TDP 2013

MRL-SPL TDP

INTRODUCTION

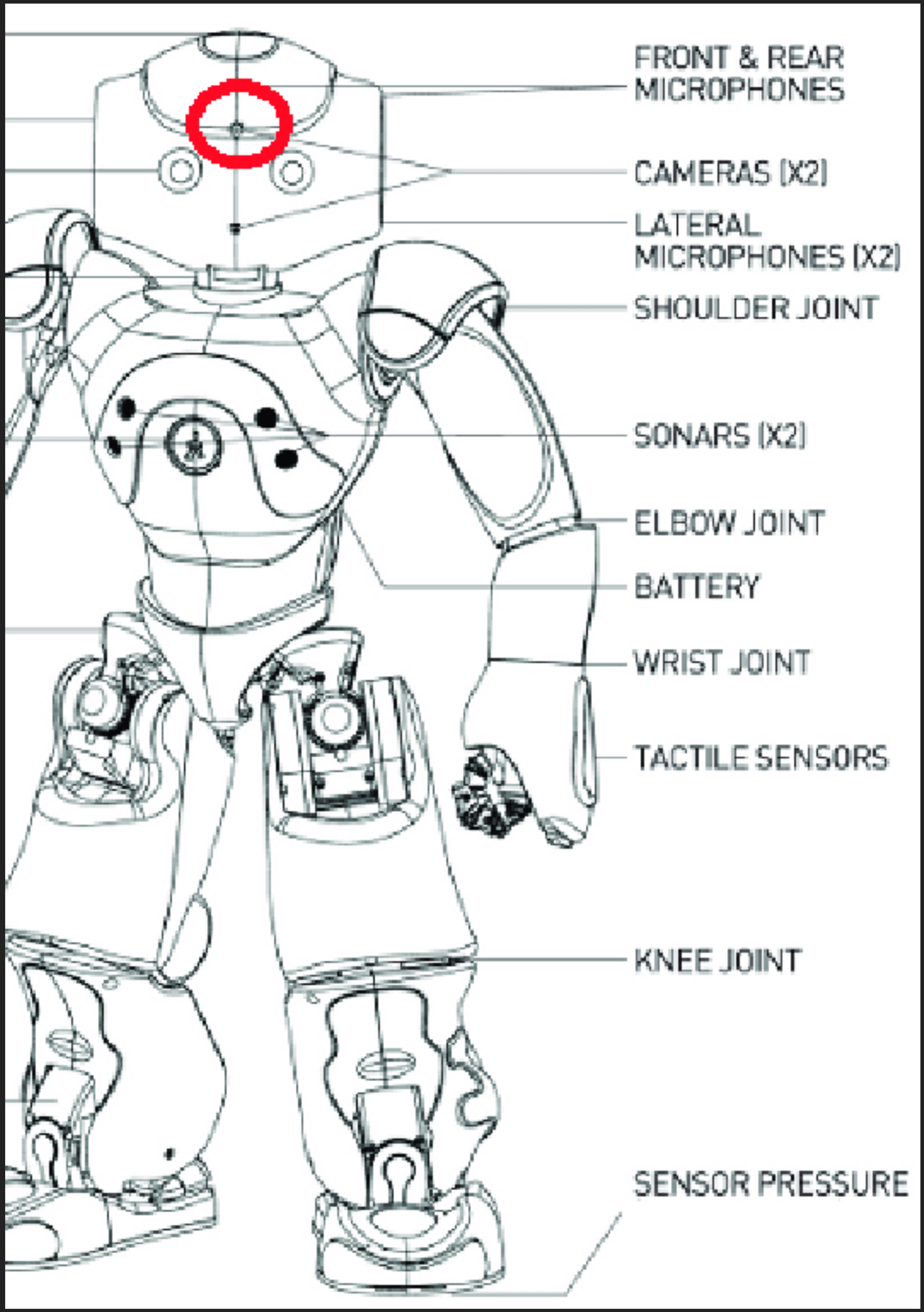
- MRL Participate in RoboCup since 2002
- MRL-SPL Participate in RoboCup from 2012 to 2017

STANDARD PLATFORM LEAGUE

- Robot Play Soccer against each other on teams of 5.
- Team only contribute on the Robot Software.

ROBOT ARCHITECTURE

- Runs Linux OS
- Intel Atom CPU
- No-GPU
- 2x Camera
- 21 DOF Joint

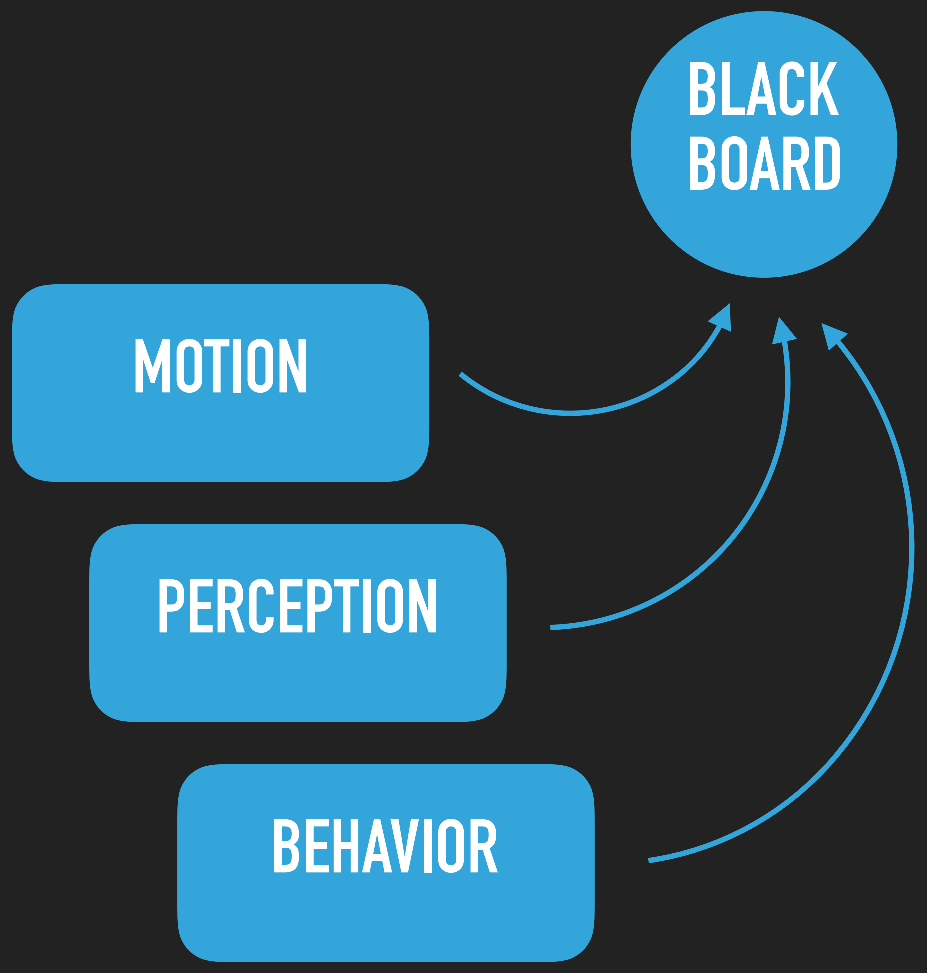


CONTENTS OF THIS PRESENTATION

- Software Architecture
- Perception
- Localization and Modeling
- Behavior Control
- Motion Control

