Robot Sports mechanical and electrical description

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Abstract. . Robot Sports is an open industrial team, meaning that its participants are all employed by or have retired from various high-tech companies in the Dutch Eindhoven region. This document is the requested Robocup2018 mechanical and electrical description together with a software flow chart (please include size and weight of the robots)

1. Mechanical and electrical description

The Robots of the Robot Sports Team are developed as a mix of the Philips robot design used in the MSL competition [1], design advancements developed by the Philips team after the last tournament participation and the Tech United TURTLE robot design from the year 2012 [2].

To control the player we use a general purpose PC (an Intel NUC with i5 processor) and Ethernet. On the NUC we are running Ubuntu 16.04 64-bits, which allows us to use the MSL Simulator [3]. The motion control tasks need strict real time behavior; these will be handled by a separate industrial motion controller.

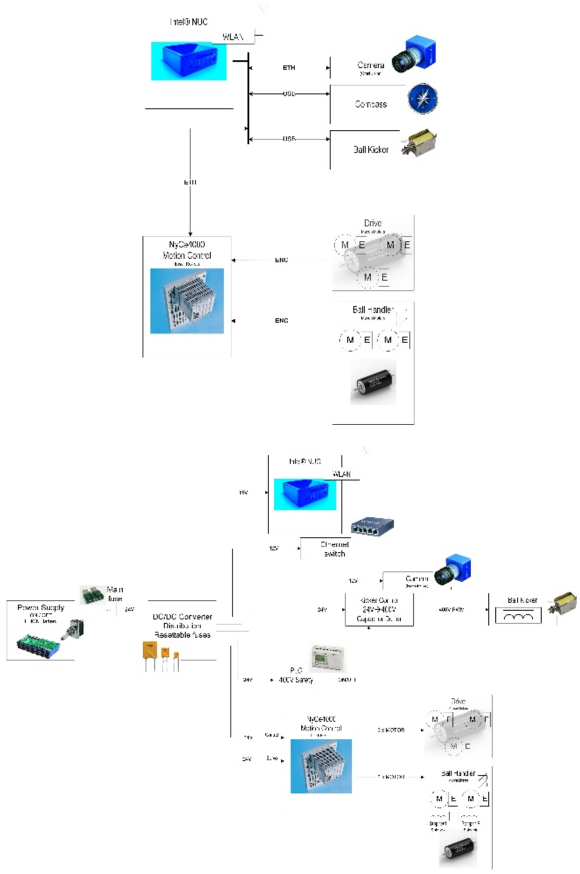


Fig1. Robot architecture with main building blocks, data and power flows

1.1. Frame

The robot frame is designed entirely in sheet aluminum, which provides rigidity at the lowest possible weight, while keeping cost down. Box structures are used to provide maximum torsional stiffness, e.g. for mounting the kicker mechanism.

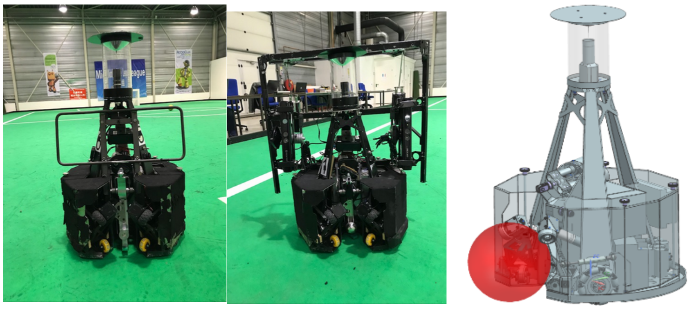


Fig2. Robot mechanical layout around sheet aluminum frame

1.2. Size and weight of the robots

	L*W*H (CM)	Weight (Kg)
Keeper	50*70*80	38 Kg
Field player (*5)	50*50*80 CM	28 Kg

1.3. Motion and ball handler control

The robots use the NYCe4000 motion control system to control and power the robot’s three drive motors. The system is a modular industrial solution that can be used to control multi-axis system. The drive wheels are not placed symmetrically, but the two front drive wheels are at a smaller angle such that the forward drive force is increased.

