RoboCup 2024 Submission Survey

Survey response 1

Software

Team Name
Tsinghua Hephaestus

Is your software fully or partially OpenSource. If so, where can it be found:
Not at this moment, but it will be openSource in the near future.

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)?
Yes. We design our robot CAD model using Solidworks and it can be easily converted into Unified Robotics Description Format by the open source ROS sw_urdf_exporter. Once the URDF has been created, the dynamic properties can be loaded in simulation and algorithm.

Are you using Inverse Kinematics? If so what solution (analytic, (pseudo)inverse jabcobian, etc...) are you using?
Yes. We use both, depending on the situation and module.

Are you simulating your robot? If so what are you using simulation for?
Yes, we are using simulation for robot control perspective, locomotion, path planning, decision making and localization.

What approach are you using to generate the robot walking motion?
To realize robust bipedal walking in RoboCup, we utilize the ZMP trajectory from FootPrints as input to generate the Divergent Component of Motion(DCM) and Center of Mass Trajectory(CoM).

What approach are you using to generate motions for standing up?
Whole Body Control (WBC)

What approach are you using to generate kicking motions?
Divergent Component of Motion(DCM)

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

Which datasets are you using in your research? If you are using your own datasets, are they public?
We collected more than 40,000 images with cloud data in different fields, including our own ground and the official venues from RoboCup 2017 to 2019. And a SOTA model is trained to realize a real-time(20FPS) detection in competition.

What approaches are you using in your robot's visual perception?
The visual perception system depends on the input of a head-mounted StereoLabs Zed 2 stereo camera. And we use deep neural networks for accurate and efficient object recognition in the competition field. Compared to the visual recognition system of last year, we revise the YOLO v7 model and run the full visual detection pipeline on Nvidia Xavier processor. With the increase of the size of the field, the probability of small and medium-sized objects in long distant has increased. YOLO v7 is a state-of-the-art, real-time object detection system and shows promising results in many scenarios. However, it is still a little bit weak for recognizing small objects. Therefore, we add more images collected in long distant into our training dataset and revise our visual model deeper and more adaptive to the larger competition field.

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?
The path planning module is running in Cartesian space, the object detection is in image space. The transformation between the two spaces is carried out using forward kinematics and state estimation.

How is your robot localizing?

The localization system consists of two parts: the global localization system and the local localization system. Both of them based on AMCL (Adaptive Monte-Carlo Localization). The global localization system aims to find out where the robot without previous location information and help to solve the kidnapped problem. It receives the type and location of landmarks that insight and a pre-defined map of landmarks, then finds out the most likely current position of the robot on the field. Landmark types including X cross, T cross, L cross, penalty point and the goal post. Due to the symmetry of the field, we use fuzzy location information to eliminate the ambiguity caused by symmetry.3D Object position transform.

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)?

Yeah, we do have path planning module and it is obstacle avoidance oriented. The global path is planned by traditional sampling method like Bi-RRT, adding humanoid robot dynamic constraints. The global path is transformed to local by the dynamic window approach as well as Bezier splines.

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

Based on the ROS Kinetic robot software platform on Ubuntu 20.04, we have written a decision node to deal with the behavior that the robot should take in different states. The decision node needs to receive information about the position of the ball, goal and obstacles from the visual node, the position and orientation of the robot on the field from the positioning node, the information about the game status from the game controller node, the angular state information (yaw, pitch) of the head node and the information about the robot's motion state from the gait node. According to these information, after calculation and processing of the decision node, corresponding decisions are made, and movement commands are issued to the head node and the gait node, so that the robot can make corresponding actions in the game.

Do you have some form of active vision (i.e. moving the robots camera based on information known about the world)?

Yes, the cameras on robots will move according to the history & estimation of ball position in the map.

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

Yes, we use Kalman filter for ball position.

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)?

For the 2 vs. 2 game was firstly added into AdultSize in 2019, we experimented rarely with the communication protocol between our two robots and made one robot a striker and another one a goal-keeper without a choice. The Monitoring Interface was not fully used, and the status of games and robots can not be visualized in real-time in 2019.
For RoboCup 2024, two robots will share the info about the environment and make synchronous actions. The status can be monitored and visualized in UI.

