Software Survey 2025

Team Name

.HERoEHS

Is your software fully or partially OpenSource. If so, where can it be found:

.Our source code is completely closed source. It is managed privately on GitHub. We have developed most of the code ourselves, while partially utilizing open-source libraries. The open-source libraries we used include BehaviorTree.CPP, microstrain_mips, pinocchio, and OSQP, all of which are documented in the submitted Robot Specification.

Do you have a kinematic or dynamic model of your robot(s)? If so, how did you create it (e.g. measure physical robot, export from CAD model)?

.We create the kinematic and dynamic model of our robot by measuring from the CAD model. The mass of the components that make up the robot is obtained through the measurement of the actual parts, which is used for dynamic analysis.

Are you using Inverse Kinematics? If so what solution (analytic, (pseudo)inverse jabcobian, etc...) are you using?

.We designed the lower body, which is based on linear actuators, to facilitate Inverse Kinematics calculations through joint axis alignment. By creating virtual joints, we implemented Inverse Kinematics using an analytic approach, which accurately calculates the virtual joint angles based on mathematical formulas.

Are you simulating your robot? If so what are you using simulation for?

.We are using Unity3D and Mujoco, and we plan to try Issac Sim as well. Unity3D is used to review overall strategies in gameplay, while Mujoco is used to verify the robot's motions. In cases where reinforcement learning is required, we plan to use Issac Sim.

What approach are you using to generate the robot walking motion?

.Previously, we used a preview control based on position control. Currently, we are developing a new walking method through a stepping controller and whole-body controller, which utilize DCM and CoP to calculate optimal steps and perform torque control.

What approach are you using to generate motions for standing up?

.Using Inverse Kinematics and ninth-order polynomial functions, motions are pre-created, and upon receiving a standing-up command, the respective motion is executed. Each step of the motion is divided by the motion execution time, allowing the sequence to proceed accordingly.

What approach are you using to generate kicking motions?

.Using Inverse Kinematics and ninth-order polynomial functions, motions are pre-created, and upon receiving a kicking command, the respective motion is executed. Each step of the motion is divided by the motion execution time, allowing the sequence to progress accordingly. During the kicking motion, the x, y, z coordinates of the foot, yaw value, and kicking speed dynamically change depending on the position of the ball and the direction it needs to be kicked. Additionally, the degree of waist bending, the height of the lifted foot, and the ankle pitch angle are configured as adjustable parameters, making the system easy to tune and develop.

Do you use any other motions than the previously mentioned? If so, what approaches are you using to generate them?

.Our robot generates movements through position control, either by using Inverse Kinematics or directly commanding angle values to each joint. We have developed a motion to defend against an opponent trying to take the ball. The head calculates the positional values to track based on the position of the ball and performs tracking motions accordingly.

Which datasets are you using in your research? If you are using your own datasets, are they public?

.We are using approximately 90,000 data samples, which we collected ourselves, for Object Detection and Segmentation models. This dataset is not publicly available.

What approaches are you using in your robot's visual perception?

."We perform vision recognition based on image and point cloud data from the ZED2i. Additionally, we utilize three deep learning models Object Detection, Segmentation, and Classification to recognize objects and perform localization.
"

Are you planning with objects in Cartesian or image space? If you are using Cartesian space, how do you transform between the image space and cartesian space?

.We utilize the PointCloud (3D) data obtained from the ZED 2i camera and use a TransformMatrix to calculate the distance between specific objects and the robot. Additionally, based on the distance between the objects and the robot, we transform the coordinates into a global coordinate system for further use.

How is your robot localizing?

.We perform localization based on a particle filter by utilizing the field features detected through Object Detection (e.g., lpoint, tpoint, goalpost), the lines on the field identified through Semantic Segmentation, as well as data from the robot's Odom, IMU, and FT sensors.

Is your robot planning a path for navigation? Is it avoiding obstacles? How is the plan executed by the robot (e.g. dynamic window approach)?

.Our robot generates a path using Bezier curves to navigate to the target location. During the path generation process, if obstacles are detected, the robot creates waypoints to create a new path for avoiding these obstacles. Through this modified path, the robot can effectively avoid obstacles and reach its destination.

