

WolverBot Kickers Extended Abstract 2026

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Abstract. Our team, WolverBot Kickers, is building a humanoid robotic system to compete in the 2026 RoboCup Humanoid KidSize League. In this paper, we describe the decision making behind the design and software implementation, specifically our 4-bar parallel mechanism used to control the feet and reinforcement learning control policy development. We then explain the importance of our team’s participation in RoboCup to the University of Michigan and our team’s goals for researching parallel mechanisms in the ankle and generating control policies with RL.

Keywords: humanoid robot · reinforcement learning · RoboCup · parallel mechanism.

1 Introduction

WolverBot Kickers is a new student organization founded in 2023, at the University of Michigan. The purpose of the organization is to increase student understanding and interest in humanoid and bipedal robotics and provide a space for students to practice their comprehension of this field. In this paper, we give an overview of our humanoid, which we began development for in the fall of 2025, for the 2026 RoboCup competition. We will then explain our research goals for the future, specifically our 4-bar parallel mechanism used to control the feet and reinforcement learning control policy development.

2 Overview of our System

2.1 Hardware

The primary hardware focus of our team’s humanoid robot is in the parallel mechanism used in the ankle design. The robot it stands 0.87m tall and weights 10.1 kg, with an upper body that follows the general design plan that has been used in many proven RoboCup designs such as the NUGus from NUBots [1] and Darwin OP from Robotis [7], with motors that are directly connected to the joint they drive. For the lower body, primarily the ankle, we took inspiration from the parallel mechanism described in [5]. We designed an ankle that uses two linkages to form a parallel mechanism to allow the two motors at the ankle to control the roll and pitch of the foot in tandem instead of each motor controlling roll and pitch independently.

2.2 Software

Our software combines modern low-level control techniques with high-level planning and navigation in a modular software stack using ROS2. The decision making and path planning of our system is built around the UTAustinVilla code base developed by the University of Texas at Austin [2], which we have repurposed for our own high-level behaviors. For localization, we use a particle filter supplemented with iterative landmark matching [4]. We use Yolo v11 to process data from our cameras and provide the information needed for localization. We implement the A* navigation algorithm for obstacle avoidance to improve path planning. To connect the high-level decision making and path planning to the low-level controls of the robot, we are also developing control policies that output joint torques given reference velocity command inputs, which are developed using reinforcement learning on Isaac Lab inspired by Unitree’s RL Lab (unitree_rl_lab) [3].

3 Education and Research Focus

3.1 Education

The primary focus of our organization is to provide a space where students can be introduced to, learn about, and gain experience in the field of humanoid robotics. For the past three years, our organization’s development process has introduced our members to the electro-mechanical design, high-level decision making process, and low-level controls of humanoids. Though many student organizations at the University of Michigan focus on autonomous drones, rovers, and marine robots, we are the only student group that develops and researches humanoid robotics. The organization has members from all grade levels, from undergraduate freshman to graduate students. Through this club, we hope to increase the opportunity for interested students to gain experience in the blossoming field of humanoid and bipedal robotics.

3.2 Research

We have challenged ourselves to pursue the cutting edge of humanoid research and to be unique from prior RoboCup designs, attempting several components novel to the competition.

One example of this is our pursuit of control techniques currently explored in industry and research labs. In this process, we have coordinated with industry professionals, professors, and post doctoral researchers alike, familiarizing ourselves with reinforcement learning and developing a basic 5-link walker which we simulated using optimization techniques. Using this simulation, we also generated foot positions to train gait motions for early reinforcement learning attempts. Since then, we have been inspired by Unitree’s RL laboratory to explore NVidia Isaac Lab for its GPU parallelization [3] [6]. Using Isaac Lab, we have developed a clean walking gait through the use of dense rewards that penalize

joint deviation and gait shape while rewarding velocity tracking. Additionally, we utilize noise and domain randomization to decrease the sim2real gap.

Another instance of our ongoing research efforts is implementing iterative landmark matching. Iterative landmark matching receives visual detection of common field landmarks, such as line intersections and goalposts, for more accurate localization given a fixed field layout [4]. This approach supplements our simple particle filter localization algorithm and takes advantage of the known environment of the play field.

In addition, we are attempting innovations in mechanical design. By using a differential linkage to drive the roll and pitch of the ankle we can increase the overall torque being applied to the ankle as the torque from both motors is being used to control both directions [5]. After familiarizing ourselves with the design and dynamics of this mechanism, we hope to focus on changing the gait generation of the robot from a quasi-static gait to a more dynamic gait. The motion of this gate will potentially allow us to underactuate the ankle during movement, or even reduce the size of the motors in the ankle, resulting in more efficient locomotion. While we have yet to verify this idea on our physical system, we have tested the concept in the 5-link simulation.

4 Conclusion

By competing in the RoboCup competition this year, we hope to introduce ourselves to the humanoid robotics research community. We further hope to contribute to the RoboCup research challenge for years to come and continue fostering education in cutting-edge robotics at the University of Michigan.

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