THMOS Extended Abstract for Humanoid Kid-size League of RoboCup 2024

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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 2024. Our major changes to the previous version of robot are also presented. To prepare for RoboCup 2024, we have made continuous efforts to the walking, vision, localization model and the decision making of our robot.

1. Lessons Learned and Problems

Our team has been participating in RoboCup humanoid league (kid-size) competition for almost ten years and have made outstanding achievements. Currently, our team is also steadily growing, with many new members joining. However, due to their unfamiliarity with the competition, newly joined members may make mistakes during the initial stages of the competition. Therefore, we have decided to train the new members through simulated matches. We use our own robots to conduct internal matches, allowing team members to understand their responsibilities, become familiar with the basic operations, and learn how to handle unexpected situations.

Additionally, drawing from our previous competition experiences, we have made several upgrades to our system, which are listed below.

2. Plans of the major changes

2.1 Walking

In terms of gait algorithms, the biggest difference from the previous year is that we adopted a ZMP gait algorithm based on Model Predictive Control. The key advantage of this algorithm is that the robot's mass center trajectory is optimized based on the ZMP model, thereby enhancing the robot's adaptability and walking stability. This control algorithm has fewer parameters, making it easier to debug. Additionally, we have incorporated attitude feedback and correction using IMU inertial information based on the open-loop ZMP gait algorithm, further improving the robot's walking speed and stability.

Furthermore, we have developed a separate repository for managing the robot's gait parameters, separating the algorithm from the parameters and resolving the issue of parameter loss.

Currently, we have completed the deployment and debugging of the open-loop ZMP gait algorithm for the robot, and the robot's walking speed has reached the level of previous year's competitions. In the upcoming semester, we will continue to refine the closed-loop feedback algorithm and perform further debugging work.

2.2 Vision and Localization

We upgrading the camera from a monocular camera to ZED 2i Stereo Camera, a binocular camera generating depth information through two RGB images, to perceive the surrounding environment. Binocular camera can obtain the depth of landmark/corner points, which will help improve accuracy. Meanwhile, binocular camera is equipped with IMU, working like a human brain and synchronizing vision and attitude. This allows the extrinsic matrix of camera more accurate.

We have developed the framework of Particle Filtering Algorithm based on YOLO feature point recognition, and improved it by mixing algorithm which can solve kidnapped robot problem.

Developing a Line Segment Detector is of great importance. We plan to fully develop an algorithm which can recognize different line features. Combining this with the Particle Filtering Algorithm, hopefully, we can achieve high-accuracy positioning. We will work hard on this target and make it in the coming spring semester.

2.3 Decision making

As robots are allowed to communicate with each other, we will utilize the Robot Operating System (ROS) as a mechanism for information exchange. This will enable the robots to share crucial information, such as the positions of the ball and players, facilitating more accurate localization.

Currently, we have designated the goalkeeper as the talker (host) in ROS. This decision is based on the fact that the goalkeeper's decision-making process requires less computation to the upper computer during the game. The goalkeeper's role involves obtaining ball position updates from teammates and moving to an appropriate location for defensive action.

The remaining robots will actively search for the ball on the field and make decisions such as chasing it, passing it to teammates, or kicking it toward the goal. These robots will also function as listeners in the ROS system, constantly communicating with the host. They will provide updates on field information and share their decision on the appropriate action to be taken.

In the future, our robots will incorporate the enemy's position into their decision-making process, utilizing path planning algorithms like A* to enhance the effectiveness of their aggressive actions. Additionally, we will endeavor to reconstruct the entire decision-making framework to achieve more comprehensible decision-making logic.