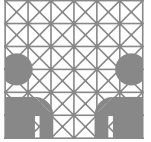


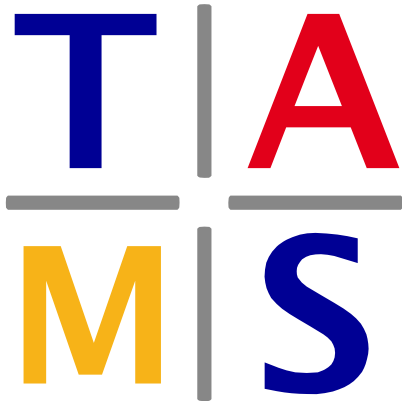


Universität Hamburg
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MIN Faculty
Department of Informatics



Adaptive Strategies in RoboCup Soccer

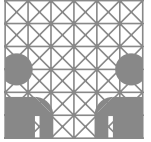


University of Hamburg

Faculty of Mathematics, Informatics and Natural Science

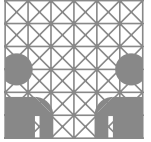
Department of Informatics

Technical Aspects of Multimodal Systems



Goals of todays presentation

-
- ✓ Introduction of RoboCup Soccer and its leagues
 - ✓ Introduction of different attacking and defending approaches and delimitation of each other
 - ✓ Evaluation of attacking and defending approaches
-



Content

- 01** RoboCup - Soccer
- 02** Attacking and defending approaches
- 03** Conclusion
- 04** Future Competition



01 RoboCup - Soccer

Topic	Description
Established	1995
Idea	<ul style="list-style-type: none"> • Playing football by combine robotics and artificial intelligence • Team of fast-moving robots under a dynamic environment • Soccer can be simplified and is reducible in labs
Location	Hosting a competitive tournament in different locations world wide
Alternative forms of AI & robotics	Rescue @Home Logistics Junior
Vision	Beating the FIFA World Soccer Team by 2050 with fast-moving robots



Teams compete in different leagues

Focus of presentation

01 Simulation



- Focus on artificial intelligence and simulation
- Teams play on a virtual field
- 2D or 3D

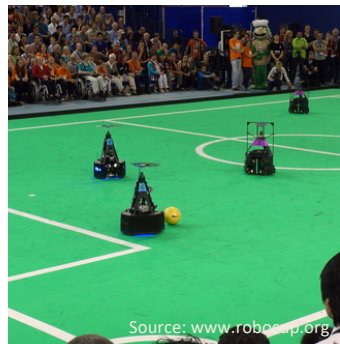
Source: <https://www.robocup.com>

02 Small Size



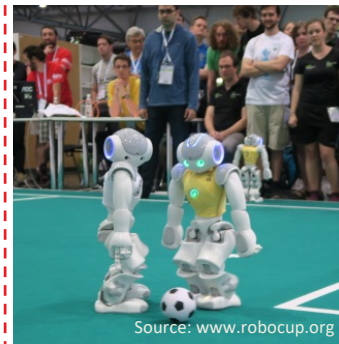
- Use of intelligent multi-robot/agent coordination and control in a highly dynamic environment

03 Middle Size



- Fully autonomous robots
- Defined measures and weight for robots
- Focus on mechatronics design, control and multi-agent cooperation at plan and perception levels

04 Standard Platform



- Fully autonomous robots with individual decision making process
- Usage of standardized robots (NAO robot from SoftBank)






05 Humanoid



- Fully autonomous robots with human like body plan
- Subdivision in KidSize, TeenSize and AdultSize



02 Small Size League (SSL)

Characteristics	Description
 Playing field	Carpeted playing field with dimensions of 12m length and 9m width
 Robots	<ul style="list-style-type: none">• Specification: F180 regulation (fit in an 180mm diameter circle and maximum height of 15cm)• robotic equipment is fully autonomous• intelligent multi-robot/agent coordination and control in a highly dynamic environment with a hybrid centralized system
 Positioning	<ul style="list-style-type: none">• Centralized localization solution (information from two cameras above playing field)• Identification of each individual robot through patterns by camera (All robots of a team are controlled by central control unit (CCU) / Orange ball)
 Communication	central program “SSL-Vision” distributed a local network connected to vision servers and the two team Off-field computer to communicate referee commands and position information to robots
 Decision Making	Individual decision making by robots

