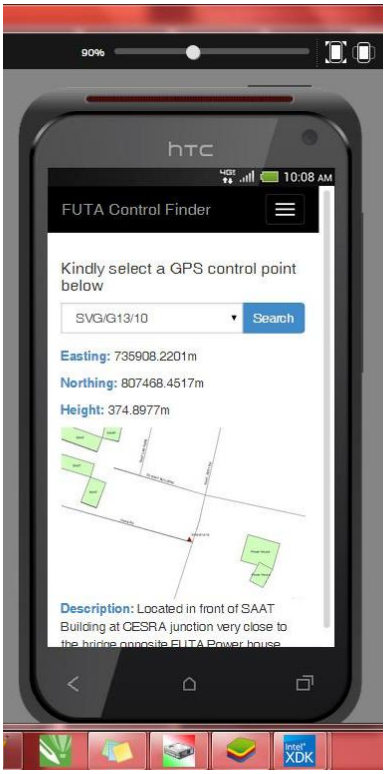

Figure 3: End Result of the mobile application in testing mode. (Source: Author's field work)

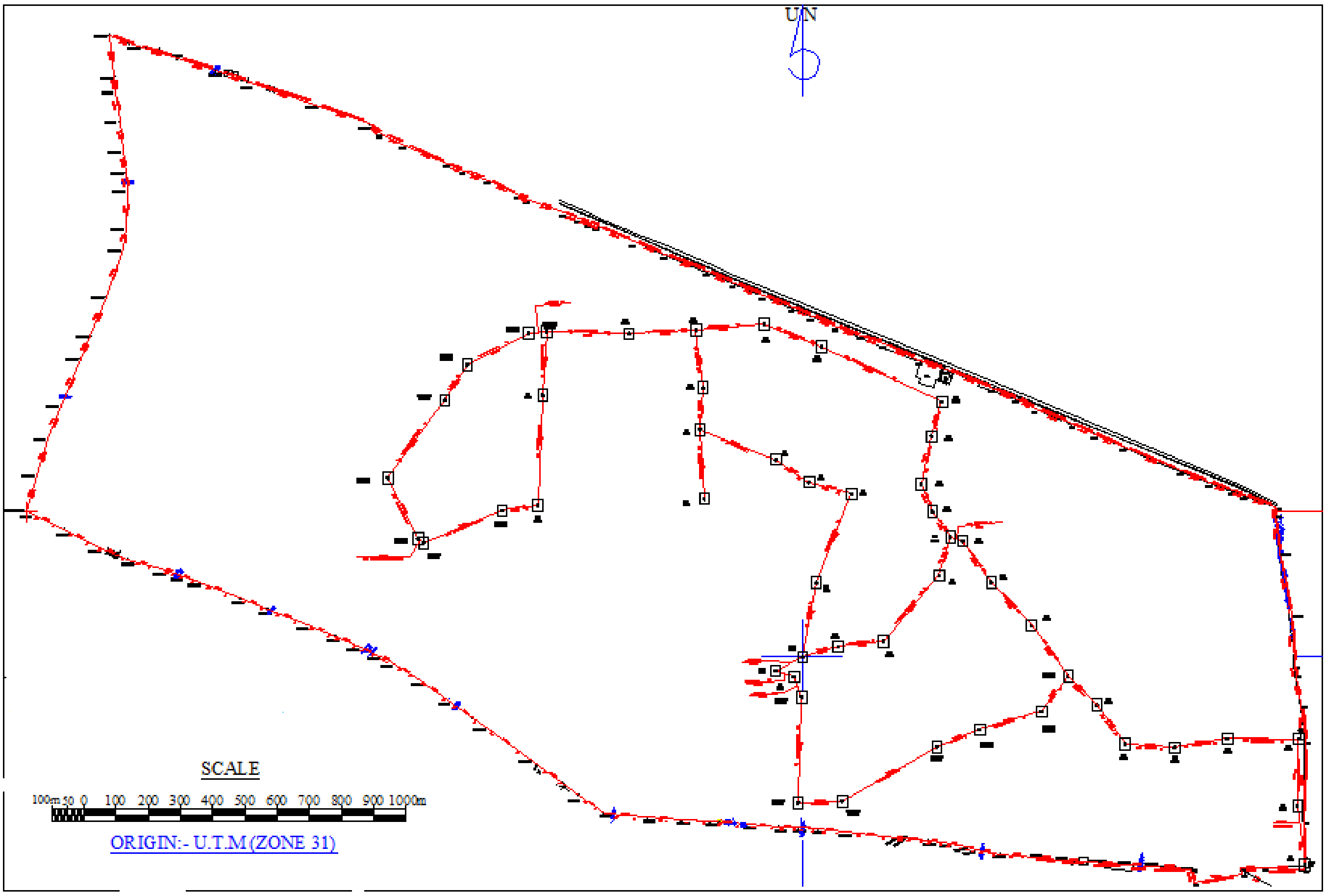

Figure 4: Survey plan showing the GPS Control Points Distribution Network in FUTA

