Hamburg Bit-Bots Team Description for RoboCup 2022 – Humanoid League KidSize –

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Abstract. In this extended abstract, we present new software approaches and hardware developments since RoboCup 2019. We present valuable lessons learned from our participation in the last competition, describe our developments, and reference the publications we made about our contributions.

1 Lessons Learned

During RoboCup 2019 we experienced major hardware failure where our robots' necks would break due to the new camera's increased weight. We adapted to this improving the 3D printed mechanical parts and introducing a flexible element that causes the impact to be dampened. To compensate for this introduced uncertainty in the neck joint's position we added a 6-axis IMU in the robot's head to measure its orientation more accurately than the position sensors could.

We also experienced issues with the knee joint not being strong enough to perform certain motions (i.e. standing on one leg during kicking, standing up motion). To reduce this peak load we introduced torsion springs in the knee and upgraded the motors from DYNAMIXEL MX106 to XH540-W270.

We also experienced strongly changing behavior of the actuators depending on the remaining voltage in the battery. To compensate for this we changed to batteries with more cells and step down the voltage to a constant level.

2 Changes compared to RoboCup 2019

TORSO-21 Dataset We created the Typical Objects in Robot Soccer (TORSO-21) dataset[1]. This was a prerequisite for continuing our research on computer vision which is more robust to different environments.

YOEO Since computation hardware is limited on mobile platforms we developed a hybrid approach to object detection (e.g. for balls, robots, and other obstacles) and semantic segmentation (e.g. for the field area and lines). This approach, we called You Only Encode Once (YOEO) [5].

Training Data Selection To reduce the effort of labeling data, we are currently working on an approach to automatically select the images which are most useful for neural network training.

Stand Up Motion Previously, we use key-frame-based animations for the stand-up motion. This was quite tedious to manually tune. Therefore we implemented spline-based motions and automatically optimized them in simulation, and afterward adapted them to work on the real hardware. Our approach is described in [4].

Walking Currently, we are using a spline-based walking algorithm with sensor-based stabilization. For the next edition of RoboCup, we plan on transferring our reinforcement learning based approach, which shows promising results in simulation, to the real world.

Furthermore, we are working on solving the path planning and execution problem using reinforcement learning based footstep planning.

Behavior Our behavior uses the Dynamic Stack Decider framework [3]. We improved our behavior significantly by introducing team communication, team behavior, and a cost-map-based approach of where to kick or dribble the ball to.

Hardware We significantly improved our hardware as opposed to the version used in RoboCup 2019. We describe our robot platform in [2].

ROS2 migration We are currently using ROS as our framework. Since ROS2 promises a significant reduction in processing overhead and latency, we are migrating our code base to it.

References

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