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"Spatial Analysis and Visualization through 3D GIS Model: A Case Study of University Campus."

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Abstract:

It is observed that the need for 3D building Models with geo-referenced information has increased rapidly over last decade in the field of 3D urban planning & development, Visualization of the three-dimensional metropolitan area is essential for effective urban development planning, utility management, public facility management and environmental impacts studies. To replicate the multi-dimensional world around us, it is relevant to carry out 3D modelling and use 3D environment while portraying the Geographical data. Geographic Information Systems (GIS) combined with 3D visualisation technology is an emerging tool for urban planning and landscape design applications. It has become an essential tool since its purpose is to extract the relevant information in the available data, thus helping it in exploring, analysing and designing process. The new developments in the GIS technology include the storage, processing and visualization of 3D geodata. The primary objective of this study is to propose a methodology that can be implemented during Smart Campus project for the creation of a 3D model of campus which can be a foundation for application such as solar panel installation, ventilation and so on. The 3D models are created in arc scene interface by taking input from Google earth which gives 2D features in KML.

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1. Introduction

In the last decades, 3D city models appear to have been predominantly used for visualisation; however, today they are progressively employed in some domains and for an extensive range of tasks beyond visualization. A 3D model is a demonstration of an urban environment with a three-dimensional geometry of familiar urban objects and structures, with buildings as the most prominent feature (Billen et al. 2014, Zhu et al. 2009). A typical 3D city model is derived from various acquisition techniques (Biljecki et al. 2015), for instance, photogrammetry and laser scanning (Tomljenovic et al. 2015, Blaschke et al. 2010), extrusion from 2D footprints (Ledoux et al. 2011, Ohori et al. 2015), synthetic aperture radar (Shahzad et al. 2015), handheld devices (Rosser et al. 2015) and volunteered geoinformation (Goetz et al. 2013). The most significant achievements in the 3D research area are related to critical issues of 3D GIS such as 3D structuring and 3D topology. 3D GIS is a three-dimensional geographic information system. Geographic Information Systems (GIS) technology has been widely introduced into the field of real estate mass appraisal in recent years (Zhang et al. 2014). Geographic information is the key to better decision-making: whether in the day to day operations or long-term planning, is related to its geography as it considers the location of the feature which brings the outcomes closer to the reality. Each layer consists of geographic, or spatial, data linked to descriptive, or tabular, information. The main benefit of 3D GIS is that it deals with space and infrastructure management, event management, energy and resource management (including such as water), campus security, movement tracking, just to name a few. ArcGIS was extensively used in GIS analyses and other scientific purposes. There had been a lot of study on 3D landscapes, urban and city models but it focuses on the typical three-dimensional visualization of geo-data. Panchal *et al.* used 3D GIS to offer a platform to build state-of-art geo-spatial technology-based applications for monitoring, managing and planning of the resources as well as the environment. The primary objective of this study is to propose a methodology that can be implemented in the Smart Campus project for the creation of 3D GIS model of campus. In this study, a spatial map of the quadrangle is created which gives the association and spatial information about the college which can be used in further planning and expansion of the university.

2. Study Area

DIT University is situated in the Dehradun city which is the capital city of the state of Uttarakhand in the northern part of India. It is Located in the Garhwal region. The geographic location of the campus is 30.3992°N 78.0753°E, elevation: 640m above mean sea level. The study area profile is shown in Figure 1.

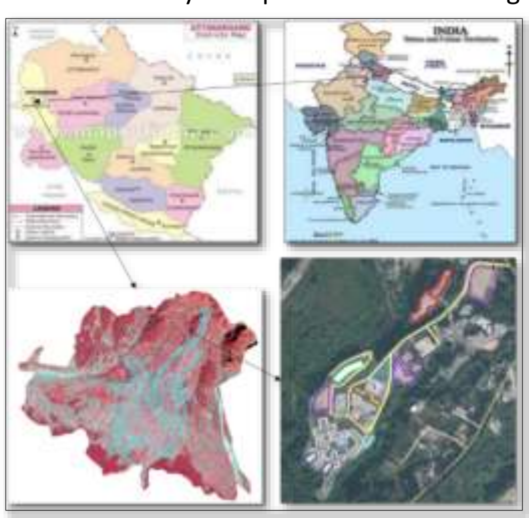

Fig: 1 – Study area profile

3. Methodology

The work has been divided into following subsections, the flowchart of the study is shown in Figure 2.

