TOPIC: CONTROLLING LOCOMOTION OF MULTIPLE GROUND ROBOT UNITS IN A PHYSICAL SPACE

TELECOM Paris
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PROJECT IGR 205

Fig 2. Omni-wheel XY motion capable Nexus robots

Description

For many years, researchers have pursued methods [1] for robots to transport themselves from place to place. These methods for locomotion also entail path planning for robots to autonomously decide how, when, and where to move. To increase versatility of robots, researchers have added onboard devices and robot arms to make a single robot multi-functional. Inspired by the emergent behavior observed in social insects, new trends have begun where desired collective behavior emerges from interaction of the robots with the environment. Multiple robots are coordinated [2, 5] for a single task in swarm configurations.

Creative uses of such coordinated robots include performances (Fig 1a), floor pixels (Fig 1b) or collective tasks (Fig 1c) in a space. Other variations of such swarm coordination have also appeared in drone displays [3, 4].

Fig 1a. Daito Manabe – Leading with Light, 1b. Ars. Electronica floor pixels (Flaxels), 1c. Jasmine micro-robots

Fig 3. Distributed robotic garden with path-planning [6] between different robots

Goal

The goal of this project is to develop an application that can control multiple robot units in a physical environment. This project will begin with an introduction to robot locomotion and basic electronics by Professor Harpreet Sareen. Students will receive close guidance throughout the project and no prior electronics/robotics experience is required.

Student teams will receive two robots, where each robot is mounted with a location tracker beacon. You will research prior work, learn, and develop a system the following:

- NodeJS application: Receive current positions of robots in space
- Central command application (developed in Unity or NodeJS etc.): Process real-time positions of robots, Set initial position of robots, Trigger robots for circular locomotion path in space, Receive data from location trackers for feedback control
- Robot programming (Arduino): Locomotion functions and communication with central command for position feedback control

Initial system will be developed by students using two Nexus omni-wheel robots (Fig 2.), with additional extensibility for more robots built into the system. Teams will propose creative ideas/applications that may be possible through such a system. Each group is expected to meet once a week with their supervisor and discuss development of the project.

Prerequisites:

Object Oriented Programming (e.g. Java, C++, C#)
Mathematic skills and familiarity with algorithms

Acquired Skills:

Learning principles of Marvelmind location tracker beacons
Working knowledge of electronics and robot locomotion
Basics of Arduino programming
Learning various communication protocols in electronics relevant to the project
Knowledge of NodeJS and integration practices to connect various systems for creative use

References:

[1] Böttcher, Sven. "Principles of robot locomotion." Proceedings of human robot interaction seminar. 2006.
[2] Rubenstein, Michael, Alejandro Cornejo, and Radhika Nagpal. "Programmable self-assembly in a thousand-robot swarm." Science 345.6198 (2014): 795-799.
[3] Hörtner, H., et al. "Spaxels." Pixels in Space (2015).
[4]https://newsroom.intel.com/news-releases/intel-drones-true-view-super-bowl-liii/#gs.wfg9di
[5] Jasmine Microrobots: http://www.swarmrobot.org/
[6] Correll, Nikolaus, et al. "Building a distributed robot garden." 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems. IEEE, 2009.

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