Feature-Based Monte Carlo Localization in the RoboCup Humanoid Soccer League

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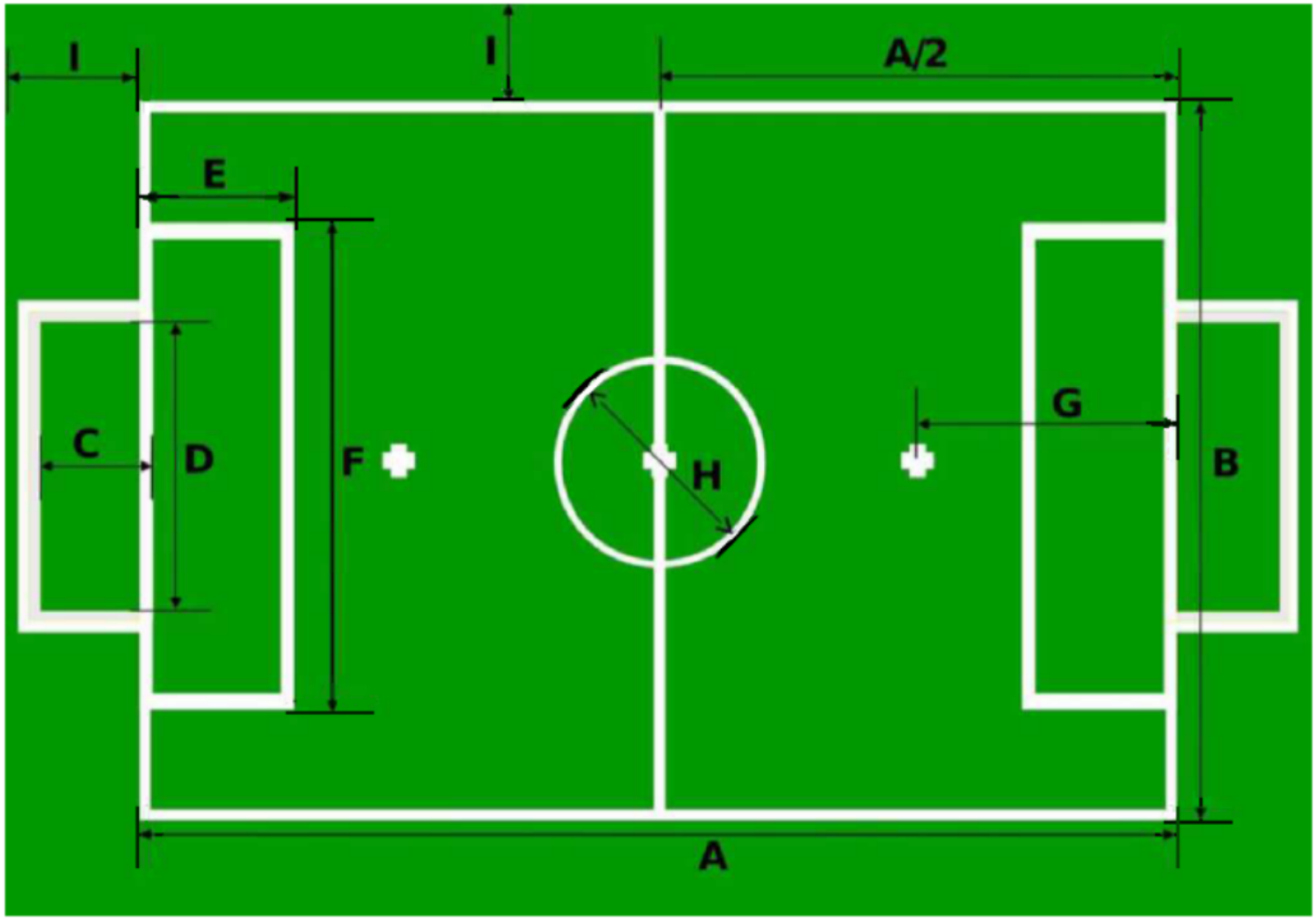
Outline

Motivation

- MCL for RoboCup Humanoid Soccer
  - Humanoid Robot
  - Soccer field
- Several kinds of information for MCL
- Evaluate performance on different combinations