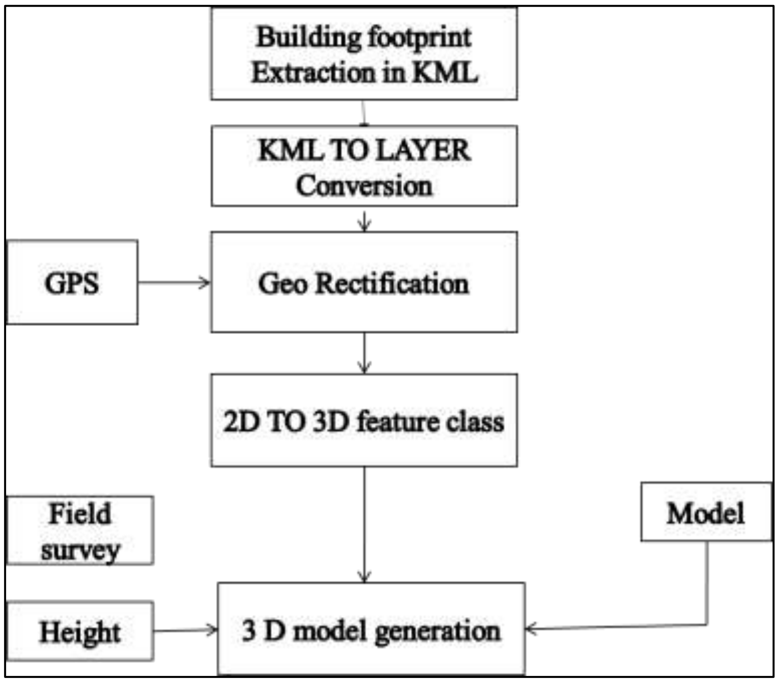

Fig: 2- Methodology framework

3.1 Digitizing and Database Preparation

Campus shapefiles are created from Google earth which gives 2D features in KML. Keyhole Markup Language (KML) is an XML-based language provided by Google for defining the graphics display of spatial data in applications such as Google Earth and Google Maps. KML enables these applications to support the open integration of custom data layers from many GIS users. Example of Building map layer digitizing is shown in Figure 3.

3.2 KML to Layer Conversion

This tool creates a file geodatabase containing a feature class within a feature dataset. Each feature class created will have attributes which maintain information about the original KML file. The original folder structure, name, and pop-up information, as well as fields that help define how the features sit on a surface, all make up the attributes of each feature. The output will be generated in the WGS84 coordinate system. The output features are then projected to UTM coordinate system, a 2D map of campus is shown in Figure 4.

3.3 Geo Rectification

Geo Rectification is the process by which a remotely sensed data is linked into a coordinate system so that it can be accurately located onto a map. Coordinates of exported shapefiles campus are then rectified with the help of coordinates collected from the handled GPS. The projection system is taken as UTM 44 N, WGS 1984.

Fig: 3 – Building map layer digitization

3.4 Added details to attribute

Information regarding each feature such as height and name of the building is collected through the field. Then the details have been added to the attribute table. Example of exported layer and attribute table is shown in Figure 5.

