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Interactive Procedural Street Modeling

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Street Modeling

Images by Eric Hanson and Ben Watson

Current Practice

Manual Editing

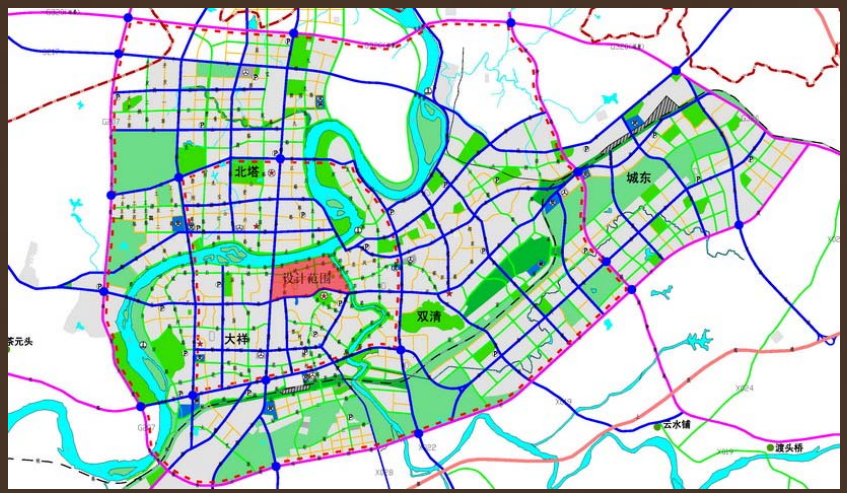

image from http://www.hnup.com/

→ *Control*

Procedural Modeling [Parish & Müller 2001]

→ *Efficiency*

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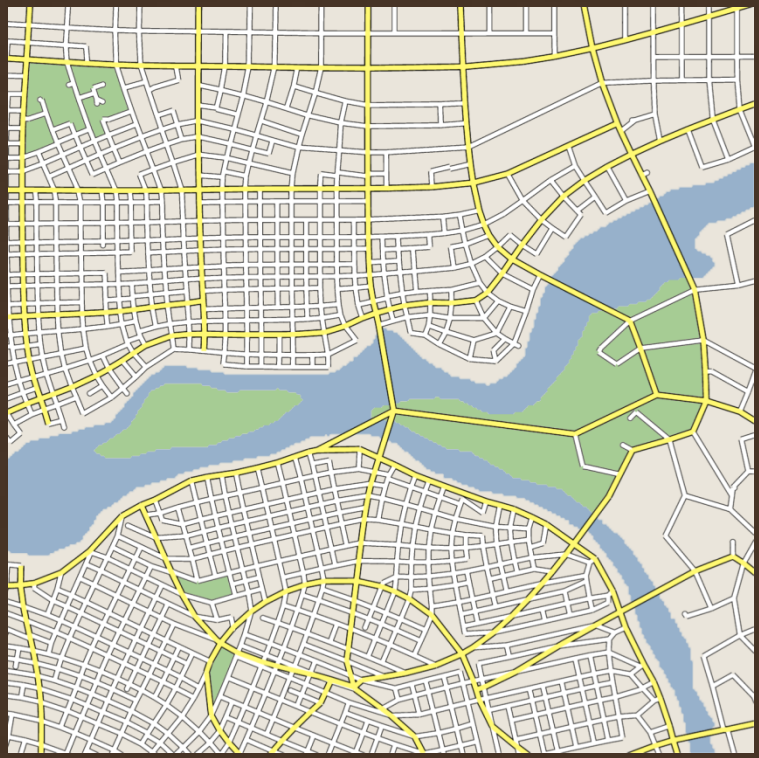
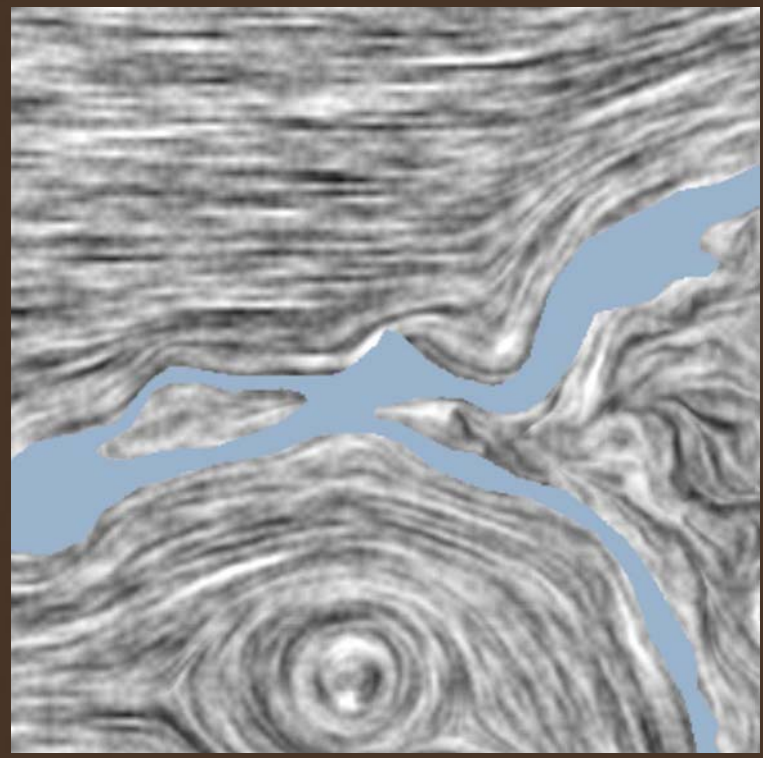
Our Solution





