The Sweaty 2023 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 coordinating the play of two robots. Moreover, we are working on stabilizing the gait by adding additional sensor information. An ongoing work is the optimization of the control strategy by balancing between impedance and position control. By minimizing the jerk, gait and overall gameplay should improve significantly.

Keywords: Humanoid · RoboCup · Sweaty

1 Lessons Learned

Apart from many things learned during RoboCup 2019 and 2021, there are two major takeaways. First of all, An active goalkeeper who clears balls or plays them to teammates can be a key to become champion of the league. Second, the time in which a robber is penalized must be reduced to a minimum in order to be competitive against strong opponents. Therefore, our goal is to get a more human like walk – unlike any other team and we are convinced that this will also improve our playing strength.

2 Planned Changes

The hardware and software setup of the humanoid robot Sweaty is depicted thoroughly in previous team description papers[1]. Several changes have been introduced or are planned for the upcoming event.

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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 overall software framework of Sweaty is ROS-based with an interface to a Java based decision component, directly based on the MAGMA-3D-Soccer simulation environment. Actual problems arise from the update of ROS1 to ROS2, which makes a lot of changes necessary with regard to communication between systems and adaption of algorithms to the new version. One goal of the software development is the introduction of kicking the ball while walking, which has been developed for the simulation in the Webots competition 2021.

Another focus is laid on perception and localization, where the ray casting approach of identifying the robot's position shall be stabilized with an additional depth estimation based on a new stereo camera system.

2.2 Hardware

Sweaty's appearance has changed with regard to the system used in the last physical RoboCup 2019. The robot was rebuild to a closer human appearance by adopting the shoulders and arms. Further, we include a additional degree of freedom for the upper body. Now Sweaty can turn his upper body around the yaw-axis.

To further enable a human like behavior in playing soccer, the goal keeper shall be able to use his arms, hands and fingers. So far, dynamixel motors are used for arm actuation, but hand and finger movement is restricted to more weight efficient systems, e. g. cable actuators.

To enable new gait control and COP determination, newly developed inertial sensors are integrated into Sweaty. The team is still evaluating the accuracy and efficiency at the internal update rate of 200 Hz. The motors of Sweaty are still operating out of normal specification.

The hardware of the exteroception of Sweaty has been changed, too. The camera was replaced with a ZED mini stereo camera system, capable of computing the disparity and reconstructing the environment directly based on the GPU of our computer hardware. This should speed up the calculations and enable the combination of fast neural network based object detection with a precise depth estimation and ball localization.

2.3 Kinematics and Kinetics

Sweaty is operating with classical control strategies combined with models of kinematic degrees of freedom and constraints. We plan to enhance this strategy by finding an equilibrium between position and impedance control algorithms. Possible methods are fuzzy-like or based on model predictive control (MPC) approaches. Therefore, we work on improvements on the used inverse kinematics and try to develop inverse dynamics, which is mainly done by a current PhD student. Open points to be addressed are the implementation of the new yaw rotation capability of the upper body in Sweaty's gait behavior and using the results of the dynamics calculation for control algorithms.