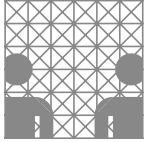
Source: <https://tigers-mannheim.de/download/papers/2011-A%20Simulation%20for%20the%20RoboCup%20Small-Size-League%20I-Leinemann.pdf>



02 Small Size League (SSL) – Exemplary game field



Source: <https://tigers-mannheim.de/download/papers/2011-A%20Simulation%20for%20the%20RoboCup%20Small-Size-League%20I-Leinemann.pdf>



03 Middle Size League (MSL)

Characteristics

Description



Playing field

Carpeted playing field with dimensions of 18m length and 12m width



Robots

- Specification: 50 x 50 x 80 cm maximal size
- 40 kg limit
- All robots are completely autonomous



Positioning

- Self localization



Communication

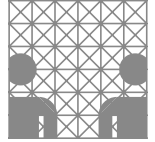
- Wireless networking between each robot, base station and referee box
- Only human interaction is the referee through a referee box – controlled by an assistant during the game



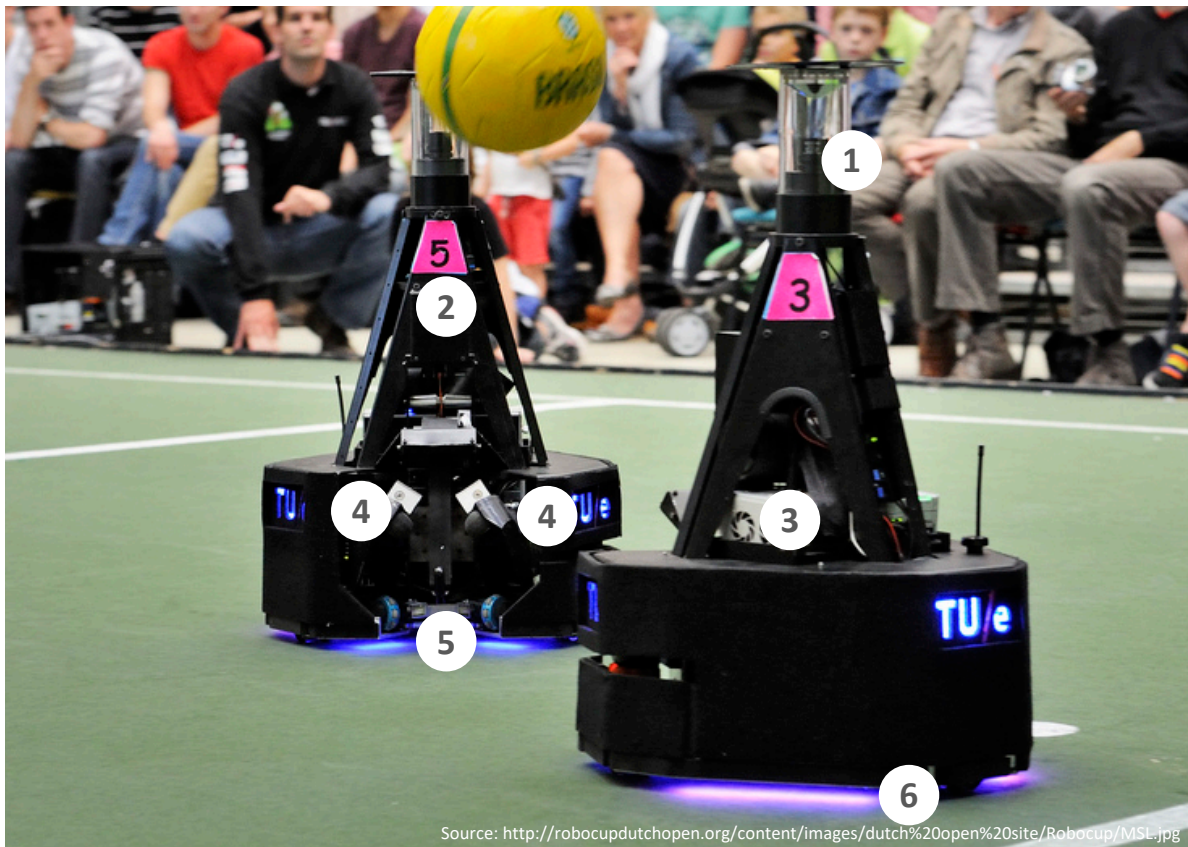
Decision Making

- All robots are completely autonomous
- Individual decision making by robots
- Playing cooperative together

