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## 3d Modelling of Federal Polytechnic Mubi, Adamawa State, Nigeria

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### ABSTRACT

*The demand for 3D geospatial data and modeling for urban environments continuously increases as GIS models and applications are changing from traditional 2D to actual 3D spatial representations. This research work is aimed at the development of a three dimensional (3D) virtual photorealistic model of the Campus of Federal Polytechnic Mubi. Virtual models provide an enriching interactive visual exploration of 3D digital environments. This paper presents the background of the Campus and the initial preliminary outdoor field observation with GPS/ Total Station and the indoor modeling results obtained using available software such as Google Sketch Up, AutoCAD, ArcView, ArcGIS, Google earth and Global mapper. Initial reconstruction results of realistic buildings are given using the in-house developed software tool like Google Sketch up 7.2 and the terrain surface were been developed using the Global Mapper. The result was the developed 3D model of the study area. Research findings revealed that built up area is at a higher altitude, hence more suitable and conducive atmosphere is experienced at such area. Recommendations were made to implement the 3D model mapping for effective and efficient development.*

### INTRODUCTION

3D city models are increasingly used for the presentation, exploration, and evaluation of urban and architectural designs. Visualization capabilities and animation support of upcoming 3D geo-information technologies empower architects, urban planners, and relevant authorities to visualize and analyses urban and architectural designs in the context of the existing situation. To make use of this possibility, first of all a 3D city model has to be created (Döllner et al 2006).

It is expected that the use of this technology can support communication and information processes, which will lead to more transparency in planning processes and also to better designs. An important factor which is seldom mentioned is that the use of 3D city models might help to save money and time. Large urban regeneration projects for example, often have a long planning history, Environmental damages, conflicting interests, a large diversity of stakeholders, legal requirements, political interests and many other issues are factors that have to be obeyed, moderated and finally lead to planning decisions. (Smith and Friedman, 2004) Digital 3D plan representations, in conjunction with 3D city models might reduce costs and effort spent on preparing high quality presentations, map-print outs and physical models.

The research work aimed at producing a 3D model of Federal Polytechnic Mubi Thus, the objectives are:

1. To determine the feasibility of the one-man GPS field party to replace the current two-man field party with total station.

2. To determine the position of all the new and old structures and all other features in the study area.
3. To produce up to date digital map of the area.
4. To develop the 3D model of the study area.
5. To develop the database of the study area and generate other relevant information of the study area.

The federal polytechnic Mubi is experiencing a rapid increase in developmental activities, hence need to come up with an updated 3d model which will assist in physical planning so that all future development can be made base on that.

Federal polytechnic Mubi is one of the biggest and oldest polytechnic in Adamawa state, and the increasing number of programmes in the institution attracts more students from different parts of the country. This has led to an increase number of development. These structures have to be situated in a disaster free locations, hence research on 3D model is of great significance since such maps can depict the real view of the entire environment and can also depict the un-utilized parts of the polytechnic.

The polytechnic is located in Mubi north L.G.A of Adamawa state. It lies approximately between latitudes  $10^{\circ} 16' 30.4795''$  N and  $10^{\circ} 17' 44.3031''$  N and longitude  $13^{\circ} 17' 23.5381''$  E and  $13^{\circ} 18' 2.6782''$  E respectively. Mubi has an approximate population of 225705 people as at 1993. The area covered by this research work is approximate 304.974 hectares.

GIS technology is typically implemented in the property field when the proper systems are designed to support geographical information (Wyatt and Ralphs, 2003). Recent technological advances in the delivery of spatial and attribute data across the web have facilitate the development of open and scalable land management solutions with interfaces to centralize data sets from the internet for local and wide area networks.

According to Zlatanova (2002), commonly established systems dealing with spatial data are two dimensional (2D) GIS and three dimensional (3D) computer aided design (CAD) system. The CAD system was found to have difficulties in developing large models of 3D visualization. These deficiencies can be overcome with the technology such as the Virtual Reality (VR), Google sketch Up, Erdas Imagine and ArcGIS and the improvement of hardware and libraries. VR is a form of human-computer interface (HCI) that involves the creation of base on a reality (Brodliet al, 2002).

These technologies that allow users to interact with data that gives the appearance of a three dimensional (3D) environment and at the same time provides depth perceptions (Kolbe and Groger, 2005), have demonstrated numerous applications of Virtual Reality in geography. Earlier studies such as MdSadek et al. (2005) and Smith and Friedman, (2004) have identified the uses of 3D and VR for city modeling and planning. The result has shown a significant difference in the degree of efficiency throughout the study.

