Applying Heterogeneous Teams of Robotic Agents Using Hybrid Communications to Mapping and Education

by

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Abstract

Robotic agents are being increasingly utilized to carry out tasks that are difficult or dangerous for humans. Many of these missions are best performed by heterogeneous teams of agents with various individual abilities. Communication among agents and with operators is a critical element in the performance and efficiency of these missions. Although radio frequency communications dominate the robotic networking field, they are limited in range and bandwidth due to spectrum congestion and subject to interference from noise or hostile jamming and can be intercepted. Optical communication has many advantages such as higher bandwidth and focused beam, however the line-of-sight requirement generally limits its range and application. Maintaining a continuously connected network between agents is also overly restrictive, dramatically limiting their freedom of motion and therefore efficiency.
In this work, we have developed a method to coordinate a heterogeneous team of agents using hybrid high frequency (HF), ultra high frequency (UHF) and optical wireless (OW) intermittent communications and cloud based computing resources to efficiently achieve a mission. This method is demonstrated by accomplishing an exploration and 3D mapping mission through a realistic simulation. The simulation includes accurate models of RF and optical noise and attenuations to reproduce real world scenarios. An experimental testbed was also developed to demonstrate the effectiveness of the system in real hardware.

Teams of robotic agents are also well suited to space exploration and the development of these agents and the algorithms to direct them are crucial elements of the education of engineering students. At the Southwestern Indian Polytechnic Institute (SIPI), we have developed a robotics-based educational program to teach engineering and programming through teleoperated robotic systems inspired by those used by NASA. The internet accessible Mars Yards provide a platform through which students in middle school, high school and college can learn programming, engineering, math and science. As part of the SIPI Mars Yard program we also developed an efficient visual localization system which is computationally light enough to operate on low power processors.