

Tech United Eindhoven

Mobile Robot Control – April 2020
Wouter Houtman
Credits: Yanick Douven

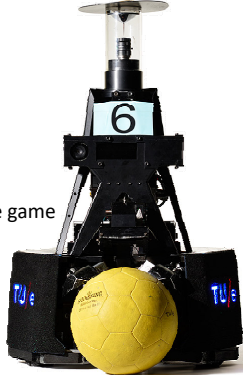



 @TechUnited
 techunited@tue.nl
 www.techunited.nl
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Challenges in Robot Soccer

- Robust but complex mechatronic design
- On-board sensors and processing
 - A single agent does not have a complete view of the game
- Multi-agent system without supervision
 - Infinite amount of possible situations



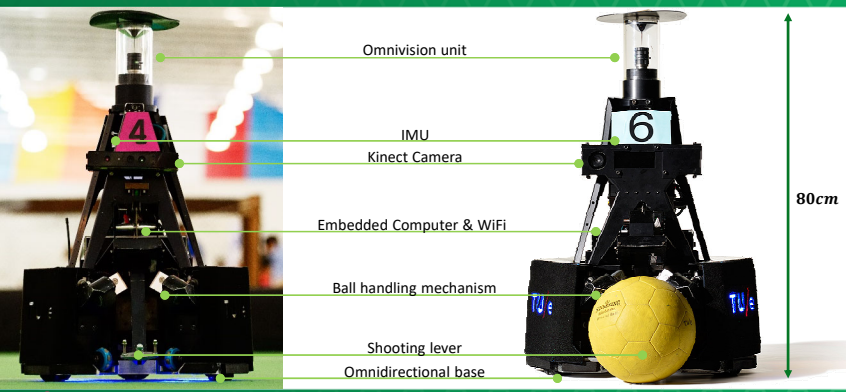
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WC 2018 – Montréal, Canada




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RoboCup Middle Size League: Hardware



- Omnivision unit
- IMU
- Kinect Camera
- Embedded Computer & WiFi
- Ball handling mechanism
- Shooting lever
- Omnidirectional base

80cm

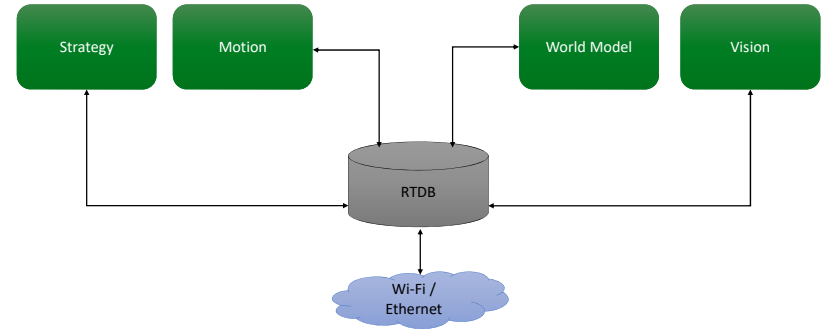
50cm

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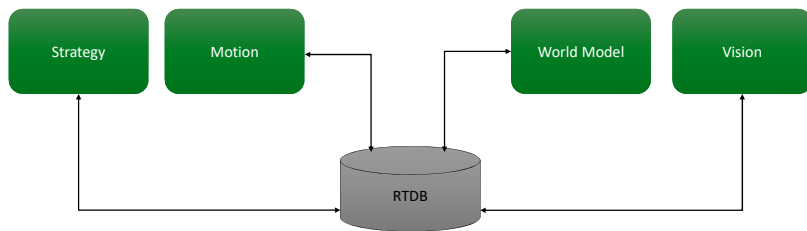
Software architecture