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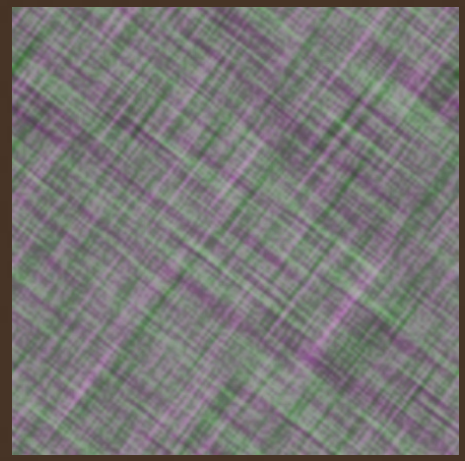
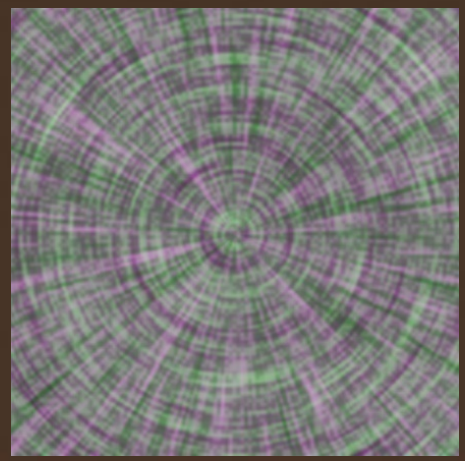
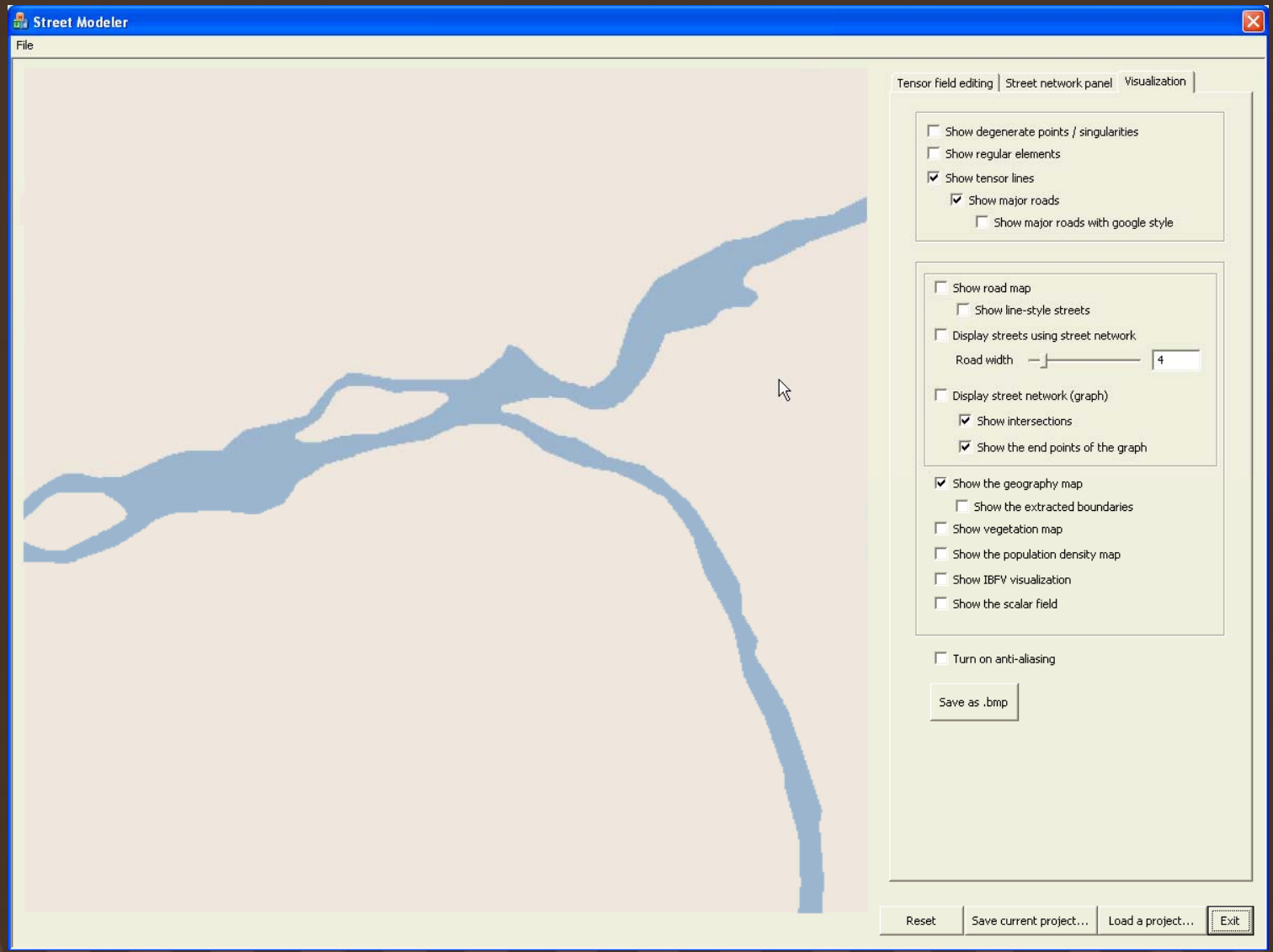
Street Patterns vs. Tensor Fields





Real street patterns **Tensor fields**



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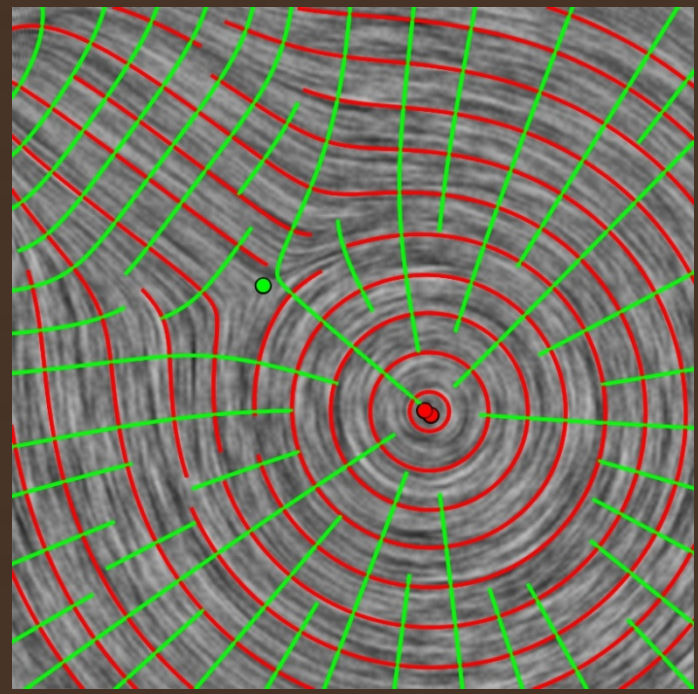
Tensor Field

