Symmetry Detection Competition

Evaluation Details
PART II: Translation Symmetries

Ingmar Rauschert
Translation Symmetry
Translation Symmetry

– Translation symmetries considered
  • 1D: Frieze Pattern
  • 2D: Wallpaper pattern

– Examples

Frieze

Wallpaper
This is a subset of images used in Park et al’s PAMI 2009 paper
Lattice - Dataset
Lattice - Dataset

<table>
<thead>
<tr>
<th>Easy</th>
<th>Medium</th>
<th>Hard</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Easy Patterns]</td>
<td>![Medium Patterns]</td>
<td>![Hard Patterns]</td>
</tr>
</tbody>
</table>
# Lattice Detection: Dataset - Groundtruth

# Images: 31

<table>
<thead>
<tr>
<th></th>
<th>Easy</th>
<th>Medium</th>
<th>Hard</th>
</tr>
</thead>
<tbody>
<tr>
<td>#Images</td>
<td>11</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>#Texels</td>
<td>536</td>
<td>1330</td>
<td>702</td>
</tr>
</tbody>
</table>

![Easy Image]![Medium Image]![Hard Image]
A Tile

Wallpaper Pattern

$T(t_1, t_2) = \text{Tiles}$
Lattice Detection: Dataset - Groundtruth

A lattice is defined
• as a regular grid
• with vertices defined at the corners of each texel

A texel is defined
• as a quadrilateral,
• that when repeated along two vectors (T1 and T2), reproduces the pattern seamlessly
Lattice Detection: Dataset - Groundtruth

- Different valid quadrilateral lattices (varying texel shapes)
Lattice Detection: Groundtruth Labeling

Correct

Incorrect
Lattice Detection: Evaluation Metric

- Count number of correct texels (True Positives, TP)

- A quadrilateral lattice is “correct” if all its four corners match up to corners in the ground truth

- Align lattices by minimizing a distance cost-function between paired lattice points that applies a globally linear transformation to all detected lattice points

A global offset between ground truth (red) and detected lattice (dotted black)
Translation Symmetry: Evaluation Score

- We use **precision** and **recall** to judge algorithm performance

- In terms of Type I and Type II errors

  Precision = TP / (TP + FP)  
  Recall = TP / (TP + FN)

  TP = True Positives,  
  FN = False Negatives  
  FP = False Positives

- Precision and recall scores are computed and then averaged over all test images
  - Avoids bias towards images with large number of texels
Results and Comparison
Lattice Detection: Contestants

– Yunliang Cai
  • Hong Kong Polytechnic

– Changchang Wu, Jan-Michael Frahm and Marc Pollefeys
  • University North Carolina, USA
Lattice Detection: Baseline

– Minwoo Park et al.
  • Pennsylvania State University, USA
Translation Symmetry: Considerations for Evaluation

– Yunliang Cai’s method
  • Requires user input (a box specifying initial texel estimate)
  • Result output is point cloud with unspecified degree of neighborhood connectivity
  • Not clear how to convert into lattice structure for comparison

– Changchang Wu’s method
  • Designed for frieze pattern detection
  • Requires strong horizontal features for vanishing point detection
  • Does work on some lattice images as well

– Minwoo Park’s method
  • Fully automatic
  • Result output is a valid lattice grid, with individual texels
Translation Symmetry: Considerations for Evaluation

Cai’s output not a valid lattice structure

Wu’s output often only shows vanishing lines
Lattice Detection: Results

- We attempt quantitative evaluation by
  - Transforming output into lattice form when possible
  - Discounting images for which output cannot be transformed into a lattice

- Number of valid images: 4
## Lattice Detection: Results - Easy

<table>
<thead>
<tr>
<th>Groundtruth</th>
<th>Y. Cai</th>
<th>C. Wu</th>
<th>M. Park</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GT: 30</strong></td>
<td><strong>TP: 14, FP: 0</strong></td>
<td><strong>TP: 20, FP: 0</strong></td>
<td><strong>TP: 21, FP: 0</strong></td>
</tr>
</tbody>
</table>

![Images showing groundtruth and detection results for Y. Cai, C. Wu, and M. Park]
## Lattice Detection: Results - Easy

