RoboCup 2022 Humanoid Soccer Competition Bold Hearts Extended Abstract

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1 Introduction & History

Bold Hearts are the RoboCup (RC) team of the University of Hertfordshire (UK). The Bold Hearts was founded in 2002, and originally started competing in both the 2D and 3D RoboCup Simulation Leagues. The team continued its long history in RoboCup by entering into the Humanoid League (HL - kid size), and has competed since 2013. Since then, we are the longest continuously active RoboCup teams in the United Kingdom, and in our knowledge we are still the only British team in HL.

Electric Sheep is the RoboCup team of the University of Canterbury (NZ). The Electric Sheep has been founded in 2018 by Dan Barry, former Bold Hearts team member, with the Electric Sheep competing first in RC 2019. The team mainly comprises of students from the University of Canterbury with different engineering backgrounds and from multiple disciplines.

Bold Hearts and Electric Sheep share common ideas and goals for Robocup, and they have same love and interests for robotic research. Hence, due to the strong connection between the members of the two teams, they will join RoboCup 2022 for successfully competing and showcasing their common approaches and skills.

2 Changes and Scientific Developments

Hardware and Design Since 2018 we started to modify the hardware for creating more competitive robots. In particular, we developed the upper torso, legs, arms and head. During the 2019 competition, however, we realised that the servos used for the legs did not provide adequate torque to allow actuator targets to be reached for the completion of motion scripts or walking. Our initial approach for the 2020 competition we changed the servos of the knees adopting the MX64 instead of the MX28 servos. We observed an improvement in the upgraded area, and decided to replace all MX28 servos in the legs with MX64

servos to support a more robust and dynamic robot motion. Consequently, the legs have been redesigned, while new brackets for the hips are being designed and are now in the testing phase, including experimenting with different materials and a new 3D printer (Stratasys J750).

For the last competition, we adopted a new camera, Logitech C920 Pro HD Webcam, for improving the robot vision system, and we designed a simple support for holding this camera. Unfortunately, the plastic parts printed for the camera holder were not stable and sturdy enough to resist robot movements and falling. For this reason, we designed a new head.

Walking Currently our team makes use of the open-loop IKWalk engine open-sourced by Rhoban in 2015[1] which is wrapped in a ROS2 node[2]. In 2019 we demonstrated our humanoid's ability to walk on artificial grass with limited stability, and have since been working towards an active balance control system. We work towards building upon ideas from bipedal reinforcement learning[3] and use the walk engine as a pattern generator, greatly reducing computation during learning and operation. We utilize previous efforts to integrate our codebase into the league's simulation environment to reduce hardware stress.

Vision In 2018 and 2019, we adopted a semantic segmentation object classification approach[4] which was successively improved. While the approach proved to be accurate and allowed for scalabale object recognition on minimal hardware, we actively research methods to combine the lessons learned with the Electric Sheep's XNOR convolutional neural network (CNN), that would allow us a fast and accurate recognition of multiple fields objects, including robots, field lines, goal posts.

Academic & Scientific activities In 2020/2021 we included RoboCup as an extra-curriculum activity unit for BSc and MSc students. We significantly contribute to the periodic review for the BSc Computer Science online programme by designing a robotic module that will comprise RoboCup as a learning platform. This module, will be also accessible to on-campus students. We have recently received funding for organising a RC hackathon week for hardware design and software development. Moreover, since last year we have created several tutorials and lectures for providing detailed information about RC rules, our ROS 2 framework, and so on. Our desire is not only to form new robocuppers, but also for the betterment of the scientific and RC community. Towards such end, we are also actively participating in editing and contributing to the unique journal project called "The human in the loop: perspectives and challenges for robots' behaviours in RoboCup 2050" that aims to use RC for benchmarking the progress in AI and robotics development by bringing together experiences and knowledge of HL members, trustees and members of other RC leagues.

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[1] Rouxel, Q., Passault, G., Hofer, L., N'Guyen, S. and Ly, O., 2015. Rhoban hardware and software open source contributions for robocup humanoids. In Proceedings of 10th Workshop on Humanoid Soccer Robots, IEEE-RAS Int. Conference on Humanoid Robots, Seoul, Korea.

[2] IKWalk ROS2 node wrapper: `https://gitlab.com/boldhearts/ros2_ik_walk`

[3] Kumar, A., Paul, N. and Omkar, S.N., 2018. Bipedal walking robot using deep deterministic policy gradient. arXiv preprint arXiv:1807.05924.

[4] van Dijk, S.G. and Scheunemann, M.M., 2018, June. Deep learning for semantic segmentation on minimal hardware. In Robot World Cup (pp. 349-361). Springer, Cham.