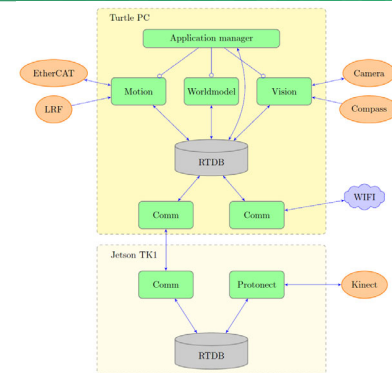
Software architecture



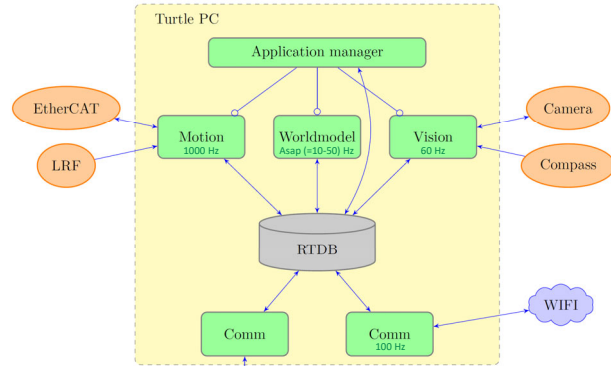
Software architecture



Software architecture



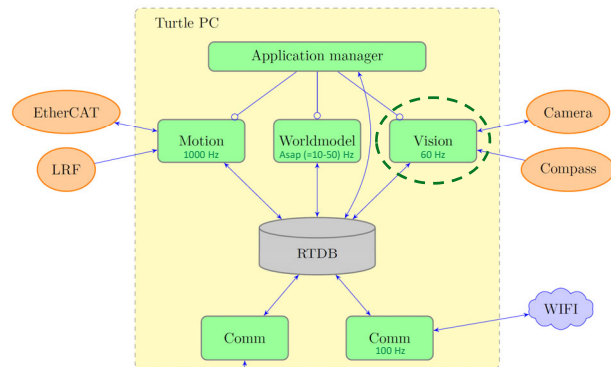
Software architecture



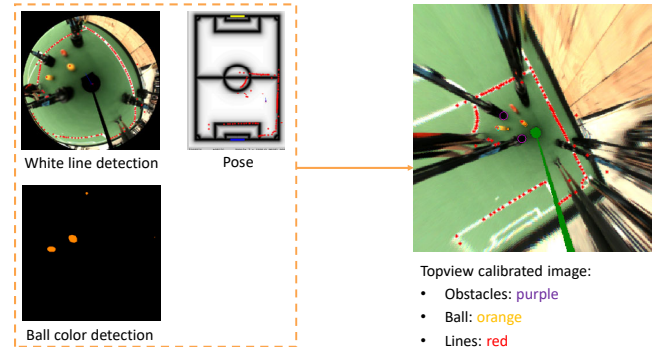
Vision



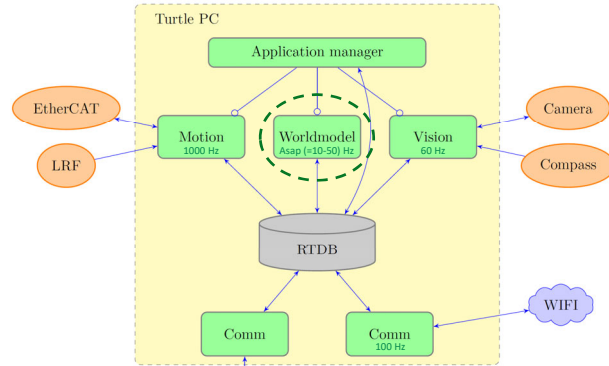
Software architecture



Vision

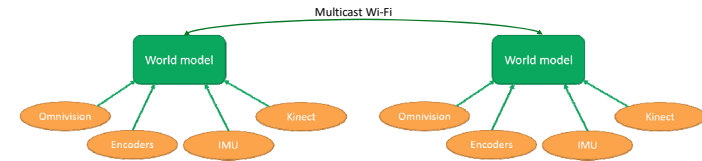


Software architecture



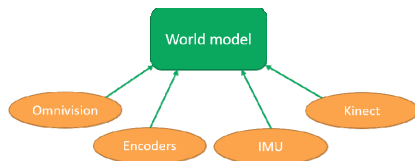
World Model

- World model based on local and communicated data



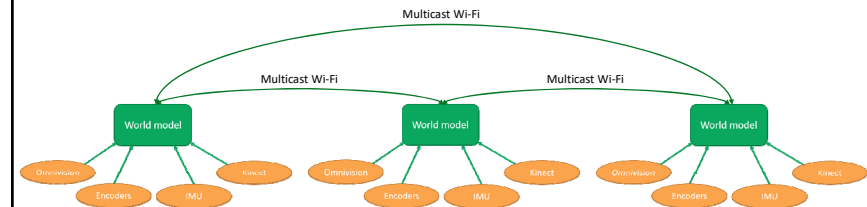
World Model

- Desired: position and velocity of peers, opponents and the ball
- World model based on local and communicated data



