# UTRA - Humanoid KidSize
# Team Description Paper for RoboCup 2024

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**Abstract.** This paper discusses lessons team UTRA has learned from previous competitions and details information about their robots and current research developments. Moreover, major robot design changes are discussed and the current state of the implementations. Hereby UTRA apply for participation at the RoboCup 2024 for **Team Competition** in Eindhoven, Netherlands[1].

## 1 Introduction

Team UTRA is from Toronto, ON, Canada and is supported by the Department of Applied Sciences and Engineering at the University of Toronto. We are an interdisciplinary group of Undergrads, Bachelor's and Master's students from various disciplines such as Computer Science, Engineering Science, Mechanical Engineering and Electrical Engineering. We believe in innovation and have our code shared in a public repository on our GitHub [2]. In this paper, we will provide an overview of our challenges in RoboCup and how we are trying to overcome them as we intend to participate at the RoboCup 2024 for Humanoid League, KidSize.

## 2 Lessons Learned and Problems

RoboCup 2023 was our second in-person competition since 2018 and was a great success as two out of our three robots planned for submission were operational. One of the robots that qualified for competition, featured our new mechanical design which consisted of a custom 3D-printed torso, arms and legs. During matches, our robot managed to walk to the middle of the field and ended up stopping a goal from being scored by the opposing team. However, despite the mechanical success of our robots, we ran into networking issues while trying to connect to the game controller. Although we enhanced the mechanical performance of our robots, in the future we will increase our time spent on testing to ensure smooth performance when it comes to the functionality of our software.

## 3 Major Changes and Status of Implementation

We intend to create a UKF system from the ground up, addressing the need to replace our current AMCL-based approach, which is optimized for wheeled robots and may not be suitable for our purposes. Our new UKF system will leverage data from multiple sources, including robot movement and visual odometry, calculated using field lines. By fusing these different data points, we aim to develop a more accurate and reliable system that will improve our robot's navigation capabilities and operate in complex environments. Additionally, we aim to implement behaviour trees for a more robust strategy, improve localization to reduce the kidnapped robot problem and increase automation in camera calibration. We are also looking into integrating a ZMP-based walk engine, the CUDA-accelerated computer vision library, and upgrading to ROS2 and Foxglove Studio for better debugging features and enhanced capabilities. In past years, we successfully trained an object detection model using YOLOv5, achieving high accuracy[3]. Our main focus now is on transitioning to SAM for segmentation, moving away from OpenCV to increase robustness. Moreover, reinforcement learning for control-related skills is currently in use. Isaac GYM is utilized to train agents using advanced motion obtained from motion capture data from real human motions to teach skills such as walking, kicking, and defence. This year, there will be an increased focus on Sim2Real implementation. In terms of PCB design, we are in the process of shifting from through-hole to SMT components to save space, and add current and voltage sensing circuits to collect real-time operational data. Additionally, we plan to incorporate a Zener diode to counter back EMF from the motors. The performance and integration of the MPU6050 was not ideal and completely functional, leading us to upgrade to the BMI088/BMI085 for improved accuracy and precision. The existing embedded code relies on basic HAL library functions and is investigating how to incorporate Dynamixel SDK for enhanced functionality. Lastly, the team has successfully repurposed hobby servos to perform functions similar to Dynamixel servos, with comparable specs to the Dynamixel MX108 at a significantly lower cost. By utilizing these hacked servos, we have constructed a humanoid robot that is capable of walking. Moving forward, our team intends to continue testing and refining these hacked servos for use in our humanoid robots.

## References


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3. *YOEO - You Only Encode Once: A CNN for Embedded Object Detection and Semantic Segmentation.* .10.1109/ROBIO54168.2021.9739597 (2021).