High-level perception and control for autonomous reconfigurable modular robots

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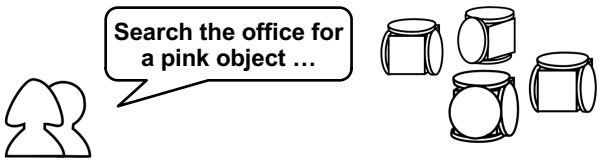
Objective

Develop a cyber physical system that **automatically generate correct, low-level perception informed control and configurations for modular robots from user-defined, high-level reactive tasks in real-world environment.**

Approach

- Task specification language for modular robots
- Library of parametrized controllers for perception and motion
- Temporal controllers composition to create complex behaviors
- Onboard perception hardware for localization and object detection

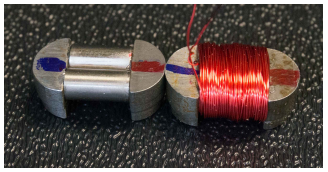


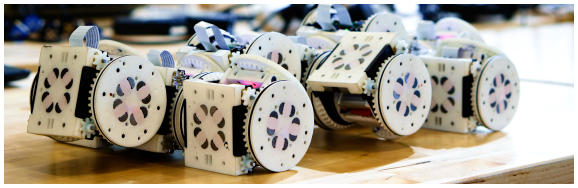
Hardware (SMORES V2 modules)

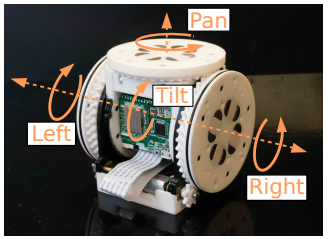
SMORES-EP can rearrange its modules in all three classes of reconfiguration: lattice, chain, and mobile reconfiguration.

Highlights:

- 4 degrees of freedom per module
- 802.11 Wi-Fi and onboard battery
- 25 modules made (30 eventually)
- Electro-Permanent magnets used for latching







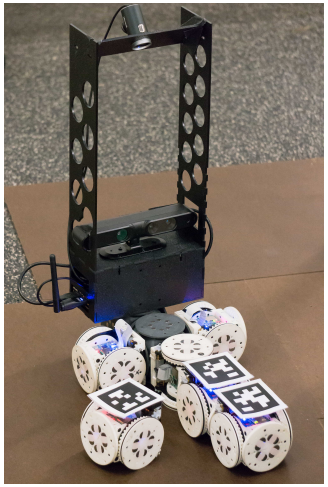
Perception Hardware (Sensors + Brain Module)

Brain Module

- Attaches to SMORES modules
- Up Board CPU (Linux + ROS)
- Performs sensor processing + centralized robot control, navigation

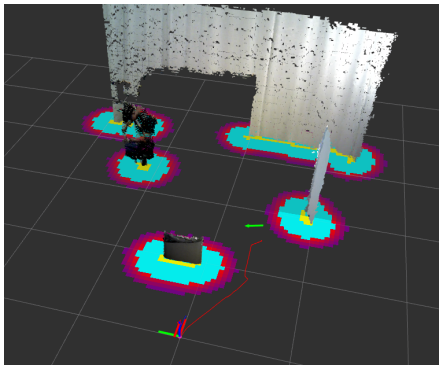
Sensors

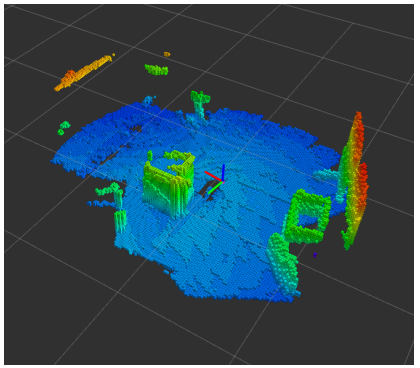
- ASUS Xtion Pro Live RGB-D Sensor:
  Enables modules to perceive environment in 3D and perform online SLAM
- Microsoft LifeCam HD Webcam:
  Used to observe and direct modules to reconfigure robot (using AprilTags for module localization)



Hardware constrained perception

Probabilistic, Perception-Driven Next Best View Planning





- Subject to hardware constraints, intelligently plan motion/reconfiguration to obtain information about the environment (such as shape estimation of an unknown 3D object).
- Use this information to inform planning for completion of high-level tasks.