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TERRAIN-AWARE COMMUNICATION COVERAGE PREDICTION FOR COOPERATIVE NETWORKED ROBOTS IN UNSTRUCTURED ENVIRONMENTS

Abstract

Future planetary space exploration is expected to use a plethora of robotic entities: be it a swarm of homogeneous robots forming sensing arrays, or heterogeneous teams of robots collaboratively solving complex tasks. The level of autonomy for in-situ instrumentation ranges from remotely controlled robots to semi-autonomous systems. For all of them, a key element is communication. Remotely controlled robots have strong communication demands in terms of connectivity among the robots and to a lander platform. Semi-autonomous systems require communication to share information: they compose a self-organized network and can support each other to enhance communication where needed. Connectivity and communication coverage for networked robots depend on a variety of factors, including knowledge of the terrain and a deep understanding of radio-propagation. Thus, their prediction is a challenging problem which is not yet solved. In the ARCHES (Autonomous Robotic Networks to Help Modern Societies) project we particularly have a look at predicting the communication coverage for such robotic networks. In an intra-disciplinary team, we developed a framework that supports an operator at the ground control. This framework predicts the communication coverage for the targeted exploration areas and points of interest for in-situ instrumentation and provides a graphical user interface. In our novel approach, we combine real-time robotic terrain mapping with radio-propagation modeling. With the help of the predicted communication coverage map, an operator can make sound decisions intuitively on where robots can move for in-situ instrumentation while preserving communication connectivity. In addition, the operator can view areas where robots acting as communication relays should be optimally placed. Besides showing details of our framework, we present results from a space-analogue in-situ instrumentation campaign on the volcano Mt. Etna, Sicily, Italy. In this campaign, a team of heterogenous robots, partly remotely controlled and partly (semi-)autonomous, explores and maps an unknown rough terrain. Our framework predicts communication coverage for the operator at the ground control in near real-time. We show details of this campaign and provide an outlook on the extension of our framework.