Geospatial researchers have attempted to utilize GIS technologies in emergency situations, (Cheesman and Perkins, 2002). 3D modeling is created in different ways. They are used for commercial, educational and municipal purposes. It can easily be understood that a standard procedure "How to produce a 3D model" does not exist. But on the other hand, for accompanying difficulties and barriers in creating and using a 3D modeling, a fruitful exchange of knowledge is

essential, which can be realized by means of establishing working contacts with experts involved in this area of research.

Traditionally, the features of interest in a GIS are spatial objects, i.e. object that have thematic and geometric characteristics. It is said to be 3D GIS when the objects are geometrically represented in three dimensional. Several extended studies have conducted investigation on 3D objects in urban environments (Smith and Friedman, 2004)

Dahany (1997) suggested three groups of objects to be considered: terrain, vegetation and built form. Operational data needed for urban planning and especially cadaster, however, goes often far beyond the real objects of interest discussed so far. For example, cadastral offices maintain jurisdiction boundaries and legal status of the real estate, i.e. items that cannot be classified as 3D spatial objects.

Zlatanova (2000) proposed objects as people, companies and taxes. To be included in the scope of objects organized in a GIS. Four basic groups of real objects are introduced, i.e. juridical objects (e.g. individual, institutions, and companies), Topographical objects (e.g. buildings, streets, and utilities), fictional objects (e.g. administrative boundaries) and abstract objects (e.g. taxes, deeds, incomes).

The challenge of 3D modelling and 3D GIS is to support analysis between all the different types of real objects. Therefore, this research work considered topographical and fictional objects to form part of the spatial relationship model.

## MATERIALS AND METHODS

### *Materials*

#### **The software used for this research work include:**

1. AutoCAD 2009
2. Google Earth v 5.13533.1731
3. Surfer 8.0
4. Arcview 3.2a/ArcGIS
5. Global Mapper 10.01

#### **The hardware used for this research work include**

1. HP Compaq 6720s with 1G RAM 150G Hard disk and 4.00GHZ processor
2. HP Printers K7100
3. GPS Germin 12 channel (Hand held) and mobile 24 channel hand held GPS
4. TPS 400 total station
5. 5m Graduated leveling staff

The primary data comprises the data acquired from the field by ground method, they include the x, y, z coordinate obtained using GPS receiver and the x, y, z coordinate or positions of points obtained using the TPS 400 total station. While the secondary data are mainly the relevant literatures, publications on 3D city models, and journals.

## Methods

The field procedure for the data collection involves measurement with Total station and the GPS. Two points were identified on the satellite image and on the ground, the x, y, z coordinates was extracted in the office before the field observations. Measurement of building heights was carried out, where by the reflector was held vertically before the building and the distance from the instrument to the building was measured. The instrument position was at right angle to the building (Figure 1).

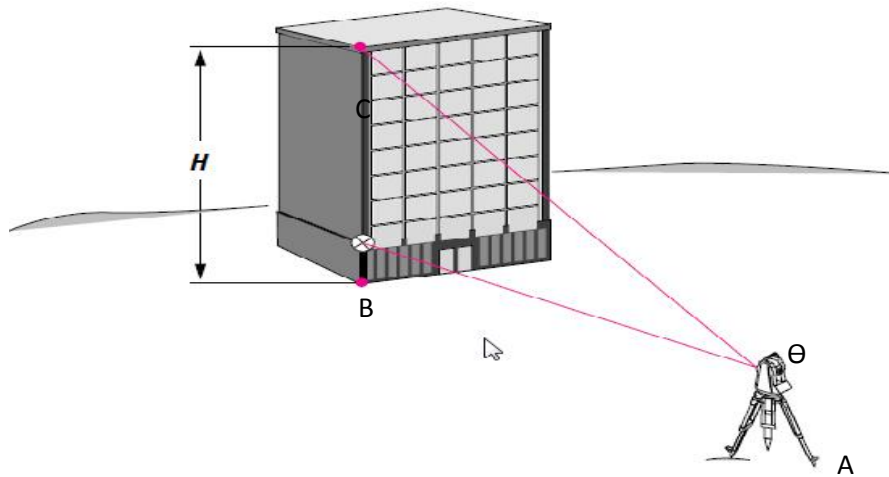


Figure 1: The building and instrument positions

$$\text{Tan}\theta = \text{BC}/\text{AB}$$

$$\text{BC} = \text{AB Tan}$$

$$\text{BC} + \text{hr} = \text{height of building}$$

$$\text{Therefore, height of building} = \underline{\text{AB Tan}} + \text{hr}$$

Where:  $\theta$  = vertical angle

Hr = height of reflector

AB = Adjacent

BC = Opposite.