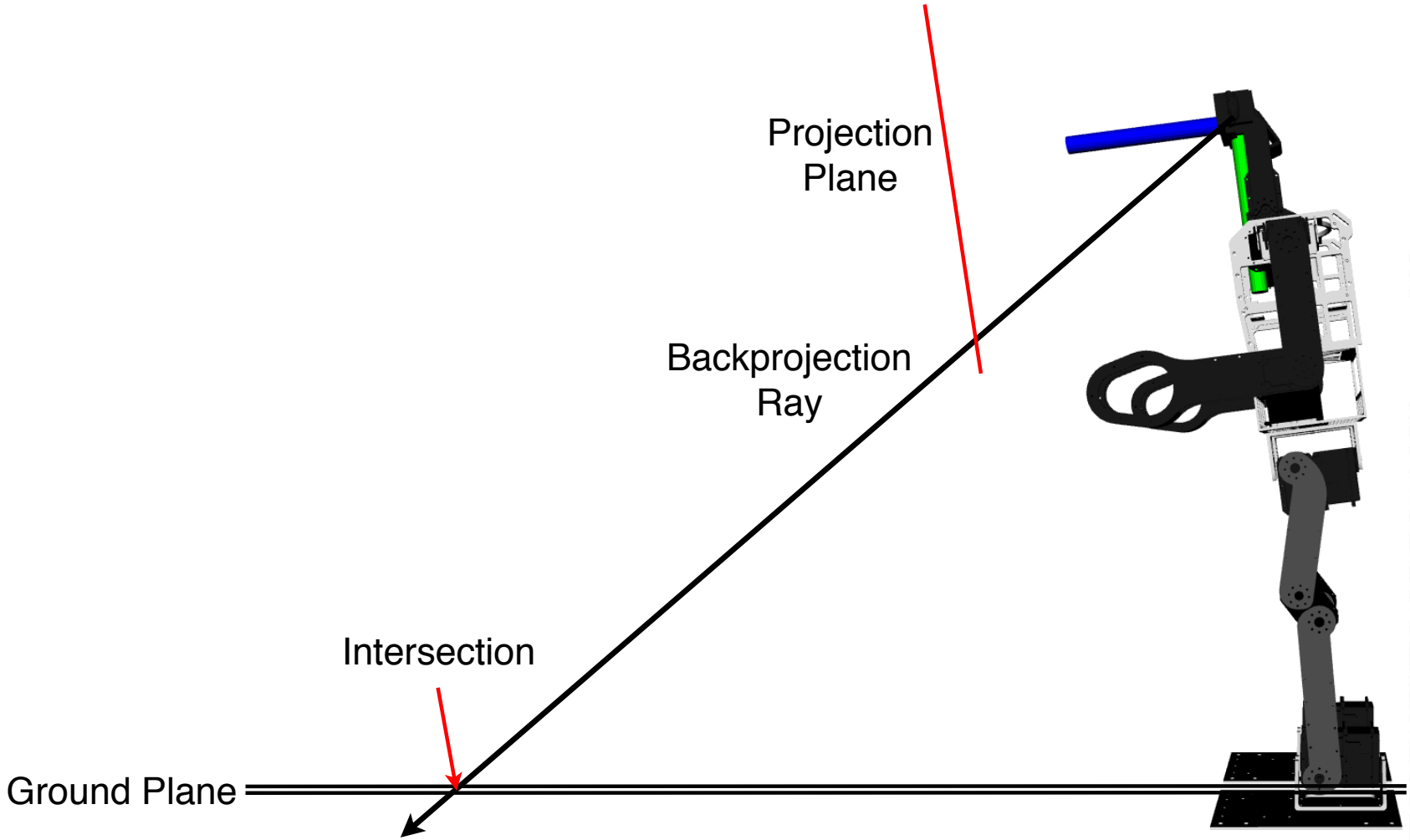
RoboCup Soccer



https://humanoid.robocup.org/wp-content/uploads/RCHL-2019-Rules-final.pdf

Hamburg Bit-Bots - Wolfgang

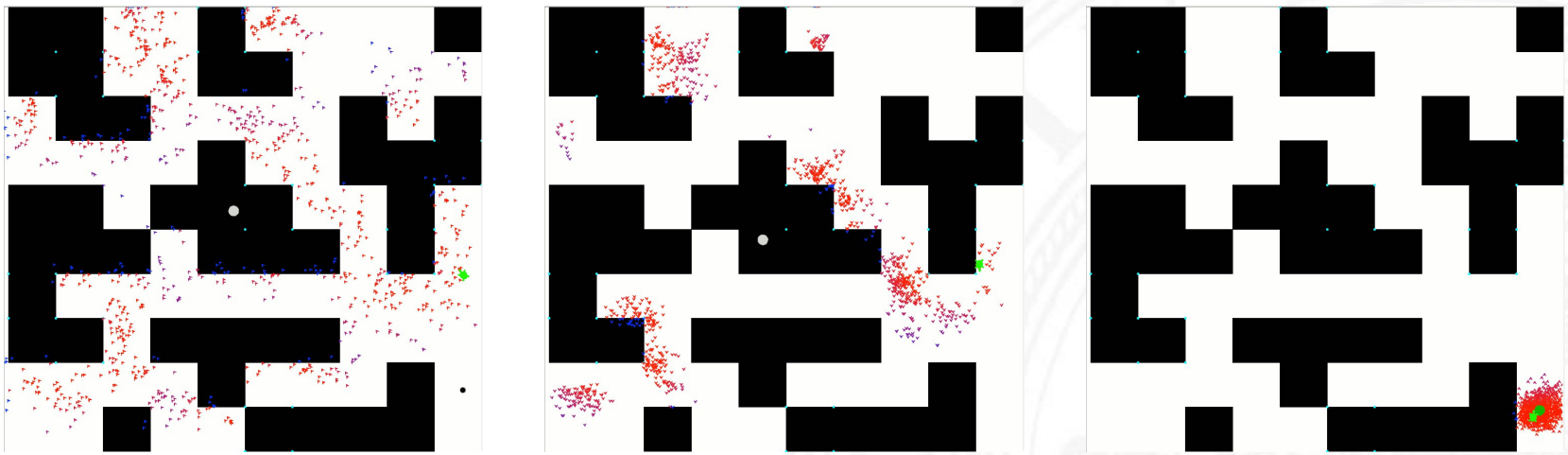
Transformation to Cartesian Space



Transformation from image space to Cartesian space. [Gü18]

Related Work

- MCL
  - Particle filter for self-localization [DFBT99]
    - Prediction
    - Update
    - Resampling [LV00]



1 2 3

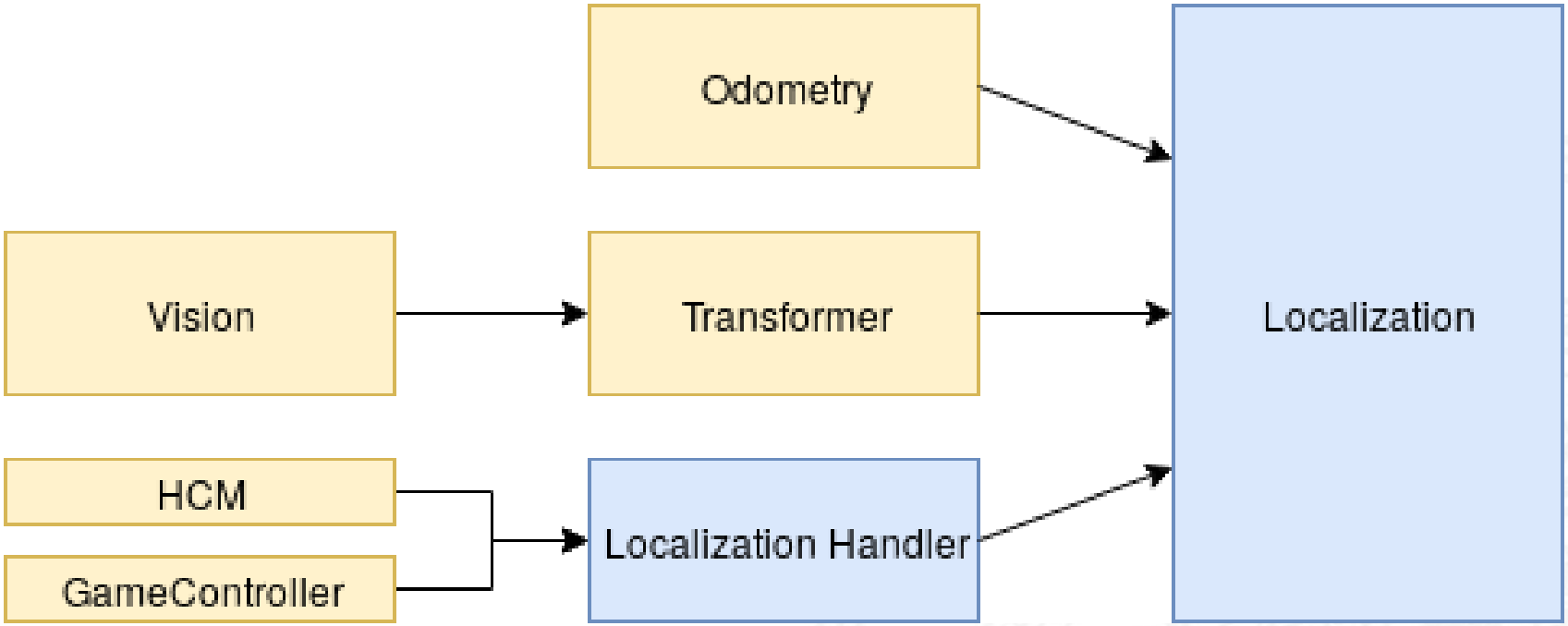
https://i.stack.imgur.com/YylQT.gif

Related Work - cont.