SOFTWARE ARCHITECTURE

- Blackboard Structure.
- Modules:
  - Motion
  - Communication
  - Cognition
    - Perception
    - Modeling
    - Behavior

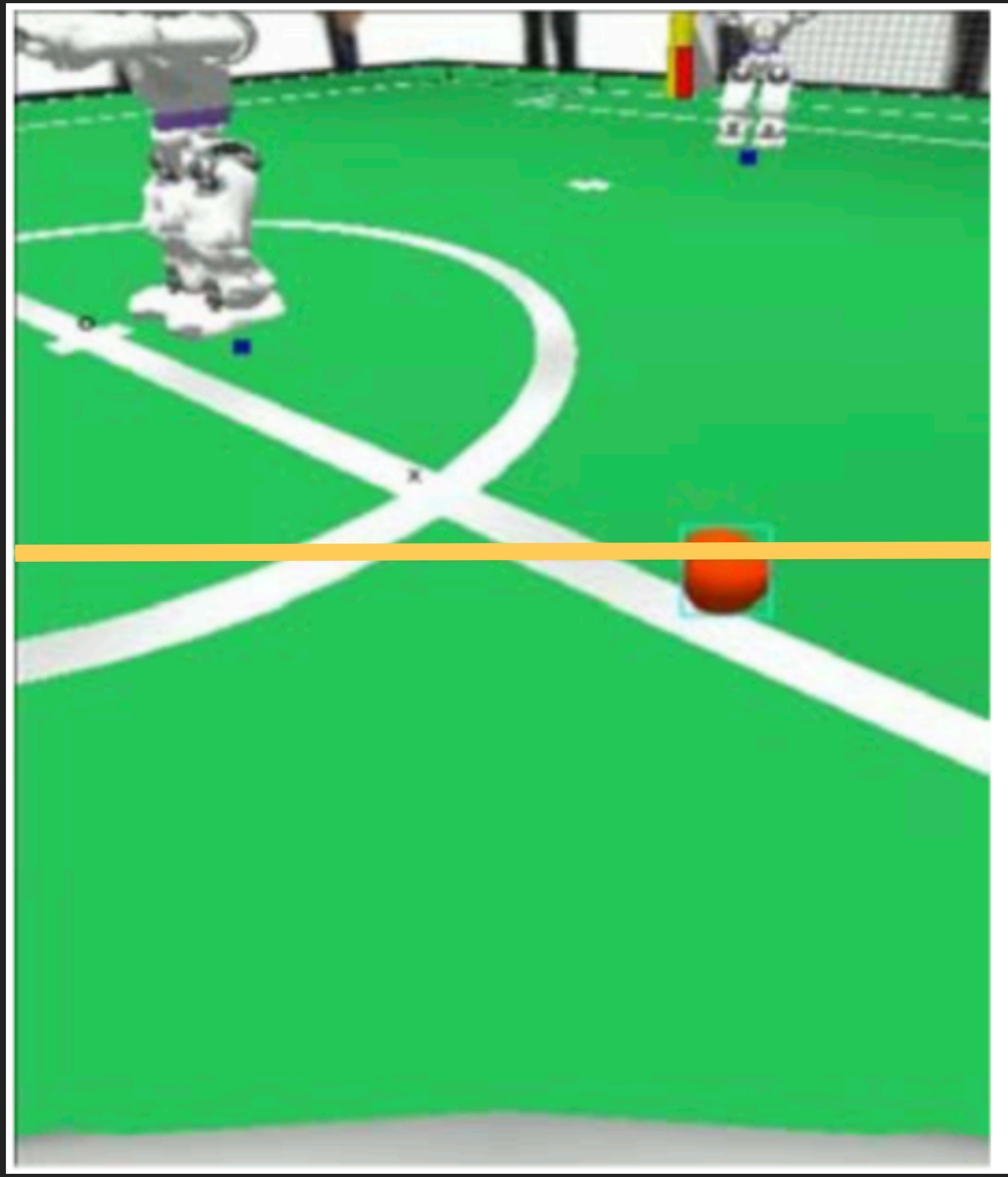


PERCEPTION

- Simultaneous Image Acquisition
- Camera and Torso Calibration
- Robot Detection
- Color Calibration

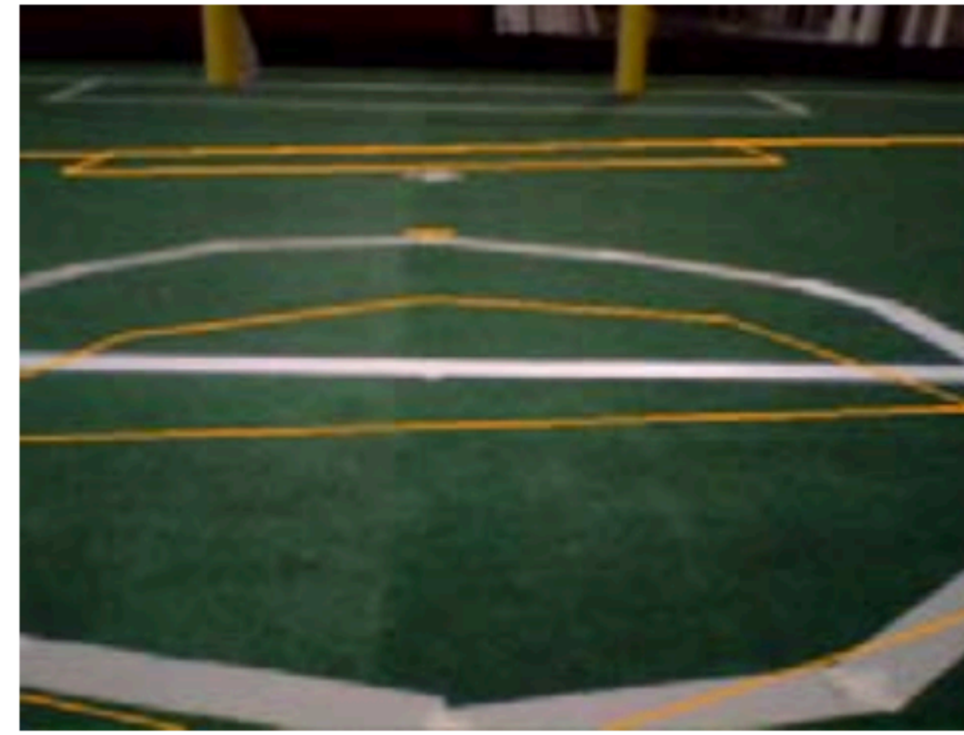
SIMULTANEOUS IMAGE ACQUISITION

- Previously Each image processed separately. (Processing whole world each other frame)
- Image Inconsistency



CAMERA AND TORSO CALIBRATION

- Displacement in Gyro Sensor and Cameras. (caused by collisions)
- Project Field lines on the Image.
- Calculate Errors using: Levenberg-Marquardt
- Optimize Error using: Gauss-Newton optimization



