TH-MOS Extended Abstract for Humanoid Adult-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.

Keywords: RoboCup, Humanoid Robot, TH-MOS.

1 Lessons Learned and Problems

Our team has been participating in RoboCup humanoid league 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.

Based on TH-MOS's experience in kid-size and thanks to the sponsor Fourier Intelligence, we decided to take part in adult-size in RoboCup2024. 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

The main process of our robot's walking control is an integration of LIP-Based MPC and QP-Based WBC.

Firstly, the algorithm estimates the current state of the robot based on sensor data, such as position, velocity, and attitude. Using these data and the motion command as an input, the model analyses the corresponding action to control.

Using the LIP model, the algorithm predicts the future motion of the robot and calculates optimized basic control inputs to maintain balance. Additionally, the QP-Based algorithm considers task requirements and various constraints, optimizes the entire body movement through quadratic programming, ensuring that the robot maintains overall stability while executing tasks.

Through the combination of these two models, the final control input is sent to the robot's actuator, driving the robot to perform optimized actions.

2.2 Vision and Simulation

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.