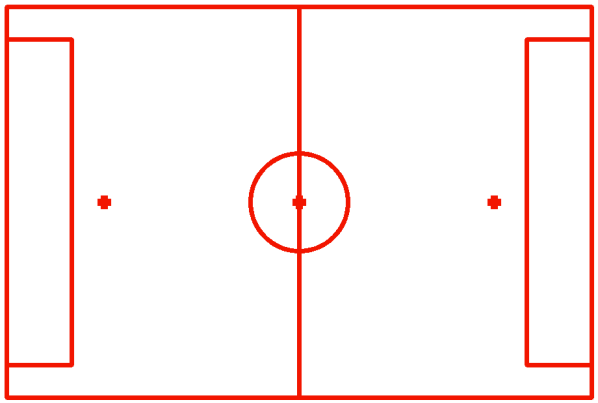
- MCL in RoboCup Soccer
  - Sony Four-Legged League [RJ04]
    - lines and walls around the field
    - color-coded beacons
  - 3D Soccer Simulation League [MAMP16]
    - lines, goalposts and corner flags
  - Humanoid Kid Size League [AGH+19]
    - goal posts and corners
    - information from referee

- MCL with ROS
  - amcl [Bri]
    - KLD-Sampling
    - wheeled robot, laser range finder
    - only one input

