

# Dynamically reconfiguring modular robots for efficient maneuverability in initially unknown terrains

Zachary Ramaekers, Prithviraj Dasgupta  
*Computer Science Dept., University of Nebraska, Omaha*  
{zramaekers, [pdasgupta](mailto:pdasgupta@mail.unomaha.edu)}@mail.unomaha.edu

Carl Nelson  
*Mechanical Engg. Dept., University of Nebraska, Lincoln*  
[cnelson5@unl.edu](mailto:cnelson5@unl.edu)

We consider the problem of efficiently navigating a modular self-reconfigurable robot (MSR) on an initially unknown terrain such as the Lunar or Martian surface. An MSR is composed of multiple modules which can be re-organized to achieve different formations such as a chain formation or a circular formation, depending on the mobility requirements of the terrain. Existing techniques for maneuvering MSRs use pre-determined and hand-crafted movements for each module to bring about a desired gait pattern in the overall MSR. The problem with such hard-coded maneuvers is that they can result in inefficient motion, or could even prevent the MSR from moving in tight spaces. To address this problem, we have investigated techniques from game theory and multi-agent planning which allow the modules of an MSR to autonomously reconfigure based on their perceived environment and desired motion. We have developed a coalition game based framework that allows a set of modules to determine a configuration with the best 'value' that they can organize themselves into. However, the noise in the readings of the different sensors of the modules can result in erroneous parameters being used by the modules while computing this best valued configuration. We model the sensor noise as uncertainty in the configuration determination process and use a Markov decision process (MDP) to determine the configuration that gives the best expected value under uncertainty. Our algorithms were evaluated on the Webots robotic simulation platform while using a model of a modular robot called ModRED that is being developed as part of this project.