Fig: 4 – 2D map of campus

OBJECTID	Building Name	height	Shape_Leng	Shape_Area
1	vedanta	10	179.510231	1847.102385
2	vastu	8	123.017057	738.356003
3	charak	7	97.784437	512.327015
4	vishvakarma	10	162.518022	1525.222946
5	vishvesaraya	4	184.927889	1184.540044
6	BH1	12	217.232533	1575.182995
7	BH2	12	176.590843	812.595239
8	BH3	14	179.809378	994.52239

Fig: 5 – Details filled in the attribute table

3.5 Conversion from 2D to a 3D feature class

For conversion of two-dimensional features into three-dimensional features, it is essential to add elevation value in attribute and also, they are converted into multipatch features which are the features that were designed to be closed but have geometric gaps that keep them open, such as buildings. It is a 3D set operator that provides analytical functions on 3D features. Each feature's elevation will be derived from the value obtained in the specified height field. Polygon features can optionally contain a second height field. Using two height fields will result in each line feature starting from the Z-value obtained in the first height field and ending at the Z-value from the second height field. The heights for any intermediate vertices will be interpolated based on the slope of the line between the two endpoints.

3.6 Three-Dimensional Model

Each feature's elevation will be derived from the value obtained in the specified height field in arc scene interface. Extrusion tool supports points, multi-points, lines, and polygon geometries. The heights for any intermediate vertices will be interpolated based on the slope of the line between the two endpoints.

4. Results

Outcomes of the study are further divided into two sections, first, spatial analysis of campus and 3D modelling.

4.1 Spatial analysis of campus-

Spatial Analysis includes any of the formal techniques which study entities using their topological, geometric properties. The outcomes of spatial analysis are dependent on the locations of the objects being analysed. It is essential to understand the pattern of college. The study has shown that a significant amount of campus area is still uncovered [included road] which can be further utilised for future construction and expansion, Figure 6.

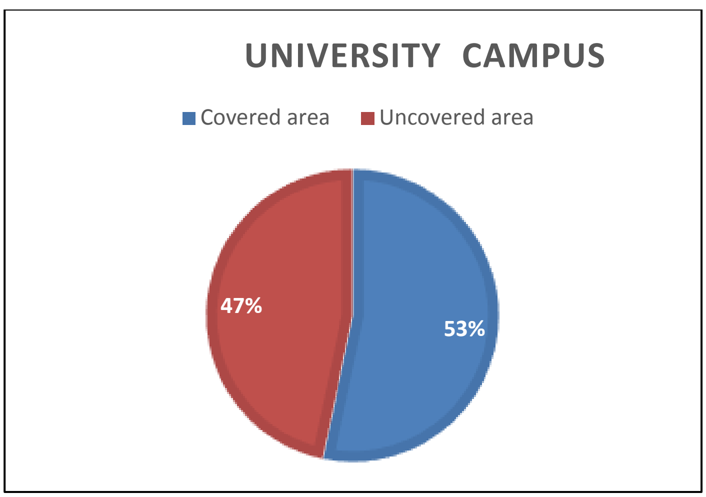

Fig: 6- The covered area of campus

The detailed areal distribution of campus is shown in figure 7.

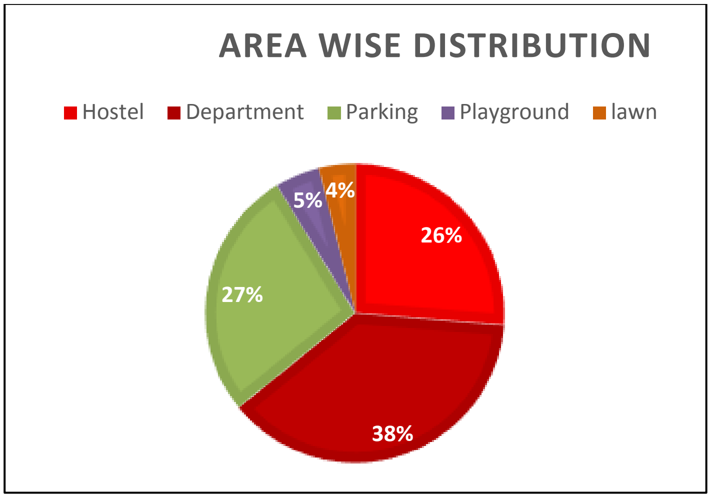

Fig: 7 - Areal distribution of campus

4.2 Three-Dimensional model of campus

The three-dimensional modelling describes the image with the perception of depth.3-D modelling of college campus showed an additional feature to the image such that the study became more interactive. The following screenshots show the various street view of a university campus in Fig. 8 shows the overall 3D model of campus with different colours according to the building use.

