3D GIS for Smart cities

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Abstract:

Smart City is an urban development vision to integrate information, communication technology and Internet of things that worry a large number of researchers. This paper is interested to 3D visualization and analysis in GIS geographic information requirements in the Smart City construction and development process as well as environmental properties of urban space. We discuss GIS application in Smart Cities and possibilities given by the GIS analysis methods applied on 3D visualization and takes Tangier Geographic Information as an example.

Keywords

Smart City; 3D Geographic Information System

1. INTRODUCTION

Modern cities need an intelligent infrastructure, where urban data must be managed, visualized and analyzed. Geospatial and intelligent city design Currently, the connotation of geographic information has been enriched by the development of a large variety of applications that use three-dimensional data rather than traditional two-dimensional vector or image data.

Complexity of real world and wide variety of shapes and styles are major challenge to create 3D digital city and virtual environments. Procedural modeling by generating 3D internal model of buildings in batch mode provide a new method for 3D rapid modeling of buildings in the big scene [1].

Also with several software like City Engine can create 3D modeling of buildings which can quickly generate 3D models using existing 2D GIS data, feature geometry, feature attributes, then from the number of floors, floor height, window location.

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Geographic information for released 3D GIS services can be used in many areas of smart city in the context of Great Tangier. Indeed, this city in plain extension needs this technology to help decision-makers to participate in the development of sustainable urban planning [2]. These 3D GIS services can give the high efficiency features, great visual effects, wide coverage, up to date data and so on. Furthermore, in summary, this article will discuss the 3D GIS features, according to Tangier smart city development requirements, and its implementation, management and application.

2. Grand Tangier

Tangier city has enjoyed an exceptional boom in recent years, led by the emergence of major projects (airport's free zone, industrial Gzenaya zone, Mediterranean port and Grand Tangier project).

Tangier is experiencing a spectacular urban sprawl, with new areas open to urbanization over vast areas. This can be seen along the northern coastline and in the heart of the Tangier peninsula, in connection with the Mediterranean port. Also in the west of the agglomeration, with urban areas on the Rabat road, or on the east, future urban corridor in the direction of Tetouan. With this urban development, regions to the south remain with not completely controlled structures.

Figure 1 : Geographical map of Tangier

It's important to have standardized set of collective urbanism, socially homogeneous and geographically reachable [2]. GIS geographic information analysis can play a principal role to reach this objective.

3. Methodology adopted

3.1 Data Collection and Processing

3D geographic information consists on 3D model data and related management process. For geographic information development purposes, we need to use spatial database management systems. In fact, traditionally 3D model data is stored in file system, that leads to lost a huge amount disk space and require a lot processors time when loading and processing. We can store 3D spatial entity, relevant texture, attribute data in spatial database. An effective system, which consists of 3D model data maintaining, data retrieval, data extraction and quality inspection [3].

3.2 Building 3D Model

First step consist to create 3D modeling of buildings using attribute value of existing 2D GIS data, the building model will be designed and extruded according to floor height and adds the façade to each floor using a SIG 3D software like City Engine, ESRI, Infrastructure Design Suite, Autodesk, Bentley Map, Bentley and Geo Media

3D Hexagon Geospatial. Uploading information to the city area (DTM, BIM,CAD, 3D models, etc.)As seen in the following table [4] not all the software options are equal efficient for related functionalities.

Functionality	Esri	Autodesk	Bentley	Geomedia
Import CAD and GIS	●●●	●●●	●●●	●●
Support Geo DBMS	●●●	●●●	●●●	●●●
Editing tools	●●	●●●	●●●	●●
3D Modeling & Texturing Tools	●●●	●●●	●●	●●●
Terrain and Maps	●●●	●●●	●●●	●●●
Basic 2D and 3D Format Support	●●●	●●	●●	●●●
OpenStreetMap Import	●●●	○	○	○
3D Web Scene	●●●	○	○	○
KML Support	●●●	●●●	●●●	●●●
CityGML Suport	●●●	●●●	●●	●●
3D Libraries	●●●	●●●	●●●	●
Advanced 3D Format Support	●●	●●●	●●	○
3D Analysis	○	●●	●	●●●
3D Navigation	●●●	●●	●●●	●●●
BIM interaction	●	●●●	●●●	●
Virtual flights films	●●	●●	●	●●
Scripting Interface	●●●	●●	●	●
Simulation	●●●	●●●	●●	●●

Table 1. Qualitative comparison of software functionality (○: none, ●: bad, ●●: regular, ●●●: good)

This first modeling approach has been used successfully over the Internet, either with browser or plugins developed for this purpose is Google Earth. that started using buildings grey from GIS data (Figure 1).

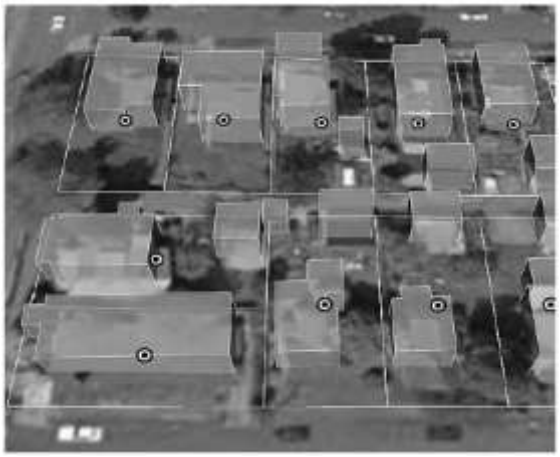

Figure 2 : Buildings extruded and uploaded in Google Earth[3].

3D modeling is adopted to generate 3D models using existing 2D GIS data. Using attribute value of the 2D vector data each floor of the target building model will be designed and extruded according to floor height of each floor and adds the façade to each floor using City Engine procedural rule.