(a)

ROBOT DETECTION

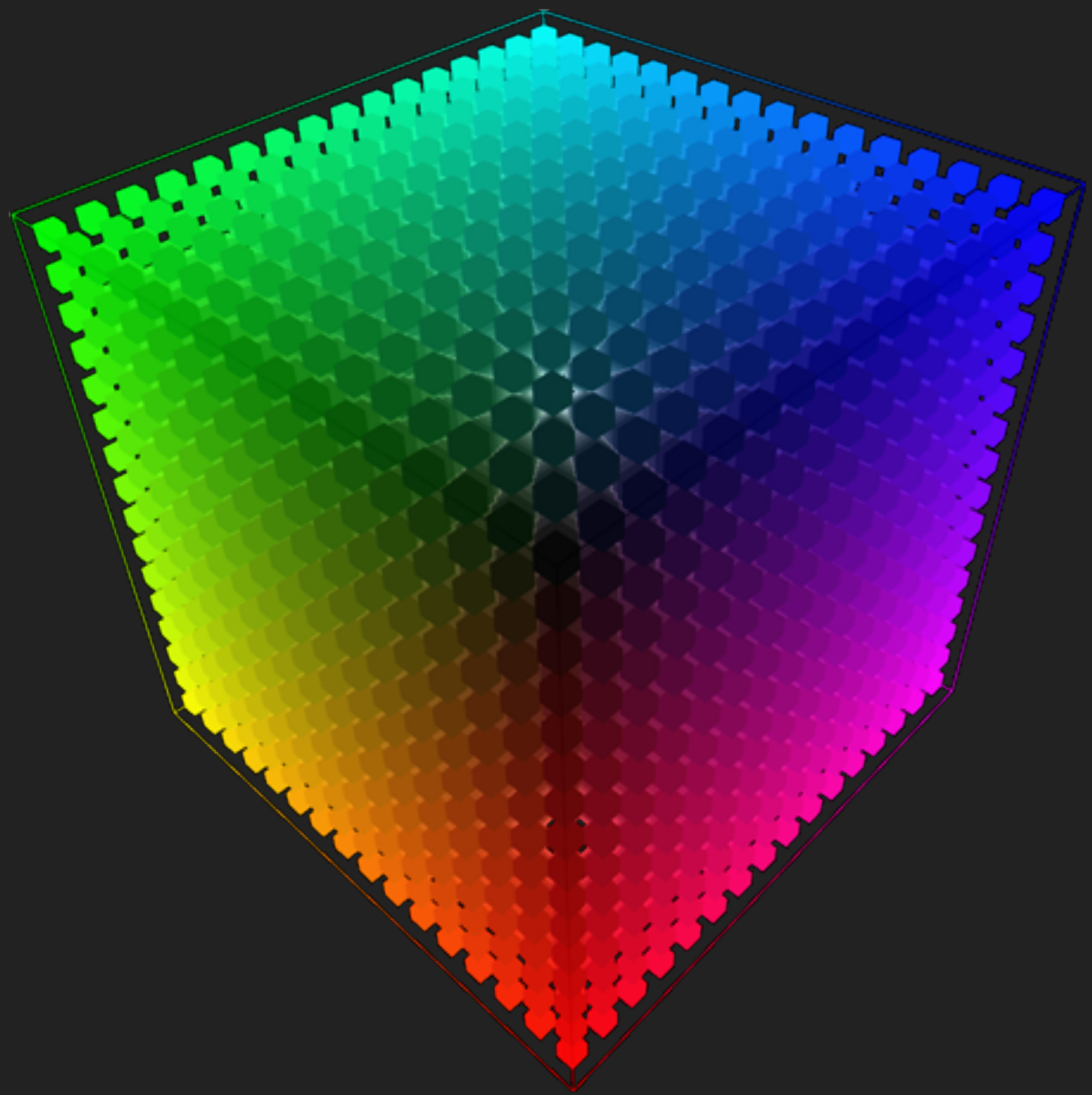
- Detect Robot **Wrist Band**
- Rundown until reach the Field-Green
- The white area around is Robot

ROBOT DETECTION - ON LOWER CAMERA

- No longer wrist band is visible
- Fit Curve on the white pixels
- If it is not a straight line, then it is a Robot

COLOR CALIBRATION

- Label each color prior to each game.
- Use predefined color labels to detect objects.