Source: https://www.researchgate.net/publication/275040614_RoboCup_MSL_-_History_Accomplishments_Current_Status_and_Challenges_Ahead

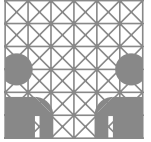


03 Middle Size League (MSL)



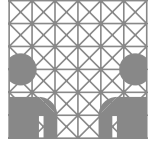
Description

- 1 Omnivision unit
- 2 Front camera
- 3 PC
- 4 Ball handling mechanism
- 5 Kicker
- 6 Omniwheel platform



Content

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Approaches

01

Attacking

02

Defending

Source: <https://www.menschundtechnik.com/bremer-team-b-human-ist-zum-fuenften-mal-weltmeister-im-robocup/>

Attacking Approach by
ZJUNlict

Defending Approaches by **Tech United**
Eindhoven



01 Attacking approaches by ZJUNlict

ZJUNlict

SSL

University Zhejiang University (China)

Approach Optimized movement by predicting the collision of robot with the ball

Important to predict velocity & direction of ball after impact (bouncing back of obstacle)

Improvement

- to predict the movement of the ball

- Procedure
1. Identification if ball runs to enemy or not (by unique motion model) and by what velocity
 2. Estimation of defending robots direction & speed/ velocity to define interception point
 3. Calculation/ Identification best player to reach & play ball

Source: https://www.robocup2017.org/file/symposium/soccer_sml_size/Robocupssl2017-final21.pdf



Picture a)



Picture b)



Evaluation of attacking approaches



ZJUNlict

- Supports team play
- Faster able to shoot again
- Movement of the robots will be improved
- Improve task match of each robot
- Active movement

Errors appear:

- Wireless connection problems
- Prediction needs to be exact
- Velocity prediction
 - use same as they shot



02 Defending approaches by Tech United

Tech United Eindhoven

MSL

University University of Eindhoven

Approach **Player**

Block the direct way to the goal with two robots (a)

Only 2 robots are allowed in a scum

Compute space around the attacker (b)

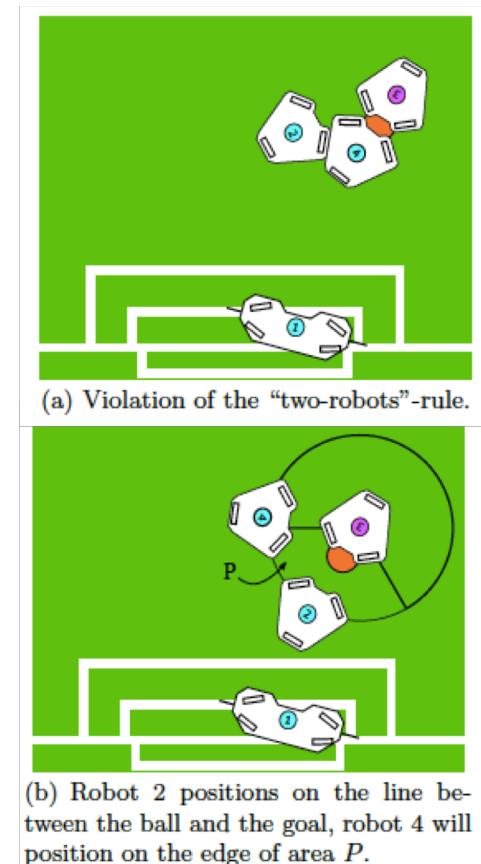
Second defender is waiting at the edge

Ideal both defenders are waiting at the edge

Closest defender to the goal covers the middle of the goal

Once the set of positions is computed, they need to be assigned to defender

- Use
1. Compute the covered angle of the attacker to score a goal
 2. Needs two players and goalkeeper to cover the open angle