World Model

- World model based on local and communicated data



World Model: Visualization



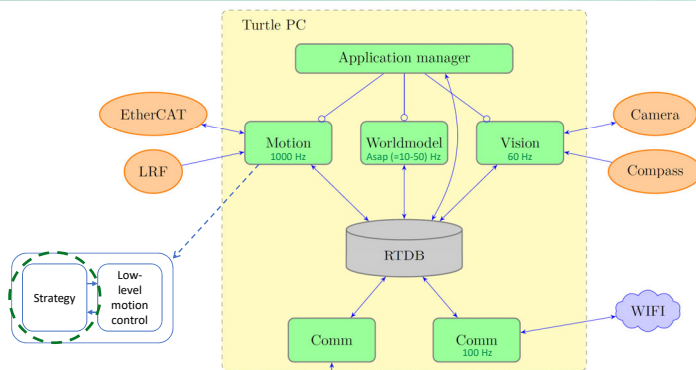
Strategy

- Division in roles
- Classify limited number of game situations



```
Defcon_ourBall
Defcon_ourBallFree
Defcon_ourPass
Defcon_oppBall
Defcon_oppBallFree
Defcon_oppPass
Defcon_scrum
Defcon_ballLost
```

Software architecture



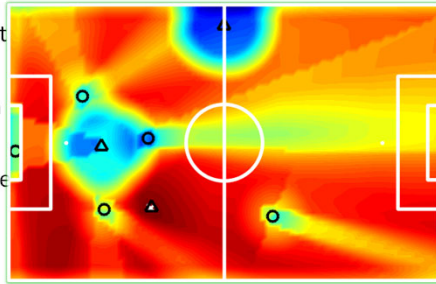
Strategy

- Division in roles
- Classify limited number of game situations
- Defensive actions mostly based on if-this-then-that

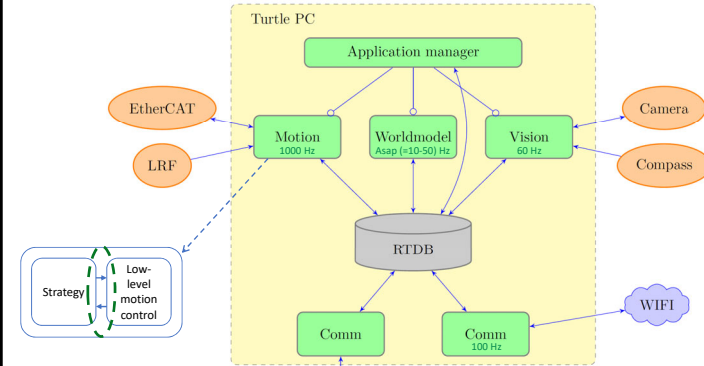
```
if(in_our_half(opp_with_ball) == true) {
    target = (opp_with_ball + own_goal)/2;
}
```

