Guest Editorial

THIS Focused Section contains nine papers (seven regular papers and two short papers) that cover the most recent advances in self-reconfigurable robots. Self-reconfigurable robots are robots that are made from reconfigurable modules that can autonomously change their physical connections and configurations under computer or human command to meet the demands of the environment. Each reconfigurable module is an autonomous robot equipped with controllers, communications, actuators, sensors, power distribution, and most importantly, connectors for joining with other modules. With the shape changing capability, these robots can perform remarkable actions that go beyond the traditional, fixed-shaped robotic systems. For example, some self-reconfigurable robots can become a "crab" and crawl under low-clearance areas or climb over rubble. They can then smoothly morph into a "snake" to slither down between the stones to locate a person or some artifact. They can become a ball to roll down a hill, or transform a leg into a gripper to perform a grasping operation. Multiple snake-like systems may join together to form one longer snake, or they may join together, each snake forming a limb. Alternatively, a larger snake may divide into smaller ones or a multilimbed robot may divide into many robots with each limb as a separate robot.

Because of their self-reconfigurability, these systems promise versaile capabilities for a wide range of applications, low cost for constructions, and self-repairing for fault tolerance. An example of fault tolerance would be a system with multiple legs; where, if one or more legs fail, a self-reconfigurable robot can either walk on the remaining legs without changing the control program, or it may reconfigure into other configurations that do not depend on the failing modules.

The potential applications for self-reconfigurable robots are tremendous. For example, in search and rescue missions after disasters, these robots can be deployed to perform missions or operations that are dangerous and difficult for fixed-shaped robots. In space applications, techniques developed from self-reconfigurable robots can enable self-assembly for large space structures or self-replication on other planets.

It is a great challenge to control a self-reconfigurable robot or system. Each module is an autonomous and intelligent agent and its actions must cooperate with others in order to generate the desired global action in a given physical configuration. The concept of configuration can be interpreted in several ways. The physical interpretation could be the configuration represents the structure or shape of the system. The connectivity interpretation is that the configuration could represent a communication network topology. The control implication is that global actions (such as locomotion for a robot) may require a recomputation of the local actions to be executed by the individual modules. These local actions depend on the position of the agent in the current configuration. Ultimately, the control of self-reconfigurable robots must be *dynamic*, to deal with the changes in network topology; *asynchronous*, to compensate for the lack of global clocks; *scalable*, to support ever-growing structures and shape alteration; *collaborative*, to enable global efforts by local actions in a physically and tactically coupled organization; *reliable*, to recover from local damages and provide fault-tolerance; and finally, *self-adaptative*, to select and form the best configuration for the task and environment at hand.

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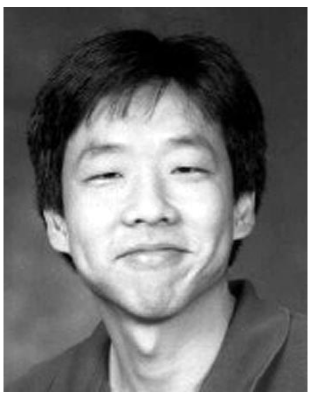

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