UTRA Extended Abstract
RoboCup 2023 Humanoid League (KidSize)

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1 Lessons Learned From Previous Competitions

RoboCup 2022 was our first in-person competition since 2018, but due to severe neglect, only one of our planned three robots was operational. Incomplete development and testing resulted in wasted time and flawed projects. The delay in hardware development caused significant testing delays for the one working robot. During the competition, poorly optimized modules caused CPU and GPU overload, leading to mistiming in our algorithms. Building binaries for mxnet took over 24 hours. We learned valuable lessons and will place more emphasis on early rigorous testing and integration going forward.

2 Cheaper Custom Servo

Our team has successfully repurposed hobby servos to perform functions similar to Dynamixel servos, with comparable specs to the Dynamixel MX108 at a significantly lower cost. By utilizing these hacked servos, we have constructed a humanoid robot that is capable of walking. Moving forward, our team intends to continue testing and refining these hacked servos for use in our humanoid robot. We plan to compare their performance with that of robots equipped with genuine Dynamixel servos and utilize the results to further develop these hacked servos for future applications.

3 Mechanical redesign

One significant change we will make is to utilize a more rigid and impact-resistant material, such as carbon fiber polycarbonate, to reinforce the legs and enhance their rigidity. Additionally, we will explore other modifications, such as optimizing component placement and upgrading existing parts, to further enhance our robot's capabilities and address any issues identified during the competition.

4 Software Improvements

We intend to create a UKF system from the ground up. We have identified the need to replace our current AMCL-based approach, which is optimized for wheeled robots and may not be suitable for our purposes. Our new UKF system will leverage data from multiple sources, including robot movement odometry and visual odometry calculated using field lines. By fusing these different data points, we aim to develop a more accurate and reliable system that will improve our robot's ability to navigate and operate in complex environments.

5 Research Interests

Object Detection
One of our current research interests lies in computer vision and object detection tasks. Previously we were using a custom FCNN for object detection [3]. This has caused numerous problems that have taken a lot of time to debug. We have decided to switch back to using a pre-trained model such as YOLO v5 and have been exploring other potential solutions such as YOEO to replace our traditional computer vision process for field line detection [4].

Reinforcement Learning
One of our current research interests lies in reinforcement learning for control-related skills. Our plan is to use Isaac GYM to train agents using advanced motion prior obtained from motion capture data from real human motions to teach a variety of skills such as walking, kicking, and defense. This approach should incentivize more energy-efficient motions and less complexity in training for Sim2Real compared to reward engineering [5].

References

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