- **Appendix C**

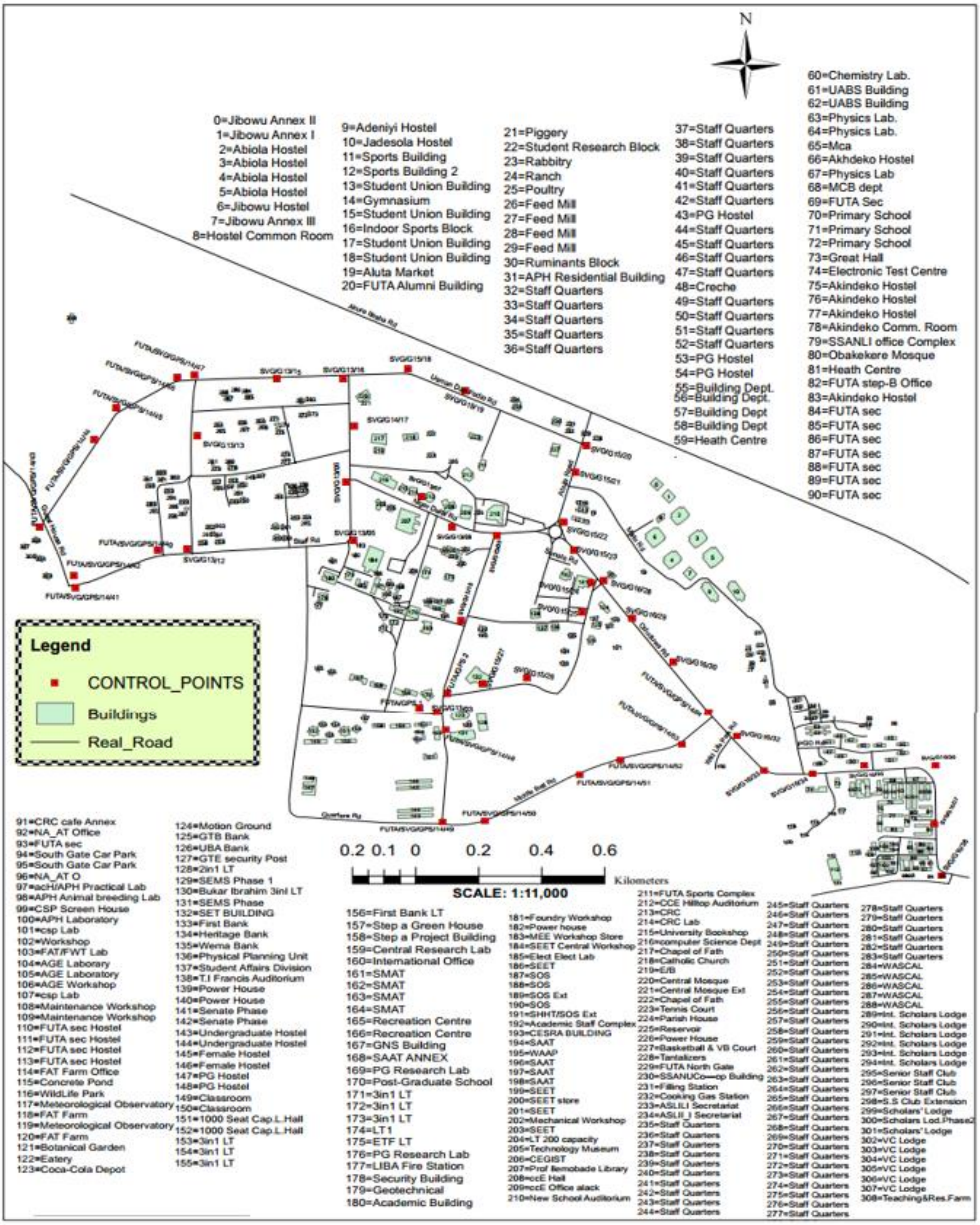

Figure 5: Digital Map of GPS Control Points Distribution Network in FUTA

- **Appendix D**

Table 1: Sample of Observed (**O.**) and Existing (**E.**) Coordinates.