02 Defending approaches by Tech United

Tech United Eindhoven

MSL

University University of Eindhoven

Approach **Goal Keeper**

Problem: accuracy and velocity of the shot unable the Goalkeeper to save the ball

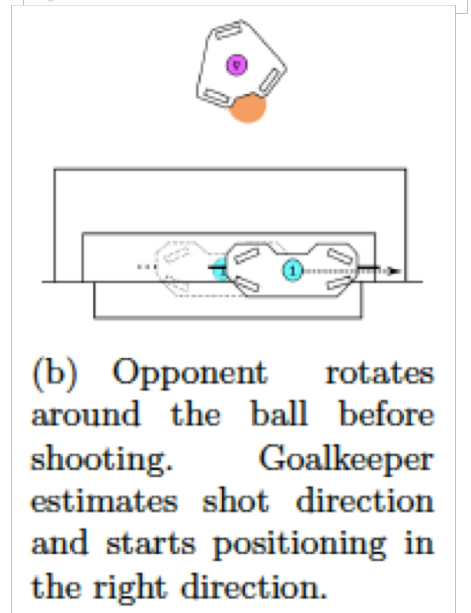
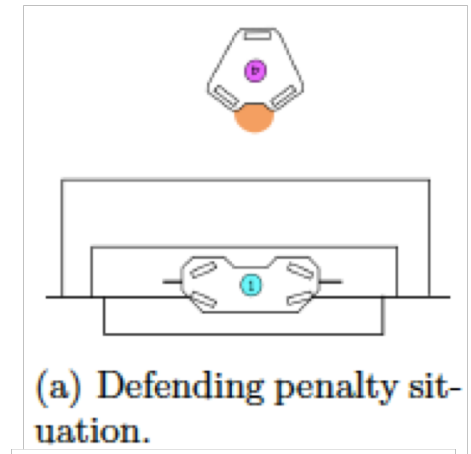
Identification of shooting direction and allocate the position on goal line

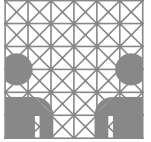
(a) *Switches the mode to penalty situation*

Takes a look at the defender it self and not only to the ball

(b) *Through rotate to the predicted direction possible to catch the ball*

Use Caught all penalties
Till all robots need to rotate it is usable





Evaluation of defending approaches



Two defenders

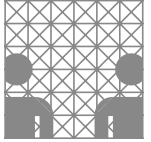
- Covers more defending space
- Minimize the space to pass/shoot of the attacker
- Good against slow building up teams

- Uses two defenders on one attacker
- Assign role to attacker
 - Needs to move back (time)
- Exact computation

Penalty

- Saved all penalties
- Enough time to move to right positions

- Needs exact localization of itself/opponent
- Based on rotation of the shooting robot



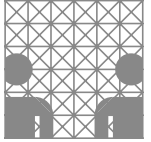
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**Conclusion what
to take
from those
strategies?**

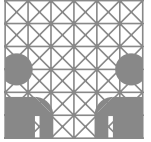




Conclusion

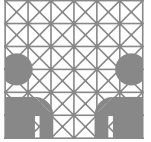
- »» Every league has their own ideas and their not simple to transfer
- »» Strategies are crucial to improve the attack with different approaches
- »» There are dynamic parts (two defenders) and more statically parts (predict penalty)
- »» Defending strategy(MSL) could be used in SSL / Attacking approach(SSL) could be used in MSL
- »» Crucial: exact localization of robots/ball – leagues use different ways

There is not one perfect strategy - the combination of different approaches will lead to win