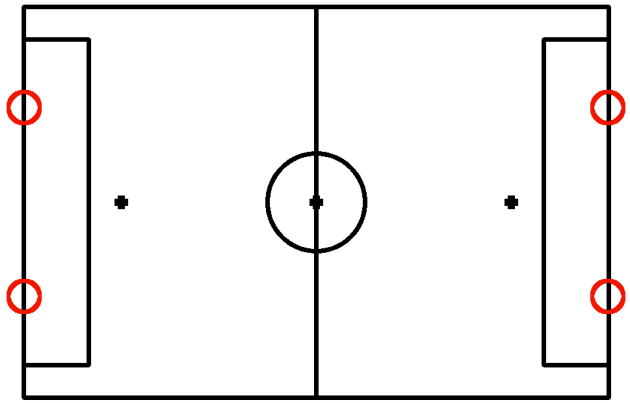
Approach


Odometry
Vision
Transformer
Localization
HCM
GameController
Localization Handler

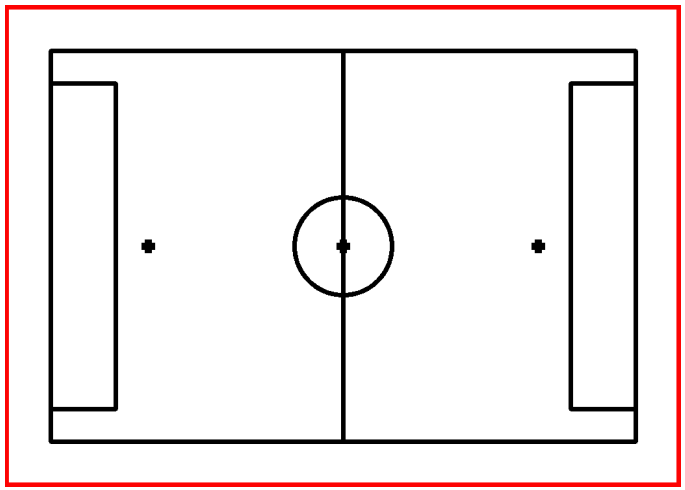
Input



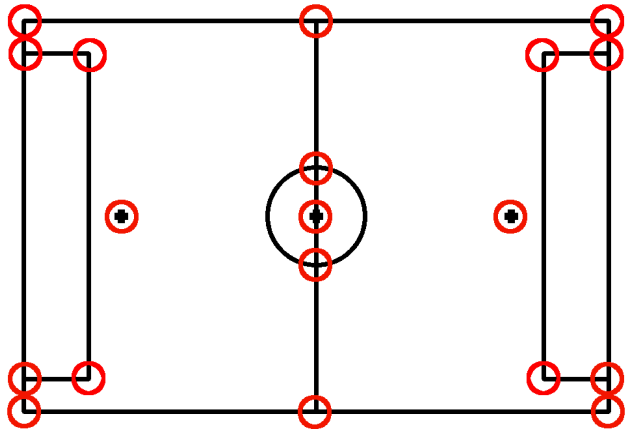
field markings