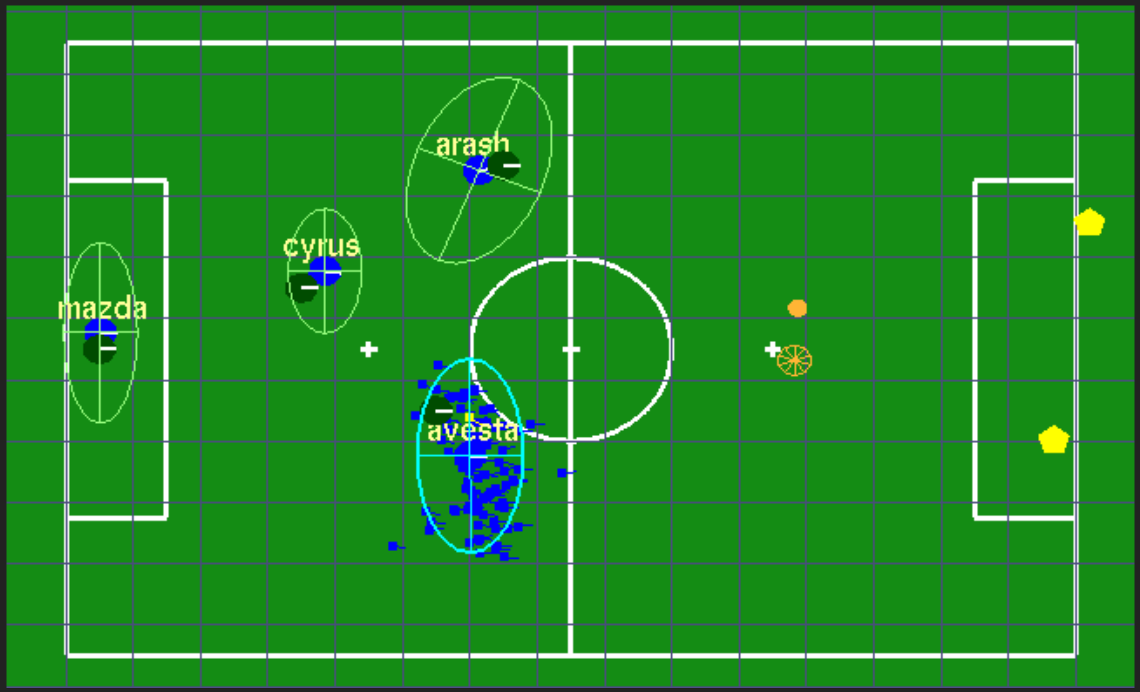


LOCALIZATION AND MODELING

- Localization
- World Modeling
- Coping with Symmetrical Environment

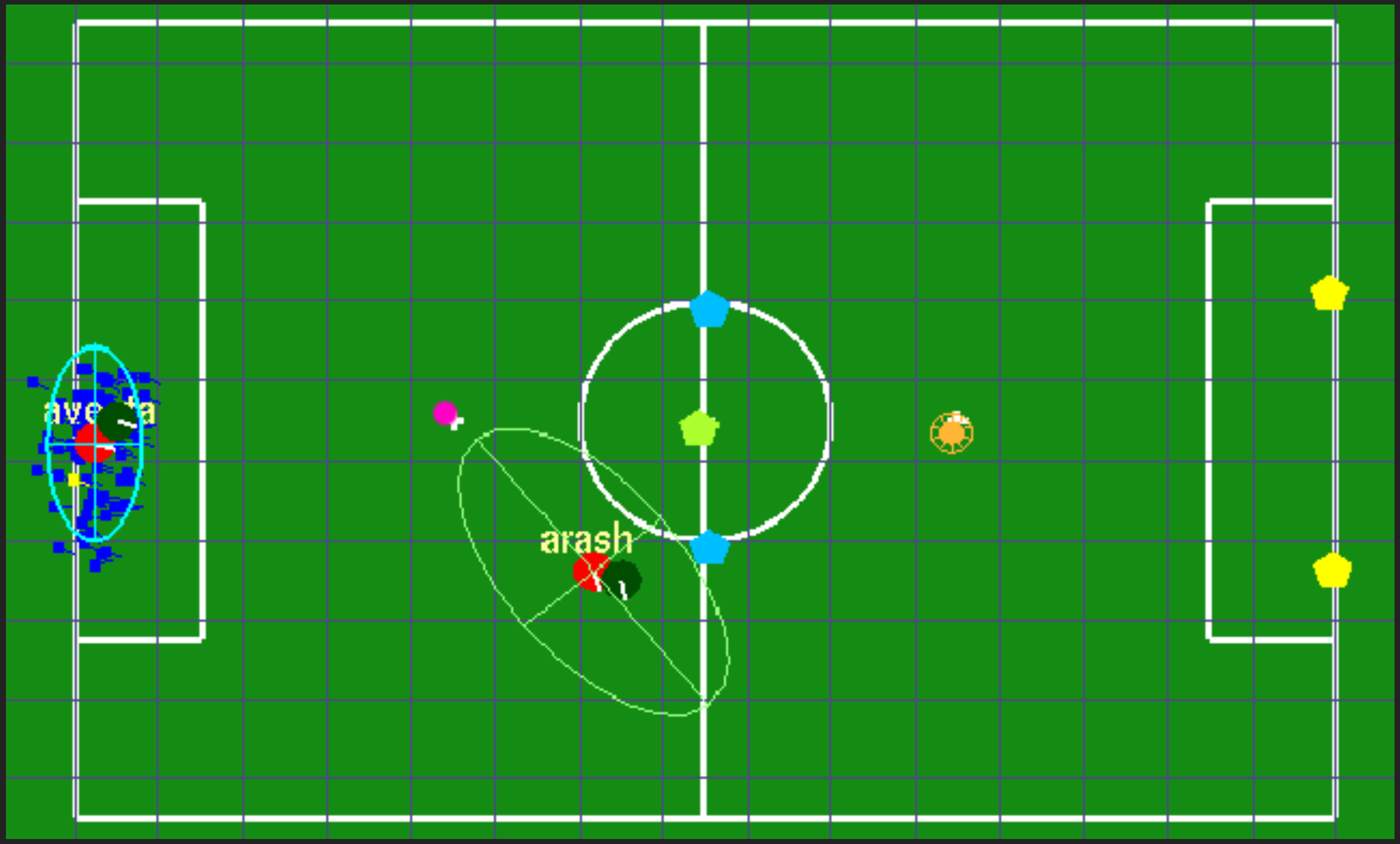
LOCALIZATION

- Reduce noise effect
- Monte-Carlo Localization (Particle Filter)



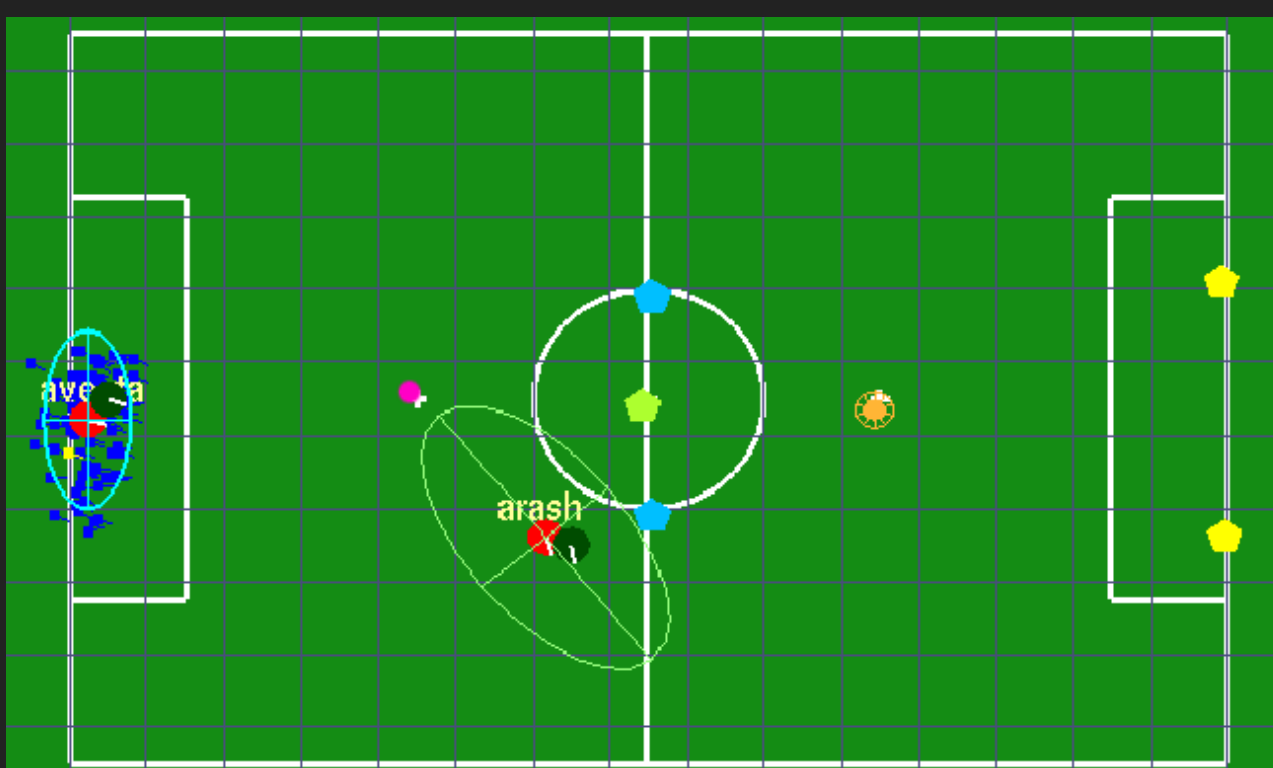
WORLD MODELING

- Model the object in order to track them.
- Robot Pose-Correction Flag*
- Role probability
- Universal Ball



COPING WITH SYMMETRICAL ENVIRONMENT

- Goalie see the ball and report to other players.
- Check the personal ball with the goalie report.