- 2nd Order *Symmetric Tensor Fields*

$$F(x,y) = \begin{bmatrix} a(x,y) & b(x,y) \\ b(x,y) & -a(x,y) \end{bmatrix}$$

- *Eigenvectors*
- *Eigenvector fields*
- *Hyper-streamlines*



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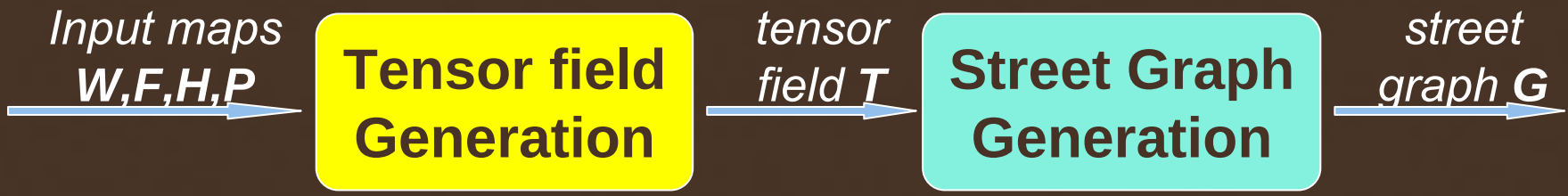
System Pipeline



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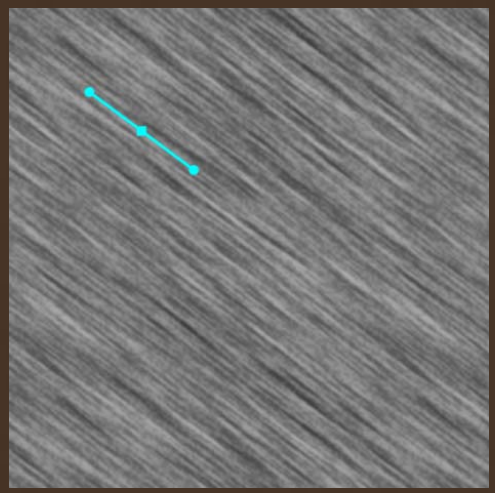
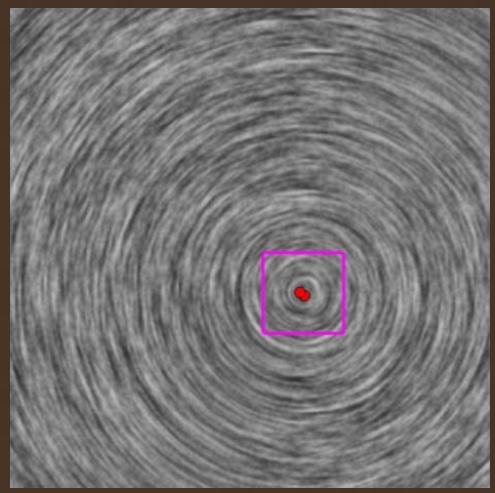
Tensor Field Design



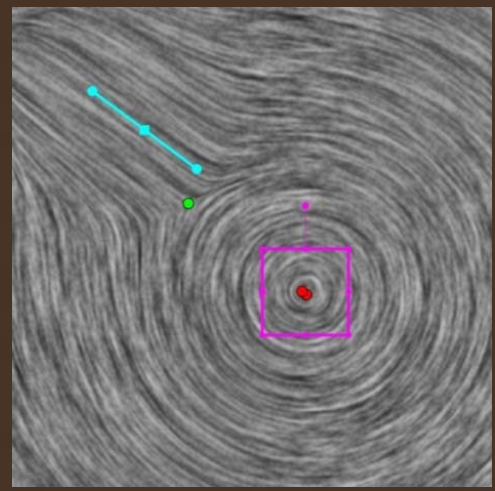
$$T(x,y)=\begin{bmatrix} a & b \\ b & -a \end{bmatrix}$$