goal posts

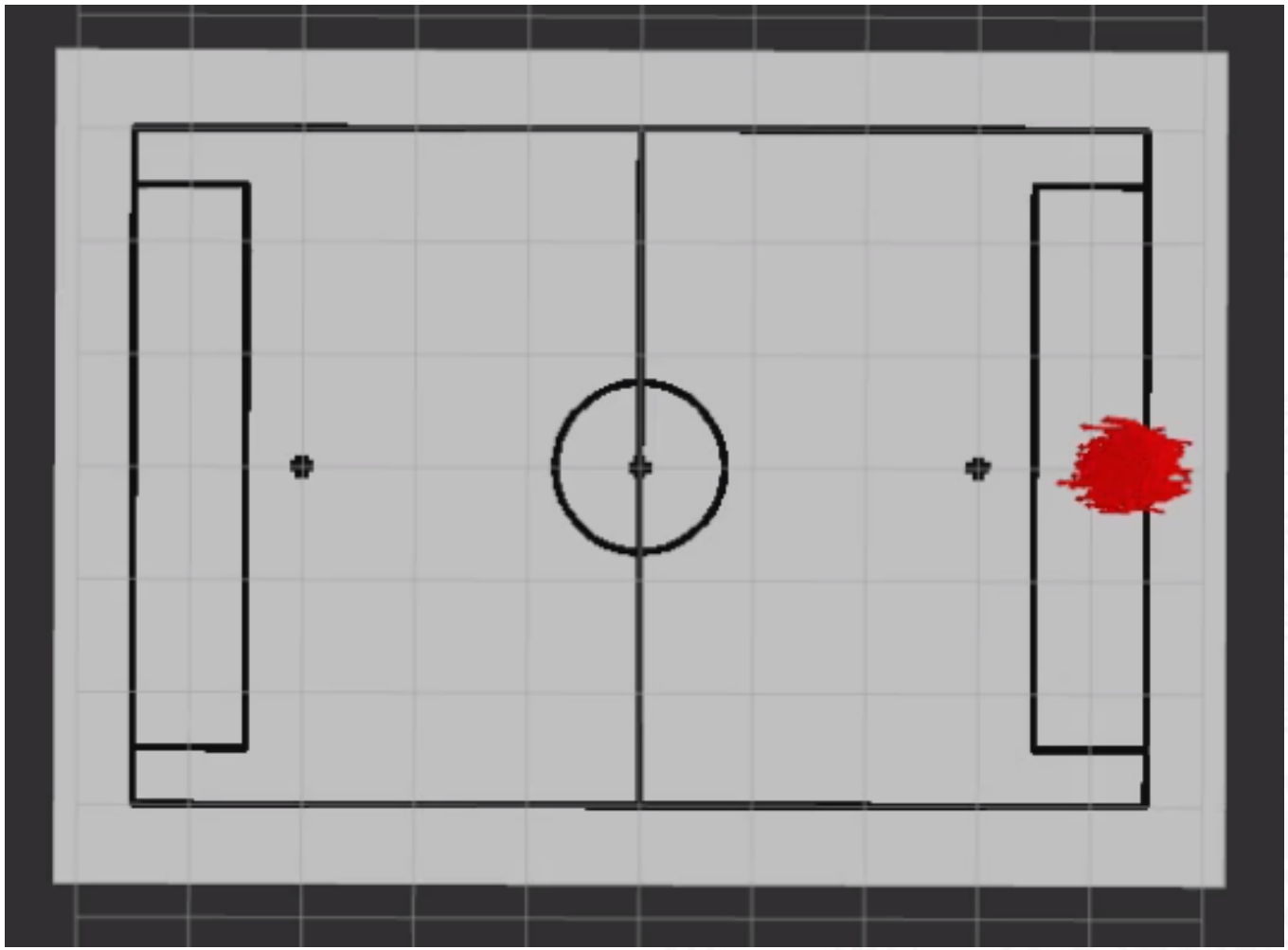


field boundary

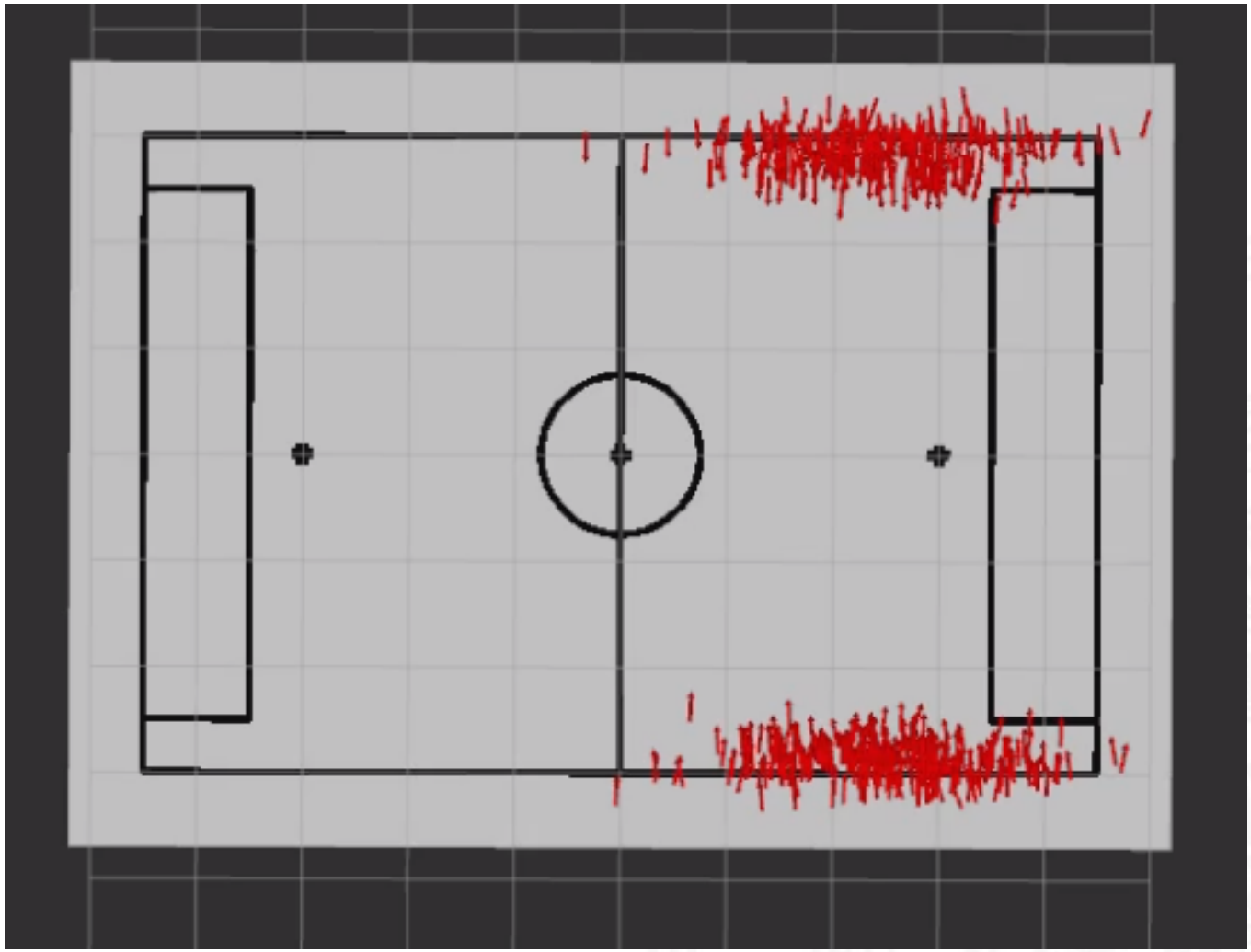


features

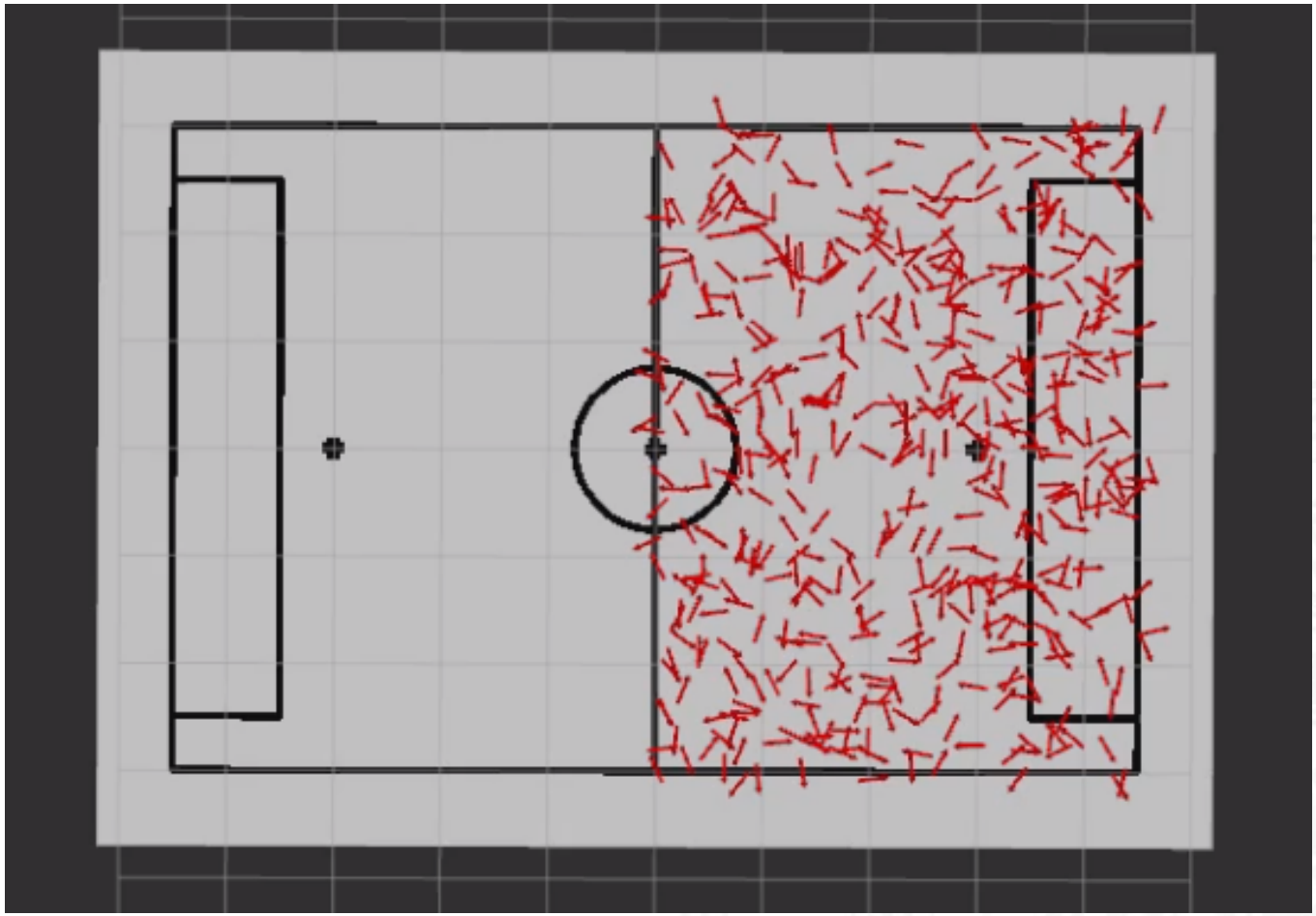
Initial Distributions - Pose



Initial Distributions - Multiple regions