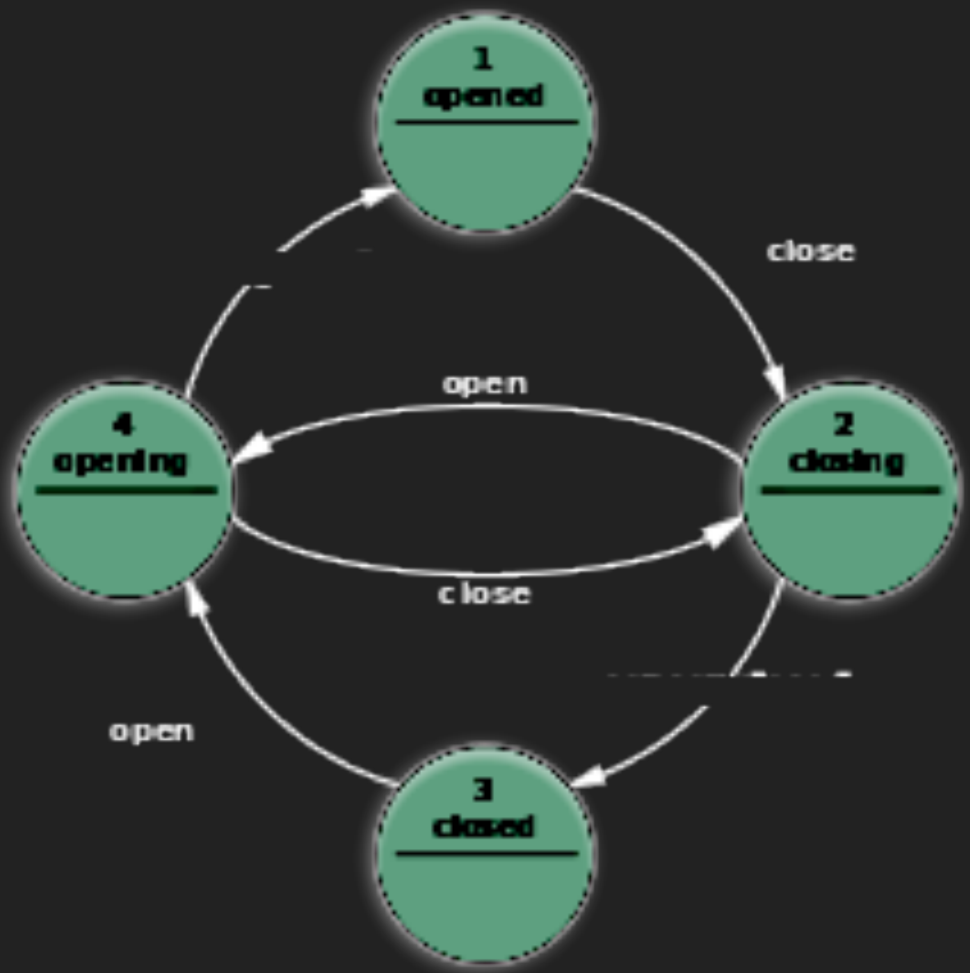


BEHAVIOR CONTROL

- Behavior Module Structure
- Path Planning
- Dynamic Head Motion

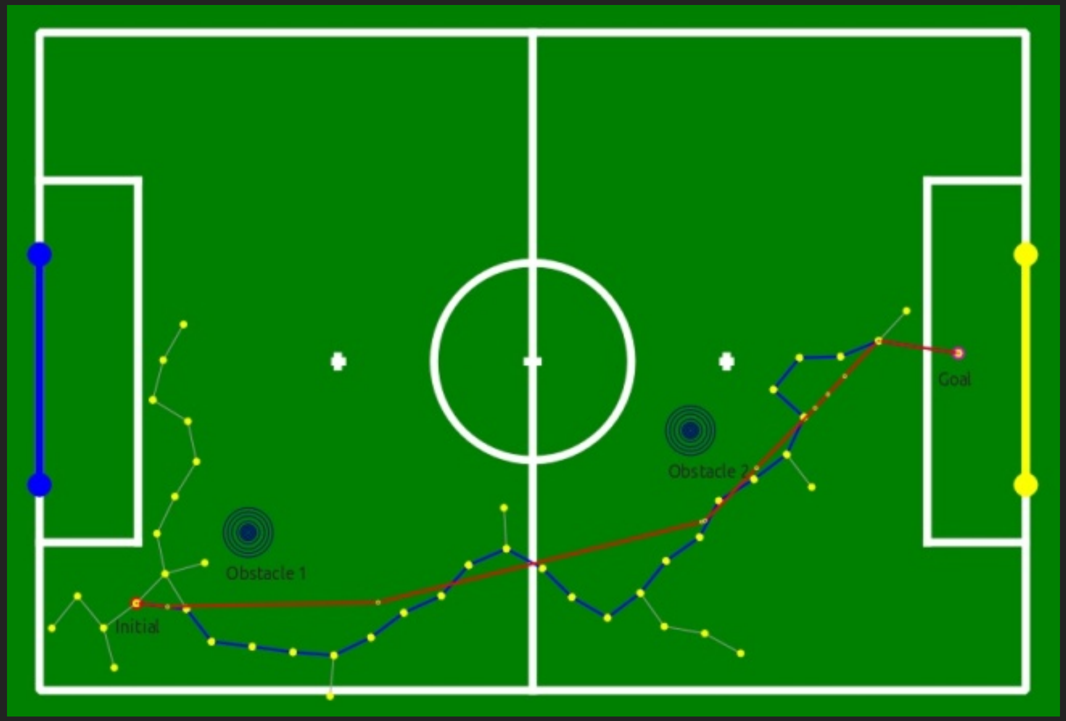
BEHAVIOR MODULE STRUCTURE

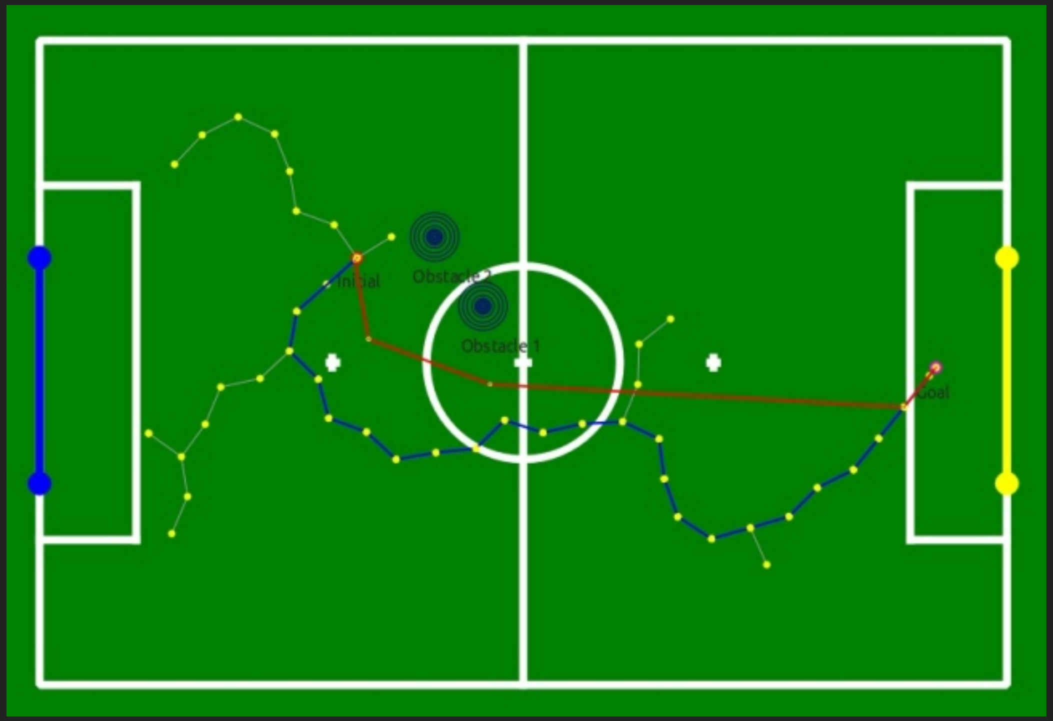
- Finite State Machine
- Control the robot actions based on World-Model Data.
- Action Level:
  - ✓ High-Level (e.g. player role)
  - ✓ Mid-Level (e.g. Search for Ball)
