HERoEHS, Team Extended Abstract

Jeakweon Han[1], Yeonghun Chun[1], Junwoo Yong[1], Sihyeong Park[1], Seokhwan Kim[1], Sunghoon Lee[1], Sunhyuk Jee[1], Junseo Park[1], Wonyong Lee[1], Haewon Jung[1], Jaewon Jeong[1], Uijin Kim[1], Hyewon Jung[1], Cheonyu Park[2], Gihun Kang[2], Junhee Won[2], Yuhyun Kim[2], Seongjoong Kim[2], Jaewook Jung[2], and Younseal Eum[2]

[1] 527, Engineering Building 5, Hanyang University ERICA,
55, Hanyangdaehak-ro, Sangnok-gu, Ansan-si, Gyeonggi-do, Republic of Korea
jkhan@hanyang.ac.kr
https://heroehs.com

[2] 405, Business Incubator, Hanyang University ERICA,
55, Hanyangdaehak-ro, Sangnok-gu, Ansan-si, Gyeonggi-do, Republic of Korea
arobotmaster@arobot4all.com
https://arobot4all.com

Abstract. The team HERoEHS and AROBOT are upgrading our ALICE version 3 to participate in RoboCup 2024. Our ALICE version 3 is steadily improving on machine design, walking and balancing algorithms, vision recognition, and localization performance, based on previous gaming experiences and data. Team HERoEHS and AROBOT hope that our ALICE version 3 will be able to show more dynamic and smart performances at RoboCup 2024.

Keywords: ALICE · RoboCup · Adult Size League · Humanoid Robot

1 Introduction

Team HERoEHS has been participating in the RoboCup Humanoid Adult Size League since 2018. We upgraded ALICE to ALICE version 3 for three years since 2018. [1], [2], [3], [5] AROBOT is a startup company comprised of Team HERoEHS members. AROBOT will generously support their know-how and capabilities to showcase all of our team's capabilities in the RoboCup.

As we prepare for participation in RoboCup 2024, we are trying to make ALICE stable but more dynamic, and smarter.

2 Technical Issues

2.1 Walking Algorithm

Team HERoEHS and AROBOT initially used ZMP-based preview control walking techniques for their humanoid robots, which improved gait stability but were not effective in dynamic, real-time situations like soccer matches. To overcome this, they developed and presented an omnidirectional walking system at the 2023 RoboCup. Our future focus is on further enhancing robot performance and stability by integrating Whole Body Control (WBC), Preview Control, ZMP, and Landing Point Control strategies. This integrated approach is expected to optimize movement, improve predictability, and maintain balance and stability in dynamic environments.

2.2 Mechanical Design

ALICE increased the length of legs 1.2 times compared to the previous one for fast walking speed. Accordingly, it was replaced with a higher performance actuator for the knee, which carries the most load. The capacity of the battery increased 1.2 times to operate for a longer period of time, and a spring latch was used for rapid battery replacement. The neck used a four-bar link structure to see the ball in front of the foot without getting caught in the cover.

2.3 Vision Recognition

At RoboCup 2023, we were able to convert to Yolov4-tiny trained with 60,000 datasets, optimize through Tensor RT, and recognize (e.g., ball, goals, goal posts, etc.) in real time through ZED2i cameras. For RoboCup 2024, we plan to enhance our vision system by upgrading to Yolov7 and implementing a new algorithm for more accurate ball recognition that considering the unique presence of a single ball on the field. Additionally, we aim to improve the ball's positioning accuracy by refining the Transform Matrix, applying various filters, and replacing manual HSV filters with more precise, deep learning-based segmentation methods. We anticipate that these upgrades will significantly improve object detection and localization performance, contributing to more efficient and sophisticated gameplay in RoboCup 2024.

2.4 Localization

We have implemented vision-based localization, which is using points and lines on the soccer field from Vision System. Also, our localization system can overcome even if a robot is moved by a handler, such as an entangle or a penalty situation. Currently, we are developing our localization algorithm to reliably cope with variable situations, overcoming noise on sensors, control, vision data caused by the robot's movement and implementing an algorithm about getting the starting position anywhere on the edge of the soccer field.

2.5 Team Robot Communication

We implemented UDP communication in accordance with competition rules to share essential game information, such as the positions of the ball and opponent robots, and developed a GUI for real-time monitoring of the robot's status from outside the field.

3 Future Work & Conclusion

Team HERoEHS and AROBOT are concentrating on enhancing robot performance and stability for the 2024 RoboCup by advancing their omnidirectional walking technology using a combination of Whole Body Control, Preview Control, ZMP, and Landing Point Control strategies. This approach aims to optimize robot movement, increase predictability, and ensure balance and stability in dynamic environments. ALICE version 3, set to compete in the 2024 RoboCup, will undergo upgrades including longer legs with high-performance knee actuators for enhanced speed, increased battery capacity, and spring latches for quick battery changes. Additionally, improvements in the vision-aware model will bolster localization and object recognition, and an inter-robot communication system will be applied to share the ball's position for more strategic gameplay.

Team HERoEHS and AROBOT's preparation process to participate in RoboCup in 2024 is an important step in line with the ultimate goal of developing humanoid robots for humans and society. We have no doubt that continued competition in RoboCup will contribute to promoting the advancement of robotic technology and exploring the various possibilities that can contribute to human life and society.

References

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