Hamburg Bit-Bots Humanoid League 2020

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Abstract. This extended abstract describes the current research of the *Hamburg Bit-Bots* Humanoid KidSize RoboCup team, lessons learned from last years competition and improvements planned for 2020.

Keywords: RoboCup · Humanoid · Soccer.

1 Lessons Learned from RoboCup 2019

In the RoboCup 2019 competition, we had recently installed new cameras on the robots with a new 3D printed head. These heads sometimes broke when the robot fell. We have learned from this to not make major hardware changes close to a competition, since there is not enough time to test the changes sufficiently. Another lesson we have learned from this problem is to test the robustness of our hardware more rigorously.

A major problem we faced was the integration of the different components of our software stack. Our software was able to solve most problems when tested in isolation.

For example, our walking algorithm published inaccurate odometry, overestimating the distance the robot walked. This caused our pathfinding to change its plans more often and radically than necessary. Due to the change in plans, the walking had to change its speed and direction. This again led to a more unstable walking and oscillation around the planned path.

2 Major Problems to Solve for RoboCup 2020

One major problem we need to solve is instability in motions which comes from the servos not reaching their goal position using their internal PID controller. Thereby the motion is not executed as planned and the robot becomes unstable. We are currently investigating if better tuning of the PID controller solves this problem or if other measures need to be taken.

We are experiencing a lot of wear on the servo bus cables, which leads to frequent communication problems on the servo bus resulting in more repair time. We started working on this problem last year, but it is still not completely solved, thus requiring more hardware modifications. Our developments in [1]

which will be implemented for RoboCup 2020 will furthermore allow us to isolate bus problems to their respective bus (e.g. a fault in the cables in the arm does not cause problems in the legs of the robot).

3 Planned Development for RoboCup 2020

We plan to use an updated version of our robot platform from last year. We already fixed the mechanical issues with the head design. We are currently working on weight loss in the torso and the feet, as well as better cable handling. Furthermore, we are currently integrating our new servo/sensor control board QUADDXL [1] to achieve faster control cycles.

We already used flexible 3D printed parts in the shoulder roll motor at the last RoboCup. We plan to integrate these in the elbow to reduce damage from falling. Furthermore, we want to include them in the knee joint with an additional rotary encoder. While we believe that this will not be ready in the RoboCup 2020, we believe it is necessary for the future so that shocks from walking or even running can be better absorbed.

We do not plan major improvements to the vision system (described in [2]) for RoboCup 2020 since it performs very well.

Last year we used an implementation of AMCL[1] for localization with line information as input. There were multiple problems since it is optimized for working with LiDAR sensors. Therefore, we implemented a new particle filter based localization, which uses all field information from the vision (lines, line features, posts, field boundary, visual compass) and also handles information from the game controller.

Our decision making uses the Dynamic Stack Decider[2]. We plan on integrating rule changes and improving robustness.

The problems with the integration of walking and path planning have already been solved and we plan to implement better handling of obstacles in for RoboCup 2020.

Our closed-loop implementations for walking and kicking already work well and we are only planning on small improvements. The getting up motion is currently reworked as a closed-loop approach, but we also have the working open-loop solution from last year.

Our software stack is currently based on ROS Melodic. We will not migrate to ROS 2 before the world championship but plan to do it right afterward.

References

1. Bestmann, M., Güldenstein, J., Zhang, J.: High-frequency multi bus servo and sensor communication using the dynamixel protocol (2019)
2. Fiedler, N., Brandt, H., Gutsche, J., Vahl, F., Hagge, J., Bestmann, M.: An open source vision pipeline approach for robocup humanoid soccer (2019)

[1] http://wiki.ros.org/amcl
[2] https://github.com/bit-bots/dynamic_stack_decider