  - ✓ Low-Level (e.g. Move forward 10step)



PATH PLANNING

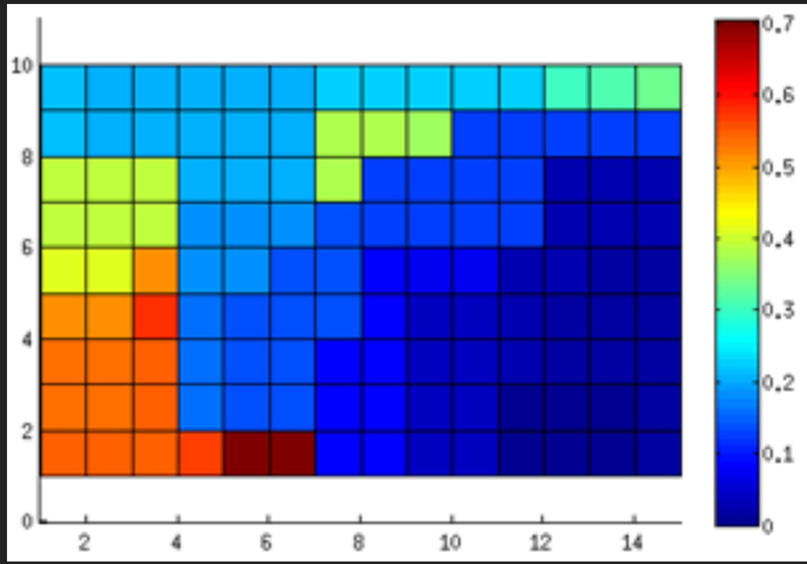
- Using Rapid-Exploring Random Trees (RRT)
- Find the optimal path to the target.

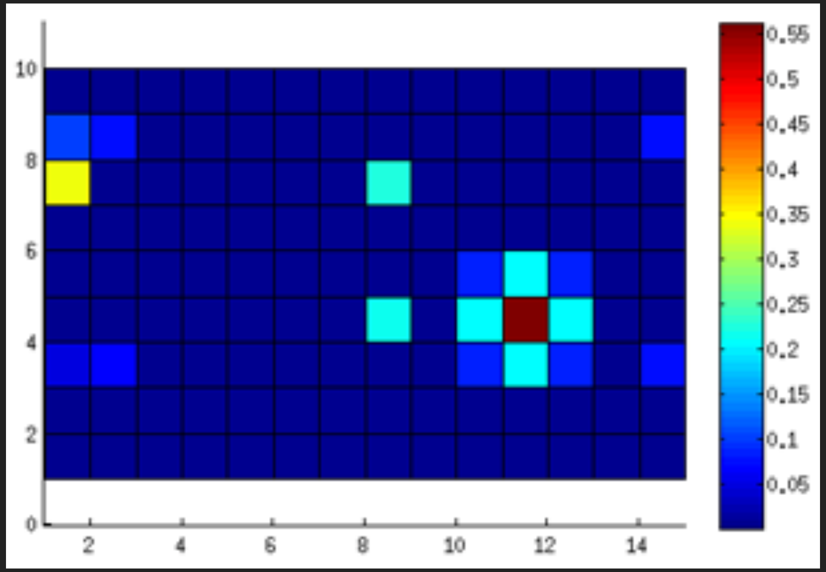




DYNAMIC HEAD MOTION

- Probability Grid on the Field
- Look grid with highest information
- Informative objects:
  - ✓ Landmarks (Goal-posts, Lines)
  - ✓ Ball
  - ✓ Obstacles