<table>
<thead>
<tr>
<th>Groundtruth</th>
<th>Y. Cai</th>
<th>C. Wu</th>
<th>M. Park</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT: 64</td>
<td>TP: 0, FP: 193</td>
<td>TP: 0, FP: 1</td>
<td>TP: 52, FP: 0</td>
</tr>
</tbody>
</table>
## Lattice Detection: Results - Medium

<table>
<thead>
<tr>
<th></th>
<th>Groundtruth</th>
<th>Y. Cai</th>
<th>C. Wu</th>
<th>M. Park</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GT:</strong></td>
<td>19</td>
<td>TP: 19, FP: 0</td>
<td>TP: 0, FP: 4</td>
<td>TP: 16, FP: 0</td>
</tr>
<tr>
<td><img src="image1.png" alt="Groundtruth" /></td>
<td><img src="image2.png" alt="Y. Cai" /></td>
<td><img src="image3.png" alt="C. Wu" /></td>
<td><img src="image4.png" alt="M. Park" /></td>
<td></td>
</tr>
</tbody>
</table>
## Lattice Detection: Results - Hard

<table>
<thead>
<tr>
<th></th>
<th>Groundtruth</th>
<th>Y. Cai</th>
<th>C. Wu</th>
<th>M. Park</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT:</td>
<td>132</td>
<td>TP: 60, FP: 18</td>
<td>TP: 0, FP: 1</td>
<td>TP: 60, FP: 0</td>
</tr>
</tbody>
</table>

![Image of lattice detection results with groundtruth and detections by Y. Cai, C. Wu, and M. Park.]
Lattice Detection: Quantitative Results 1

Recall

Number triplet (a,b,c) means number of images used for each contestant. Here we used the only four images for which all contestants got valid results.
• Evaluate each algorithm separately
  – only valid outputs counted

• Algorithm Performances cannot be directly compared
  – Each algorithm has valid output on a different set of images
Additional Tests: Building Facades

Additional Tests

Building Facades
Additional Tests: Building Facades

• Additional Testing on Wu’s method
  – 1D Lattice from Frieze Pattern Detection
  – Emphasize on buildings with strong horizontal frieze patterns

• Additional Testing on Cai’s method
  – A comparison against Park’s method published at ACCV, which was modified to use human input
  – Emphasize on sky scrapers with regular window patterns
Frieze Test Set

Total number of Images: 15
Frieze Detection Results

C. Wu
Frieze Detection Results

<table>
<thead>
<tr>
<th>C. Wu</th>
</tr>
</thead>
</table>

|----------|----------|----------|----------|----------|

|----------|----------|----------|----------|----------|
Frieze Detection Results

C. Wu
<table>
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<tr>
<th>C. Wu</th>
</tr>
</thead>
</table>

| ![Frieze Detection Results](image1) | ![Frieze Detection Results](image2) | ![Frieze Detection Results](image3) |
Frieze Detection Results

C. Wu
Frieze Detection Results

C. Wu
# Facade Detection

- Image 1 / 4

<table>
<thead>
<tr>
<th>Park et al (ACCV 2010)</th>
<th>Cai et al</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
</tbody>
</table>
## Facade Detection

- Image 2 / 4

<table>
<thead>
<tr>
<th>Park et al (ACCV 2010)</th>
<th>C. Wu (requires input)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Facade Detection" /></td>
<td><img src="image2.png" alt="Facade Detection" /></td>
</tr>
</tbody>
</table>
Facade Detection

- Image 3 / 4

<table>
<thead>
<tr>
<th>Park et al (ACCV 2010)</th>
<th>Cai et al</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Image 1" /></td>
<td><img src="image2" alt="Image 2" /></td>
</tr>
</tbody>
</table>
Facade Detection

- Image 4 / 4

<table>
<thead>
<tr>
<th>Park et al (ACCV 2010)</th>
<th>Cai et al</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Image 1]</td>
<td>![Image 2]</td>
</tr>
</tbody>
</table>

![Image 1](image1.png) ![Image 2](image2.png)
Facade Detection: Summary

- On valid output images

<table>
<thead>
<tr>
<th></th>
<th>Recall</th>
<th>Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Park et al.</td>
<td>0.95</td>
<td>1.0</td>
</tr>
<tr>
<td>Cai et al.</td>
<td>0.78</td>
<td>0.97</td>
</tr>
</tbody>
</table>
The End