RoMeLa Extended Abstract for RoboCup 2020 Humanoid League

Min Sung Ahn[1], Taoyuanmin Zhu[1], and Dennis Hong[1]

University of California, Los Angeles, Los Angeles CA 90066, USA
{aminsung,tymzhu,dennishong}ucla.edu
http://www.romela.org

RoMeLa (Robotics and Mechanisms Laboratory) at the University of California, Los Angeles is a robotics research lab with extensive experience in humanoid robots. Renowned for releasing DARwIn-OP (Dynamic Anthropomorphic Robot With Intelligence-Open Platform), an open-source humanoid platform now sold by ROBOTIS, and building CHARLI (Cognitive Humanoid Autonomous Robot with Learning Intelligence), the first humanoid robot in the United States which also competed in RoboCup, RoMeLa has conducted humanoid research in diverse applications which includes fire suppression and disaster response using in-house built humanoids such as SAFFiR (Shipboard Autonomous Fire-Fighting Robot), THOR (Tactical Hazardous Operations Robot), and THOR-RD (Tactical Hazardous Operations Robot-Rapid Deployment).

Team RoMeLa hopes to participate in RoboCup 2020 with two humanoid robots that are vastly different in its core principle to demonstrate that despite the differences, they can cooperate in such a tournament setup. However, the new breed of humanoids (and legged robots in general) equipped with proprioceptive actuators will be able to do much more dynamic motions while also interacting with its surrounding environment in a seamless way. The team expects THOR-RD and ARTEMIS (Advanced Robotic Technology for Enhanced Mobility and Improved Stability) to takepart in the competition.

THOR-RD is 1.47 m tall, weighs 49 kg, and has 31 degrees of freedom (DOF), with all joints being powered by Dynamixel PRO servo actuators. ARTEMIS is 1.5 m tall, weighs 45 kg, and has 19 DOF for the tournament. The software architecture for both platforms are identical except for the control frequency and the actual control algorithms due to the difference in the hardware.

RoboCup 2019 is the third time that THOR-RD will be taking part in the competition after two successive championship runs in 2014 and 2015, while for the team, it will be its 6th participation. Our two primary lessons learned from previous RoboCups is always having the capability to have hardware support and also having a robust vision algorithm. Because the hardware is brought out of the lab and has to travel to a remote location, there are many unforeseeable events that can damage or make the hardware function erroneously. As a mechanical engineering lab, we build and repair the robots ourselves. Having sufficient equipment, tools, and manpower to repair as needed has been key, as a quick service prevents downtime and saves valuable time which can be used for testing the robot on the field. Furthermore, because visually the field (i.e. lightings on it) and its surroundings are unknown, having a vision algorithm that can

properly adapt to the different time of the day (in the case that outside lighting affects the venue's brightness) as well as overcome the outliers from the dynamic environment around the field (i.e. spectators) seem to be areas of improvement going into next year's competition.

Team RoMeLa strives to push the limits of humanoid soccer and RoboCup's state-of-the-art. Therefore, rather than relying on traditional position controlled humanoids, we try to solve the problem of using torque controlled humanoids that use proprioceptive actuators in an environment where other moving robots exist. In essence, this problem is composed of three parts. First, an on-board torque controlled motion generation and soccer playing capability needs to be developed. Second, because force control can be unsafe, a well thought out safety logic around the controllers need to be developed such that when the robot does loose balance or malfunctions, its limbs do not uncontrollably swing, potentially damaging the robot or people near it. Lastly, a capable hardware that can support such a control approach needs to be developed and manufactured from the ground up. Ideally, such design principles would be adoptable by other teams in the future.

Regarding our immediate plans for the upcoming tournament, because our new humanoid ARTEMIS is currently in its final stages of manufacturing, the primary plan is loading the algorithms on the physical hardware and continuously testing for the tournament. We do not expect major changes to occur to the physical hardware, aside from some interior modifications on the body for mass distribution purposes and potentially changes in the camera model and computing units.

The status of the team is that currently the robot's custom proprioceptive actuators have been designed and tested, while its structural parts are being manufactured. The software architecture and preliminary torque controlled motion controllers are continuously modified to be robust in simulation such that when the hardware is ready (expected February 2020), testing on the physical platform can proceed immediately. Localization and vision algorithm are adopted from our previous participation, but separate development to make it more robust to the aforementioned difficulties are concurrently in progress.

Team RoMeLa is excited at potentially competing in Bordeaux, France and taking part in pushing the limits of humanoid soccer from both a hardware and a software level. Therefore, we are particularly interested in pushing ARTEMIS to be a part of this competition, accompanied by THOR-RD, to demonstrate and assess torque controlled robots for such dynamic games. We firmly believe that our experience in implementing this fundamental actuation technology in humanoid soccer will open another set of doors in both hardware and software design for the next breed of humanoids that the community can collectively further research.