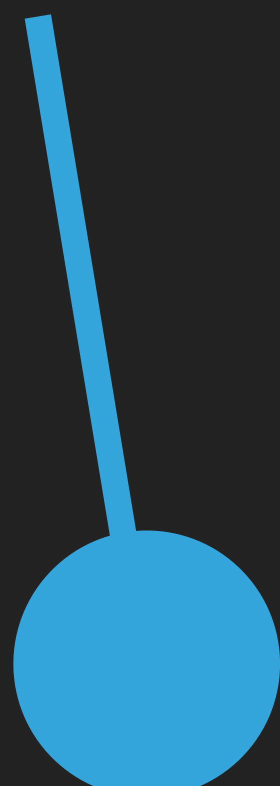


MOTION CONTROL

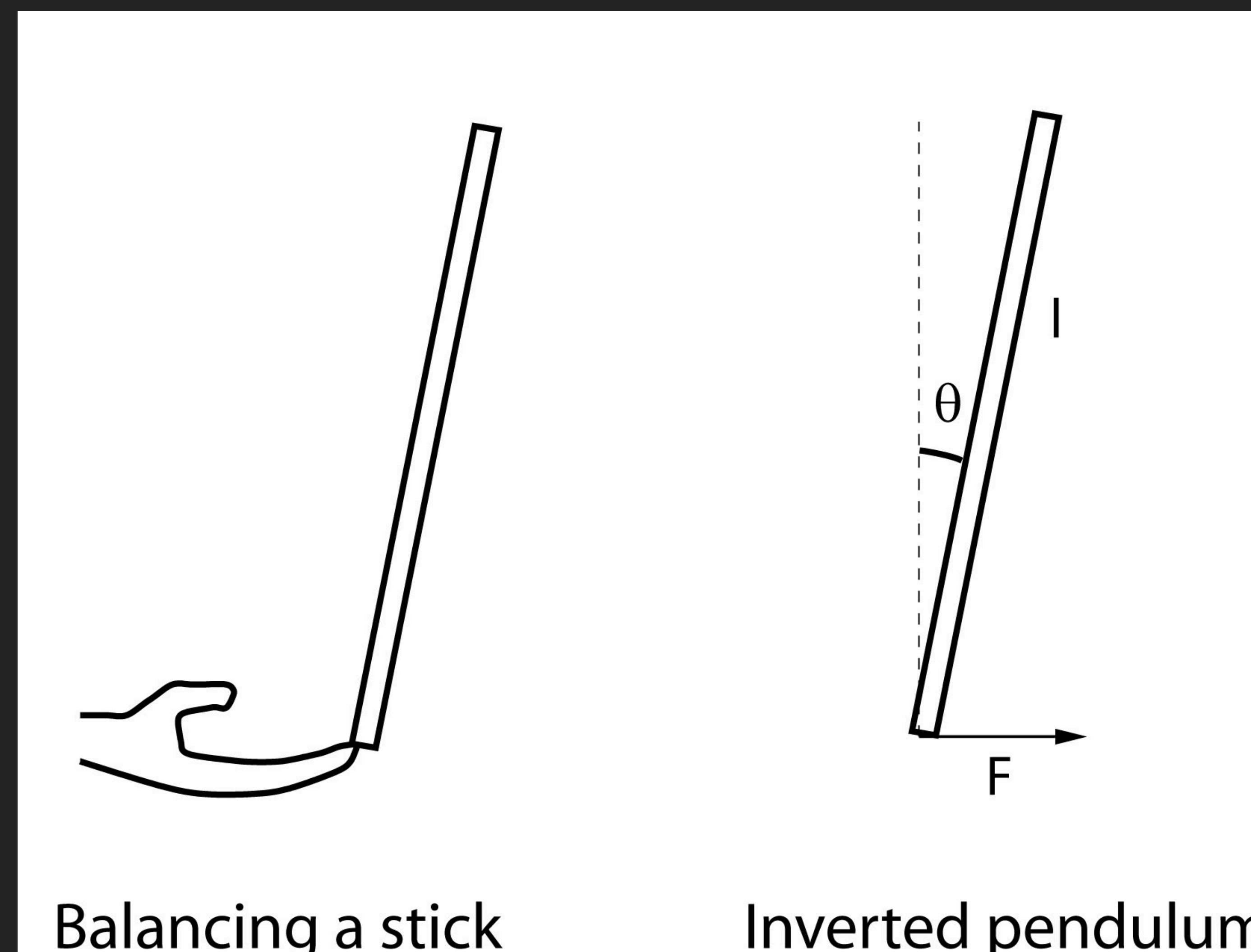
- Walk Engine
- Dynamic Kick Engine

WALK ENGINE

- Inverted Pendulum

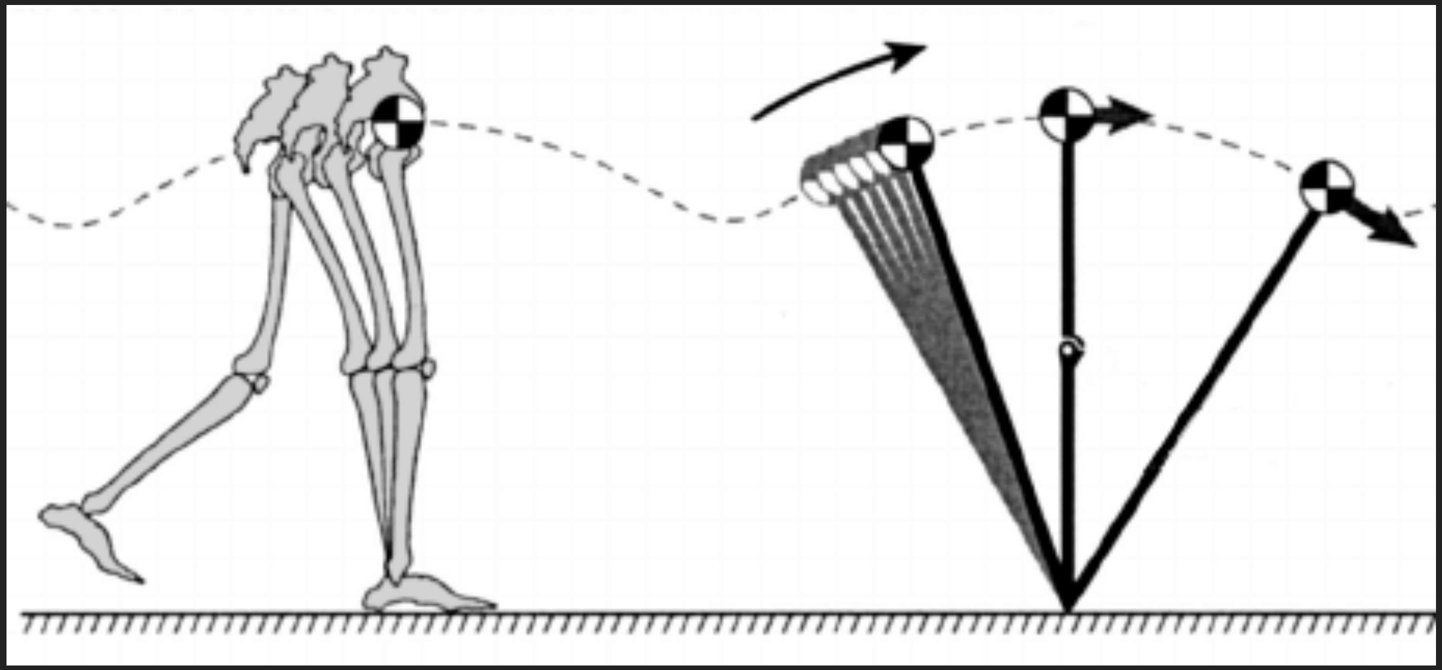


Pendulum



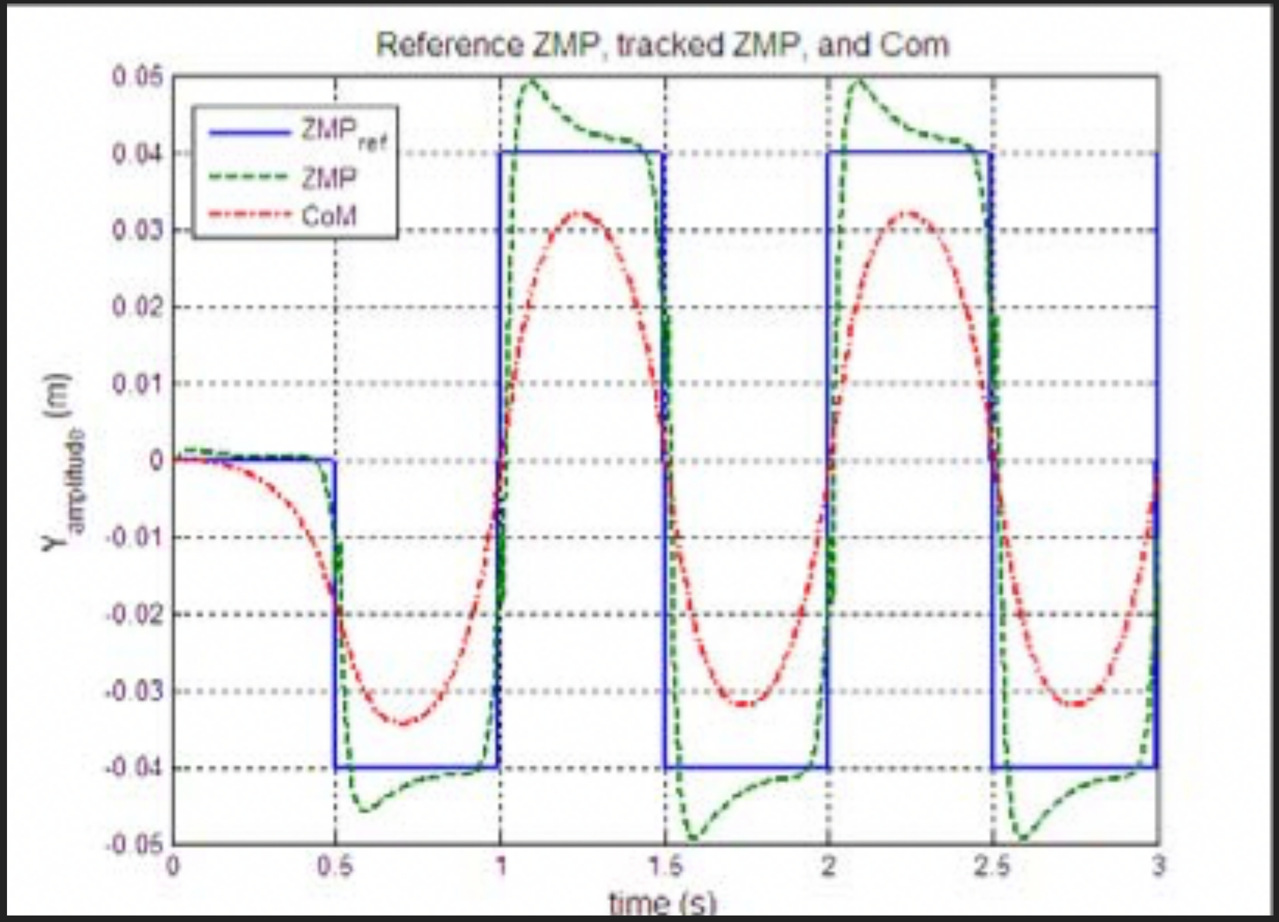
WALK ENGINE

- Balancing on two foot is like inverted pendulum.
- Center Of Mass (CoM) is the pendulum.



WALK ENGINE

- Zero Moment Point (ZMP) is calculated via CoM
- We control the robot in a way that ZMP follows the CoM
- Control using: LIPM



DYNAMIC KICK ENGINE

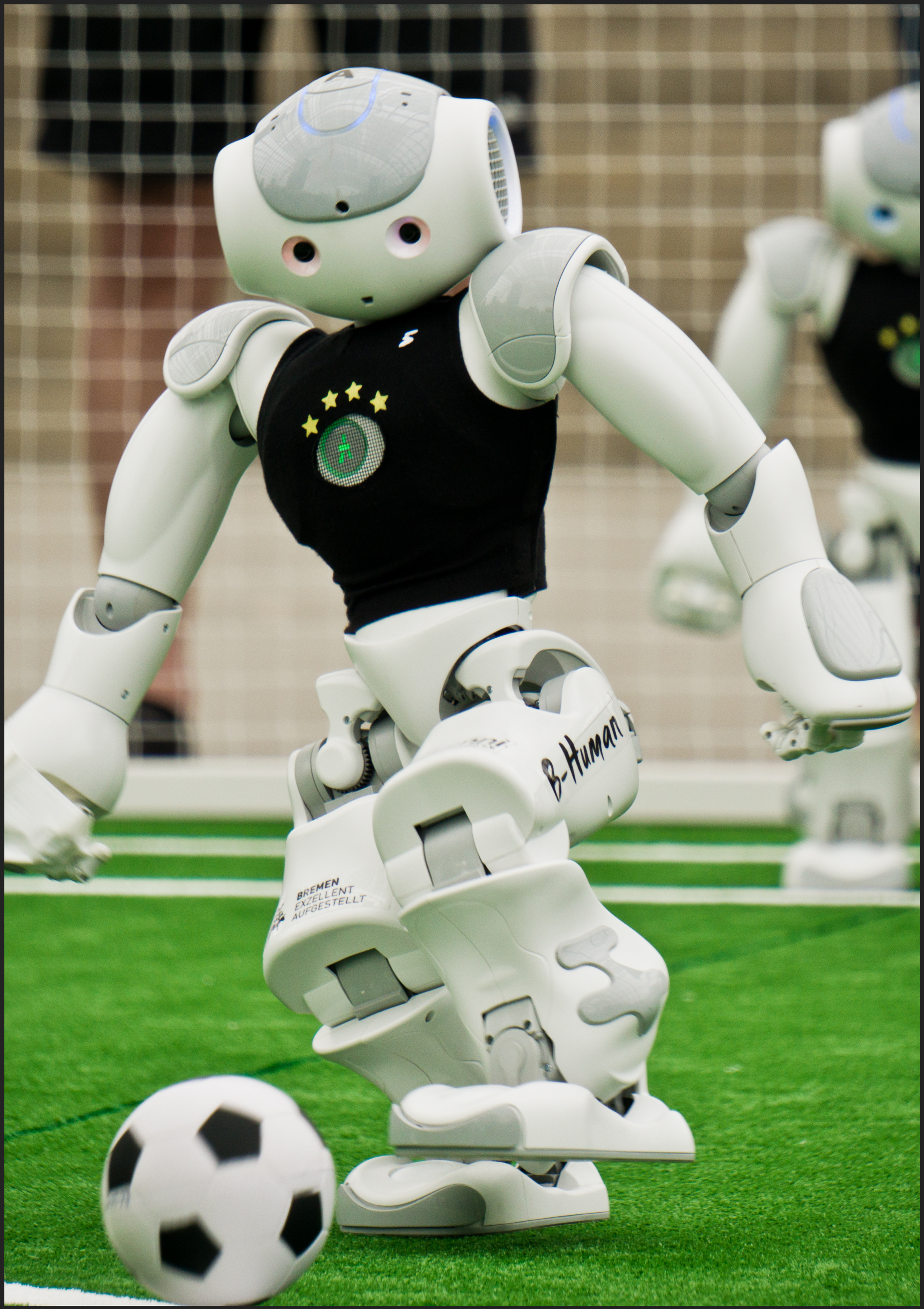
- Normally we use Special Action
  - x Very dependent to the initial formation
  - x Take a long time to get in position
- Dynamic Kick Engine
  - ✓ Fast
  - ✓ Accurate
  - ✓ Controllable

FUTURE WORKS

A) Development of an unfailing multi agent planning to use role base selection with a range of procedures such as ad-hoc role selection and matrix cost

B) Enhancements of the available dynamic head motion to be adaptive with different world model data such as predicted universal ball and obstacle models

C) Improvements in the combined path planning practice which implements both global and relative positioning data in diverse maneuvers. Moreover, active strategy selection and planning during the game accompanied by rapid decision making



MRL-SPL Qualification Video - 2014

THE END