+



$$T(x,y)=\begin{bmatrix} y^2-x^2 & -2xy \\ -2xy & -(y^2-x^2) \end{bmatrix}$$

=



$$T(p)=\sum_i e^{-d\|p-p_i\|^2} T_i(p)$$

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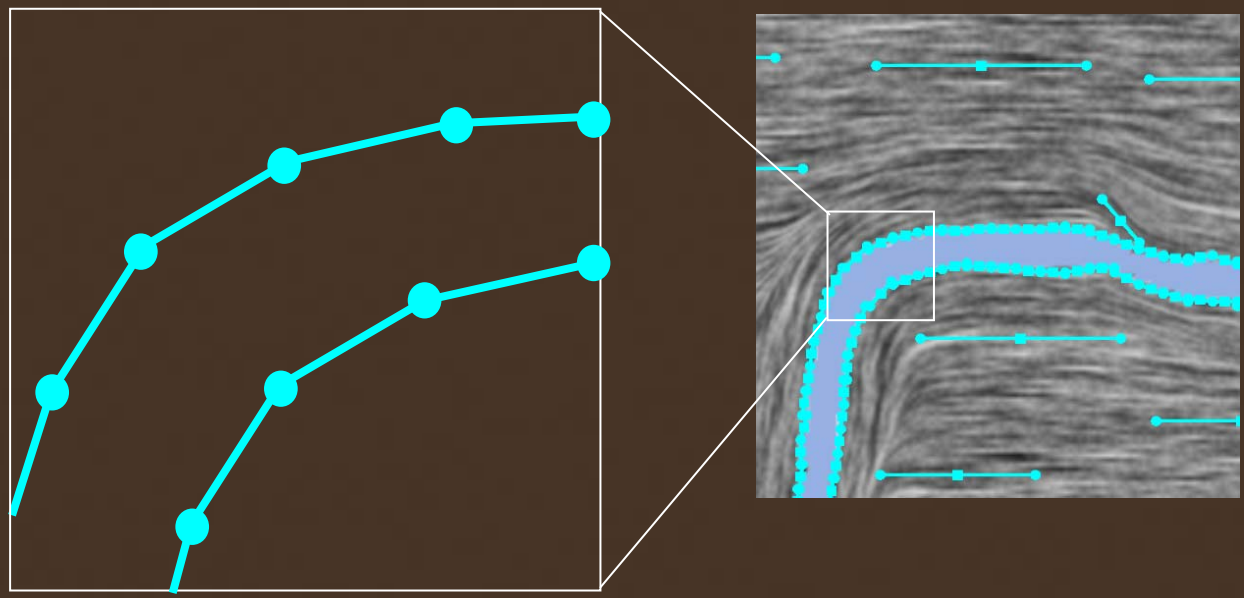
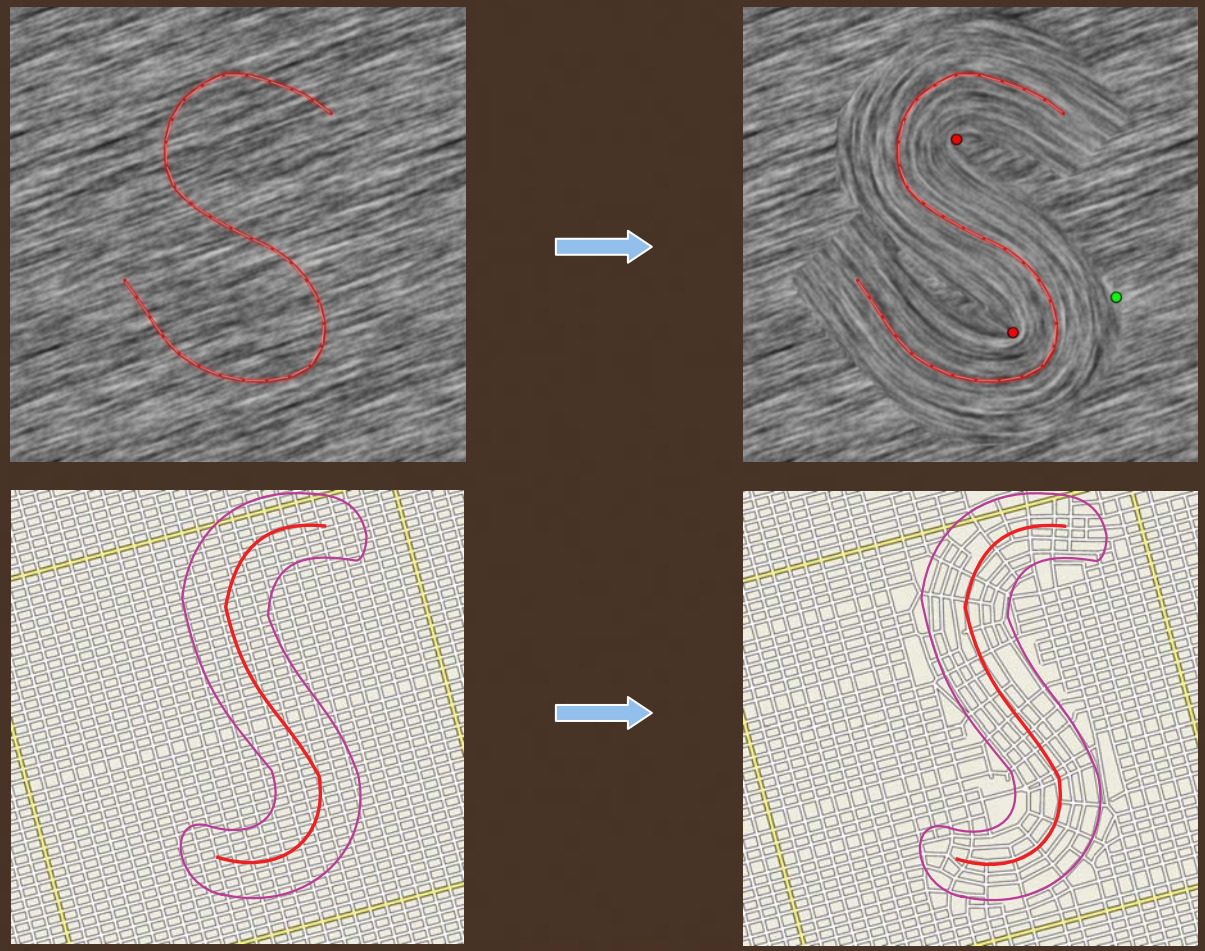
Map-based Tensor Fields

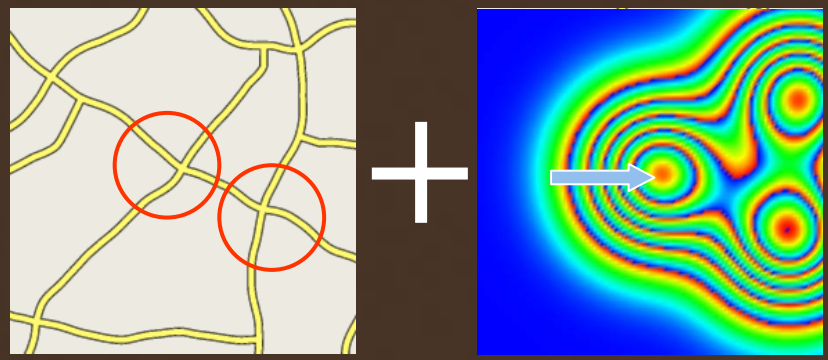
- Generating tensor fields from topographical maps



