Pose Estimation for Robotic Soccer Players

in the Context of RoboCup

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Outline

Motivation

Knowing own pose is essential for decision making.
How can a robot know its pose on the field?

1

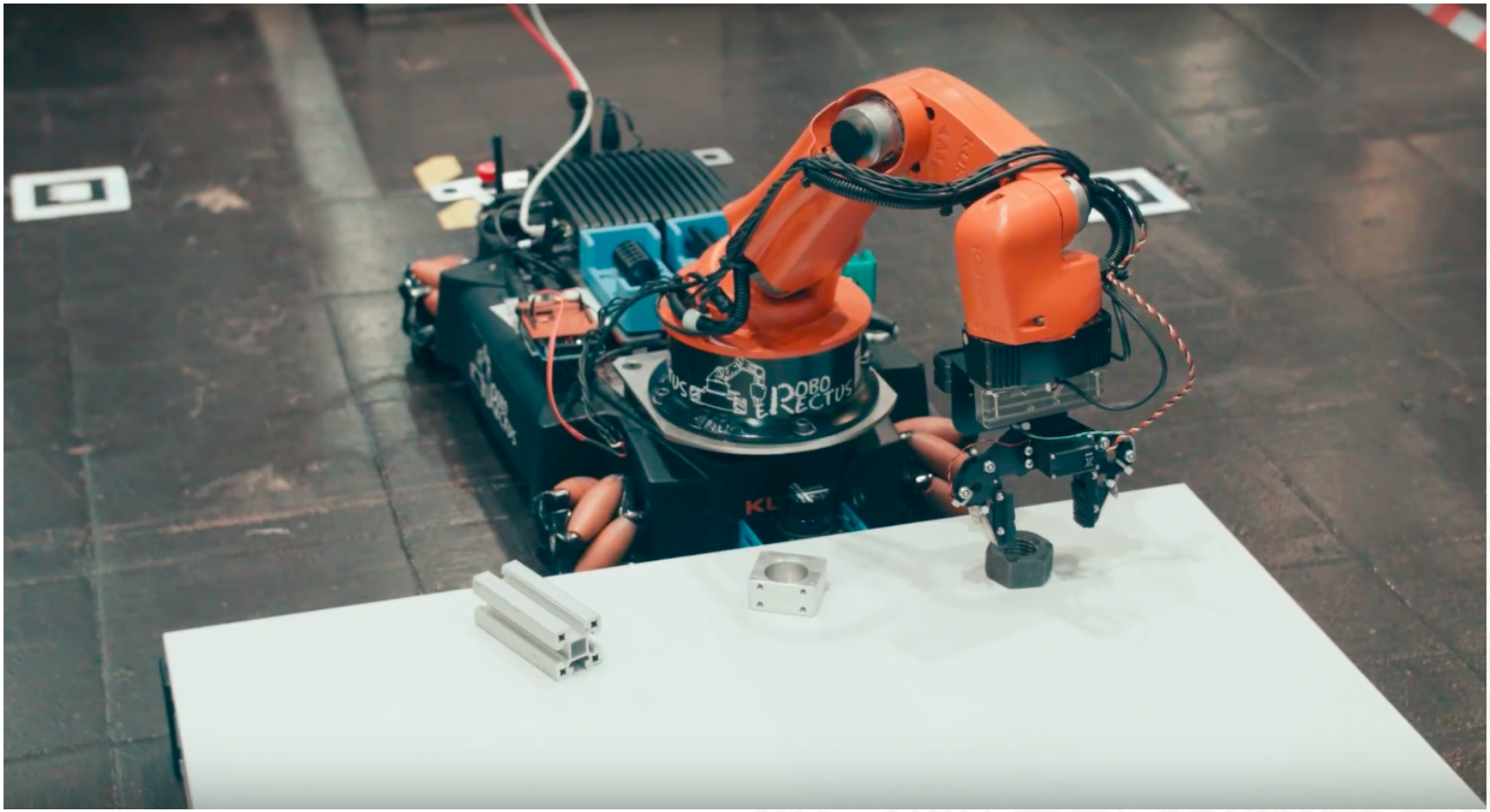
[1] http://clipart-library.com/images/8iGb5XKbT.jpg