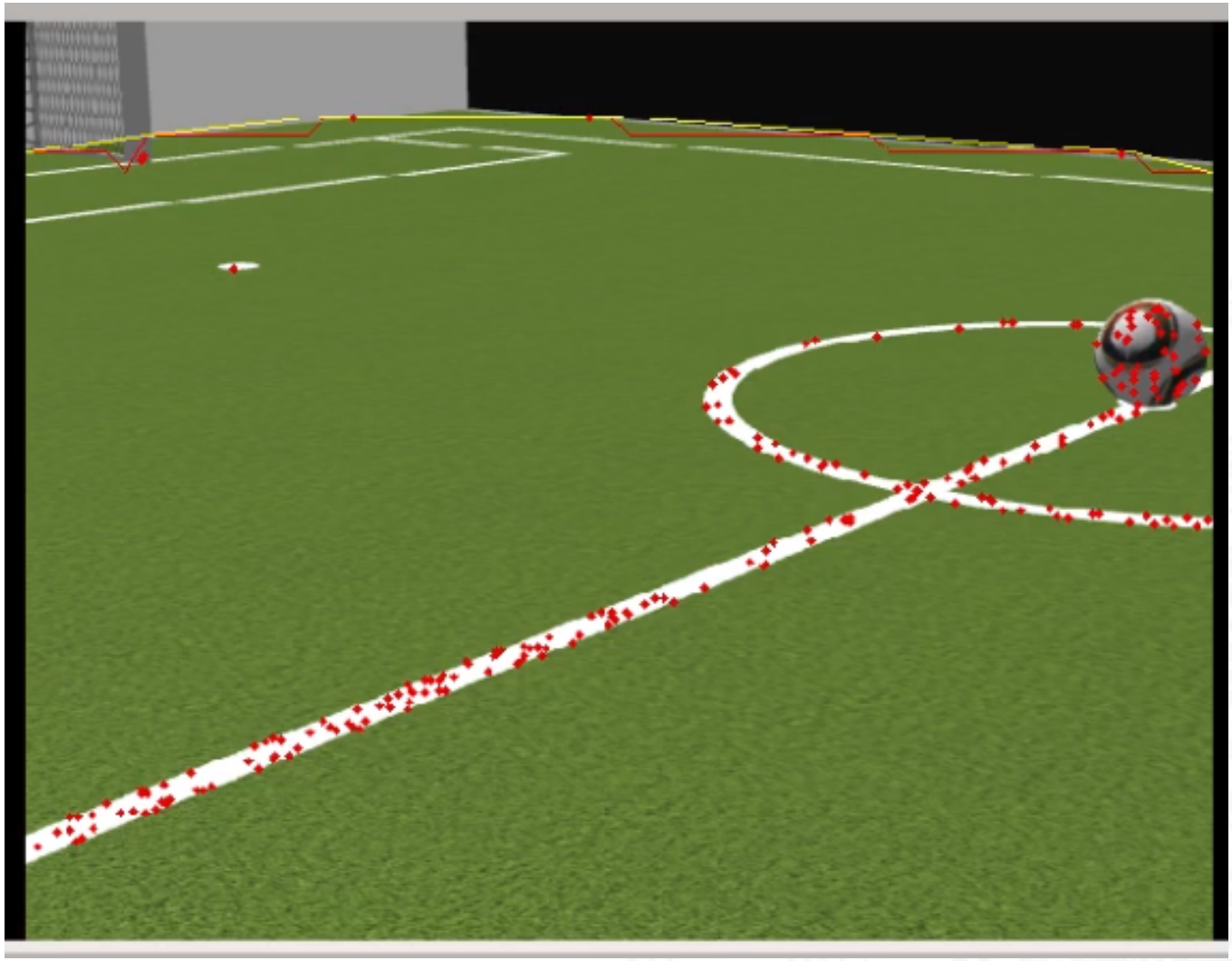
Initial Distributions - One half



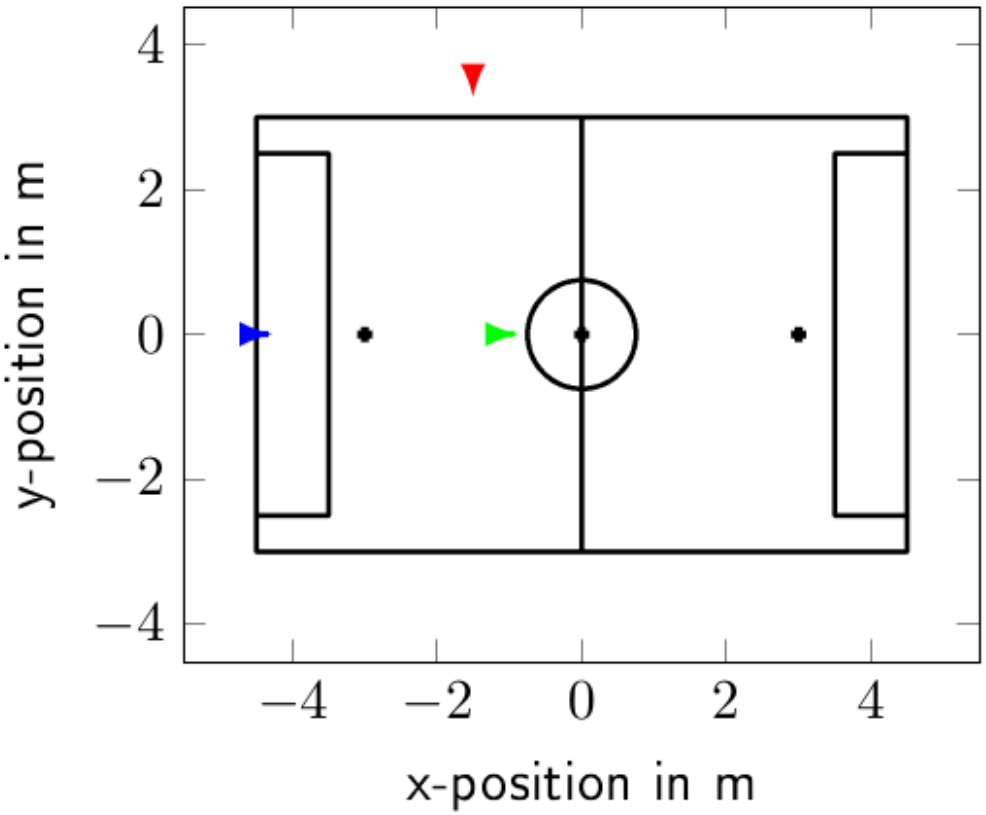
Evaluation

- Realistic scenarios
- Localization
- Pose tracking
- in simulator

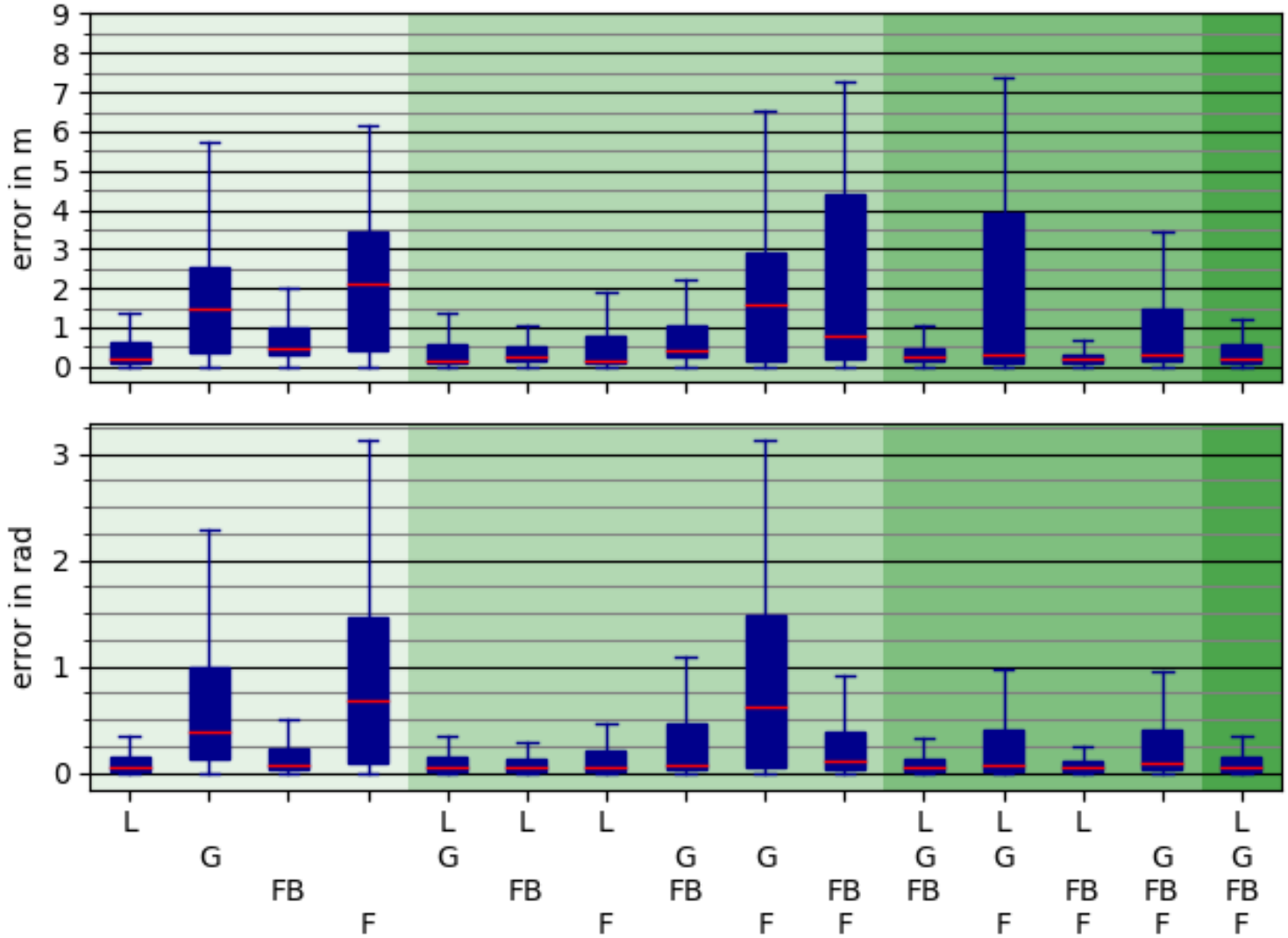
Evaluation (cont.)



