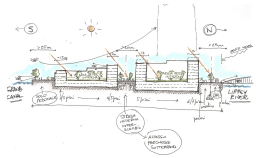
Vis-A-Ware: Integrating Spatial and Non-Spatial Visualization for Visibility-Aware Urban Planning.

Thomas Ortner, Johannes Sorger, Harald Steinlechner, Gerd Hesina, Harald Piringer, Eduard Groller.
IEEE TVCG 23(2):1139-1151 2017



Matthew Chun

High Level Overview

- Urban planning
  - What is the visual impact of new buildings on city scape?
  - How will it look from multiple different perspectives?
  - How can we easily compare different buildings beyond subjective perception?

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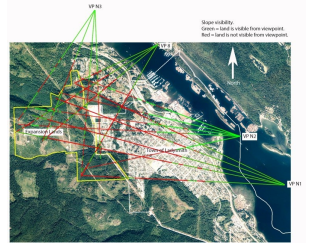
- Urban planning
  - What is the visual impact of new buildings on city scape?
  - How will it look from multiple different perspectives?
  - How can we easily compare different buildings beyond subjective perception?
- Vis-A-Ware
  - Qualitative and quantitative evaluation, ranking, and comparison on the different types of "visibility" of candidate buildings from various viewpoints
  - Links together a 3D spatial urban view with non-spatial data for more context

Domain Practice

- Experts create visibility and landmark occlusion maps



Domain Practice

- Photo montages that overlay real images with virtual candidate buildings

Before

After

Domain Practice

- 3D rendering from a few viewpoints
- Haptic models

Task Analysis

- With a combination of above techniques, compare candidate buildings with respect to visual impact (Current Practices)
  - Qualitative -> Potential subjective bias
  - Can only compare a few viewpoints at a time

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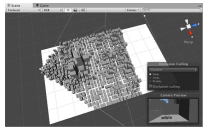
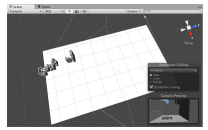
- With a combination of above techniques, compare candidate buildings with respect to visual impact (Current Practices)
  - Qualitative -> Potential subjective bias
  - Can only compare a few viewpoints at a time
- Can we also compare candidate buildings in a more holistic manner? (Suggested New Practice)
  - Quantitative -> More specificity in details (eg. How occluded)
  - More comparisons possible -> Multiple viewpoints
- Is it possible to combine the current and new approaches?

Related Work

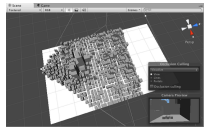
- Occlusion culling

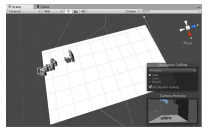


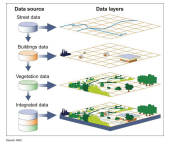


Related Work

- Occlusion culling
- Geographic Info System (GIS)

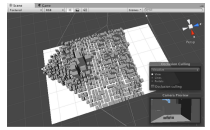


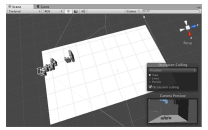


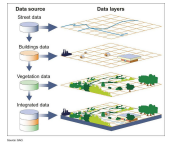


Related Work

- Occlusion culling
- Geographic Info System (GIS)
- Multiple Criteria Decision Analysis (MCDA)
- Coordinated Multiple Views (CMV)







Design Goals

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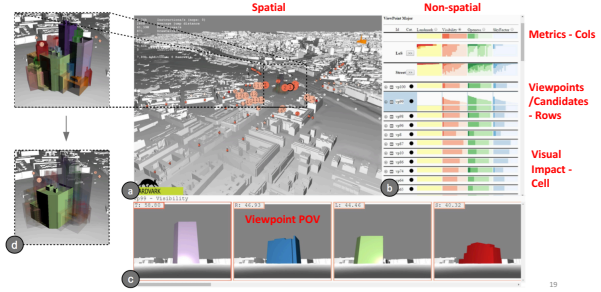
- G5: Intuitive filtering, ranking, and comparison of candidates as well as viewpoints
- G6: Incorporating exploration and visualization metaphors users are familiar with from existing tools

Video

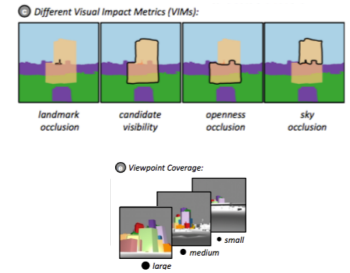
- https://vimeo.com/183311609

Vis-A-Ware



System Overview – Visual Impact Metrics (VIM)

- Coded by "false colour" -> colour that stands out in a scene
  - Landmarks are red
  - Sky is blue
  - Openness is green
  - Candidate building is orange