RoboCup Competitions

- International competitions
- Since 1996
- 500 teams
- Several leagues

[2] http://www.robocup2014.org/wp-content/uploads/2014/04/RCfed_high_M_Transp.png

RoboCup Industrial Leagues



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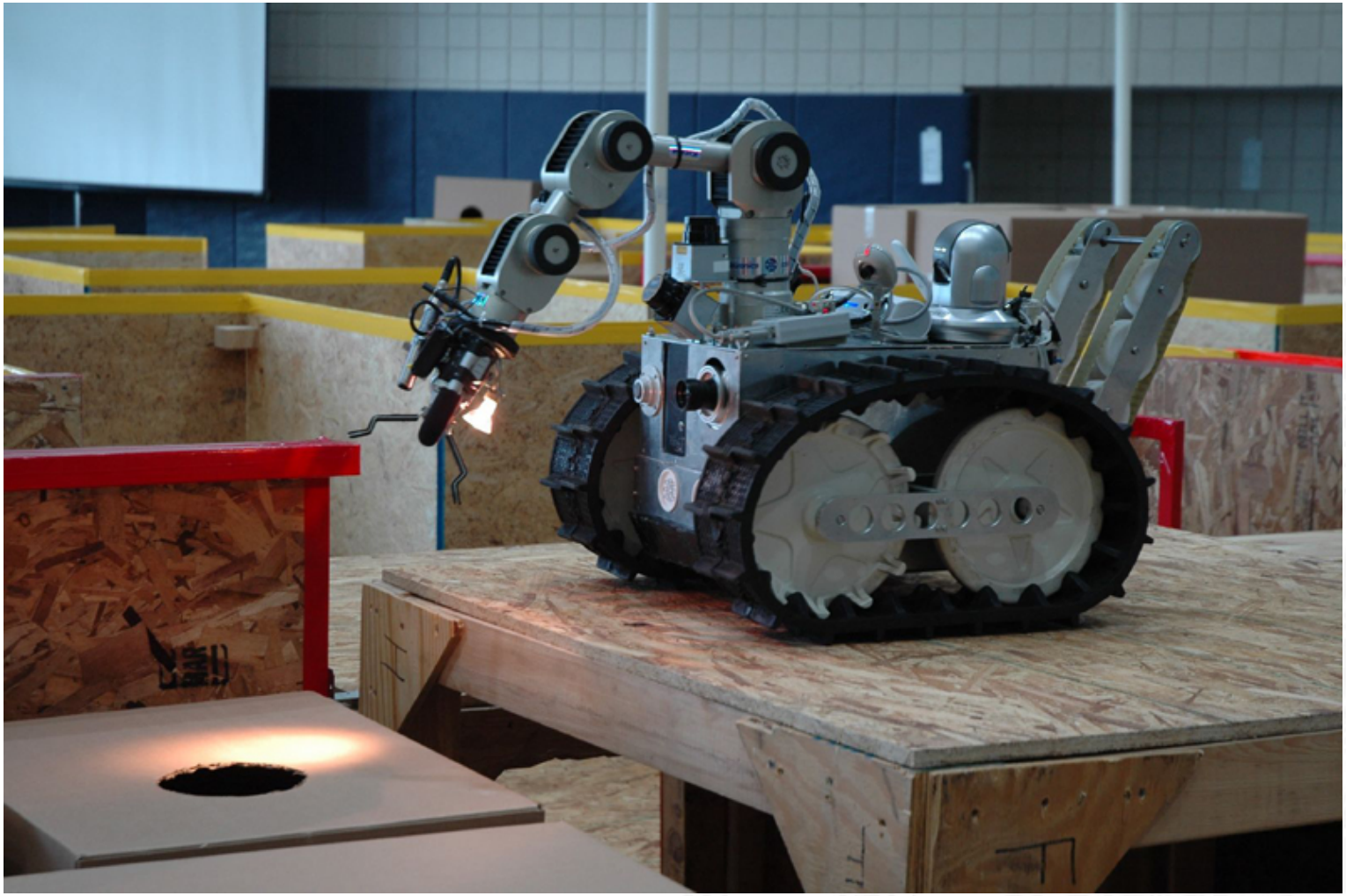
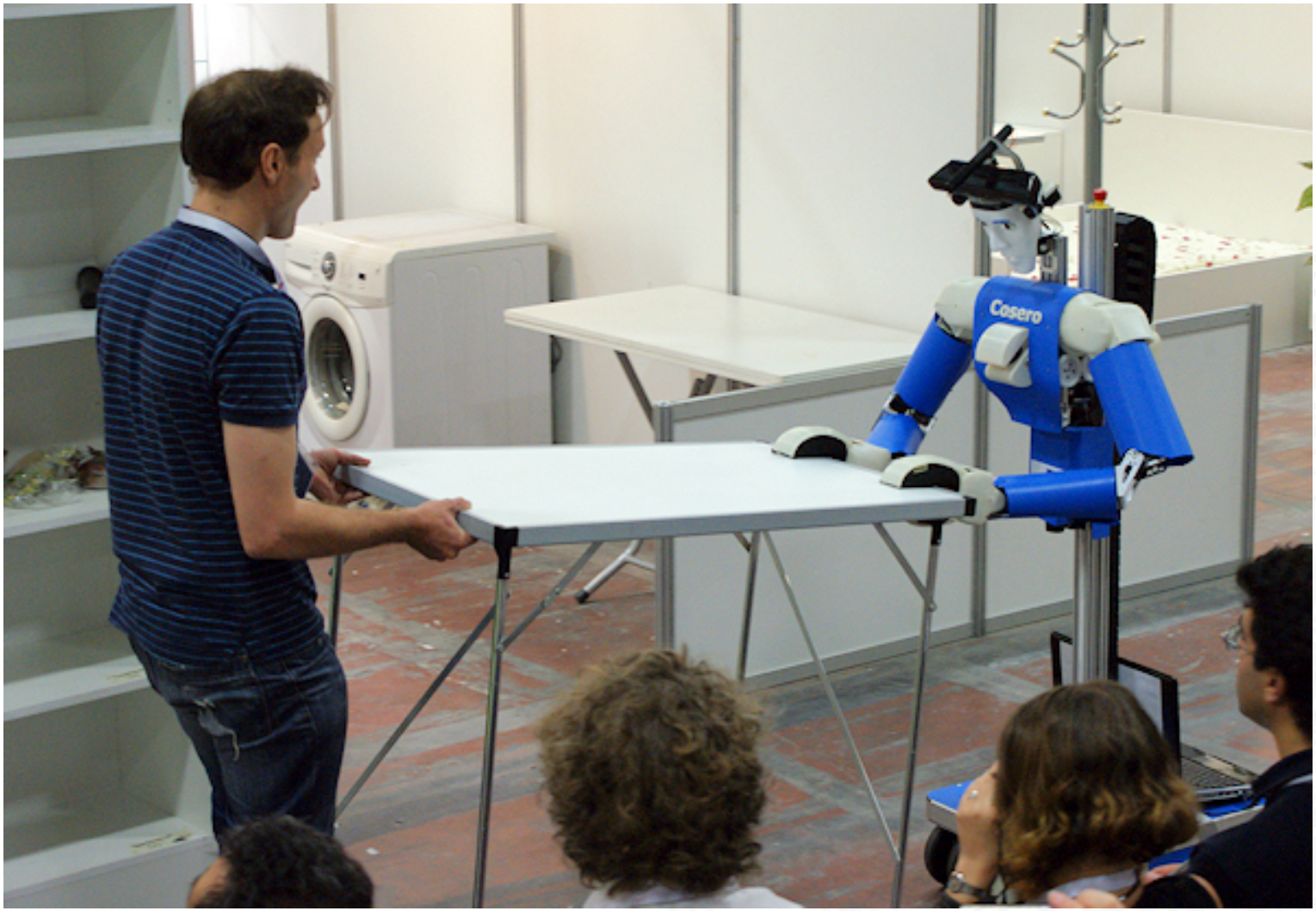
[3] http://robohub.org/robocup-video-series-industrial-league/