## Data Processing

For a successful 3D modelling of an area, a base map has to be created, this base map depict the topography from which 3D model can be developed. To create the base map and to incorporate the various data types in to the GIS, a computer system equipped with Google Earth, Surfer 8, Global mapper 10.01, AutoCAD 2009, Google Sketch up 7.1, Arcview 3.2a and ArcGIS 9.3 was made available.

With the computer connected to the internet, launch the Google earth by double clicking its icon on the desk top. The image saved as jpeg format and this image will later saved in a specified directory. In the surfer environment it is processed, and a grid file is automatically created which can be recognized by the Global mapper for further processing.

The Global Mapper software plays a crucial role in the processing of our data due to its capability in processing both vector and raster data. Georeferencing was carried out in Global

mapper and was ready for digitization; the file is latter transferred to AutoCAD for further processing to generate DTM and later to Global Mapper for contour generation. *The AutoCAD was used to extrude the building heights and for further graphical manipulations of the data after which most of the digitizing have been done in the global mapper software.* The Google sketch up 7.1 software was used for textual representation and realistic visualization of the 3D model. While ArcGIS 9.3 package was used to show the land uses of the project area and they were generally used to link the whole project work to the real GIS so that both the spatial and attribute information or data can be linked up and also, any other further analysis can be made relating to this project area.

## RESULTS AND DISCUSSION

All the data collected for the research work were processed and results in form of graphic and tables were obtained. The results include 3D model of the project area which was produced using both the AutoCAD and the Google Sketch up7.1 software. Also a digital elevation model (DEM) of the area was generated using both Global Mapper and Arcview 3.2a. The Global Mapper was used to give the 3D view of the terrain and a better appreciable view of the area.

The overlay operation was carried out using the Arcview 3.2a software package. In this operation, two maps were superimposed, i.e. the theme of base map (topo map) and the theme of the land use map of the area.

The topographical map of the area was created using both the Global Mapper and AutoCAD, but basically, the AutoCAD was used for the final editing of the topographical map due to its capability in graphical manipulation and presentation.

Vector data which was added to the 3D model such as building height, transportation network or road network, trees e.t.c. were mostly obtained from the satellite image covering the project area. The vector data was used for two main purposes.

- i. Vector data is directly integrated as terrain texture.
- ii. Point information is used to place tree and object representation

The four different analyses carried out for this research work were:

- i. Statistical analysis
- ii. Overlay analysis
- iii. Topographical analysis
- iv. The Dimensional model and spatial analysis

The statistical analysis was carried out on the data obtained from both ground method and remote sensing method using the Surfer 8. The analysis tested for the following: univariate statistics, inter-variable correlation, inter-variable covariance, inter-parameter correlations, nearest neighbor statistics. The results are given in form of histogram and pie chart (Figures 2 and 3).