Brush Interface

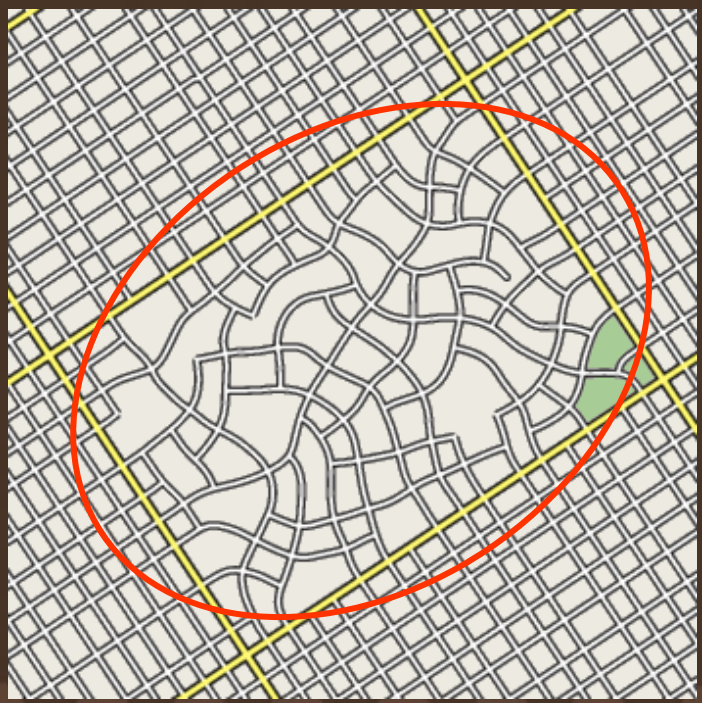


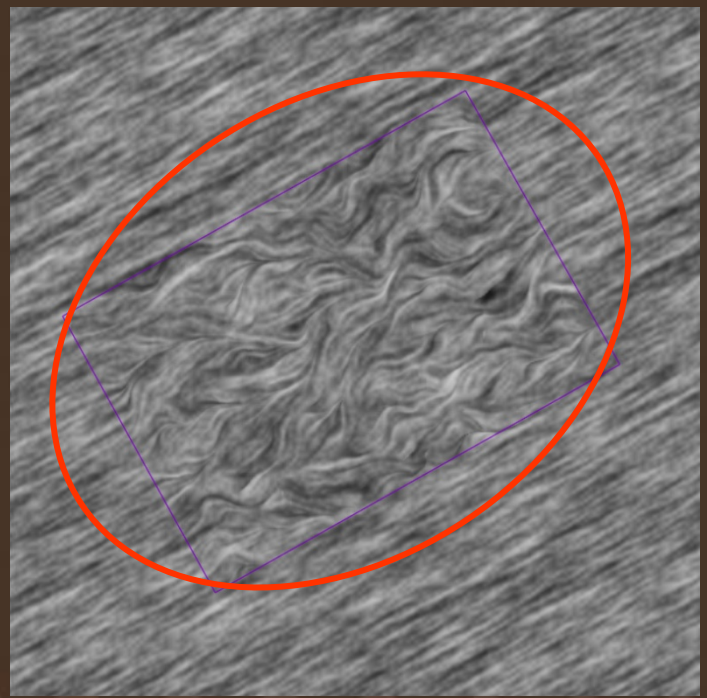
Non-Rectangular Intersections



Organic Street Patterns

- Adding Perlin noise [Perlin 1985]





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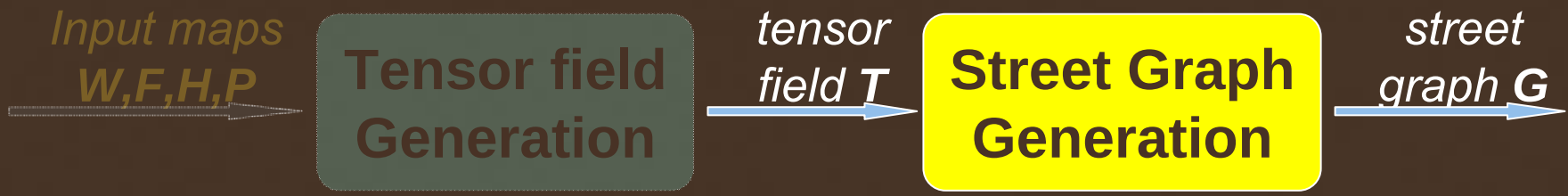
System Pipeline



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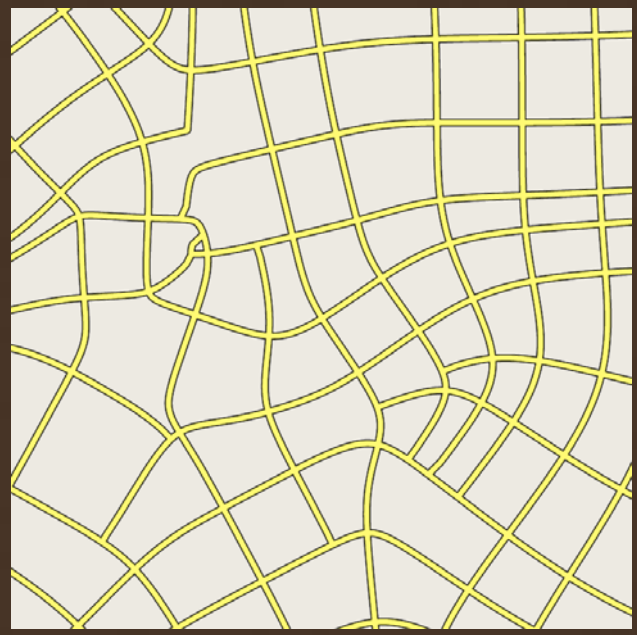
Hyper-Streamline Placement

- [Jobard and Lefer 1997; Alliez et al. 2003; Zhang et al. 2007]

The method based on Jobard and Lefer's



Our method

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Street Network Hierarchy

- ***Highways***
- ***Major Roads***
- ***Minor Roads***

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Multi-level Street Network Generation