Please list contributions your team has made to RoboCup

The Tsinghua Hephaestus is a RoboCup Humanoid League team running at Dept. of Automation, Tsinghua University, China, since July 2006. The team had taken part in the RoboCup2007 both in KidSize and TeenSize. Our TeenSize team got the 2nd place in RoboCup2008, the 3rd place in 2009 and 2010. From 2011, we started to participate in Adultsize competition. We got the 2nd in Robocup2012 and the 3rd place in 2011, 2013, 2014, 2018 and 2019. We Also got the 2nd place in the AdultSize Technique Challenge in 2017, 2018 and 2019.

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

[2023]
1. Qingkai Li, Yanbo Pang, Wenhan Cai, Yushi Wang, Qing Li, and Mingguo Zhao, Xiu Li? Mingguo Zhao*?An Overview of Multi-task Control for Redundant Robot Based on Quadratic Programming, CIAC-2023.
2. Xueying Chen?Yong Yang?Wenhan Cai?Songrui Huang, Hopping Motion on Heavy-Legged Bipedal Robot Based on SLIP Model and Whole Body Control, FRSE2023.
3. Songrui Huang, Wenhan Cai and Mingguo Zhao*, Three-Rigid-Body Model based NMPC for Bounding of a Quadruped with two Spinal Joints, CLAWAR2023.
4. Qilun Wang, Qing Li, Mingguo Zhao, Xiaozhu Ju, Fast Terrain-Adaptive Motion of Humanoid Robots Based on Model Reference One-Step-Ahead Predictive Control, IEEE Transactions on Control Systems Technology.
5. Yushi Wang, Yanbo Pang, Qingkai Li, Wenhan Cai, and Mingguo Zhao, Trajectory Tracking Control for Robot Manipulator under Dynamic Environment, ICIRA2023.
6. Qingkai Li, Yanbo Pang, Yushi Wang, Xinyu Han, Qing Li, Mingguo Zhao, CBMC: A Biomimetic Approach for Control of a 7-DoF Robotic Arm, Biomimetics.

[2022]
7. Yan Xie, Jiajun Wang, Hao Dong, Xiaoyu Ren, Liqun Huang and Mingguo Zhao, Dynamic Balancing of Humanoid Robot with Proprioceptive Actuation: Systematic Design of Algorithm, Software,and Hardware, Micromachoines,2022,13,1458.
8. Xiaozhu Ju, Jiajun Wang, Gang Han and Mingguo Zhao, Mixed Control for Whole-Body Compliance of a Humanoid Robot[C]// ICRA2022.
9. Gang Han, Jiajun Wang, Xiaozhu Ju and Mingguo Zhao, Recursive Hierarchical Projection for Whole-Body Control with Task Priority Transition, IROS2022.
10. Jiajun Wang, Gang Han, Xiaozhu Ju and Mingguo Zhao, Whole-Body Control with Motion/Force Transmissibility for Parallel-Legged Robot, IROS2022.
11. Wenhan Cai, Qingkai Li, Songrui Huang, Hongjin Zhu, Yong Yang, Mingguo Zhao, Squat Motion of a Bipedal Robot Using Real-Time Kinematic Prediction and Whole-Body Control, IET C&R.
12. Yong Yang, Jiyuan Shi, Songrui Huang, Yuhong Ge, Wenhan Cai, Qingkai Li, Xueying Chen, Xiu Li and Mingguo Zhao, Balanced Standing on One Foot of Biped Robot Based on Three-Particle Model Predictive Control, Biomimetics.
13. Sun Yiyong, Zhao Haotian, Chen Zhang, Zheng Xudong, Zhao Mingguo, Liang Bin, Fuzzy model-based multi-objective dynamic programming with modified particle swarm optimization approach for the balance control of bicycle robot, IET Control Theory and Applications(1751-8644?IF2.670), 2022, 16(1), p.7-19.
14. Luo Guifu, Du Ruilong, Zhu Shiqiang, Song Sumian, Yuan Haihui, Zhou Hua, Zhao Mingguo, Gu Jason, Design and Dynamic Analysis of a Compliant Leg Configuration towards the Biped Robot's Spring-Like Walking?JOURNAL OF INTELLIGENT & ROBOTIC SYSTEMS(0921-0296?IF3.129), 2022, 104(4).

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

None

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

Ubuntu 20.04

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