Estimating visibility of existing landmarks for urban planning

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@ Geodesign Summit Europe
The touch and feel of visibility
Research Design

Application case urban planning

Required visibility information

Comparison by Gap Analysis

Suitability of Methods

Visibility analysis methods

Measurable visibility properties
Visibility analysis methods overview

**Geoinformatics**
- Viewshed
- 3D sightline
- Viewsphere

**Computer Graphics**
- Ray-tracing
- 3D Isovist

**Architecture**
- 2D Isovist

And many more
Viewsphere calculation

Idea from 2D Isovist + viewshed

Batty 2001
Visibility with Viewsphere

- Pyramid volume with its tip at observer location
  - Base area is built of visible line-of-sight (los) segments and a width
  - Iteration around the observer
- Visible volume calculated for each los-segment by
  - Visual angle (horizontal + vertical)
  - Viewing distance

Yang PPJ, Putra SY, and Li WJ 2007 Viewsphere: a GIS-based 3D visibility analysis for urban design evaluation. Environ Plan B-Plan Des 34 971-992
Visibility with Viewshed

- Terrain divided into:
  - Visible
  - Non-Visible

- Calculation:
  - Along a Line-of-Sight
  - Rotated by 360° around the observer
Viewshed extension: Visual exposure for detailed digital surface models

- **Surface model:**
  - Extruded square column with side surfaces

- **For each cell**
  - Calculate the visible front surface

- **For a Feature of Interest**
  - Cells are grouped
  - Calculate sum of visible front surfaces

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Bartie P, Reitsma F, Kingham S, and Mills S
2010 Advancing visibility modelling algorithms for urban environments. *Comput Environ Urban Syst* 34 518-531
Viewshed extension: Visual exposure for detailed digital surface models

- **Exposure:**
  - Visible front surface from observer’s position

- **Exposure in the Field of View (FOV):**
  - Height and width of an object transformed into
  - Horizontal and vertical angle
  - \( \alpha \) = vertical angle
  - \( \beta \) = horizontal angle
  - \( d \) = distance
  - \( h \) = height
  - \( w \) = width
  - \( \Rightarrow \) distance and perspective matter
3D Isovist visibility method

- Visible space above the terrain as a 3D grid of voxels
  - „Isovisimatrix“

- Each voxel divided into
  - Visible
    > transparent
  - Non-Visible
    > opaque

Vector 3D Isovist

- **Urban Environment**
  - All surfaces as 3D polygons

- **Visible polygons**
  - Are a solid angle in Field of View (FOV)

- **Visible space above the terrain as a 3D volume**
  - Represented by bounding 3D polygons

*Suleiman W, Joliveau T, and Favier E 2013*
A new algorithm for 3D isovists. *In: Timpf S, Laube P (Eds.) Advances in Spatial data handling 157-173 Springer Berlin Heidelberg*
Vector 3D Isovist

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Suleiman W, Joliveau T, and Favier E 2013
Summary: Major objectives of visibility analysis methods

1. Viewsphere → Visible 3D volume
2. Viewshed - visual exposure → Visible facade area + exposure
3. 3D isovist voxel → Visible volume + facade area
4. 3D isovist vector → Visible volume + facade area + exposure
Needs for visibility analysis in urban planning

- Visual characteristics relevant for urban planning:
  - The free space between buildings of a city (Lynch’s elements of a city, -> space syntax)
  - Visual openness:
    The open view to a preferred scenery
  - Visual exposure:
    The privacy of a space (visibility by other observers)

- The visual impact
  Impact of planned city objects (i.e. their visual dominance in the observer’s perspective)
Application case: Visibility of landmarks in urban planning (1/5)

- What is a Landmark? Building(s) of cultural heritage!

- Objective 1:
  - Preserve view to landmark (keep visual impact high)
Application case: Visibility of landmarks in urban planning (2/5)

- Objective 2: do not disturb visual impression
- Need: control visual changes by urban planning projects
Example Unipark Nonntal:

- Identification of measurable visibility objects
- View from garden of Unipark Nonntal to Festung Salzburg

Unipark Nonntal, © Julia Moser.
Required visibility objects for measuring change in view

- **Visible space volume**
  - Change (in front) causes less visible volume

- **Visible-to-hidden space divider (behind Skyline)**
  - Change (in background) causes smaller area of dividing surface

Unipark Nonntal, © Julia Moser.
Application case: Visibility of landmarks in urban planning (5)

- Required visibility objects for measuring change in view
  - Visible facade area
    - Change (in front) causes less visible area
  - Skyline
    - Change (in front or back) causes shorter skyline
**Summary: Major objectives of visibility analysis methods**

<table>
<thead>
<tr>
<th></th>
<th>Visible 3D volume</th>
<th>Visible-to-hidden space divider</th>
<th>Visible facade area</th>
<th>Skyline</th>
</tr>
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<tbody>
<tr>
<td>1 Viewsphere</td>
<td>✔</td>
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<td>2 Viewshed - visual exposure</td>
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<tr>
<td>3 3D isovist voxel</td>
<td>✔</td>
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<td>✔</td>
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<tr>
<td>4 3D isovist vector</td>
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</tr>
</tbody>
</table>

- **Extendable?**
  - Visible 3D volume
  - Visible-to-hidden space divider
  - Visible facade area
  - Skyline

- **For one object?**
  - Viewsphere
  - Viewshed
  - 3D isovist voxel
  - 3D isovist vector

- **Extended method**
  - Viewshed

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Outlook

What next?

- Adapting visibility analysis method for 3D city models
- Perform testing with use cases

Project idea: Urban green as perceived by the citizens

- Using EO satellite data and Digital Surface Models
- Interviews with citizens
...thank you for your attention!