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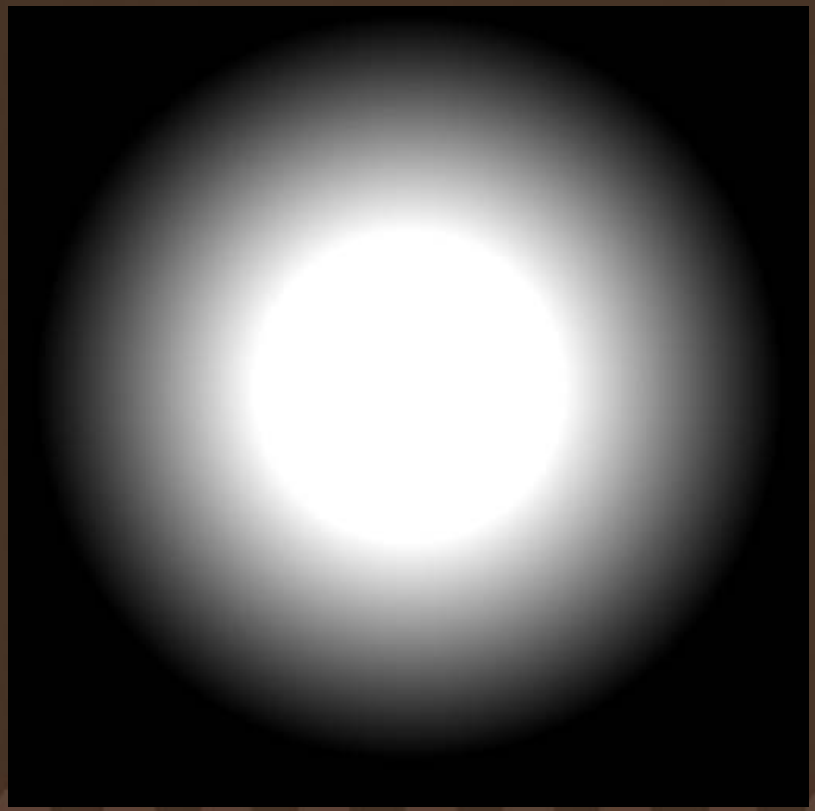
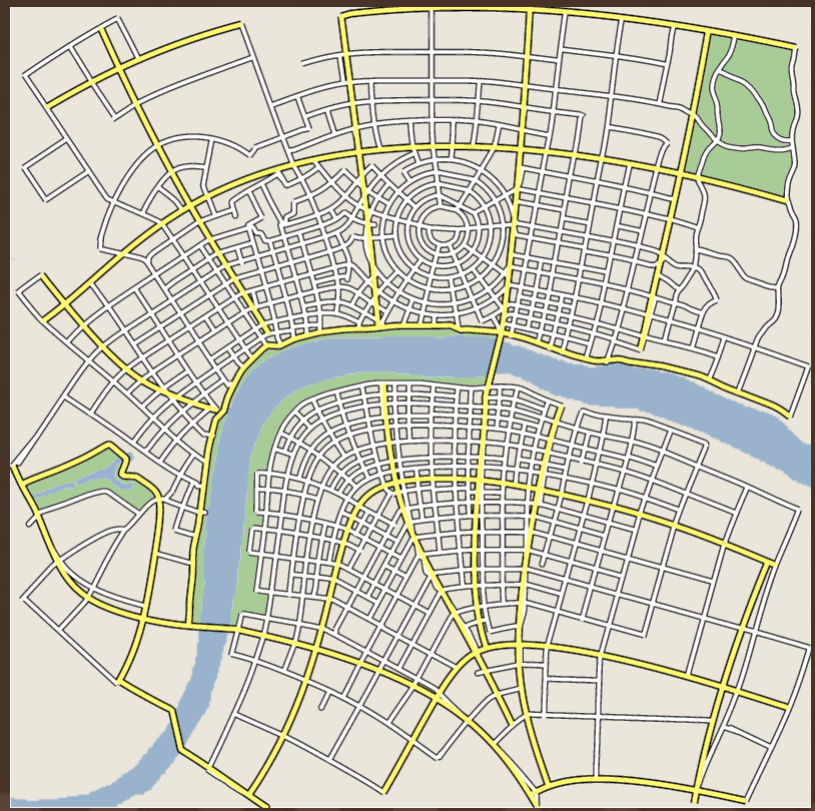
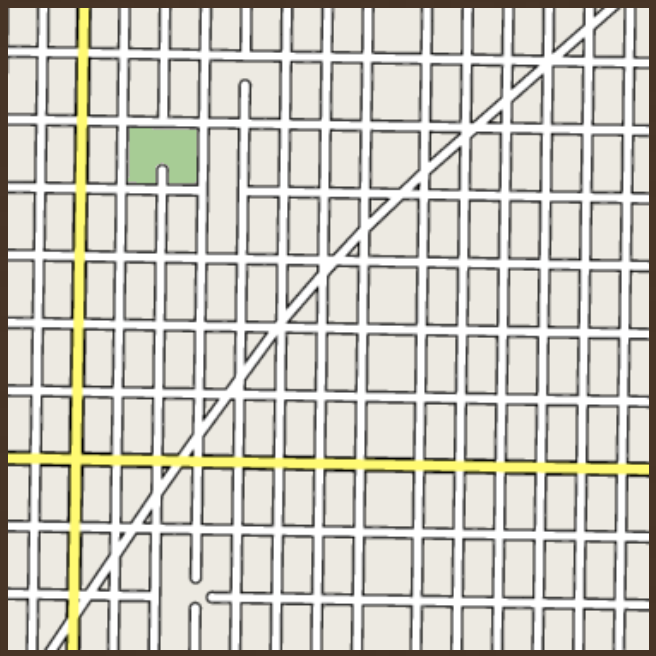
Density Transition





