3D and standards for virtual cities
Towards an automatic construction of digital cities based on standards

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3D and standards for virtual cities

- Introduction
- Interoperability
- Data infrastructures
- Conclusion
Introduction

• Gilles Gesquière
  – Assistant professor,
    • Aix- Marseille University/ LSIS Lab (France)
    • 200 researchers
  – Research area
    • Geometric modeling,
    • Data exchange
  – Working on AFNOR (ISO TC/211 mirror committee)
  – Involved on several works in OGC
    • CityGML, SLD/ SE, W3DS, WVS ...
Introduction

My presentation is focused on 3D modeling of urban data

- Land management becomes more and more complex
- Urban or suburban modeling require more concerted use of data from various sources
  - CAD (1), GIS, BIM (2), ...
- Aggregating data permits to enhance
  - land management
  - understanding of data
  - Providing a dataset for simulations of physical phenomena
- Exchanging data leads to interoperability

In this presentation, I will make a quick overview of useful standards and propose two examples developed in my team

(1) Computer Aided Design
(2) Building Information Modeling
Introduction

• In first application, 3D visualization was used
  – Decision help for city planning
Introduction

- Using data to simulate physical phenomena
  - Making simulation in large scale

Fire propagation model

Forest fire consequences on a terrain let rough (up) and brush-cleared (down)
Introduction

• Using data to simulate physical phenomena
  – Making simulation in large scale
  • In different scales
Several interactions with models
Introduction

- Mixing results of different models (traffic/pollution)

- GIS and 3D data

- Traffic simulation (2D)

- Pollution propagation (3D)

- Simulation of Wind, rain, ...

Courtesy of Terra Magna
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Providing interoperable data

- Interoperability may be defined as “the ability of two or more systems or components to exchange information and to use the information that has been exchanged
- standardization is the most efficient and global solution to interoperability problems
- Several organizations, industry consortia and communities are involved in standards development activities related to urban matters:
  - ISO TC/211
  - Open Geospatial Consortium (OGC)
  - AFNOR (France)
    - 3D: Web3D consortium, BuildingSMART
    - CAD: Open Design Alliance
    - Standards dedicated to graphic technology: Khronos group
Encoding geospatial information

• **ISO TC 211** :
  – ISO 19107: geometric modeling and topology, 2D / 3D
  – ISO 19108: temporal models
  – ISO 19125-1: Simple Feature access + **Partie 2 (SQL)**
  – ISO 19123: « coverage »
  – ISO 19136: OGC standard **GML 3.2.1 ↔ data format for 2D and 3D**

• Develop application schemas by using components defined in abstracts standards
• Standards for 3D data
  – Provided by CAD domain (STEP ISO 10303, IGES)
  – For building with the IFC standard (ISO/PAS 16739).
Urban modelisation **CityGML** (OGC)

- **Thematic modeling**: building, transport network, hydrography, vegetation, street furnitures, textures...

- **Multi-scale management**
  - Regional model
    - LOD 0 – 2.5d Digital Terrain Model
  - City/ Site model
    - LOD1: « block model » without roof structure
    - LOD2: Explicit roof structure
    - LOD3: Detailed architectural model
  - Interior model
    - LOD4: « walkable » architectural models (in relation with IFC)

- **2D (surfaces) and 3D (solids) with texture**
Urban modelisation **CityGML** (OGC)

- **External references: Objects may**
  - Refer to their original data sources
  - Refer to other external data sources containing additional data

- **Application Domain extension**
  - Specific applications need extra information
    - Environmental simulations,
    - Utility networks
    - ...
  - Types of domain extension
    - Extend existing cityGML feature types
      - Extra spatial/non spatial attributes
      - Extra relations/associations
    - Definition of new feature types
      - Preferably based on cityGML base class CityObject
    - Each ADE requires its own XML schema definition
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Examples of applications

• 3D PIE
  – Preparing 2D/ 3D data for a client-server visualization

• SIMFOR
  – Preparing an operational theatre for training systems
3D PIE Example

• Context
  – In the 3D Portrayal Interoperability Experiment (OGC, 2011-2012)
  – Client-server environment
  – Compatibility with client and network capacity
    ⇒ Level of detail management
  – 3D visualization without any plugins

• Use case: Paris dataset of IGN(*)
  – Available as 446 tiles of 500 x 500 m² (i.e. around 100km²).
  – Total size: around 150 Go (zip files)
  – CityGML LOD 2
  – Model components: buildings

(*) www.ign.fr
Environment Editor

- Data aggregation
- Using processes to modify data
- Export Data to dedicated applications

Chambelland JC, Gesquière G, « Complex Virtual Urban Environment Modeling from CityGML Data and OGC web services: Application to the SIMFOR Project », SPIE, San Francisco, 01/2012

Create and manage 3D data

• Our environment editor
Data aggregation

- IGN Data(*)
  - Orthophoto (raster)
  - BD Alti (DTM)
  - BD Topo (roads, building footprints, ...)
  - Bati 3D (CityGML files)
- OGC Standards (WFS, WMS, CityGML, ...)
- Open Street map
Simplification/ Generalization (1)

• Creating missing LOD
Simplification/ Generalization (2)

- LOD 1 creation
- Simplification/ generalization
  - For buildings (with modified Douglas-Peucker Algorithm)
Simplification/ Generalization (3)

- Using Heuristics
  - Roof, front creation
  - Generation of generic textures
Creating level of abstractions (LOA)

- District creation

Mao Bo et al, A Framework for generalization of 3D City Models Based on CityGML and X3D, 2009
Building and terrain tiling

- Each layer is decomposed into tiles for indexation
Pyramidal representation

- LOA + DTM
- LOD 1 + DTM
- LOD 2 + CityGML terrain

500 m x 500 m (with district and a simplified DTM)
250 m x 250 m (with LOD 1 and a simplified DTM)
125 m x 125 m (with LOD 2 and the DTM provided in the cityGML files).
Data fusion

- Agglomerate data provided by different sources
Export for dedicated applications
Data exchange

Server (MapFaces) → Internet → Client

- MapContext
- Servlet
- Listener on .w3go
- Get Request
- JSON
- WebGL
- Render + Display

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http://mapfaces.codehaus.org/
THREE.js https://github.com/mrdoob/three.js/
Demonstration

- WebGL visualization in the OGC 3D portrayal experiment
Demonstration

• SIMFOR : « Serious game »
• Training system for risk management
Demonstration
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Conclusion

• Sharing and exchanging 2D and 3D data defined in different scales (coupled with semantic informations) is an important goal
  – Visualization geo data
  – Exchanging data between simulation models
  – Preparing an environment and a scenario for a training system

• Data interoperability is necessary
  => Important to use standard focused on geographic informations

• For instance, we may use
  – Data access WFS, WCS, SOS
  – Visualization service in 2D : WMS / WMTS
  – Visualization and portrayal service : emerging standards likes for example W3DS
Future works

• Using more standards to create in an automatic ways other set of elements like roads, trees, ...
• Complete real data with procedural methods to add details
• Extend generalization processes to reach the virtual globe level
• Following the standards evolution
  – Modification of
    • CityGML 2.0
    • ISO 19107
  – Creation of W3DS/ WVS