

Bit-Bots Extended Abstract

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1 Lessons learned in previous RoboCup competitions

Over the past competitions, we learned a lot about running a RoboCup team. We learned about organizing and structuring, as well as the importance of regular team meetings and how to properly plan ahead. Especially in last year's competition, we learned the importance of prioritizing tasks instead of trying to solve multiple large problems at once. Since we introduced big hardware changes to our platform at the same time as we were migrating to ROS2 [2], we got overwhelmed quickly. We were still working on the sim-to-real transfer from the previous competition, which added to the problem. All of this meant that we had very little time to integration test the components, which led to major problems in the competition. Furthermore, oftentimes, the different problems depended on each other in unexpected ways, which often impacted our progress in solving them.

Nonetheless, we also learned a lot about ROS2 and how to solve some common issues and increase efficiency. We documented our experiences with ROS2 as well as the solutions in a blog post on our website¹, so that other teams can also profit from it. Finally, we also learned a lot about the other teams and the state of the league by conducting a survey among the teams. The results of the survey are also documented on our website².

2 Major problems the team is trying to solve for RoboCup 2023

Our team wants to resolve a variety of different problems for the next competition. First, we want to finish up the ROS2 migration and the sim-to-real transfer, mainly in regard to solving the performance issues in ROS2. Once that is completed, we will be working on the whistle recognition to be able to comply with the rule changes. We're also working on using team communication more extensively on the real robot. Previously we used the new team communication only in the virtual season and will now transfer this to the real world. Finally, we are working on increasing the walking stability, as we noticed our robot falling over more often than expected during the last competition.

From the hardware perspective, we are working on increasing our resilience against falls and overall increase the reliability of the robot.

¹ <https://bit-bots.de/en/2022/07/experiences-with-ros-2-on-our-robots/>

² <https://bit-bots.de/en/2022/07/results-of-humanoid-league-survey-2/>

3 Plans for the major changes the team expects to have implemented for RoboCup 2023

To resolve the problems described above, we have several changes to both software and hardware planned. To fix the performance problems with ROS2, we are working on using the EventsExecutor proposed by irobot³. So far, in our tests, this version performs significantly better than the default executors, and we are currently pushing for it to be merged to the ROS2 upstream. We are also experimenting with real-time kernels to achieve more consistent scheduling.

For whistle recognition, we are planning to use a neural network-based solution trained on a diverse dataset. We are also planning to use a Kalman filter-based approach [1] to track multiple robots at once, and a neural network-based player number and team detection. This information will help to get a more detailed game state and make informed decisions based on robot positions.

For hardware, we will integrate microphones to be able to recognize the whistle. As this will introduce additional weight to the head assembly, we must redesign our head to ensure it does not break when the robot falls. Furthermore, we are planning on stiffening the robot’s legs to reduce issues we had with flexing mechanical parts.

4 Implementation status of the planned changes at the time of submitting

As of the time of submission, we are still working on some performance issues with ROS2, we try to solve by using explicit binding of different parts of the software to isolated CPU cores and manually setting different scheduling. The EventsExecutor is however already in use in simulation and seems to work and perform well. The whistle recognition setup is prepared to allow starting to train a network with a small dataset in the following weeks. Multi robot tracking, however, is currently still in a proof of concept phase, as it is part of a bachelor’s thesis. Our neural network-based approach for team and player number recognition is still in development, but recognizing teams based on colors is already working well. Any planned hardware changes have not yet been worked on, as we are currently working in a simulated environment for the Humanoid League Virtual Season.

References

- [1] Rudolph Emil Kalman. “A new approach to linear filtering and prediction problems”. In: (1960).
- [2] Steven Macenski et al. “Robot Operating System 2: Design, architecture, and uses in the wild”. In: *Science Robotics* 7.66 (2022), eabm6074. DOI: 10.1126/scirobotics.abm6074. URL: <https://www.science.org/doi/abs/10.1126/scirobotics.abm6074>.

³ <https://github.com/ros2/design/pull/305>