Graph Level Editing

- Layered editing



- Graph noise

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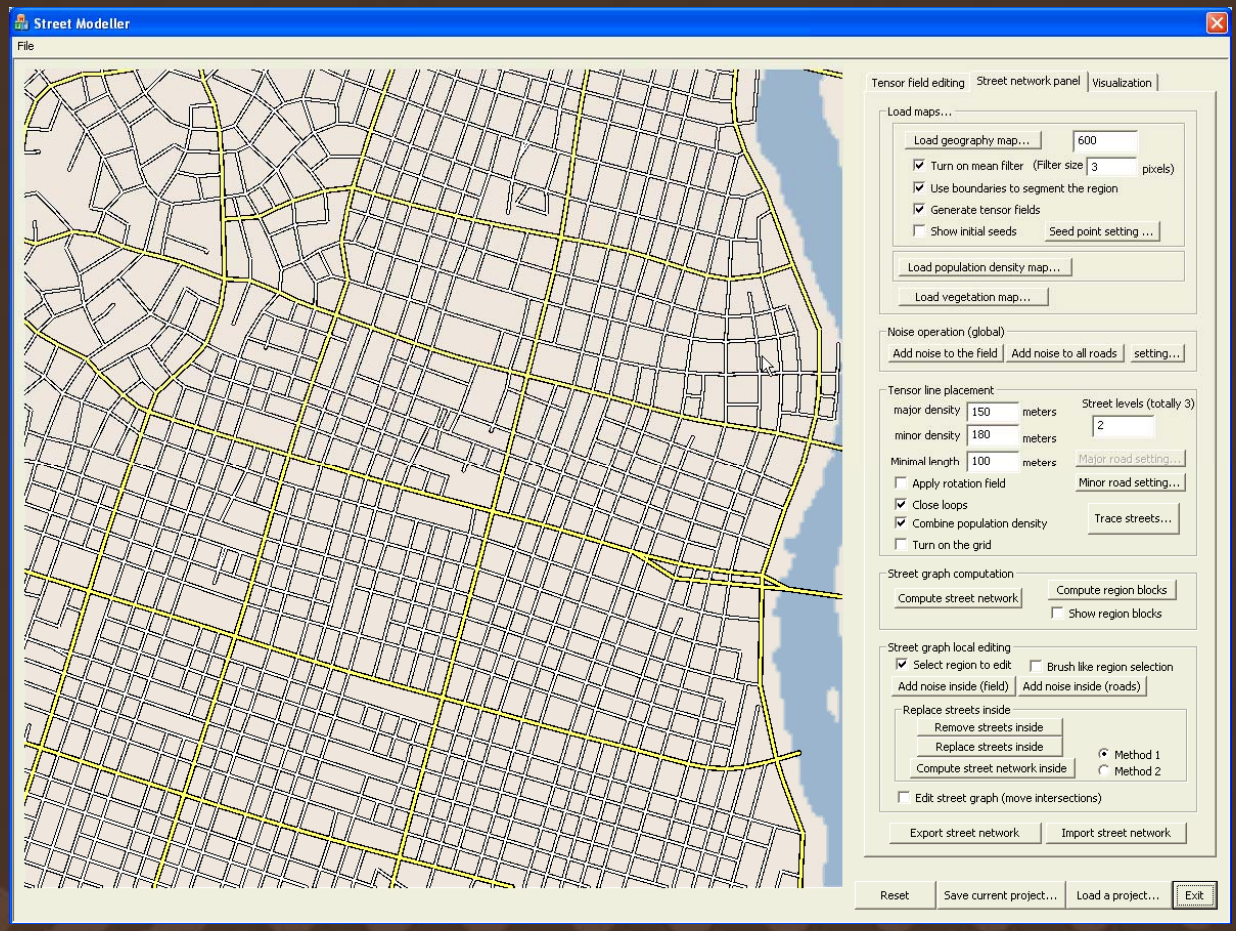
Local Region Editing



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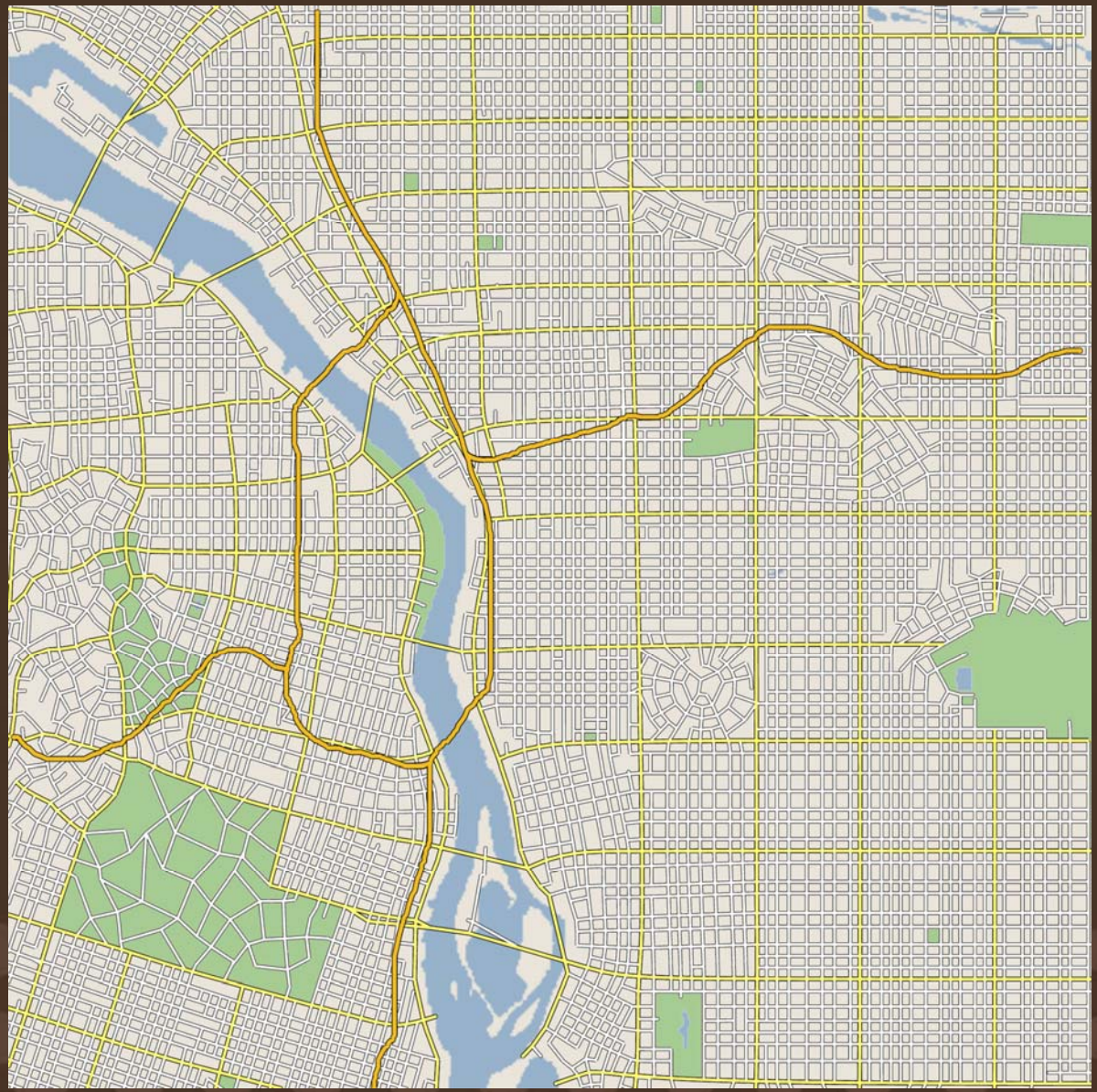
Results and Discussion