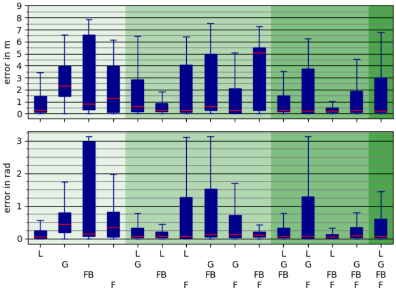
Localization

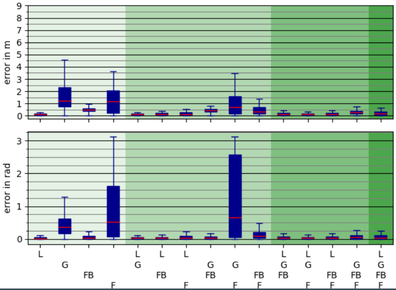


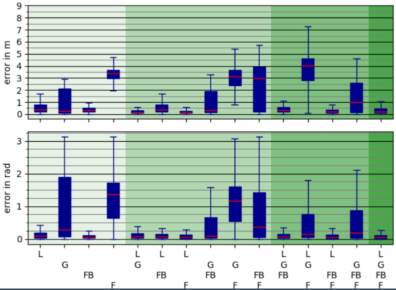
Localization



Localization - Scenarios



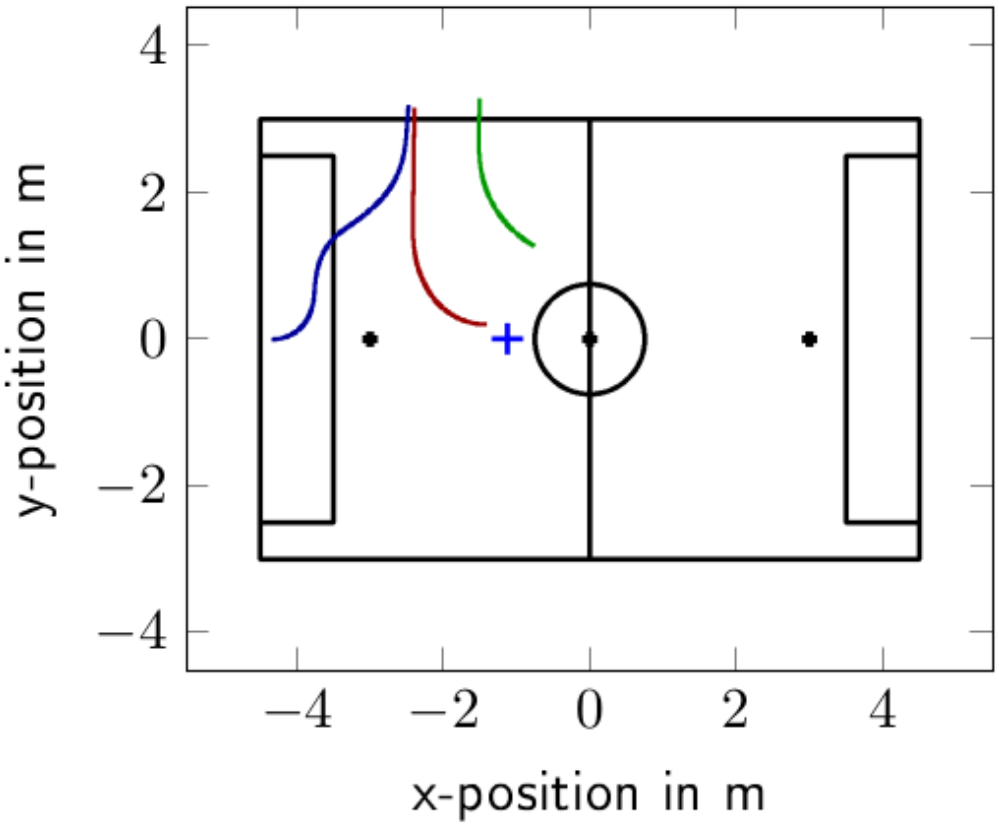




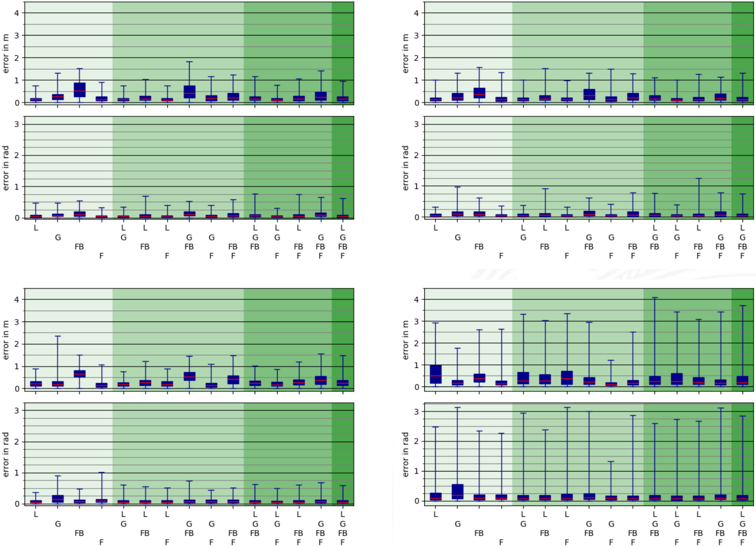
Localization

- Lines and field boundary: good localization information
- Including more inputs: no huge improvement
- Scenarios have different difficulties

