

**The Empowerment of Local Authorities: Spatial Information
and Spatial Planning Tools" And Commission 3 Annual
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The Empowerment of Local Authorities:
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**Site View Reconstruction for Urban Planning
Using ArcGIS, Google Sketch up and Google Earth**
A Case Study of the University of Nigeria Enugu Campus

Ndukwu, Raphael. Ike
Department of Geoinformatics & Surveying
University of Nigeria, Enugu Campus.

Chigbu, Njike
Department of Geoinformatics and Surveying,
Abia State Polytechnic Aba

Daberechi, Michael
Department of Geoinformatics & Surveying
University of Nigeria, Enugu Campus

ABSTRACT

Urban planning and renewal is a very complex process consisting of tasks that require collaborative decision making. In such process, the communication tools to present and convey design ideas are of critical importance. Realistic view of urban scenario are required or needed to establish a common language between professionals and stakeholders in the urban planning domain. However there are indications that a number of techniques for 3D modeling exists in literature. Some of these methods are; either not realistic, very costly (in terms computer speed) or difficult to implement and therefore create different perceptions of the real world scenario for urban applications. New emerging technologies and techniques offer a large variety of simple, cheap 3D modeling and visualization tools that may solve these problems and greatly enrich visualization and communication possibilities. This paper presents an

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approach for building and visualizing photorealistic 3D model in 3D environment. The method combines, ArcGIS, Google Sketch Up and Google Earth modeling capabilities. Using this approach or tool, the urban planner can reconstruct urban scenarios (e.g. Building) and visualize the scenarios in a 3D environments such as Google Earth.

Key words: 3D modeling, Texture Mapping, Visualization, ArcGIS, Urban Planning and Google Earth

1.0 INTRODUCTION

3D computer visualization of our world is becoming common place, appearing on the internet through popular map and geospatial information sites. Engineers and planners are becoming interested in the computer modeling of the environment to allow better visualization, greater understanding of the world, and for enhancing their decision making processes. In urban planning domain in particular, advancement in computer technology and information technologies (I.T.) has contributed to the shaping of new trends in the process of urban planning (Johanna, 2008). Traditionally, urban planning involves the physical structure of development, generally following a master plan. However, when considering urban planning as a community decision- making process, participation and communication are fundamental to the process. Public participation in the decisions taken about the projects is many times insufficiently promoted and excludes some community groups (Innes and Booher, 2004, Kingston, *et al.*, 2000). In this process, public meetings are usually the way to communicate new plans to the people. It is not uncommon that difficulties arise in understanding the urban environment and spatial relationships when plans are presented on 2-D maps or artists' impressions. The generally limited feedback among all parts involved (authorities, developers, citizens, stakeholders) may result in disapproval of the results. However, Photo realistic 3D Scene of an urban Scenario/3D modeling and

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visualization can enhance collaborative planning process by serving as a collaborative environment where users can actively take part in the decision-making process. A collaborative environment can help bridging the gap between designing and communicating the projects. In this paper we demonstrate the potentials of simple 3D modeling tools for photo realistic three-dimensional modeling and visualization of an urban built environment; using University of Nigeria Enugu Campus as a case study.

2.0 3D modeling and visualization for urban planning and management

According to (Vinay et al, 2008), the use of 3D models (e.g. marquets) has a long tradition in the field of urban planning and design. 3D models of buildings set into a landscape are employed to assist in the decision making process to better communicate or discuss urban design issues, e.g. the (re)development of an area. Traditional marquets have the advantage to be easily understood by the audience, however drawbacks are that they cannot be viewed from different viewing angles/perspectives as well as they are isolated from their surrounding environment. The implementation of digital 3D visualizations of urban plans (using CAD or GIS environments) where the user can navigate through the urban landscape has been increasing the degrees of user interaction (Hanzel, 2007). These developments have a great potential to improve and ease the communication process between planning professionals and the community as they help in bridging the frequently observed communication friction between experts and public. Such developments are gaining importance in the context of collaborative planning in which planning professionals enable the community to come to a joined decision (Klosterman and Brail, 2002) (see figure. 2.0).