Figure 3: 3D Planning & Visibility Example

3.3 Analysis

3.3.1 Landscape Analysis

Geo-processing algorithms has been used to extract the concrete quantization indexes, such as landscape visual range and sunshine duration which could significantly influence the quality of life and real estate value.
The 3D visualization effect drawing shown like Figure 4 is got by classification rendering of rectangular panels of the building according to the landscape visual range of the corresponding points, and the gradient colors from green to red represent the landscape range from small to large[1]

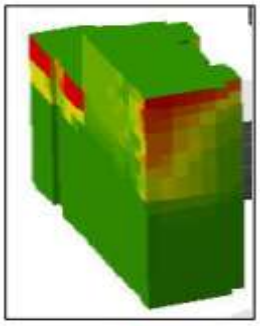

Figure 4: Diagram of Visualization Effect of Landscape Analysis

2.2. **Similarity Measurement and Matching**

In order to find reliable and accurate correspondences between features extracted from a single image, and building models, the author introduce a CGH method where the vote counting scheme of a standard geometric hashing is supplemented by a newly developed similarity score function.

In [5],new model-to-image registration method which can align a single image with 3D building models. Edged corner features, represented by a corner and its associated edges, and context features are proposed as the matching features. Edged corner features are extracted from the image by calculating the intersection of two neighboring straight lines, and verified using geometric and radiometric properties. This model-to-image registration process consists of three steps: (1) feature extraction; (2) similarity measure; and matching, and (3) estimating exterior orientation parameters (EOPs) of a single image.

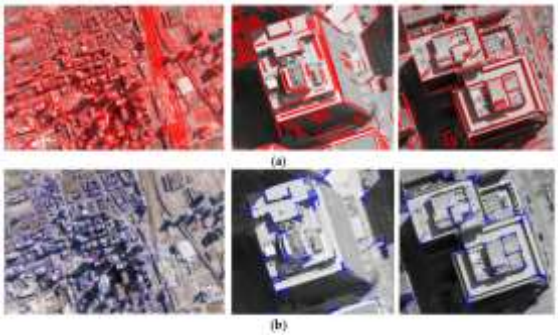

Figure 5 : Edged corner features from image: (a) straight lines (red) and (b) edged corner features (blue).

4. GIS Application in Smart Cities

The aim of smart cities is to combine urban visualizations 3D with rich analysis tools useful fields: asset Management, Planning and Analysis, Field Operations, Situational Awareness, Constituent Engagement and others.

Figure 6: Key Areas of GIS Application in Smart Cities [6]

- Asset Management : Manage asset and resource information, Integration between GIS & Waters Assets
- Planning & Analysis : Facilitate better planning and analysis : Pressure Zone Analysis, Water Leakage Analysis, Identification of Critical Customers, Critical Asset Analysis, 3D Visualization and 3D Modeling Analysis Procedural City Creation
- Field Operations: Get information into and out of the field, need to know where assets are…, Need to manage the maintenance of these assets
- Water Utility Solution: Locally Implemented, on Configuration.

5. Tangier context

We can cite as an example " Cité Mohammed VI Tanger Tech" signed in May 2016 between the Tangier-Tetouan-Al Hoceima region, the Haite Group, and BMCE Bank. The goal of the project is to create a new intelligent international city that respects the environment, integrating habitability, industry and the vitality of innovation. It concerns several fields of activity: automotive, aerospace, aviation spare parts, electronic information, textiles, machinery manufacturing and other industries.

Figure 7: Tangier city plan

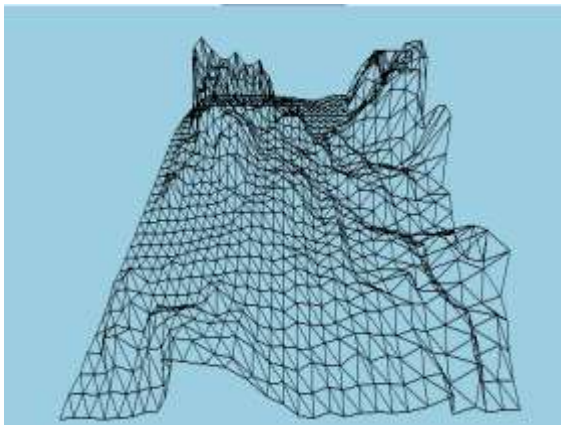

Figure 8: Tangier city 3D terrain Model

3D SIG can be integrated to existing hydraulic systems to help define the development of software, using models already proven, to represent different components of the water cycle to allow substantial progress in the modeling of urban water combined with ease use and prevent floods.

Figure 9: Tangier city plan:
Tangier airport - Cape of Mnar road

Figure 10: Elevation along this road (~21 km)

Since many roads are not well designed, it is important to verify their efficiency. In fact, we can determine, if any areas of the transportation route are hazardous: steep hills, sharp turns, poor road conditions, etc.

6. Conclusion

3D building models, visualization, analysis and management of urban areas is one of the most subjects that bring a lot of opportunities for the near future. This paper aims to review, compare and analyze the new technologies, in progress to manage geographic information technology for smart cities.

The aim of a 3D GIS is to help the city's managers to make better decisions, it is necessary to better understand the current challenges of the territory, but also be able to simulate and analyze the consequences of the actions envisaged on its territory in the future.

Right now it is still difficult to make the link between the analysis and database functions of GIS software, and the photorealistic visualizations that 3D graphics software provides. 3D GIS applications are a step in the right direction, but don't yet offer the 3D graphics power, or web publishing functions, that ideally we'd like to see. Our future works will be focalized in this direction, to give suitable solutions to these problems.

7. References

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