Scalable Symmetry Detection for Urban Scenes

J. Kerber, M. Bokeloh, M. Wand, H.-P. Seidel

Saarland University, Stanford University, Utrecht University, MPI Informatik
Symmetry Detection
Applications

- Scene understanding
- Compression
- Information Visualization
- Modeling
Main Contribution

- Scalable solution for urban data sets
  - Quasi linear

- Reduce problem
  - Nearest neighbor
  - Low dimensional space
Urban Dataset

Data captured by IKG Uni Hannover
Restrictions
State of the art  [BBWSS 09]

http://www.gris.uni-tuebingen.de/people/staff/bokeloh/project_symmetry2.html
Pipeline

Abstraction
- Input
- Crease Lines
- Key Points

Descriptor
- Line Feature Images
- Orientation Histogram
- PCA

Clustering
- KNN
- Alignment
- NCC
Example
http://www.gris.uni-tuebingen.de/people/staff/bokeloh/project_symmetry2.html
Descriptor
Descriptor
Orientation histograms
Orientation histograms
Orientation histograms
PCA reduction

\[ \begin{array}{cccc}
D0 \\
D1 \\
D2 \\
D3 \\
D4 \\
D5 \\
D6 \\
D7 \\
\end{array} \]
So far
So far
So far
So far
So far
KNN
Clustering
Clustering
Dynamic Query

- User selects area
- Additional geometric verification
  - Iterative Closest Lines
  - Very small candidate set
Video
Scaling Behavior

Graph showing the scaling behavior with two lines:
- Red line: Line Features + Key Points
- Blue line: Descriptor + Clustering

The y-axis represents the number of elements ranging from 10 to 100000, and the x-axis represents the scaling factor ranging from 1 to 1000.
## Scaling Behavior

<table>
<thead>
<tr>
<th>Model</th>
<th>#Instances</th>
<th>Size</th>
<th>#Points</th>
<th>Line Features + Key Points</th>
<th>Descriptors + Clustering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Busch-Museum</td>
<td>1</td>
<td>0.5GB</td>
<td>15.3M</td>
<td>2m 18s</td>
<td>35s</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>2GB</td>
<td>61.3M</td>
<td>4m 20s</td>
<td>1m 45s</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>4GB</td>
<td>138.0M</td>
<td>8m 22s</td>
<td>3m 46s</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>7GB</td>
<td>245.4M</td>
<td>15m 43s</td>
<td>6m 43s</td>
</tr>
<tr>
<td></td>
<td>64</td>
<td>30GB</td>
<td>981.6M</td>
<td>48m 52s</td>
<td>17m 32s</td>
</tr>
<tr>
<td></td>
<td>256</td>
<td>122GB</td>
<td>3.9B</td>
<td>3h 23m 27s</td>
<td>1h 2m 19s</td>
</tr>
<tr>
<td></td>
<td>576</td>
<td>276GB</td>
<td>8.8B</td>
<td>6h 49m 18s</td>
<td>2h 12m 17s</td>
</tr>
<tr>
<td></td>
<td>1024</td>
<td>490GB</td>
<td>15.7B</td>
<td>12h 29m 2s</td>
<td>4h 15m 47s</td>
</tr>
<tr>
<td>Hannover-Sights</td>
<td>1</td>
<td>14GB</td>
<td>463.4M</td>
<td>43m 57s</td>
<td>23m 12s</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>128GB</td>
<td>4.2B</td>
<td>5h 19m 4s</td>
<td>3h 50m 14s</td>
</tr>
</tbody>
</table>
Conclusion

- Feature Abstraction
- Low dimensional descriptor
- Indicates correspondence
- Reduced search to KNN-Problem
- Quais Linear
- Scales to massive amounts of data
Future Work

- More data
- Distributed solution
- Hierarchies
- Canonical decomposition
- Other Scenarios
- More general descriptor
- Improve mapping to low dimensions
- Proximity means Similarity
- No additional check necessary
Thank You!