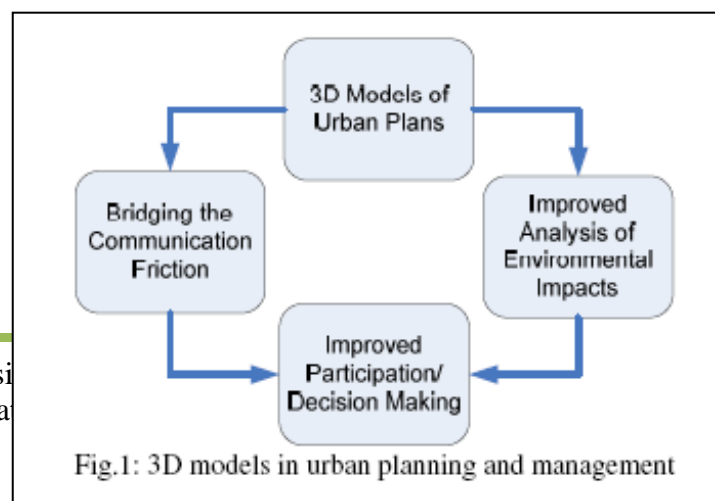


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Figure 2.0: 3D modeling in urban planning and management

3.0 Geospatial Data visualization

The term visualization implies transformation of data from a symbolic into a geometric representation, interactive data manipulation and their display, graphic rendering and animation. From the perspective of GI systems, visualization enables spatial data to be presented in ways that enables the human perception system to identify spatial patterns in the process of solving spatial problems or decision making (Jones, 1997). Geographic visualization or geovisualization refers to a set of tools and techniques supporting geospatial data analysis through the use of interactive visualization. Geovisualization emphasizes knowledge construction over knowledge storage or information transmission (Cartwright, 1997). To do this, geovisualization communicates geospatial information in ways that, when combined with human vision and domain expertise allows for data exploration and decision making processes (Jiang, and Li, 2005). Forms of three-dimensional input data are DTM, DSM, DEM and TIN (Pilouk et al, 2007). DTM (Digital Terrain Model) is a static representation of continuous surface of the Earth, with a large number of vertices for which X, Y and Z coordinates are known, in an arbitrary coordinate system. DSM (Digital Surface Model) is a raster based description of the terrain, which also includes objects on the terrain such as buildings and vegetation. DEM (Digital Elevation Model) is a digital representation of a continuous variable over a two-dimensional surface by a regular array of z values referred to a common datum. DEM is a superset of DSM and DTM and it consists of three elements: block, profile and vertex. TIN (Triangular Irregular Network) represents terrain model as a continuous surface made of mosaic of triangles which do not overlap and whose vertices are chosen elevations. In the process of geovisualisation there are two types of

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representation: 2.5D and 3D. The main difference is that in the 2.5D representation only one elevation value is defined for each pair of coordinates, so details can not be displayed. That limitation is overcome by setting up several points (elevations) to the same position, which represents 3D model. To be considered a 3D model, the system must be capable of handling data as more than a surface; it must handle data as an object. An example is a topographic map over a geologic map. Objects of interest can be represented in the form of three-dimensional models. Those models can be a rough representation of reality or they can have details and textures to become photo realistic. Techniques of multidimensional terrain visualization allow a continuous analysis of three-dimensional model to the viewer. That can be a change of the point of view, effect known as fly-by or fly-through, which adds spatio-temporal dimension to the visualization. 3D visualization models have a variety of applications in geography and urban studies: site location analysis, emergency facilities planning, design review, marketing, etc. While they are generally used to simply visualize the built environment, there are early signs of them being used as 3D interfaces to more sophisticated simulation models. Both planners and the general public can use geovisualization to explore real-world environments and model "what if" scenarios based on spatio-temporal data. While geovisualization in the preceding fields may be divided into two separate domains, the private domain, in which planners use geovisualization to explore data and generate hypotheses, and the public domain, in which these planners present their visual thinking to the general public, planning relies more heavily than many other fields on collaboration between the general public and planners. Planners use geovisualization as a tool for modeling the environmental interests and policy concerns of the general public. There are two examples: 3D photo realistic representations are used to show urban redevelopment, and dynamic computer simulations are used to show possible pollution diffusion over the next few years. The widespread use of the Internet by the general public has implications for these collaborative planning efforts, leading to an increased

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participation by the public while decreasing the amount of time it takes to debate more controversial planning decisions (Jiang et al, 2003).

