CIT Brains Extended Abstract for RoboCup2024

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Abstract. CIT Brains has been participating in the Humanoid Kid-Size League since RoboCup 2007. Last year, we got second prize in the RoboCup 2023 soccer competition. This paper focuses on the hardware and software developments that CIT Brains is pursuing for RoboCup 2024. First, we present lessons learned from past RoboCups related to robot adjustment and efficiency in development. Next, we focus on new developments to ensure stable body control and to provide an environment for detailed recording of the robots state. Finally, we discuss minimizing the effort of the dataset collection for object recognition.

Keywords: Humanoid Robot · Logging System · Sim-to-Real.

1 Lessons Learned from Past RoboCups

Since the development of software for autonomous robots is difficult, we are sometimes not be able to make the desired progress in software development. We have also experienced situations where we have could not fully demonstrate our robots capabilities due to the time spent on hardware-related adjustments during the competition.

We currently use six humanoid robot, SUSTAINA-OP™ [2]. The increase in backlash, due to actuator wear, is not uniform across these robots, making it difficult to achieve consistent performance. In addition, during a match, the actuator power fluctuates due to battery operation, leading to issues with body control. Therefore, we believe it is necessary to find a method to maintain constant output while minimizing wear and tear on the actuators.

Furthermore, during development, it was sometimes unclear whether the problem originated from hardware or software, and at which level. Such investigations could be time-consuming. Therefore, there is a need for an environment that allows for detailed logging of the robots state.

Additionally, annotating datasets for object detection is time-consuming task, and the specification of bounding boxes varies individually. Therefore, there is a need for a method to minimize these labor costs.

2 Maintaining Consistent Body Control Performance

The variations in mobility of real robots are primarily due to the actuators. In battery-powered robots, a voltage drop of approximately 1.5V typically occurs within 10 minutes during a game. This leads to a disparity in the robots body control stability between the early and late stages of the competition, increasing the likelihood of the robot falling over. Additionally, it was not uncommon for the actuators to wear out and need to be replaced during the competition. To address these issues, we are considering the implementation of an electronic circuit designed to maintain a constant supply voltage for the actuators and a mechanism to minimize the increase in backlash.

3 Building the Logging System for Debugging

When problems occur during the development of software for a robot, without detailed operational data, it is often unclear whether the issue lies with the platform or the software running on it. To address this, we have implemented a comprehensive recording system in the robot, enabling detailed status logging. Our objective is to use the rosbag API to create a system that records information, complete with timestamps. The recorded data include the coordinates of detected objects, the current task being executed, along with the joint angles and power supplied by actuators and sensory devices. Logs are continuously recorded during the robots operation to allow for prompt reference when needed, thus facilitating rapid development and validation.

4 Reducing Time and Effort by Automating Annotation

The creation of datasets for object detection is predominantly a manual process. Although a larger dataset size is desirable for improved generalization performance with unknown data, expanding the dataset size is time-intensive. Fortunately, simulators can often automatically acquire object positions, a feature that can be leveraged to almost automate the annotation process. In some instances, simulated images are transformed using image generation techniques to resemble real-world environments. These transformed images are then used as part of the dataset for real-environment recognition [1]. Similarly, we employ image generation techniques to convert simulation images into realistic-looking ones, utilizing this data to construct a dataset. This approach significantly minimizes the effort required for annotation, facilitating the recognition of real environment.

References

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