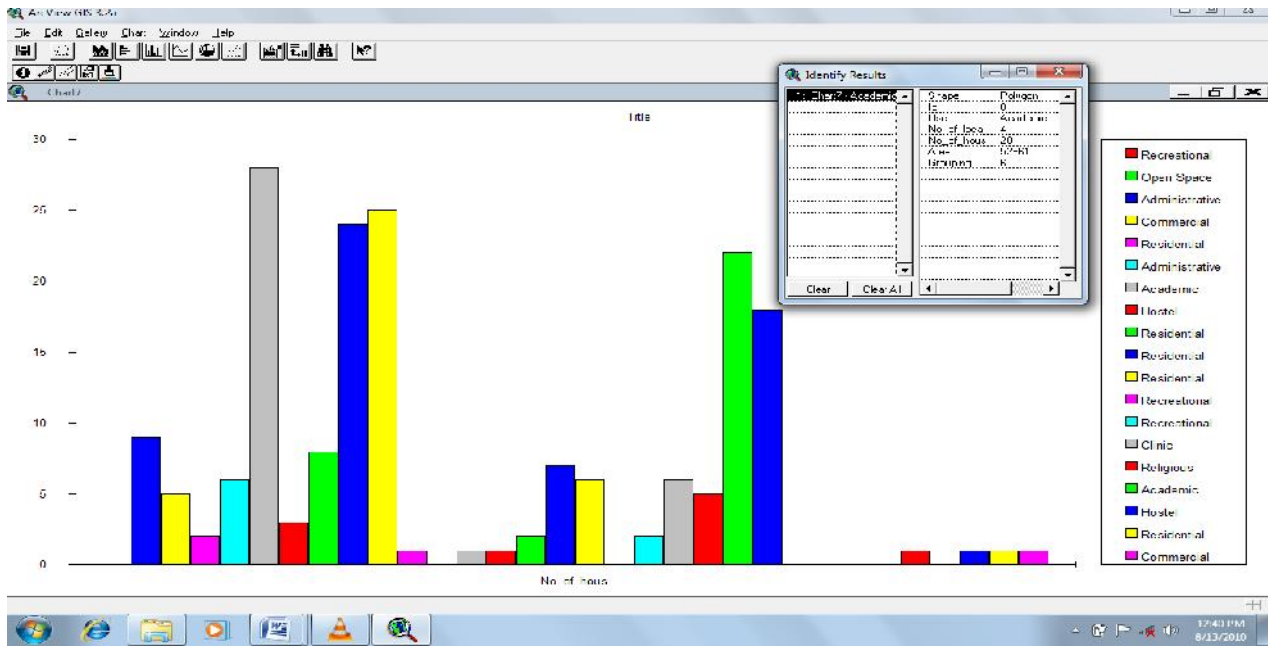


Figure 2: Results of the Statistical analysis

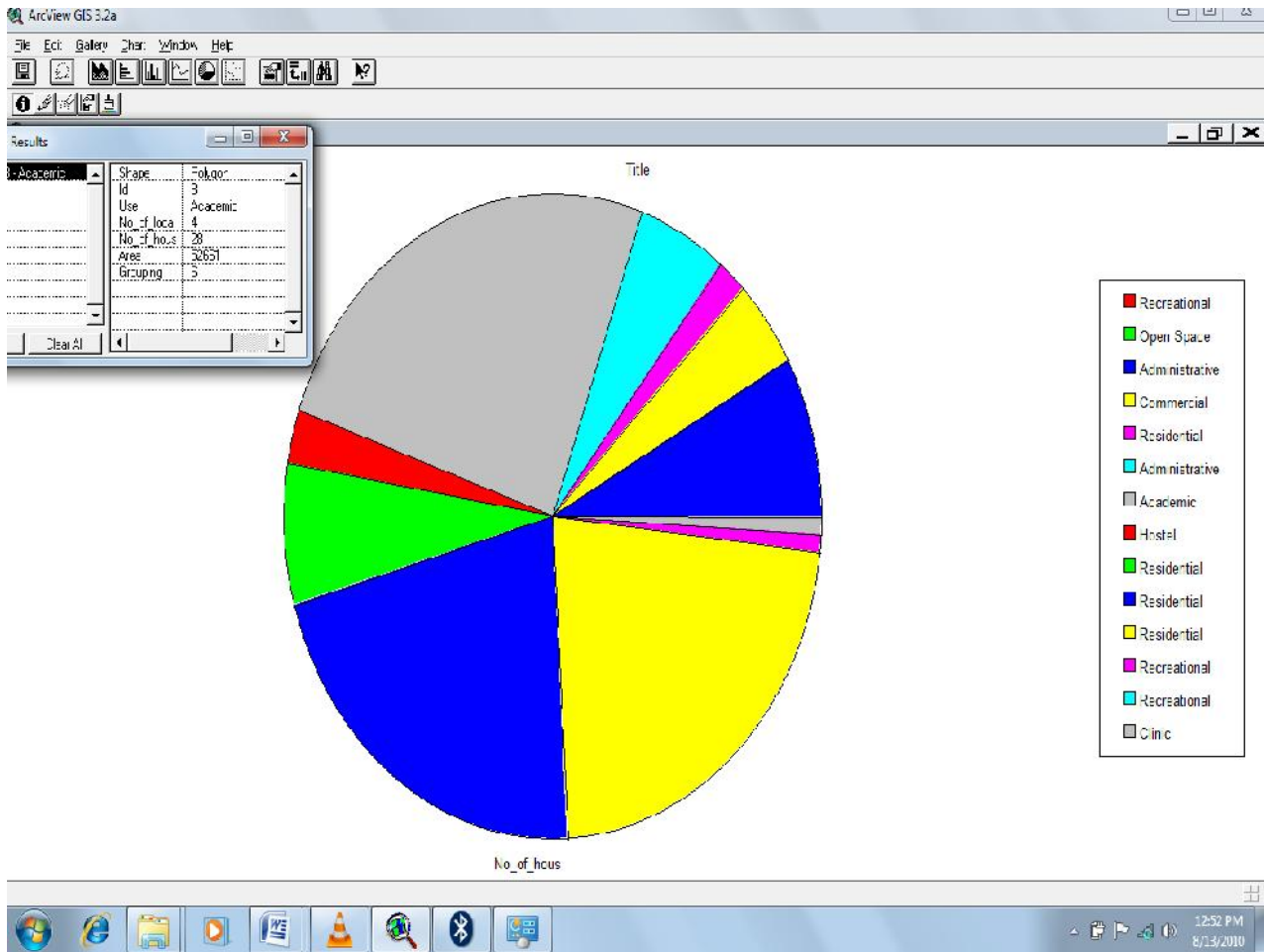


Figure 3: Results of the Statistical analysis

The overlay analysis is an analysis that deals with the combination of several maps to form one single map. For this project, this was carried out using the Global Mapper and Arcview. (Figures 4a and 4b).



Figure 4a: Satellite image, land use map and topographical map all overlaid on the DTM.

Figure 4a shows the base map of the project area is being overlaid on the digital terrain model (DTM). From the analysis, it shows that the buildings are concentrated at the higher part of the DTM.