4.0 Tools for 3D Scene Generation and Visualization of 3D Objects

Virtual Globe is a 3D software tool based on network technologies (mainly Internet) which presents geospatial data models on spherical surface of the Earth or any other planet. Spatial data model imply partial or complete digital representation of a planet based on a set of characteristic geometric parameters. Data about terrain, such as altitude are added on this representation of a planet and it represents basic layer for the visualization. After adding terrain data, various satellite and aerial imagery are added on the model in order to create an impression of three-dimensional world on the two-dimensional screen. Some examples of software tools in the category of virtual globes are Leica Virtual Explorer and Google Earth (Dubravka et al, 2009). Standard functionalities of software tools for 3D display of spatial objects and visualization include changing dimension of spatial objects, their rotation, moving toward the object, turning on and off specific layers, adding labels and new layers etc. It is also possible to read the coordinates at every point of the scene or view the attributes of specific vectors or 3D objects on the scene (for example, for a certain polygon which represents spatial extent of a city, attribute data such as its name, area, perimeter or number of inhabitants can be displayed).

4.1 Google Earth

Google Earth is the most popular 3D Geospatial Browser. In Google Earth, for most parts of the world the terrain data is available in form of the Digital Elevation Model (DEM), and the terrain can be visualised in 3D. Users input are a very important resource of data, and there are many map layers created by users. Users can create their own points and areas of interest (i.e. placemarks), define their geometries and associate semantic information with these points and areas of interest. Google Earth has the ability to visualise 3D representations (models) of the buildings which are created by the users input. These models can then be viewed by all other users of the

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software. Buildings or 3D objects visualised in Google Earth, are usually created through 3D modelling software such as SketchUp or other 3D modelling software and imported as KML/KMZ file.

4.2 Google Sketch Up

Sketch-Up is a 3D modelling or authoring software designed for professional architects, civil engineers, filmmakers, game developers, and related professions. Sketch up may also be used to design buildings to be displayed on Google Earth. It was designed to be more intuitive, flexible, and easier to use than other 3D modelling programs, which are often difficult to learn. Several features allow designers to play with their designs, unlike what is possible in other 3D CAD programs. It is marketed as an easy-to-use conceptual tool with a simple interface. A well known feature in the SketchUp World is the 3D Warehouse. Users can use their Google Accounts to upload models, and then browse the 3D Warehouse for many components and models. Some of its key features and uses include:

- A "smart" drawing cursor (inference) system that allows users to draw 3D objects using a 2D screen and mouse.
- Simple massing study capability via "push-pull".
- An interactive Heliodon, or sun angle simulator.
- Ability to animate camera and sun movements.
- Models can be individually colored with an assortment of solid colors, Textures and materials.
- Interoperability with Google Earth.
- Simplicity of use over other modeling programs for children, amateur Artists and hobbyists

4.3 ArcGIS

ArcGIS is an integrated collection of GIS software products for building a complete GIS for an organization. ArcGIS enables users to deploy GIS functionality wherever it is needed - in desktops, servers, or custom applications; over the Web; or in the field.

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ArcGIS products are widely used by various professionals in diverse discipline. In planning, ArcGIS is becoming popular these days due to analytical and mapping capability of the software. Some of the capabilities of ArcGIS package are as follows

- Interactive mapping with layer based maps
- Hard-copy map design and layout (with graphics and text for large format map printing)
- Map based query and tools (address geo-coding, spatial & attribute selection, etc.)
- Geo-processing function with various scripting & programming languages.
- 3D Analyst extension for 3D scene Construction.

ArcGIS is extensively being used in urban planning, and other fields.

5.0 Materials and Method

Study Area

. The study area is the University of Nigeria Enugu Campus (UNEC). The Campus; an offspring of the former Nigerian college of Arts, science and Technology, was integrated into the university of Nigeria in 1961. It is situated in Enugu North local Government Area of Enugu State between longitude of 7o 27' 49.35" and 7o 31' 0.94" and Latitudes of 6o 19' 52.76" and 6o 25' 18.14". Covering an estimated land area of about 123.885 hectares, it is bound on the North by Enugu State University of Science and Technology, on the east by Maryland layout on the West by Achara layout. UNEC houses five faculties namely the college of medicine, faculty of Law, faculty of Business Administration and Management, faculty of health science and the faculty of Environmental studies.