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Preview

-
- ▶ **SSL – localization apart from SSL Vision control**

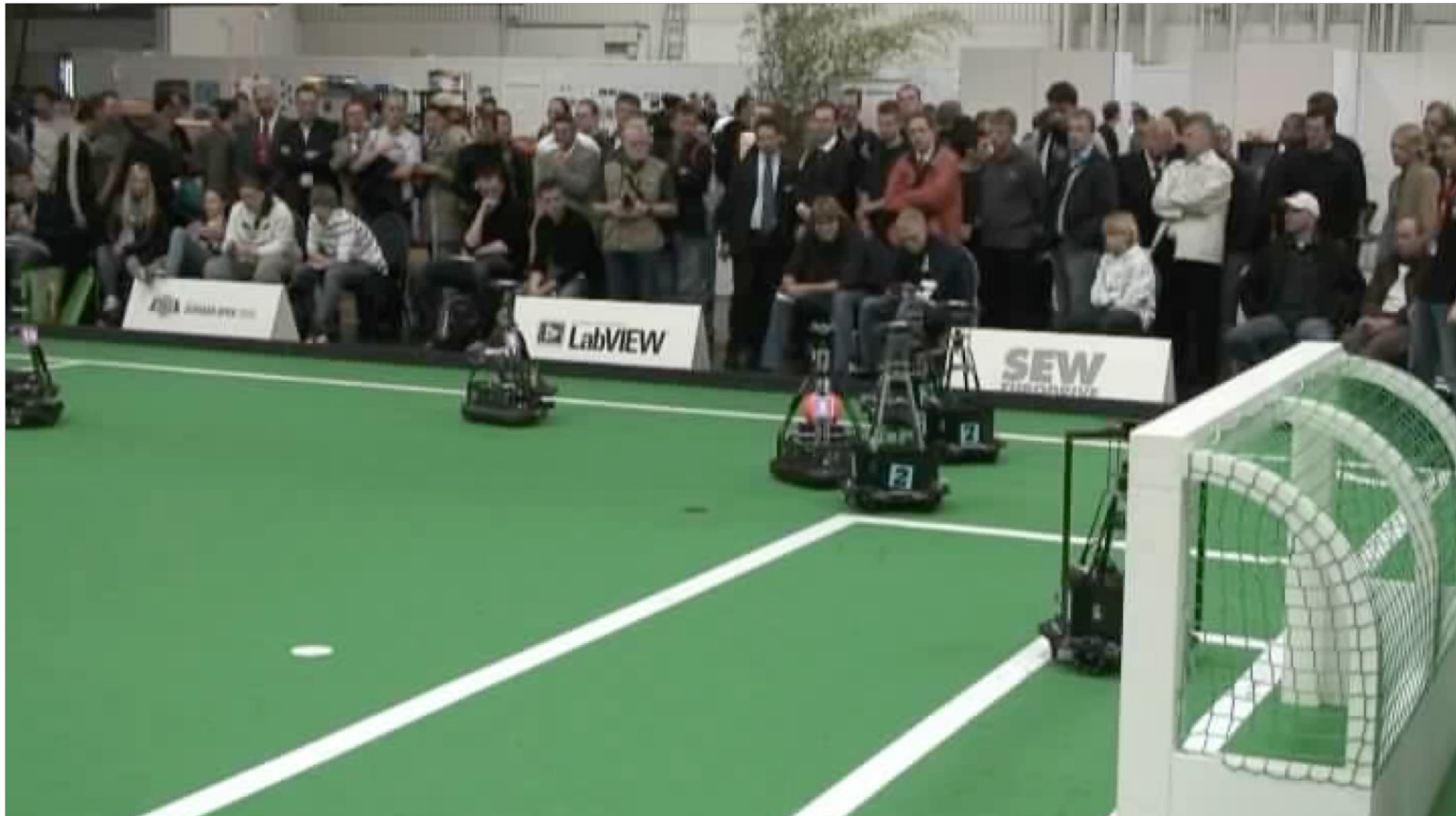
 - ▶ **More reward for passing the ball to team member**

 - ▶ **Future drop in competition – focus on even more communication - dynamical team play**

 - ▶ **Furthers ad hoc team organization → focus more on learning agents**



Middle Size League (MSL) – old gameplay



Source: https://commons.wikimedia.org/wiki/File:RoboCupSoccer_Robot_Football_at_2009_German_Open.ogv



2018 Tech United vs Humans



Source: <https://www.youtube.com/watch?v=KT2e4Z0u2C8>



Thank you for listening