RoboCup Rescue Leagues



[4] http://www.robocup2009.org/21-1-robocup%20rescue.html

RoboCup@Home Leagues



[5]

[5] https://ispr.info/2011/08/01/robocuphome-2011-when-the-home-help-is-a-robot/

RoboCup Soccer Leagues

6

[6] https://www.robocupgermanopen.de

RoboCup Soccer Leagues

- Humanoid Leagues
  - Several sizes
  - Only humanoid sensors
  - Humanoid dimensions
  - Adapted FIFA rules
- Standart Platform League
  - NAO
  - not humanoid

[7]

Win against FIFA World Cup champion in 2050

[7] https://robocup.informatik.uni-hamburg.de/wp-content/uploads/2017/07/P1100771-1.jpg

Pose Estimation Approaches

Pattern Matching [6]

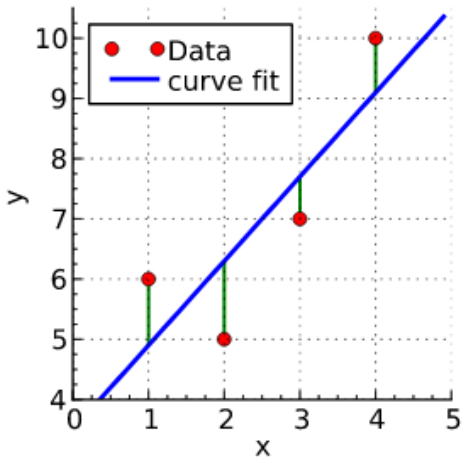
- Least-squares linear regression problem

Visual Compass [3]

- Visual map
- Histogram

Particle Filter [4]

- Probabilistic method
- Multiple sensor inputs



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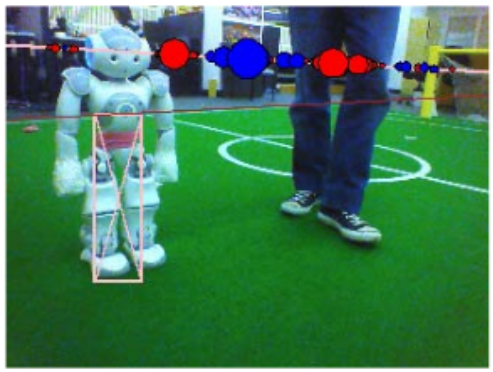

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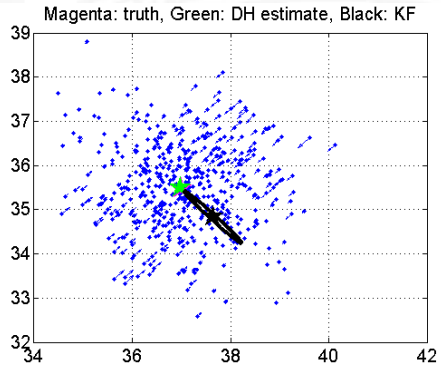