5.1 Materials

The following list of required data for construction of a 3D model was compiled

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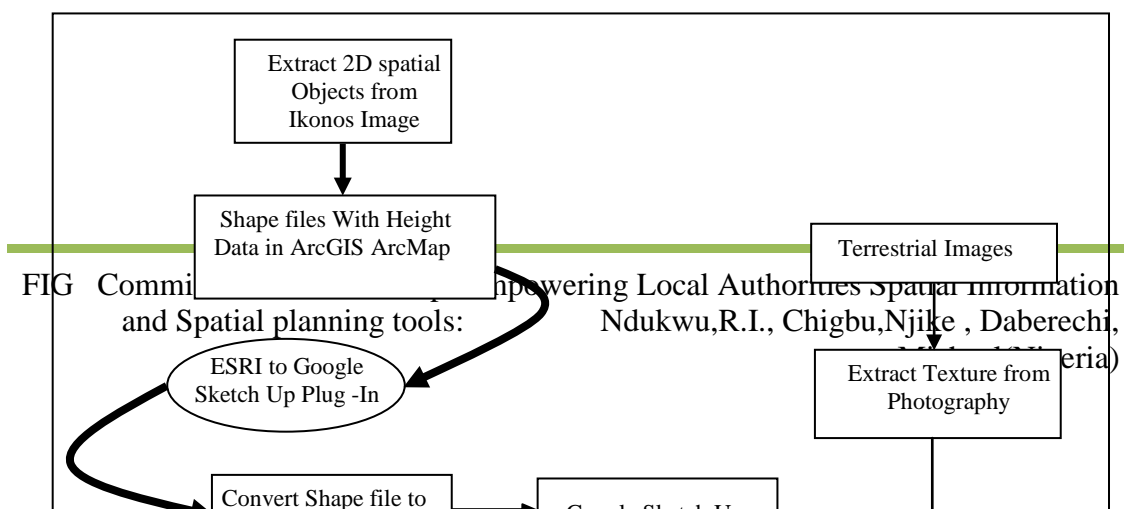
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Required data for building the photorealistic model of the study area:

1. Dataset used for modeling includes:
 - (i) Digitized 2.5D map of the study area.
 - (ii) Ikonos satellite image covering the study area.
 - (iii) Shuttle Rader Topographic Mission(SRTM)
 - (iv) Attribute dataset(height of building, Names ,elevation Values)
2. Tools These includes :
 - (i) **Hardware:** HP Pavilion laptop with the following specifications:
 - 2 giga bytes RAM size
 - Core 2 Duo Intel processor of 2 giga bytes clock speed each
 - 150 giga bytes of hard drive
 - (ii) **Software:** The software used were
 - ArcGIS 9.2(GIS software)
 - Google Sketch up 7.1(3D modeling/Authoring Software)
 - Adobe Photoshop CS4
 - Google Sketchup ESRI Plug-in
 - Google Earth 4

Methods

The workflow in figure 5.0 illustrates the steps adopted to build a textured 3D model of the University of Nigeria Enugu Campus. First step is to extract buildings and roads from the ikonos image of the university campus. The second step is to add height information to the extracted buildings. The third step is to create the 3D model of the Campus using ArcGIS and Google Sketchup, Final step is visualization of 3D model in a Geo-browser Google Earth



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Figure 5.0: Methodology for Reconstructing Textured or Photo realistic 3D
Scene of the Study Area

Extraction of 2D spatial object form ikonos satellite Image

- Import ikonos image into ArcGIS Arc Map
- Geo-reference Image six control points
- Acquire coordinate of six control points for image geo reference using a GPS
- Extract features or 2D spatial objects (Area ,line and point objects) using on screen digitizing or raster vector conversion process

Using the above procedure different features are extracted, including building and roads. For buildings, height information is stored as attributes.