How is the behavior of your robot's structured (e.g. Behavior Trees)? What additional approaches are you using?

.The robot uses the behavior tree method with the "BehaviorTree.CPP" library. It also uses the ROS2 messaging system to command the robot's joints and receive sensor data.

Do you have some form of active vision (i.e. moving the robots

camera based on information known about the world)?

.During the game, the robot tracks the ball and searches for it by looking left, right, forward, and downward when the ball is not visible. Additionally, if the recognized field lines and key features are insufficient, the camera is adjusted to better capture these features.

Do you apply some form of filtering on the detected objects (e. g. Kalman filter for ball position)?

.We use a Kalman filter to predict and estimate the position and velocity of the ball when it moves out of the camera's view. Additionally, we apply a low-pass filter to reduce noise in the object coordinates caused by the robot's dynamic movements.

Is your team performing team communication? Are you using the standard RoboCup Humanoid League protocol? If not, why (e.g. it is missing something you need)?

.We use the standard protocol of the RoboCup Humanoid League and perform team communication to implement various strategic plays.

Please list contributions your team has made to RoboCup

.We have consistently participated in the Main Competition and Technical Challenge of the RoboCup Humanoid AdultSize League for the past seven years, achieving increasingly better results. Our best achievements are 2nd place in the Main Competition and 1st place in the Technical Challenge. Our team leader, Younseal Eum, has been a member of the Organizing Committee since 2023 and contributed to hosting RCAP2023 in Pyeongchang, South Korea. Furthermore, we successfully secured Incheon, South Korea, as the host city for RoboCup2026. Additionally, our team member, Seongjoong Kim, is serving as a member of the Technical Committee.

Please list the scientific publications your team has made since the last application to RoboCup (or if not applicable in the last 2 years).

."Won, J., Kang, G., Jee, S., Ahn, M., & Han, J. (2024, June). Design and Development of the Linear Actuator for Enhanced Agility in Humanoid Robot. In 2024 21st International Conference on Ubiquitous Robots (UR) (pp. 648-654). IEEE.

Kim, J. Y., Ahn, M. S., & Han, J. (2023, December). Enhancing AdultSize Humanoid Localization Accuracy: A Vision-based aMCL Leveraging Object Detection Model and Hungarian Algorithm. In 2023 IEEE-RAS 22nd International Conference on Humanoid Robots (Humanoids) (pp. 1-8). IEEE.

Swing foot pose control disturbance overcoming algorithm based on reference ZMP preview controller for improving humanoid walking stability (RoboCup Symposium 2023)

Swing kick motion of humanoid soccer robot to successfully kick a moving ball (RoboCup Symposium 2023)

Robust Line Detection in Soccer Fields Using Semantic Segmentation: An Approach towards Overcoming Traditional Computer Vision Limitations (RoboCup 2023 Software Challenge)

Kang, G., Won, J., Ahn, M., & Han, J. (2023, June). The Development of the Linear Actuator with the Series Elastic System for Robot Linkage Mechanisms. In 2023 20th International Conference on Ubiquitous Robots (UR) (pp. 764-770). IEEE.

Choi, J., Chun, Y., Min, I., Ahn, M. S., & Han, J. (2023, June). The Study on the Energy Efficiency of the Bipedal-Walking Pattern of a Humanoid Robot Using Four-Bar-Linkage Toe Joints. In 2023 20th International Conference on Ubiquitous Robots (UR) (pp. 108-114). IEEE.

Chun, Y., Choi, J., Min, I., Ahn, M., & Han, J. (2023, January). DDPG Reinforcement Learning Experiment for Improving the Stability of Bipedal Walking of Humanoid Robots. In 2023 IEEE/SICE International Symposium on System Integration (SII) (pp. 1-7). IEEE."

Please list the approaches, hardware designs, or code your team is using which were developed by other teams.

.We did not refer to other teams' approaches, hardware designs, or code.

What operating system is running on your robot and which middleware are you using (for example Ubuntu 22.04 and ROS2 Galactic)?

.We are using ROS2 Humble on Ubuntu 22.04.

Is there anything else you would like to share that did not fit to the previous questions?

.None.

If you have additional materials you would like to show, please link to them here.

.None.