1.4. Kicking device

Automotive solenoids are used for actuation of an adjustable lever that is the “foot” that will kick the ball. Multiple geometries for this “foot” have been tried in an experimental approach, supported by FEA calculations modeling the “foot”-ball interaction. The lever adjustment allows for three discrete vertical positions of the “foot” to vary between low and elevated shots.

A capacitor stack is charged by a circuit originating from a Philips consumer electronics product; discharge is done through a custom IGBT based switch that can be pulse modulated to control shooting power and –duration. The shoot control is implemented on a Teensy 3.1 microcontroller that interacts with the general purpose PC.

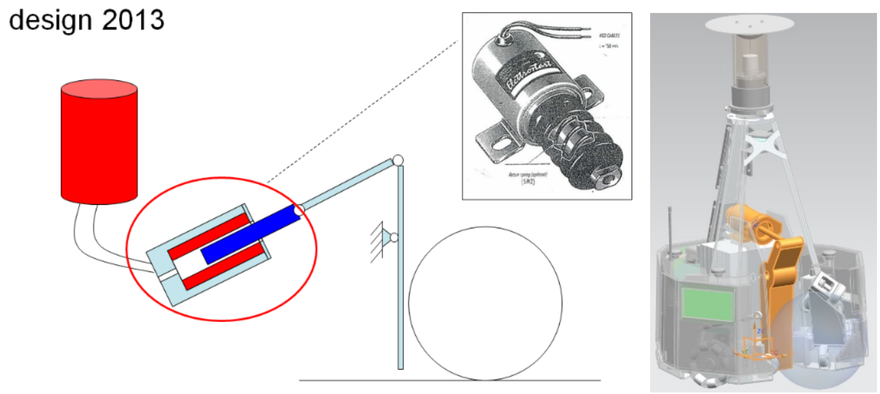


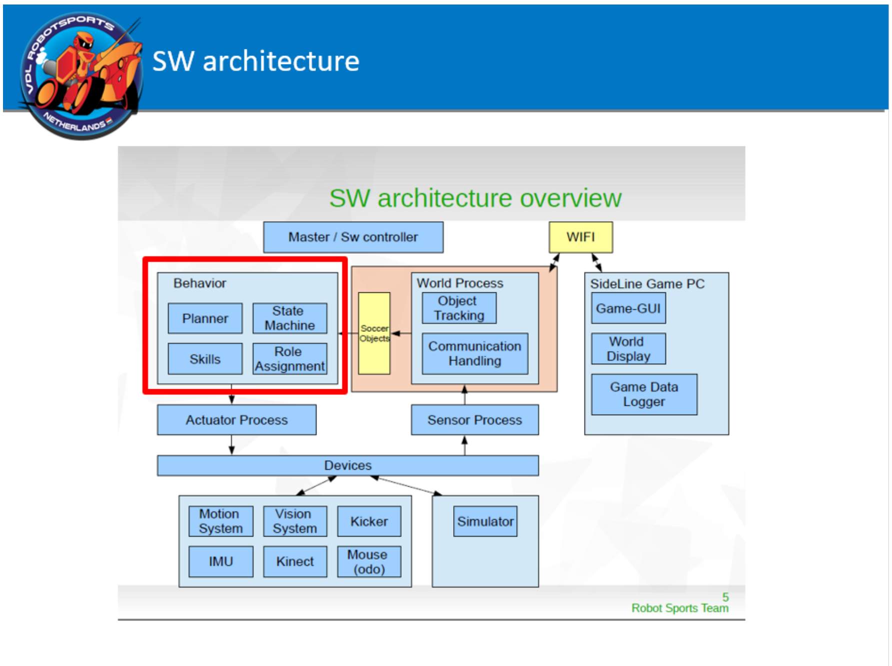
Fig3. A schematic and a physical representation of the new shooting device