STATION_ID	O. NORTHING	O. EASTING	E. NORTHING	E. EASTING
FUTA/GPS1	807194.8024	735782.5928	807194.865	735782.723
FUTA/GPS2	807238.685	735866.763	807238.673	735866.749
SVG/G13/03	807177.1658	735839.0501	807177.113	735839.009
SVG/G13/05	807729.1558	735560.2695	807729.176	735560.299
SVG/G13/06	807944.1151	735547.9702	807944.125	735547.977
SVG/G13/07	807850.5463	735783.8309	807850.551	735783.138
SVG/G13/08	807780.5021	735887.0279	807780.484	735886.310
SVG/G13/09	807744.4244	736018.1297	807744.360	736018.018
SVG/G13/10	807468.4517	735908.2201	807468.411	735908.209
SVG/G13/12	807707.8917	735043.8861	807707.863	735043.864
SVG/G13/13	808050.2656	735059.5639	808050.253	735059.542
SVG/G13/15	808241.8323	735327.0102	808241.821	735327.007
SVG/G13/16	808252.4903	735536.0146	808252.47	735536.821
SVG/G14/17	808073.7074	735557.487	808073.736	735557.448
SVG/G15/18	808271.3153	735746.7231	808271.361	735748.49
SVG/G15/19	808200.4365	735925.178	808200.211	735927.433
SVG/G15/20	808030.1363	736299.4414	808028.688	736303.567
SVG/G15/21	807923.0803	736267.0415	807921.936	736271.134
SVG/G15/22	807775.2926	736235.2953	807775.44	736237.716
SVG/G15/23	807689.1338	736269.6946	807689.05	736272.153
SVG/G15/24	807610.4423	736325.0455	807610.407	736327.938
SVG/G15/25	807491.5574	736290.9517	807493.286	736294.723
SVG/G15/26	807286.7197	736118.0873	807294.317	736115.402
SVG/G15/27	807270.1015	735977.3905	807265.649	735978.573
FUTA/SVG/GPS/14/48	807113.8005	735863.1558	807113.8036	735863.1549
FUTA/SVG/GPS/14/49	806785.9208	735852.1421	806785.8943	735852.167
FUTA/SVG/GPS/14/50	806790.2258	735989.1332	806790.1826	735989.1761
FUTA/SVG/GPS/14/51	806959.1972	736284.464	806959.196	736284.5045
FUTA/SVG/GPS/14/52	807012.3396	736416.524	807012.3359	736416.6234
FUTA/SVG/GPS/14/53	807069.0891	736608.8927	807069.0707	736608.9009
FUTA/SVG/GPS/14/54	807178.8419	736690.7516	807178.7678	736690.7304
SUM=	25034911.67	22813877.73	25034913.5	22813899.5
MEAN=	807577.795	735931.54	807577.855	735932.2419
VARIANCE =	204383,037	159358,372	204248,976	159764,02

TOTAL SUM:	OBSERVED COORDINATES:	NORTHING (m)	=	25034911.670
		EASTING (m)	=	22813877.730
	EXISTING COORDINATES:	NORTHING (m)	=	25034913.500
		EASTING (m)	=	22813899.500
MEAN:	OBSERVED COORDINATES:	NORTHING (m)	=	807577.795
		EASTING (m)	=	735931.540
	EXISTING COORDINATES:	NORTHING (m)	=	807577.855
		EASTING (m)	=	735932.2419
VARIANCE:	OBSERVED COORDINATES:	NORTHING (m)	=	21046209604
		EASTING (m)	=	17453337617
	EXISTING COORDINATES:	NORTHING (m)	=	21046210527
		EASTING (m)	=	17453342195

- **Appendix E**

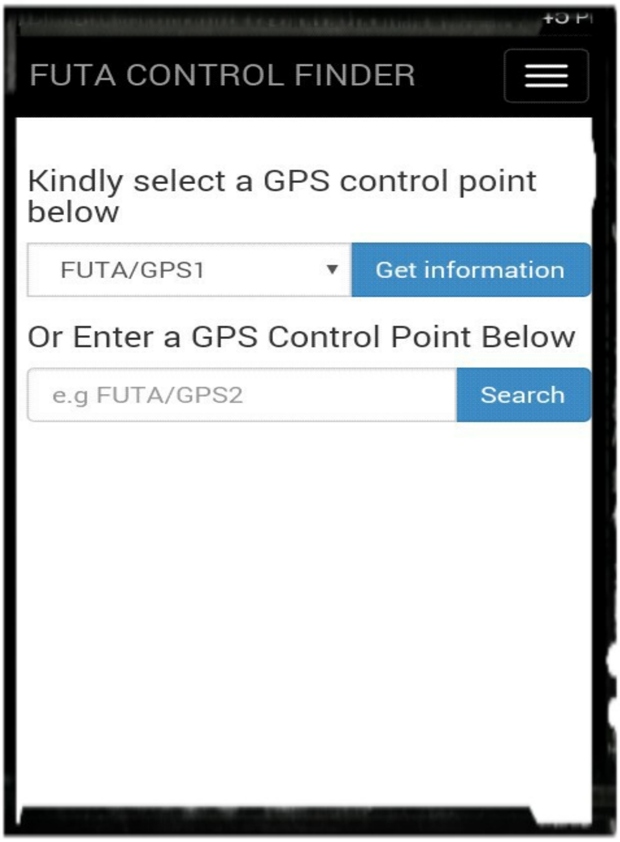

Figure 6: Mobile App Interface after Installation

Figure 7: Mobile App showing result from search made