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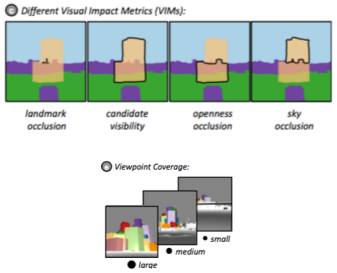
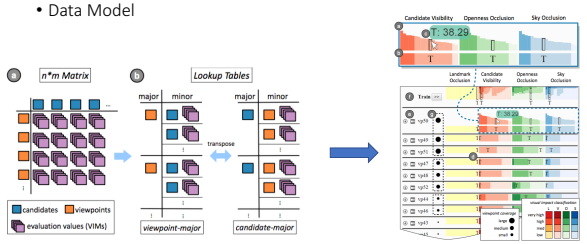
- To get a number, normalized on a ratio
  - # of pixels of VIM of interest/# of candidate pixels
  - Bin categories
    - Low, medium, high, very high
- How relevant is particular viewpoint?
  - all candidate pixels/total number of image pixels
  - Bin categories
    - Small, medium, high



System Overview – Transposable Ranking View (TRV)

- Main way to filter, rank, compare candidates based on VIM
- Data Model



Transposable Ranking View (TRV) - Visual Encoding

Viewpoint Major Mode

a) Bar charts show VIM for each candidate (letter) in distribution, saturation shows impact class

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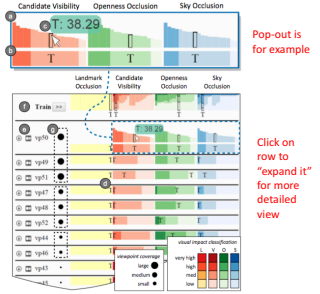

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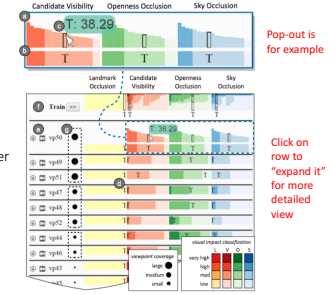
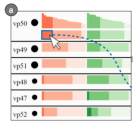
d) Any row that is ranked by distribution scores over all viewpoints
e) Arrow icon loads into spatial view of tool (Map)
f) A high level summary of a category of viewpoint



Transposable Ranking View (TRV) – Focus, Filter, Transpose Workflow Example



Select high impact VIM portion across all viewpoints (Candidate Visibility) of interest

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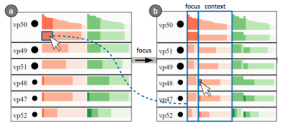

Focused subset now emphasized with split heightened bar charts (left). Remaining distribution lowered in height for context (right).

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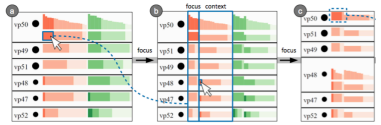
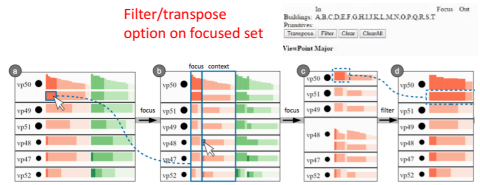


Can focus again. Can expand a row (vp48) for more detailed bar chart -> exact candidate VIM values

Transposable Ranking View (TRV) – Focus, Filter, Transpose Workflow Example

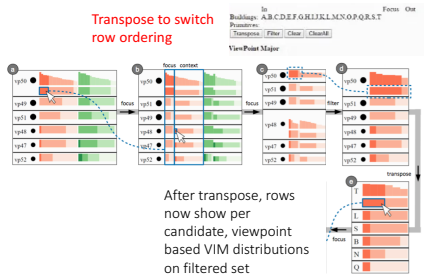
Filter/transpose option on focused set



Use filter option above to see filtered viewpoint distributions now. Emphasize focused area for inspection.

Transposable Ranking View (TRV) – Focus, Filter, Transpose Workflow Example

Transpose to switch row ordering



After transpose, rows now show per candidate, viewpoint based VIM distributions on filtered set

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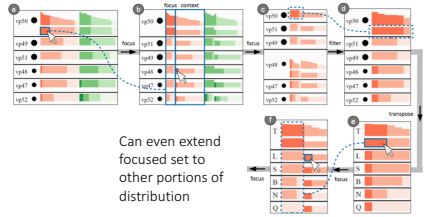
Transposable Ranking View (TRV) – Focus, Filter, Transpose Workflow Example



Can even extend focused set to other portions of distribution

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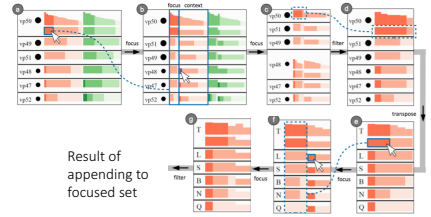

Result of appending to focused set

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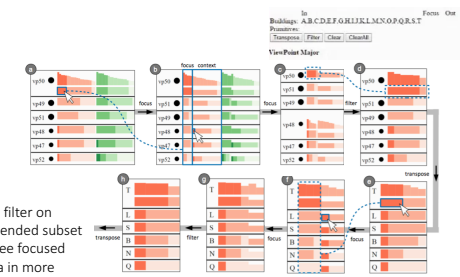