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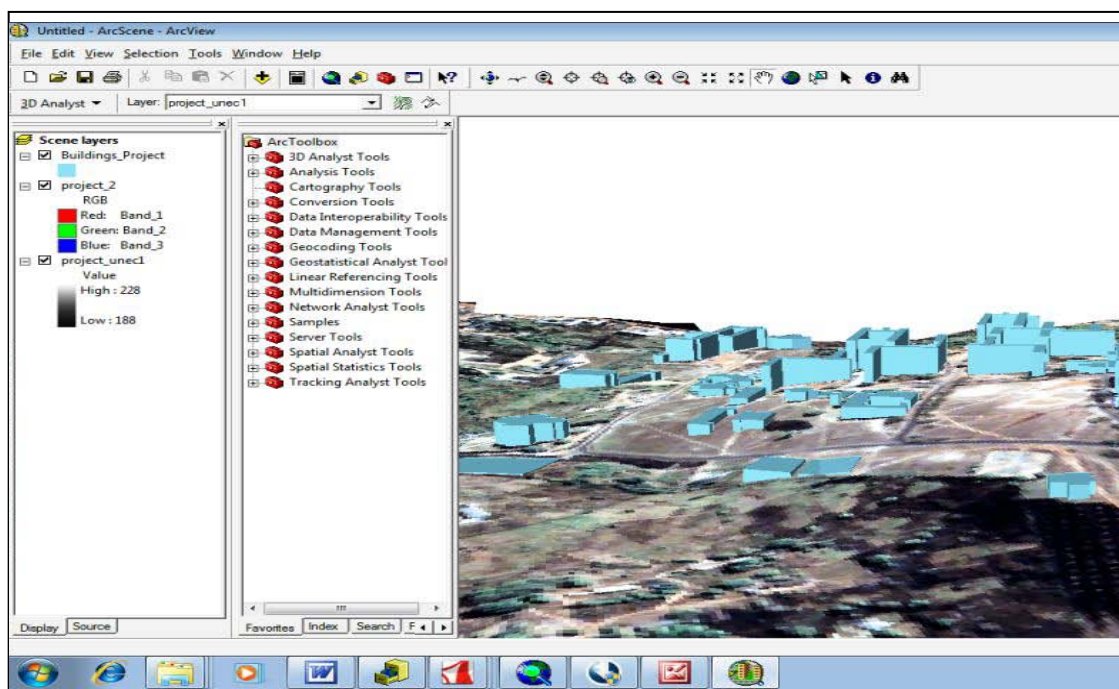
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3D scene reconstruction/modeling

In order to reconstruct 3D site view or scene of the study area, the out put of the previous step is imported to Google Sketchup; Using ESRIGoogleSketchup Plug- In. In Google sketchup modeling environment and based on building height information, 2D spatial features or objects are extruded to yield parametric 3D models with out texture.

Texture Mapping

The goal of texture is to produce photorealistic 3D model of a real world object. This entails providing a rectified image for each visible building face. Hence for each image the corresponding façade polygon has to be selected from the parametric 3D model constructed in the previous processing step. For textured mapping the image has to be correctly positioned, oriented, and scaled to represent its associated surface. The image section representing a planner surface is rectified by applying projective transformation, which is default in Google Sketchup. Using Google Sketchup texture mapping was done on the 3D model to yield photorealistic 3D model or 3D scene. Figure 5.1 and 5.2 show the 3D model of the study area in Arc Scene and Google Sketch Up modeling or authoring environment.



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Figure 5.1: 3D model of the study area in Arc Scene