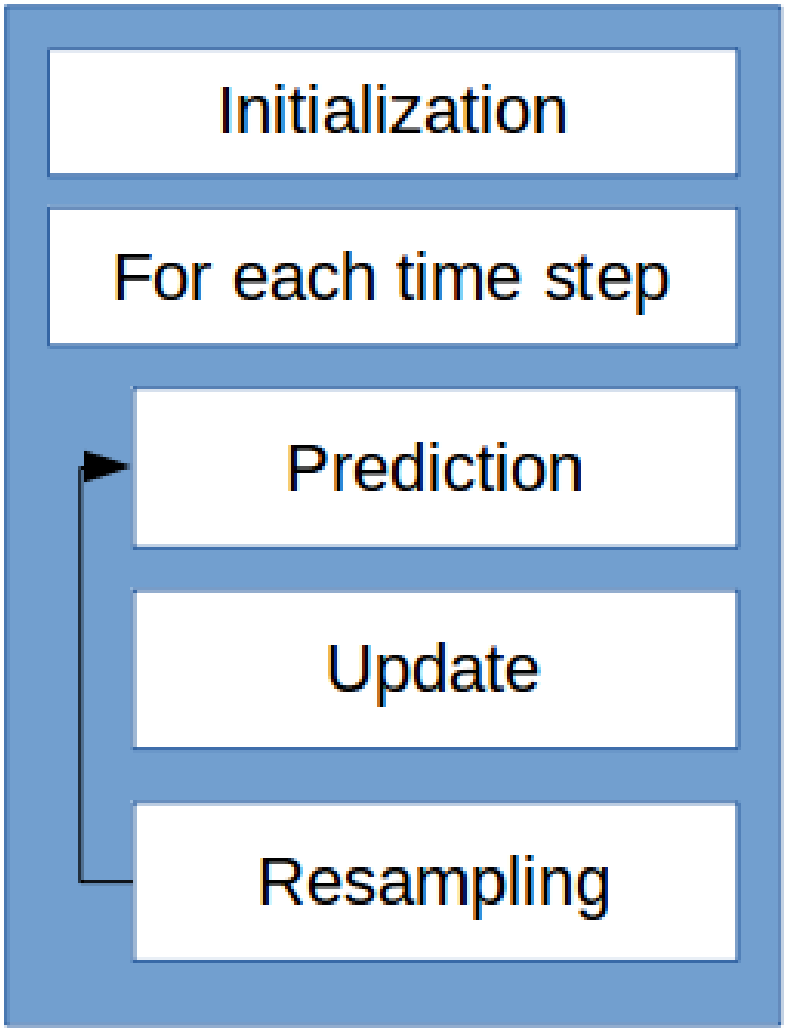
10

[8] https://upload.wikimedia.org/wikipedia/commons/b/b0/Linear_least_squares_example2.svg

[9] http://alife-robotics.co.jp/homepage2018/members2017/icarob/data/html/data/OS_pdf/OS12/OS12-4.pdf