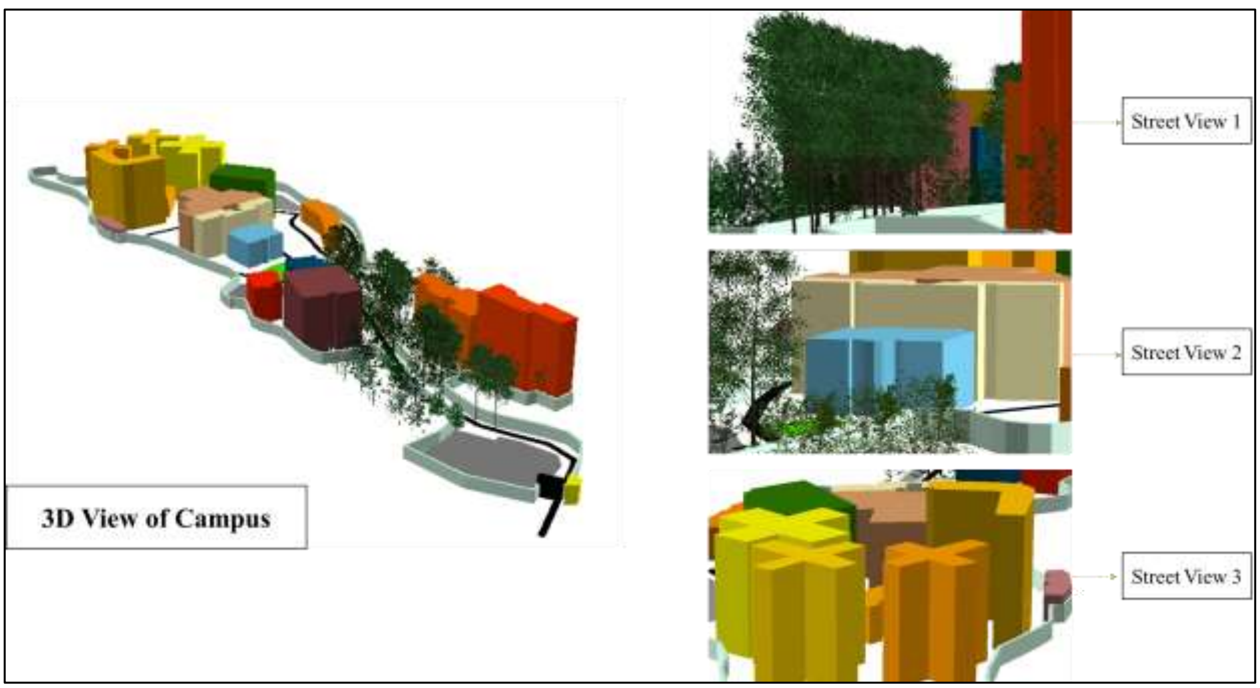

Fig: 8 – Street View of Campus

5. Conclusion

A semi-automatic approach for creating 3D building information can be made using ArcScene. Visualization on the location will have many advantages. Because of these reasons Google Earth modelling has gained much importance in the GIS field. In this paper, it was shown, that it is possible to set up an open standards-based application for internet-based distribution and visualisation of 3D geodata. There is a lack of certainty for 3D urban modelling and storing the related information in the GIS System. It can be very functional to use a defined standard for displaying and storing 3D geodata. Multipatch format can bridge the gap for exchange and re-usage of 3D geodata.

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