Can filter on appended subset to see focused area in more detail

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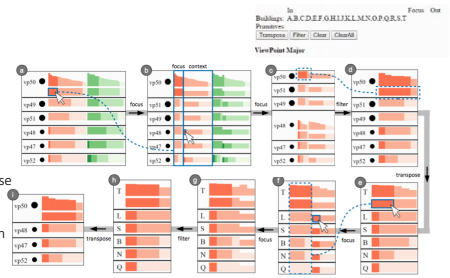
Transposable Ranking View (TRV) – Focus, Filter, Transpose Workflow Example



Final transpose to see final viewpoints based on high impact VIM candidates

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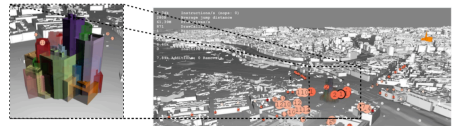
System Overview – 3D Spatial View

- City model and associated landmarks, buildings, similar to GIS
- Candidate buildings denoted by repeating 10 colours
- Viewpoints shown as circular glyphs
  - Size denotes how many candidates are covered
  - VIM Majority denoted by VIM colour
  - Number denotes how many candidates are covered
- TRV Linked Highlighting
  - Only viewpoints expanded rows shown, other viewpoints are “context” (greyed out)
  - Highlighted candidate buildings rendered opaque and coloured -> compare spatial properties with other candidates visually



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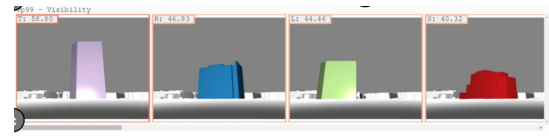
System Overview - Filmstrip

- Based on TRV loaded viewpoints/candidates
  - Show images of all candidates in one viewpoint (viewpoint major)
  - Show one candidate in all viewpoints (candidate major)
- Header in filmstrip box shows identifier of row from TRV
  - Name and value of VIM selected as well



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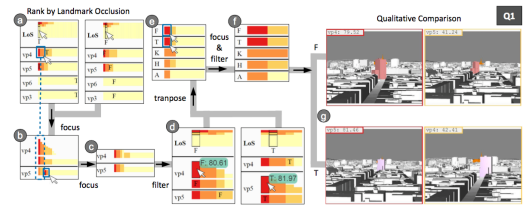
Task Analysis Example

- Which candidates cover a landmark and how strong is the occlusion?



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User Feedback

- During development, received feedback from 10 experts
  - VIM validation only with 1 expert
- Positive reactions
  - Could see benefits of large scale viewpoint evaluation for streets
  - Liked visual linking between spatial view and VIM values
  - Most popular VIM was landmark occlusion (Vienna)
- Would have liked
  - Attribute to indicate shape of a candidate

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Known Limitations

- Openness metric not clear for most
  - Use depth to quantify volume of open space occluded by candidate
- Expand TRV to other “hard criteria” eg. Max height, min. floor space, office to apartment ratio, etc
- VIM for shadow cast by candidate
- Movement profiles of a viewpoint eg. # people at a viewpoint passing through

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Summary

- What: Data
  - Spatial locations of candidate buildings
  - VIM derived metrics
- How: Encode
  - Spatial 3D view -> 3D map
  - Non-spatial transposable rank view -> histograms, bar charts, stacked bar charts
- How: Reduce
  - Elide (bar height change) and filter option to chosen focus set
- Scale
  - 30 candidates tested
  - Viewpoints problematic -> suggested further filtering of viewpoints with low coverage to compensate
  - More than 4 VIM metrics could be possible

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My Take

- What it did well
  - Great willingness to carry over domain techniques for familiarity with target users
  - Liked how they quantified aesthetic information for easier comparison, ranking, and filtering
  - Good use of linking between views to understand a candidate/viewpoint in terms of a VIM
- Improvements
  - Gallery view for filmstrip instead of horizontal strip area (visually compare viewpoints more at once)
  - “History” feature since filtering will eliminate previous steps, may have to go back?
  - Stronger VIM metric definitions -> get more experts
  - Ability to define viewpoint coverage criteria or other VIM metrics further (might be different and context dependent)
  - Figures not always clear, especially filter/transpose … had to consult video to realize

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Thanks for watching!

- Title images
  - http://www.wrirosscities.org/news/three-lessons-negotiating-urban-planning-process-embarq%E2%80%99s-city-building-exercise
  - http://archinect.com/dariomatteini/project/m-arch-in-projecting-and-urban-planning-dublin-docklands-new-masterplan
- Domain Practice images
  - http://dunster.ca/services/land-use-planning-services/examples-past-projects/
  - http://udvlab.uic.edu/education/managingphotos/types.htm
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  - http://www.nationalgeographic.org/encyclopedia/geographic-information-system-gis/
  - P. van der Corput and J. J. van Wijk, “ICLIC: Interactive categorization of large image collections,” 2016 IEEE Pacific Visualization Symposium (PacificVis), Taipei, 2016, pp. 152-159.
    doi: 10.1109/PACIFICVIS.2016.7465263
    URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7465263&isnumber=7465233
- Remaining images are from main paper

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