THMOS Extended Abstract for Humanoid Kid-size League of RoboCup 2023

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Abstract. This paper describes the lessons we learned from previous RoboCup competitions as well as the possible improvements we would like to implement in the RoboCup 2023. Our major changes to the previous version of robot are also presented. To prepare for RoboCup 2023, we have made continuous efforts to the walking, vision and localization model of our robot.

1 Lessons Learned and Problems

Our team has been participating in RoboCup humanoid league (kid-size) competition for almost ten years. During this process, outstanding achievements have been made by our previous team members. However, what challenges us the most is the conveyance of knowledge and relative technologies from one generation of team members to another. Because new team members have to learn all of these by themselves, which could be extremely difficult and time-consuming.

In light of this, in the year 2022 THMOS has recruited new team members in a large scale, some of whom are literally talented. We are now taking methods to solve this problem including holding lectures and summer camp focusing on essential knowledge of robotics, keeping a well-written documentation while we are developing the technologies so that team members can catch up quickly as well as learn from other people's mistakes, etc. And we believe these measures would have a positive effect on our performance in this year's RoboCup competition.

In addition, we have had some technical problems in the past, such as the computing power of the hardware needed to be strengthened, the robot gait algorithm was difficult to adjust parameters and the vision-based localization accuracy couldn't meet our needs. These issues and their solutions are described below.

2 Plans of the major changes

2.1 Electrical Hardware

As a main difference from last version of robot, the new version integrates NVIDIA Jetson TX2 into the robot. Thus, the computation of generating gaits such as omnidirectional walking, getting up after falling down, kicking the ball, etc., is transferred from motion controller (LPC1768) to decision controller (Jetson TX2). The prime advance is that the robot can produce gaits exploiting the abundant computing power of Jetson TX2.

2.2 Walking

At present, the kid-size humanoid robots of each team use servo motors as their actuators. Because only position control and servo clearance error exist, it is difficult to adopt the gait algorithm based on the dynamic model. So, the open-loop gait has become the mainstream gait control method, which is simple and easy to be deployed.

However, this method is based on a large number of parameters. It takes a long time to tune the parameters to achieve a relatively stable walking pattern and it is not robust enough. To solve this problem, we tried the method of deep learning. Recently, we have used deep reinforcement learning to make the MOS robot walk at 0.6 m/s in simulation. During the coming semester, we will deploy the trained policy on the real robot and test in the football field.

Besides, the open-loop gait is easily disturbed by slightly uneven ground, so we propose a gait compensation method to improve our gait stability based on ZMP theory and the existing sensors of our robots, which is inspired by the paper [1].

2.3 Vision

Currently, we are using a monocular camera to perceive the ambient environment. However, we found our localization is not accurate enough. Therefore, we decided to substitute the monocular camera with ZED mini, a binocular stereo camera, which may improve the performance of both vision and localization because the binocular camera can provide information about the depth of the photo. We plan to learn the knowledge of 3D vision and complete the new algorithm in the coming semester.

2.4 Simulation

During the epidemic, in order to participate in the simulation competition of RoboCup, simulation platform based on Webots and ROS was designed, and software tests such as gait, vision, localization, and decision-making were also carried out in the simulation platform. The simulation platform also makes the technical inheritance of new team members more convenient.

References

1. Ficht, G., Behnke, S.: Direct Centroidal Control for Balanced Humanoid Locomotion. In: 25th International Conference on Climbing and Walking Robots and Mobile Machine Support Technologies (CLAWAR), pp. 242-255. Springer International Publishing Ag, CHAM (2022).