Strategy

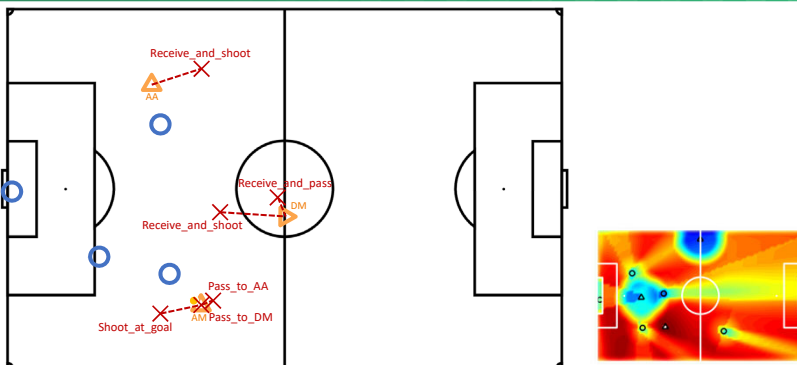
- Division in roles
- Classify limited number of game situations
- Defensive actions mostly based on "skill-fields"
- Offensive actions based on "skill-fields"



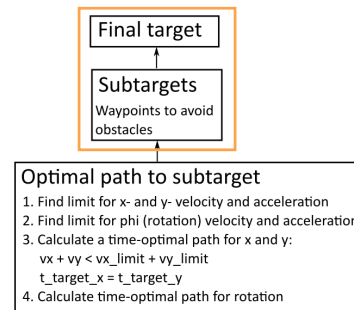
Software architecture



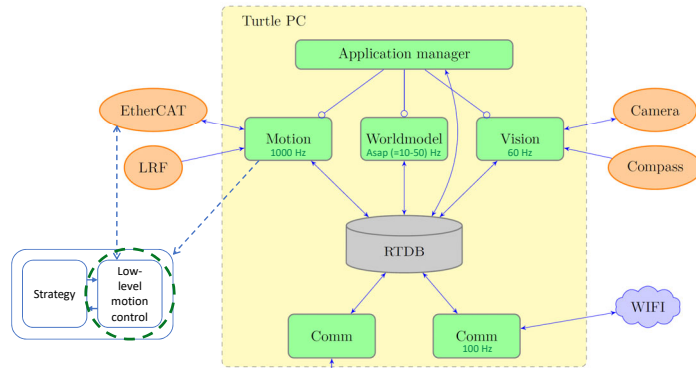
Strategy – skill-fields



Trajectory Planning



Software architecture



Limitations

- Rule-based / no AI
 - But we do use some form of learning
- Predictability (no creativity)
 - Every action is a reaction to the current situation
- Absence of actual limbs

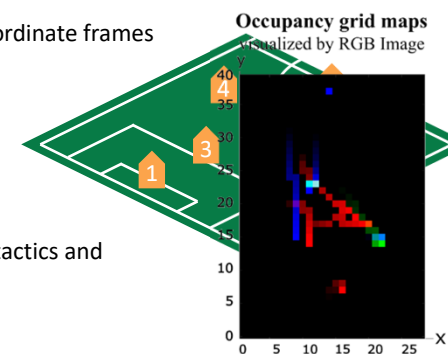
Low-level motion

- Hardware interface: EtherCAT¹ (Ethernet for Control Automation Technology)
 - Ethernet-based fieldbus system invented by Beckhoff
 - Position Estimation using
 - Odometry
 - IMU
 - Omnivision
 - Control loops
 - Shooting lever
 - Ball Handling
 - Wheels
- Open Loop PWM
Closed loop Velocity Control
Cascaded control structure (position & velocity loops)

[1] <https://www.ethercat.org>

Possible research directions

- Partly move towards local coordinate frames
- Online learning of opponent tactics and adaptation of own strategy



Tech United MSL

Started in 2006:

World Champions:

2012, 2014
2016, 2018, 2019

Second place:

2008, 2009, 2010,
2011, 2013, 2015,
2017

**12 finals in
12 years!**

