A centralized and distributed multi-robot system for 3D surface reconstruction of unknown environments

Soutenance de thèse – Guillaume HARDOUIN

Le 22/03/2022 à 14h00

Lieu : Amphi Jacques Dorey, ONERA Palaiseau, Université Paris-Saclay

Réunion Zoom : https://u-picardie-fr.zoom.us/j/81100080120?pwd=UnFlTE5CRTRqWjY0dXoxVDdCNkY4Zz09
ID de réunion : 811 0008 0120
Code secret : 169778

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Abstract :
In archaeology and cultural heritage, the 3D modelling of large-scale structures using high-quality sensors, remains a time-consuming, complex, and expensive process. In the present age of robotics, a new generation of scanning systems based on mobile robots could address this challenge, improving efficiency, flexibility and responsiveness. This PhD thesis considers the problem of 3D reconstruction of an unknown environment, with a team of cooperative vehicles. The robots, equipped with forward-facing stereo cameras, explore the environment, uncover discrete Incomplete Surface Elements (ISEs) in the volumetric map, and generate candidate viewpoints to scan them. These areas of interest are greedily assigned to the robots using a Next-Best-View approach, where the visit is planned by iteratively solving a Traveling Salesman Problem. Then, a sampling-based planner is used to compute obstacle-free paths using the volumetric map. A single-robot architecture has been first designed, which leverages the 3D surface representation of volumetric map for planning. This architecture has been extended to a multi-robot system with a centralized ground station, in order to accelerate the scanning process. Finally, a distributed architecture has been presented and discussed to increase the robustness of the multi-robot system. Extensive numerical and real-world experiments with multiple aerial and ground robots have been conducted to validate the proposed architectures in challenging environments.

Keywords
Multi-robot systems, Motion planning, Next-Best-View planning, 3D reconstruction.