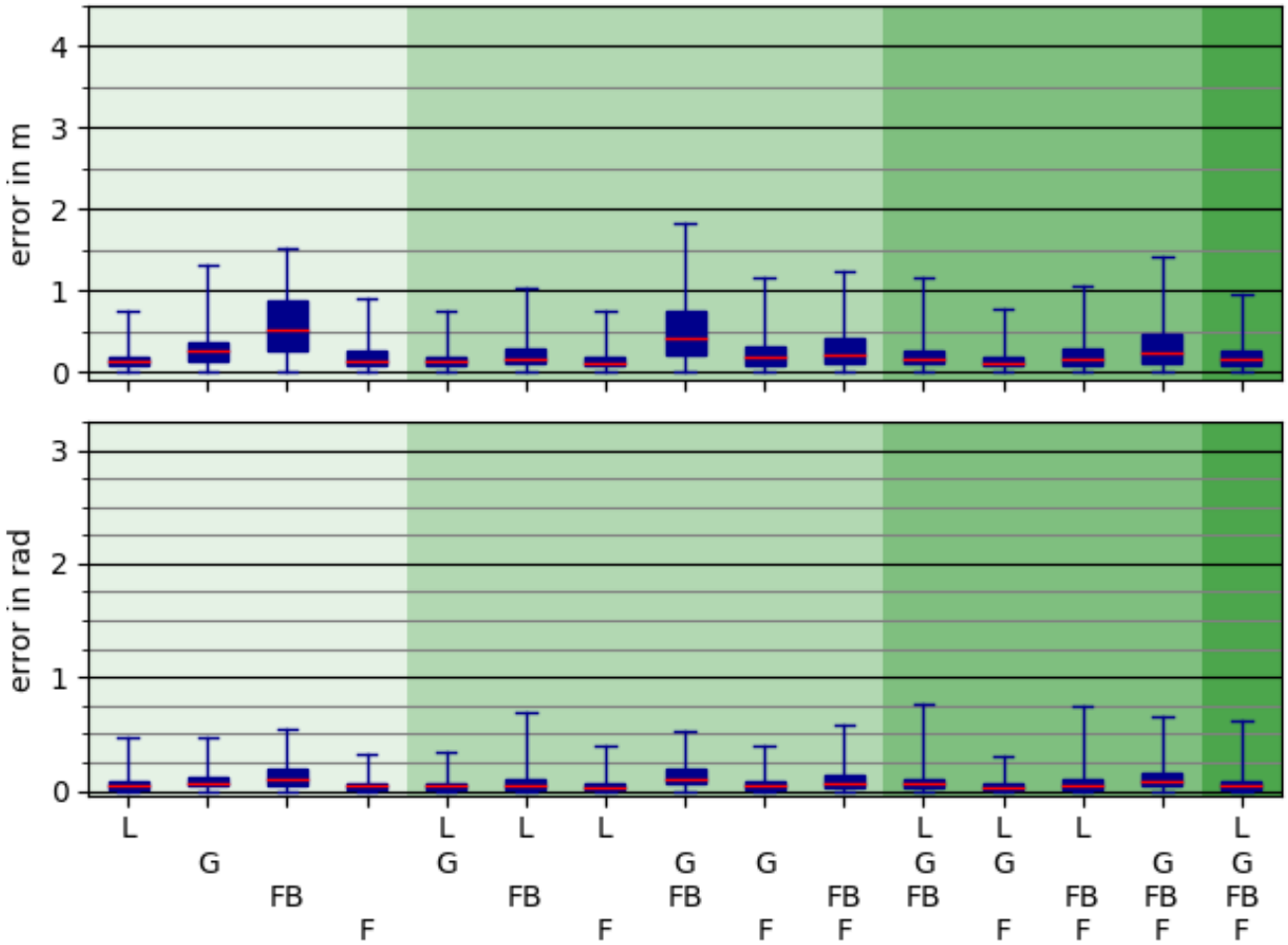
Pose Tracking



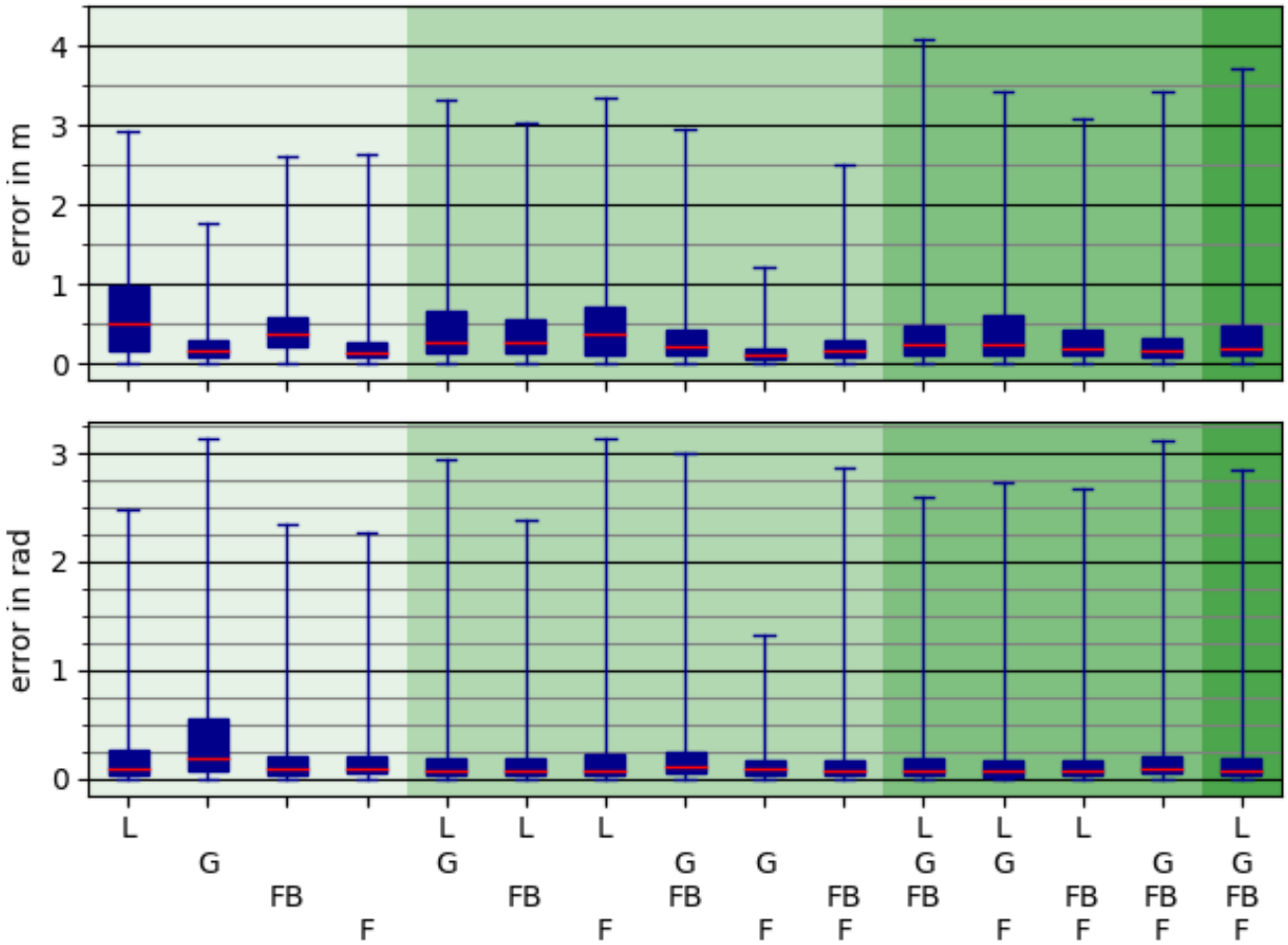
Pose Tracking - Scenarios



Pose Tracking - Scenario 1



Pose Tracking - Scenario 4



- Similar scenarios similarly difficult
- Lines are good localization input
- Features are second best
- Scenario 4: goals and features (!)
- more than two information sources have no huge improvement

Summary

- Localization and pose tracking working
- Lines most successful
- Field boundary and field features scored second
- Goals and features in one scenario
- Including more than two sources has no huge effect
- But different information sources can be helpful in different scenarios
- Scenarios have different difficulties
- Initialization with multiple known regions seems to be very helpful
- Take away message: reliable line detection good, more kinds make it more robust

Future Work

- Evaluate on real robot
- Adjust input source to scenario
- Include more information sources

References

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[RJ04] Thomas Röfer and Matthias Jüngel. *Fast and Robust Edge-Based Localization in the Sony Four-Legged Robot League*, volume 3020, page 262–273. Springer Berlin Heidelberg, 2004.