CAREER: Autonomous Underwater Power Distribution System for Continuous Operation

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Project Details

Lead PI: Nina Mahmoudian

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Institution(s): Michigan Technological University
Sponsor(s): National Science Foundation
Award Number: 1453886

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Abstract: This CAREER project responds to an urgent need to develop mobile power distribution systems that lower deployment and operating costs while simultaneously increasing network efficiency and response in dynamic and often dangerous physical conditions. The significant need for an efficient and effective mobile power distribution system became evident during search and rescue/recovery missions following the Japan tsunami and the disappearance of the Malaysia MH370 airplane. The technology outcomes from this project will apply to a broad range of environments (in space, air, water or on ground) where the success of long-term robotic network missions is measured by the ability of the robots to operate, for an extended period of time, in highly dynamic and potentially hazardous environments. These advanced features will provide the following advantages: efficiency, efficacy, guaranteed persistence, enhanced performance, and increased success in search/rescue/recovery/discovery missions. Specifically, this project addresses the following technology problems as it translates from research discovery toward commercial application: inflated energy use currently required when the autonomous vehicles break from mission to return to recharging station; lack of multi-robot coordination needed to take into account both fundamental hardware and network science challenges necessary to respond to energy needs and dynamic environment conditions. By addressing these gaps in technology, this work establishes the theoretical, computational, and experimental foundation for mobile power delivery and onsite recharging capability. Moreover, the new technology developed in this project is universally adaptable for disparate autonomous vehicles especially autonomous underwater vehicles (AUVs). In more technical terms, this project creates network optimization and formation strategies that will enable a power distribution system to reconfigure itself depending on the number of operational autonomous vehicles and recharging specifications to meet overall mission specifications, the energy consumption needs of the network, situational conditions, and environmental variables. Such a system will play a vital role in real-time controlled applications across multiple disciplines such as sensor networks, robotics, and transportation systems where limited power resources and unknown environmental dynamics pose major constraints. In addition to addressing technology gaps, undergraduate and graduate students will be involved in this research and will receive interdisciplinary education/ innovation/ technology translation/ outreach experiences through: developing efficient network energy routing, path planning and coordination strategies; designing and creating experimental test-beds and educational platforms; and engaging K-12th grade students in Science, Technology, Engineering and Math including those from underrepresented groups. This project engages Michigan Tech's Great Lake Research Center (GLRC) and Center for Agile Interconnected Microgrids (AIM)

to develop experimental test-beds and conduct tests that validate the resulting methods and algorithms, and ultimately, facilitate the technology translation effort from research discovery toward commercial reality.

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