[10] http://networks.ece.mcgill.ca/sites/default/files/1.png

Particle Filter



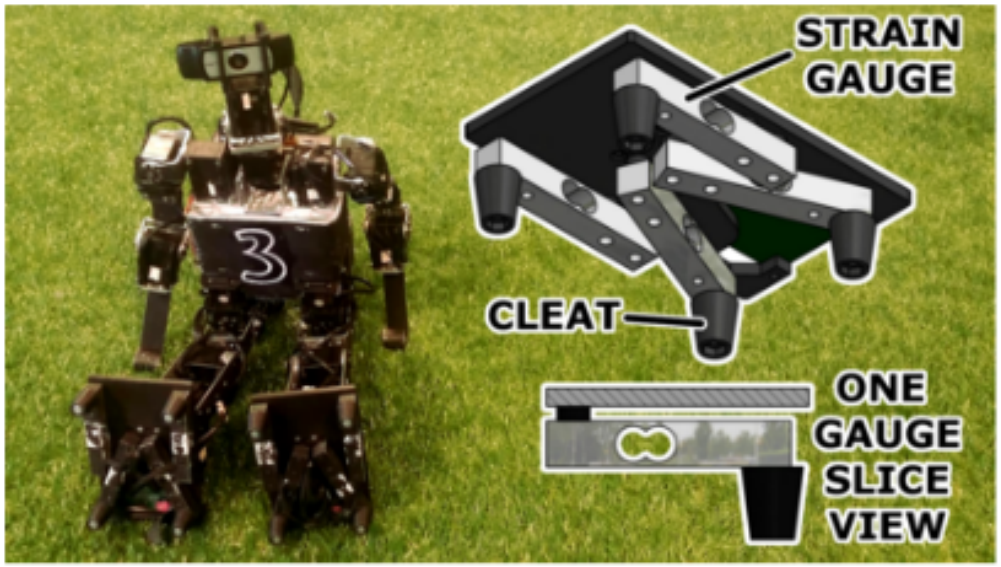
Particle filter

Problems in Humanoid Kid Size League

- Odometry hard
- Bad vision
- Computationally limited
- Symmetry of the field
- Other robots occluding view
- ...

Approaches in Humanoid Kid Size League

- Reminder: Odometry hard
- Rhoban [2]:
  - 3D Particle filter
    - Magnetometer
    - Field boarders and goals posts
  - Foot pressure sensors
    - Action model less erroneous
    - Visual observations scored

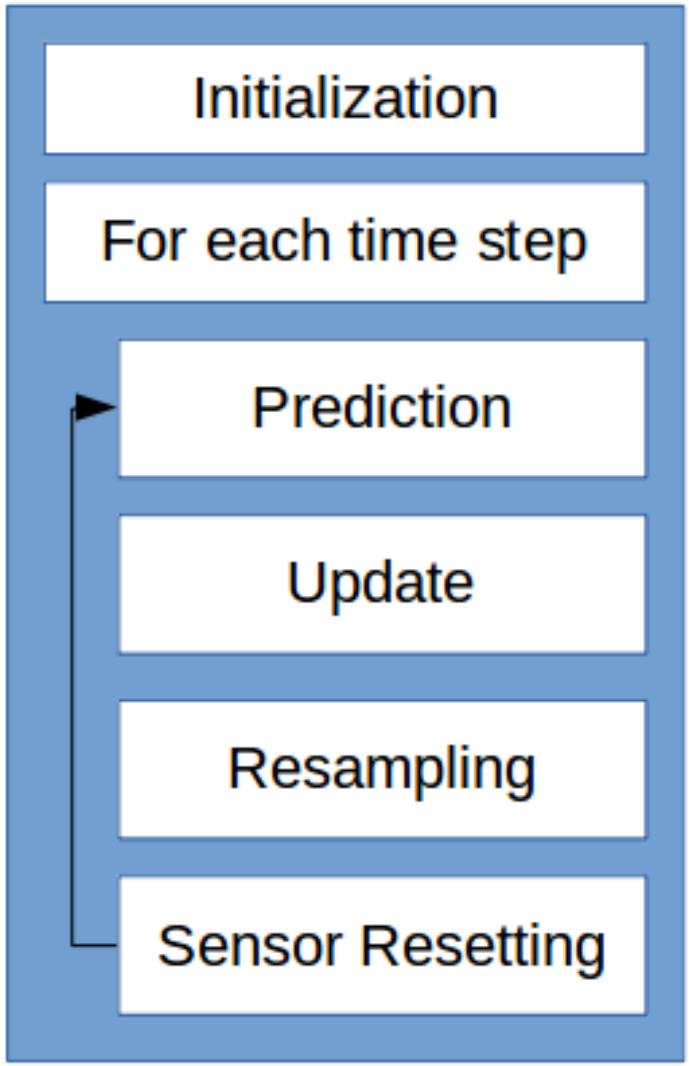


[11]

[11] https://www.robocuphumanoid.org/qualification/2017/22ee18648e39f3f656609d932ab6ccaa70a66929/Rhoban_Fooball_Club_Humanoid_KidSize_regularanddrop_in_2017_TDP.pdf