1.5. Sensing

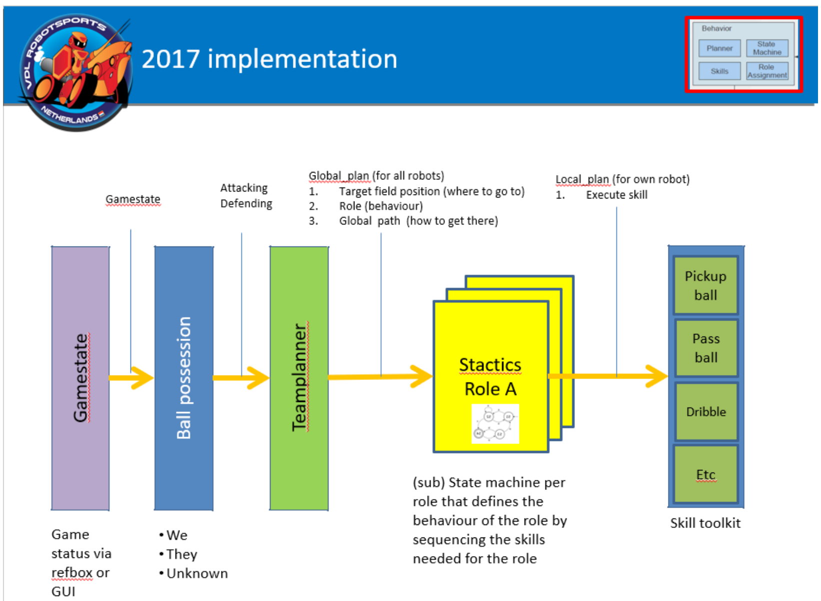
Our robots have a GigE camera from Point Grey with an 1280 x 1024 pixel image sensor. The camera omni-mirror combination is designed with a compromise in resolution close by and far away. This compromise comes at the cost of some image distortion. From the centre of the field the robot camera is able to give an overview of 12 x 18m of the playing field. With the lines at the far corners visible at a distance of 10.8m.

2. software flow chart

The Robot Sports Team uses RTDB [4] to exchange and synchronize data between team players, which results in a fast and accurate shared world model.



2.1. Behaviour and team planner



The robot behavior is implemented in a set of executable skills. These skills have dedicated responsibilities and effectively run parallel to each other.

Individual Robot behavior is defined in a domain specific language called STACTICS. The name STACTICS comes from state and tactics. It allows to express robot behavior in a higher language. STACTICS consists of two types of skills: action and decision skills. At the highest level, a finite state machine (FSM) is present with fixed transitions between states. It controls the highest-level states of the robot.

Team behavior is defined in a team planner module. The result of the team planner is a Global_plan (for all robots)

- Role (The team planner combines dynamic role assignment and strategic positioning. The dynamic role assignment is made more robust by taking previous assignments into account and allow some hysteresis.)
- Target field position (We are using a heuristic based mechanism to determine optimal target field position for a role)
- Global path (This describes a rough path. A skill smooths the rough path and adds an orientation setpoint and apply velocity constraints. The smoothed path can be executed by the motion system of the robot)

3. References

1 A.T.A. Peijnenburg, T.P.H. Warmerdam et.al.: Philips CFT RoboCup Team Description. In: preliminary proceedings 2002 RoboCup conference, July 2002

2 http://www.roboticopenplatform.org/wiki/TURTLE

3 https://github.com/RoboCup-MSL/MSL-Simulator

4 Santos, F. , Almeida, L., Pedreiras, P. ; Lopes, L.S.: A real-time distributed software infrastructure for cooperating mobile autonomous robots. In Proceedings of 14th IEEE International Conference on Advanced Robotics, Munich, Germany (2009)