Figure 4b: Satellite image and topographical map all overlaid on the DTM in 3D

The topographical analysis shows the distribution of details, both natural and man-made features. It gives information relating to the height of point below or above the mean sea level.

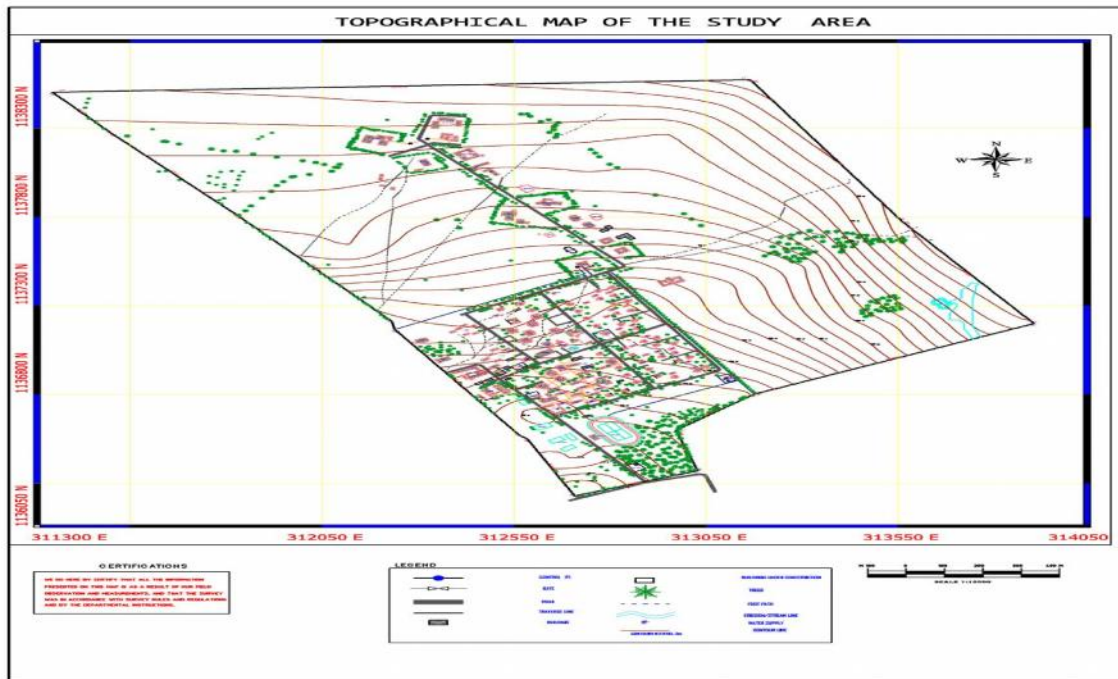


Figure 5: Topographical map

The dimensional model and spatial analysis relates to how very simple or complex sets of spatial relationship are allowed to be manipulated. The dimensional relationships allow working with a very simple or very complex set of spatial relationship. These different complexity levels may lead to either simplified or very precise descriptions of the relationships between spatial objects (Figure 6).