Approaches in Humanoid Kid Size League

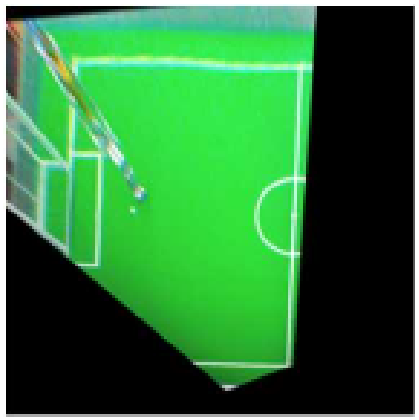
- Reminder: Bad vision
- ZJU[5]
  - Particle filter with *sensor resetting*
  - Input noisy
  - Propability of particles low
  - Replace some particles with noisy ones



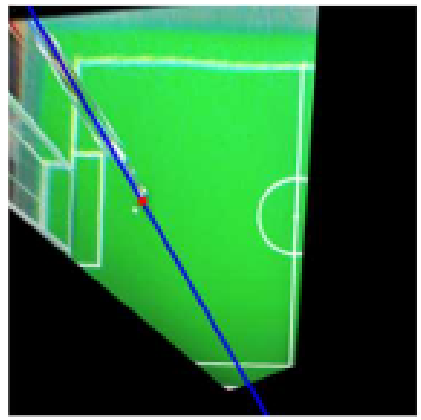
Approaches in Standart Platform League

- Improvement: Communication
- Camellia Dragons [1]
  - *Observer view* robot observing field
  - Sharing information via WiFi
  - Resampling particles with additional information
  - Not natural like in usual soccer

Camera image



True perspective image



Pose estimation

[12] http://alife-robotics.co.jp/homepage2018/members2017/icarob/data/html/data/OS_pdf/OS12/OS12-4.pdf

Summary

- Hardware
  - Foot pressure sensors: Better data for particle filter
- Software
  - Sensor resetting: Escape from bad estimates
  - Observer view: Use all capacities

Conclusion and Perspectives

- Particle filter popular and reliable
- Workarounds for bad sensor data
- Hardware improvements useful
- Communication becoming more important
- Better computers/ sensors

Conclusion and Perspectives

References

[1] Yo Aizawa, Takuo Suzuki, and Kunikazu Kobayashi. Improvement of robot's self-localization by using observer view positional information, 2017. The 2017 International Conference on Artificial Life and Robotics (ICAROB 2017), Jan. 19-22, Seagaia Convention Center, Miyazaki, Japan.

[2] Julien Allali, Louis Deguillaume, Remi Fabre, Loic Gondry, Ludovic Hofer, Olivier Ly, Steve NGuyen, Gregoire Passault, Antoine Pirrone, and Quentin Rouxel. *Rhoban football club: Robocup humanoid kid-size 2016 champion team paper*. Springer Berlin Heidelberg, Berlin, Heidelberg, 2016.

[3] Peter Anderson and Bernhard Hengst. *Fast Monocular Visual Compass for a Computationally Limited Robot*, pages 244–255. Springer Berlin Heidelberg, Berlin, Heidelberg, 2014.

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[4] S. Lenser and M. Veloso. Sensor resetting localization for poorly modelled mobile robots. In *Proceedings 2000 ICRA. Millennium Conference. IEEE International Conference on Robotics and Automation. Symposia Proceedings (Cat. No.00CH37065)*, volume 2, pages 1225–1232 vol.2, 2000.

[5] Mei WenXing, Pan Yusu, Peng Bo, Jiang ChaoFeng, Liu Yun, and Xiong Rong. Zjudancer team description paper, 2017. RoboCup 2017 Team Description Paper Humanoid Kid-Size League.

[6] Thomas Whelan, Sonja Stüdli, John McDonald, and Richard H. Middleton. *Efficient Localization for Robot Soccer Using Pattern Matching*, pages 16–30. Springer Berlin Heidelberg, Berlin, Heidelberg, 2012.