The Sweaty 2022 RoboCup Humanoid Extended Abstract*

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Abstract. Sweaty has already participated several times in RoboCup soccer competitions (Adult Size). Now the work is focused on stabilizing the gait. Moreover, we would like to overcome the constraints of a ZMP-algorithm that has a horizontal footplate as precondition for the simplification of the equations. In addition we would like to switch between impedance and position control with a fuzzy-like algorithm that might help to minimize jerks when Sweaty's feet touch the ground.

Keywords: Humanoid · RoboCup · Sweaty

1 Lessons Learned

Apart from many things learned during RoboCup 2019 and 2021, there are two major takeaways: firstly, one major strength of the winning team has been to be able to kick while walking. Secondly, to be champion of a league, it is not sufficient to try to do things other teams can do already, but to try to do completely new things or approaches. Our goal is to get a more human like walk unlike any other team and we are convinced that this also will improve our playing strength.

2 Planned Changes

The adult size humanoid robot Sweaty is described in detail in previous team description papers[1]. A couple of changes to these robot development states are planned or have already been introduced.

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[1] K. Dorer, U. Hochberg, and M. Wülker. "The Sweaty 2019 RoboCup Humanoid Adult Size Team Description". In: *Humanoid League Team Descriptions, RoboCup 2019, Sydneyl* (June 2019); M. S. Akbas et al. "The Sweaty 2018 RoboCup Humanoid Adult Size Team Description". In: *Humanoid League Team Descriptions, RoboCup 2018, Montreal* (June 2018); A. Dietsche et al. "The Sweaty 2017 RoboCup Humanoid Adult Size Team Description". In: *Humanoid League Team Descriptions, RoboCup 2017, Nagoya* (July 2017); A. Dietsche et al. "The Sweaty 2016 RoboCup Humanoid Adult Size Team Description". In: *Humanoid League Team Descriptions, RoboCup 2016, Leipzig* (July 2016).

2.1 Software

The software is ROS-based. The decision component (a subset of the MAGMA-Framework for 3D soccer simulation) is programmed in Java. Problems we would like to overcome are mainly due to the fact, that the interface between the MAGMA-framework and the rest of the robot is structured in a way, that it meets the requirements of a NAO-robot, which is what the MAGMA-framework was made for, but does not entirely suite the requirements of Sweaty.

In 2021 we were already able to introduce a kick while walking into the Webots virtual competition. The goal for 2022 is, to transfer this behavior to the real robot.

2.2 Hardware

Sweaty's appearance has changed. The shoulders are now more narrow and closer to human appearance.

Also, in future games we intend to enable the goal keeper to use his hands and fingers. Therefore it is essential that Sweaty has actuated arms and fingers. To be more or less human-like, the arms must be overactuated. Inverse kinematics need an additional constraint to solve the equations. Additional requirements for the inverse kinematics are real-time capability and suitability for code generation. The approach for the optimization algorithm is that a residual function is formed from the forward kinematics. This optimizes the joint angles in such a way that they lead to a local minimum of the nonlinear, multidimensional residual function. With these calculated joint angles the closest (to human behavior) possible pose can be approached.

We have developed new six-axis force-/torque sensors. The precision @200 Hz has to be evaluated. The subject is to measure the COP precise enough to control the gait. The newly developed PCB uses highly accurate AD-converters, as the noise in the previously used ICs was unacceptably high under the conditions during a competition: the noise introduced by the hard switching motor controllers prevented a high speed sensoring of the force and torque.

2.3 Kinematics and Kinetics

One of the major goals is to overcome the constraints of a ZMP-algorithm that has a horizontal footplate as precondition for the simplification of the equations. In addition we would like to switch between impedance and position control with a fuzzy-like algorithm. Essential for those modifications are inverse kinematics for the robot (which are already existent) and inverse kinetics (we are working on in a PhD thesis). Special emphasis is on an additional yaw joint for the upper body.