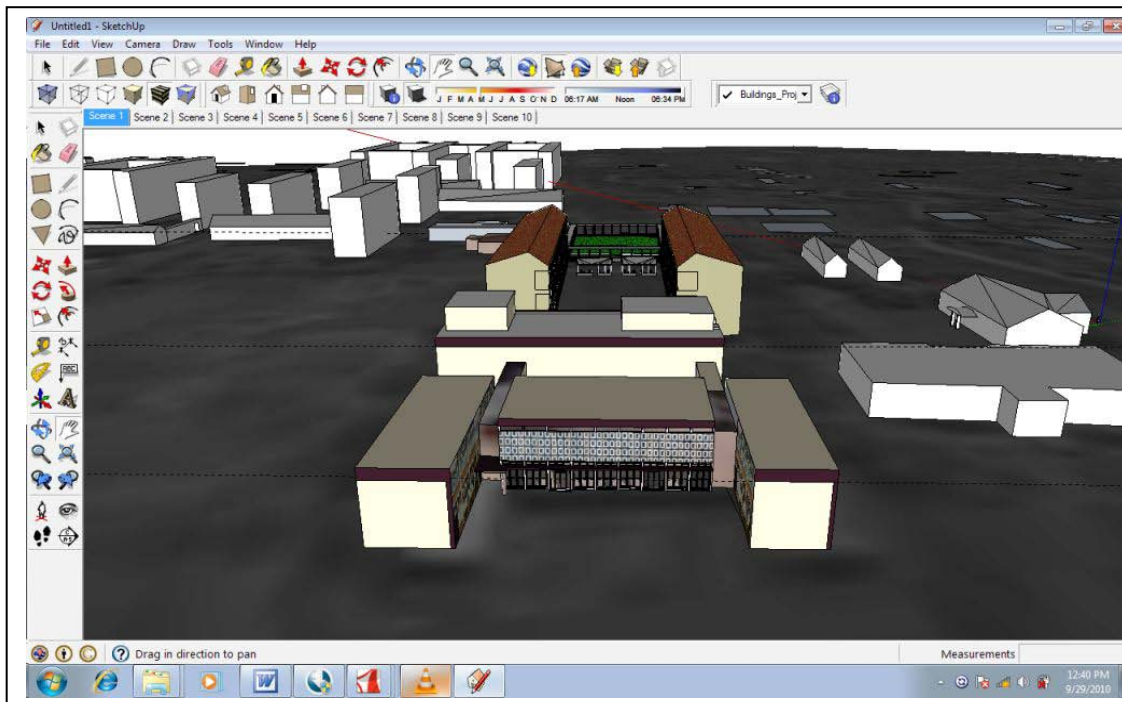


Figure 5.2: 3D model of the study area in Arc Scene and Google Sketch Up modeling or authoring Environment.

Visualization in Google Earth- a Geobrowser

For Visualization and other applications the Photo realistic 3D model constructed in the last processing step was exported into Google Earth. In Google Earth, it is possible to validate whether the Model is correctly geo-referenced and in the correct orientation. Google Earth scenes enable measuring of distances on the ground or in the air. They also enable measuring of dimensions (height, width, depth) of the 3D objects on the scene, such as buildings. All measured values correspond to the real

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values of distances and dimensions, and the accuracy depends on the added layers resolutions and accuracy of 3D modeling technique.

6.0 Results

Different scenes of the 3D textured or photo realistic model of the University of Nigeria Enugu Campus (UNEC) have been Reconstructed in this study. They are shown below in figures 6.1, 6.2, 6.3, and 6.4.



Figure 6.1: Lagos building in Google Earth

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Figure 6.2: Side View of the Moot Court, faculty of Law University of Nigeria Enugu Campus (UNEC).



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Figure 6.3: Front View of the Main Hall University of Nigeria Enugu Campus (UNEC).



Figure 6.4: Aerial view of the Academic section of the University of Nigeria Enugu Campus (UNEC).

7.0 Discussion and Conclusions

The Paper described the concepts related to 3D modeling and visualization and presented some 3D modeling Tools. It also explored the effective use of 3D modeling for visualization of urban scenario using the University of Nigeria Enugu campus as a case study. Specifically the paper demonstrates that simple photorealistic 3D model of urban built environment can be reconstructed with ArcGIS, Google Sketchup, and Google Earth. The generated model can be used in evaluating design proposals (i.e. to determine how the proposed building will affect urban fabric and also to determine how the surrounding environment will shape the final design of the building). Planners and citizens can jointly examine the proposed designs or suggest their own in

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a physical or a virtual meeting. Apart from visual realistic presentation and animated tours, 3D scene offered various possibilities such as real measurement of distances and building dimensions, accurate coordinate and elevation display for each point on the scene as well as attributes display of 3D object. These capabilities provide opportunity for urban planners and university official to properly visualize urban Scenario and making the right decision.. It also presents a near to reality situation that can easily be understood.

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