Interactive Positioning based on Visibility

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Motivation

- interact with user about what they can see
Example Dialogue

Can you see the tower?

Yes.
Concepts

• **objects** (sights) and position **hypotheses**

• **assumptions:**
  • user can determine object visibility
  • system can compute object visibility

• **problem:**
  • very large number of potential questions
  • select *good* objects for questions
Generating Dialogues

- **visibility matrix**: position hypotheses and nearby objects
- generate questions based on matrix; update with answers

<table>
<thead>
<tr>
<th></th>
<th>Pos. 1</th>
<th>Pos. 2</th>
<th>Pos. 3</th>
<th>Pos. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Church</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fountain</td>
<td>1</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Castle</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Gate</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
Algorithm - An Overview

- select best divider(s)
- generate query for user
- evaluate user reply
  - reduce matrix
  - matrix has only one element? done
  - matrix has multiple elements? repeat
  - matrix empty? fail
Generating Dialogues

$V(S, P) = \begin{pmatrix}
vis(s_1, p_1) & \ldots & vis(s_1, p_n) \\
vis(s_2, p_1) & \ldots & vis(s_2, p_n) \\
\vdots & \ddots & \vdots \\
vis(s_m, p_1) & \ldots & vis(s_m, p_n)
\end{pmatrix}$

$s_k : \forall i \in \{1, \ldots, k - 1, k + 1, \ldots, m\} :$

$$\left| \frac{n}{2} - \sum_{j=1}^{n} vis(s_i, p_j) \right| \geq \left| \frac{n}{2} - \sum_{j=1}^{n} vis(s_k, p_j) \right|$$
Some Results

- sight name
- photograph of sight
- textual question (+ speech output)
- input area
Some Results

- **functional prototype** (Deep Map)
- **significantly improve precision** of positional information in case of imprecise sensor data and in absence of any data
- **field trial**, e.g. 10 m precision on a street of 170 m length in three interactions
Integration

- Sensor data
- Measurement
- Position
- Confirmation
- Inference
- Exploration
- Interactive positioning

Motivation  Concepts  Dialogues  Results  Conclusion
Future Work

- Deep Map: visibility check done by user
- but could be done by system:
  - mobile phone with camera
  - send a number of snapshot to server
  - server does image recognition and visibility matrix computations
• new method and UI for interactive positioning based on object visibility
• system-driven dialogue
• optimised for length and information gain
• initial results from prototype (Deep Map)
• camera-equipped mobile phones interesting for deployment

Thank you!