Intelligent Robotic Locomotion: From Dynamic Walking to Autonomous Flight

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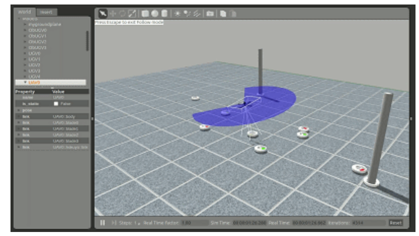

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Robotic locomotion is any of a variety of movements or methods that artificial machines use to transport themselves from one place to another, such as walking, rolling, swimming, flying, and etc. The ultimate scientific goal of robotic locomotion is to enable artificial machines both making decisions and taking movement actions in a fully autonomous way via ubiquitous computing.

In this talk, I will cover working progress in the robotics group of the Institute for Cyber-Systems & Control (CSC), Zhejiang University, mainly including three recent research projects, i.e., the humanoid robots "*Wu & Kong*" playing Ping-Pong, the quadruped robot "*Chitu*" - the horse of hero, and the shepherd robot "*Z-Hawk*" for the IARC mission 7, respectively in various locomotion categories of bipedal, quadruped walking and flight.

Scientists in Zhejiang University have spent almost eight years working toward great challenges in humanoid robotics playing table tennis through a long-term project at the university. Named for a character in the classical Chinese Epic novel ("*Monkey King*" or "*Sun Wukong*"), each robot is 160 cm high and weighed 58 kg. After multiple technical breakthroughs in mechanical structure design, high-speed computer vision, real-time data transmission, motion planning & control and etc., the robot "Wu" can demonstrate capabilities in playing Ping-Pong with either the robot "Kong" or a human player. The highest record so far is 144 rallies for the robot vs. human and 114 rallies for robot vs. robot.

Chitu robot, a quite recent developed quadruped robot in Zhejiang University, is named after a horse of Lv Bu, a hero in ancient China. Quadruped robot is one of the most popular research areas in legged robotics, which has significant advantages to generate movements in complex terrain environments. Rather than using hydraulic power systems like the BIGDOG project of the Boston Dynamics of the USA, the Chitu robot we built is fully powered by electrical motors, and then it works with very low noise and reacts quite fast. Currently, the Chitu robot can walk, trot and run through steps, slopes and other unknown complex pavement bricks.

The aerial robot “Z-Hawk” is designed by Zhejiang University’s engineers to attend the International Aerial Robotics Competition (or IARC) for the Shepherd Mission, which is the seventh generation of IARC missions since the IARC started in 1991. The aerial robot “Z-Hawk” is a quad-rotor craft, which is capable in demonstrating quite a few intelligent characteristics, including autonomous navigation without global positioning assistance, high-performance flight control, obstacle avoidance, path planning, ground mobile targets (called the sheep in the competition) detection, tracking & herding, etc. In addition, some related initiative research topics in our group related to aerial robotics research would be also introduced briefly, including mainly the flapping wing locomotion, which involves multidisciplinary studies in mechatronics, motion control, fluid mechanics, computational photography and computer vision.