Conflict Resolution Using α-shapes for Distributed Robotic Sampling of Ambient Phenomena in Initially Unknown Environments

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Robotic search and exploration of initially unknown environments such as those encountered on extraterrestrial such as the moon or mars or, in disaster scenarios, such as the Fukushima Daiichi nuclear disaster is important for the advancement of science and the recovery from disaster while minimizing risks to human assets. Recently, in some of these environments, multiple robots, such as swarm robots, are being deployed to speed up operations as well as to make the system robust to individual robot failures. These multi-robot systems rely predominantly on inter-robot wireless communications to communicate individual robot actions and updates between robots, so that the entire system can function in a coordinated manner. However, a major wrinkle to this approach occurs if the communication between robots is intermittent and unreliable, as is commonplace in extraterrestrial or cluttered terrestrial environments. In our research, we are addressing this aspect by developing intelligent algorithms that will enable multiple robots to select locations to explore while being aware of the communications availability at those regions. In this presentation, we describe a technique for multiple robots to make exploration decisions as well as avoid conflicts or collisions with each other in the locations explored, while utilizing a technique from computational geometry called α-shapes, for succinctly representing geometric regions. We will present theoretical guarantees and experimental results validating our approach with multiple robots that explore different initially unknown environments while taking samples of an initially unknown phenomenon ambient in the environment, such as moisture or radioactivity content.