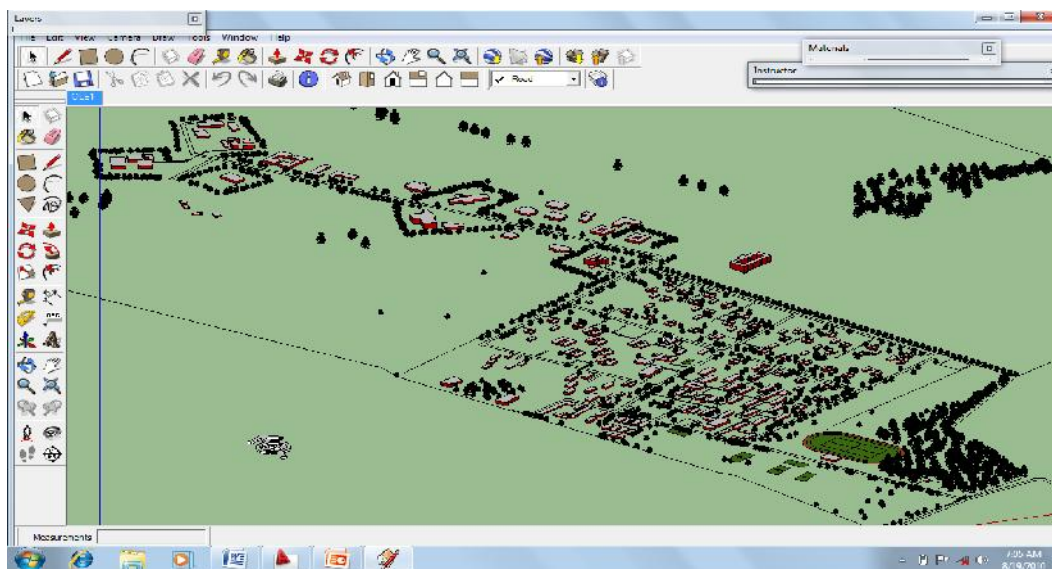


Figure 6: The 3D model map of Federal Polytechnic Mubi



## CONCLUSION

The basic and primary results of this research work is a 3D model of federal polytechnic Mubi, this encompassing about buildings and covering an area of 304.974 hectares.. A comparison of the model and the photo of project shows that the 3D model represent the campus very well, and thus, it is possible to visually access the impact of proposed urban design concepts.

The result from the methodological point of view is the 3D digitized building geometries from satellite image with full area coverage which is a good starting point to create the 3D model. The 3D model map representation proved a good and reliable media or geovirtual environment as stated by (Kibria et al.2009) and into which urban design proposals can be integrated during the planning process. However, it is not possible to control parameters such as field of view of the virtual camera in Google Sketch up 7.1. Although it is very difficult to compare the image of the campus with the model, but this approach would be a very helpful functionality in planning process.

The major findings in the research work are as follows:

- i. The build-up area within the project area is at a higher altitude; therefore, more suitable and conducive atmosphere is experienced at such area.
- ii. During the raining season, rain water flow from the southern part of the area to the northern part, i.e. from the built-up area to the open space. Thus the built-up area is located at a higher elevation.
- iii. Google earth was found to be one of the good software package in the production of city or campus model because its show how realistic the structures are on the computer system.

The 3D model map of the polytechnic Mubi was found to be more effective in terms of the method of data collection, processing and visualization than the tradition method of mapping. Therefore, it is recommended to implement the 3D modelling in places where the development is been carried out on daily bases and in places where the realistic view of the entire area or environment is needed.

In order to implement the overall accuracy of 3D modeling, it is recommended to consider all the uncertainties of each operation that includes: input data for calculations, data source of 3D modelling, building 3D model map, method of generating observation points, interpolation methods and software.

Furthermore, studies should be carried out to solve these uncertainties. The models should if possible be published via the internet in a 3D environment for the general public to view and easily understand the true nature of the project area.

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