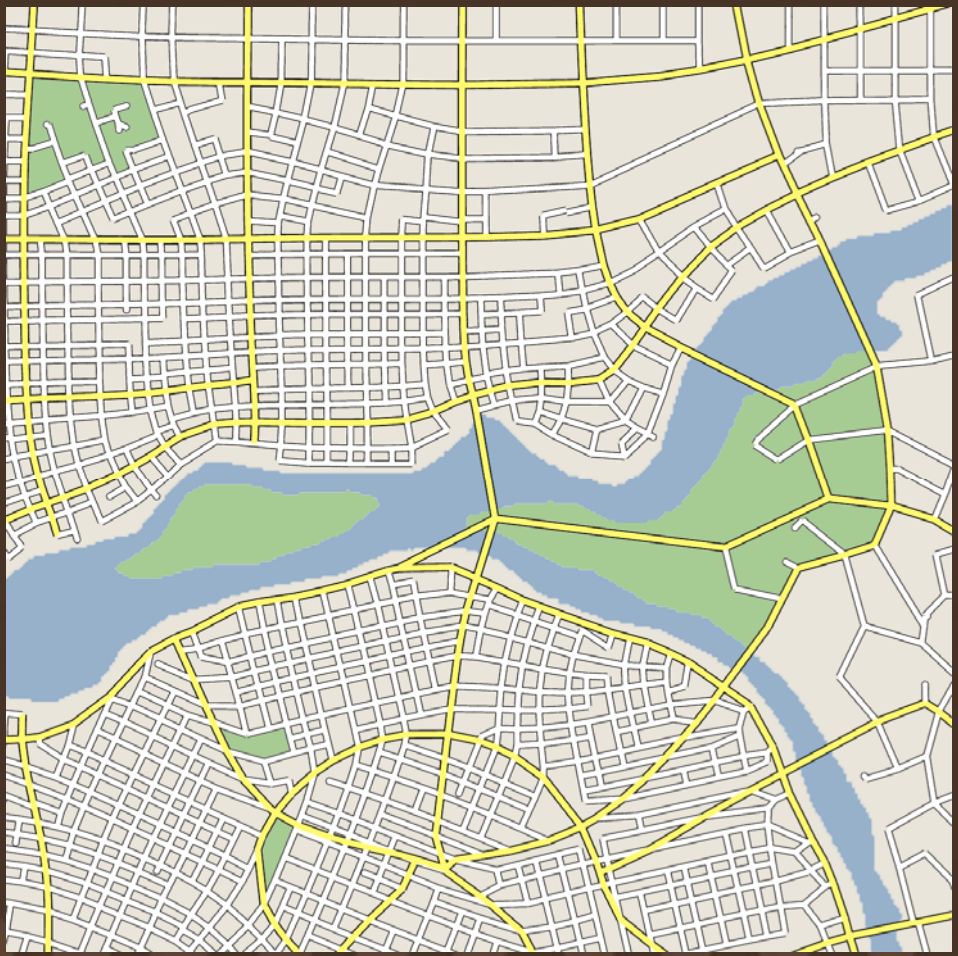


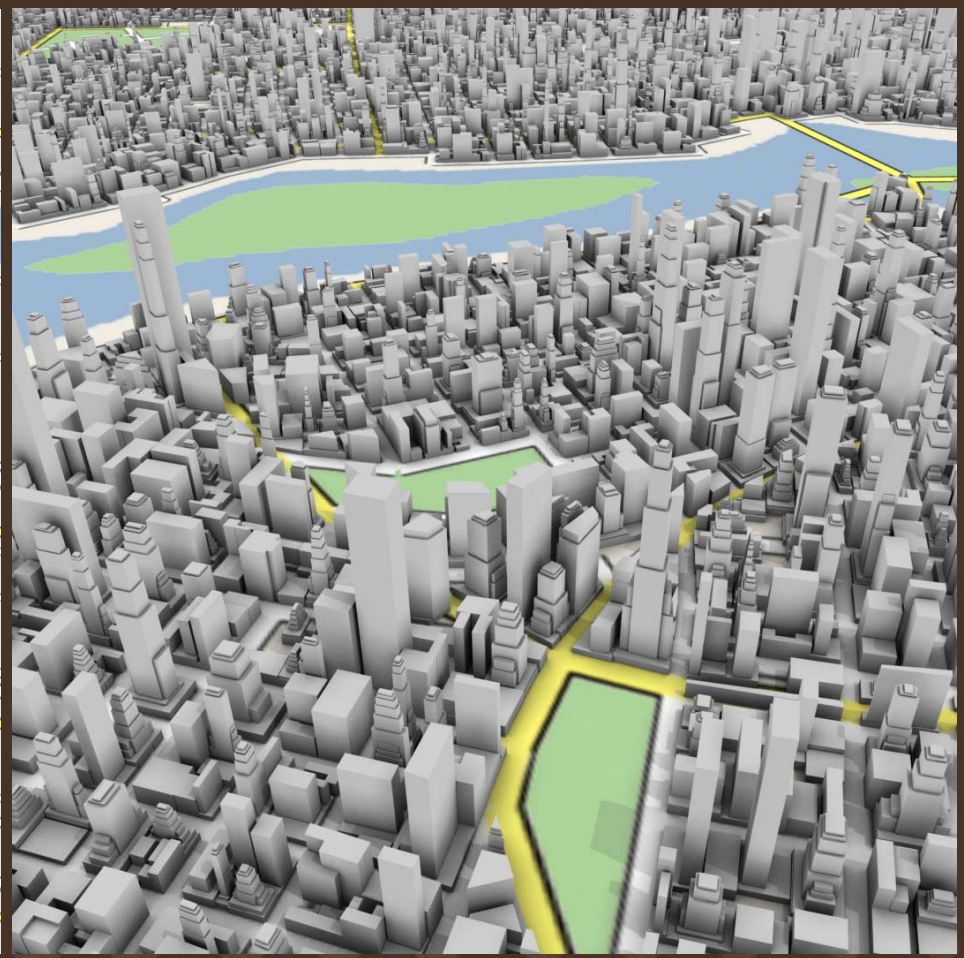
Downtown Portland, OR, USA

Results and Discussion

Downtown Taipei

Results and Discussion





Contributions

- Connection between tensor fields and street graphs
- Suitable modeling operations
- A consistent framework
- Technical novelties

Future Work

- Extend to related design problems
- Explore a more flexible design system
- Add image-based design

Acknowledgment

- **People**
  - ***Andreas Ulmer*** for 3D geometry generation
  - ***William Brendel*** for valuable discussions
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Thank you

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