Fast and Robust Edge-Based Localization in the Sony Four-Legged Robot League

Thomas Röfer
Matthias Jüngel

Center for Computing Technology (TZI)
Universität Bremen

Dep. of Artificial Intelligence
Humboldt-Universität zu Berlin
Outline of the Talk

- Motivation
- Detecting edges
- Monte-Carlo Localization
  - Sensor model
  - Details
- Experiments
- Localization in real games
- Conclusions
Localization in the Sony Four-Legged Robot League

- Advantages
  - Automatic positioning
  - Sharing perceptions
  - Full support of referee commands
- Challenges
  - Vision-based
  - Directed vision
  - Variable camera position
  - Limited computing power
Localization in the Sony Four-Legged Robot League

- Advantages
  - Automatic positioning
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  - Directed vision
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The Field
Detecting Edges

- Between field and
  - Border
  - Field lines
  - Goals
    - yellow
    - skyblue
Projection on the Field
Projection on the Field

www.robocup.de/germanteam
Approach
Assigning Observations to Field Model
Sensor Model
Details

- Probability of samples
  - Probability is adapted slowly
  - Separate probabilities for different edge types
  - Samples are randomly moved, weighted by their probabilities
- Sensor resetting
  - Draw samples based on the ratio of their probability and the average probability
  - Replace them by candidate postures that can be derived from observations
- Calculating candidates in advance
  - A large number of random postures is generated
  - Their distance to the edge they are pointing to is determined
  - The postures are indexed by their distance and edge type
Experimental Setup
Experiment 1

- Robot continuously moving (by joystick)
- Approx. 5300 measurements
- Average error < 10.5 cm
  (field size is 420 x 270 cm²)
Experiment 2

- Robot walks to random positions (approx. 70)
- Average error in positioning < 9.5 cm
- Average error in localization < 8.5 cm
Edge-based Localization in Real Games
Improvements since Writing the Paper

- Candidate postures only result from goal points
- Samples are moved in direction of candidate postures, they are not replaced by them
- The speed of this motion depends on the speed of the robot (the faster the robot walks, the slower the samples adapt)
- Samples are also moved according to the assignment of measured points to model points (weighted by the distance to the measured points)
Example
Conclusions

- Fast and robust Monte-Carlo localization
- Using edges between field and border/lines/goals
- Average error < 10.5 cm
- Works in real games

- In RoboCup 2003
  - Played with combined localizer (edges + landmarks)
  - Demonstrated match (GT vs. GT) without landmarks
- In RoboCup 2004
  - Removal of landmarks?
### Other Talks by Members of the GermanTeam

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<td>Vision 1, 1.1</td>
<td>Matthias Jüngel, Jan Hoffmann, Martin Lötzhc</td>
<td><strong>A Real-Time Auto-Adjusting Vision System for Robotic Soccer</strong></td>
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<td>Vision 1, 1.2</td>
<td>Ingo Dahm, Sebastian Deutsch, Matthias Hebbel, André Osterhues</td>
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<td>AI 1, 1.2</td>
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