Late-breaking results on *Multi S-graphs*: A Collaborative Semantic SLAM architecture

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I. Introduction

Collaborative Simultaneous Localization and Mapping (CSLAM) is a critical capability for enabling multi-robot systems to operate in complex environments. Most CSLAM techniques rely on the transmission of low-level features for visual and LiDAR-based approaches, which are used for pose graph optimization. However, the use of these low-level features can lead to incorrect loop closures, negatively impacting map generation. In this work, we present *Multi S-Graphs*, a LiDAR based distributed CSLAM algorithm, based on *S-graphs+* [1], that relies on high-level semantic information to generate a complete map of a building co-operatively, exchanging a minimum amount of information between them. The main contributions presented in this work are as follows:

1) A novel distributed multi-robot SLAM architecture that relies on high-level semantic features for exchanging information between agents.
2) A hybrid descriptor that combines the fine-grained information of a pointcloud with semantic knowledge.
3) A real-time CSLAM algorithm robust to multiple robot initialization, considering the multiple kidnapped robot problem.

II. Collaborative Situational Graphs

In this work, we tackle the multi-robot SLAM problem by leveraging the use of semantic information in form of *S-graphs*. We consider a distributed algorithm in which each robot interacts with the other N robots. We also consider the multiple kidnapped robot problem, in which each robot is not aware of its initial position or the initial positions of other robots.

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In our approach each robot builds its own *S-graphs* and broadcast the information of the semantic layers (Walls, Rooms, and Floors) to the other robots.

To generate loop closures between the maps generated from different robots we take advantage of the semantic information from the Rooms, like their extension and center, and combine it with the low-level information obtained from the pointclouds to generate a hybrid descriptor, the *Room Descriptor*. These descriptors are also broadcasted to the rest of the robots.

Initially the information of each robot Situational Graph and the information of the top-layers graph provided by the other robots are not connected. When a match is found between two *Room Descriptors*, an edge connecting these nodes is created. In the graph optimization step, these edges force the alignment of the graphs, becoming a connected and aligned graph that fuses information from the different robots that can be used for optimizing the following steps of the SLAM algorithm.

III. Experiments and Results

Using real world data, we generate a map of a building floor collaboratively with two robots, see Fig 1. Each robot starts at a different place which is unknown for it and the rest of robots.

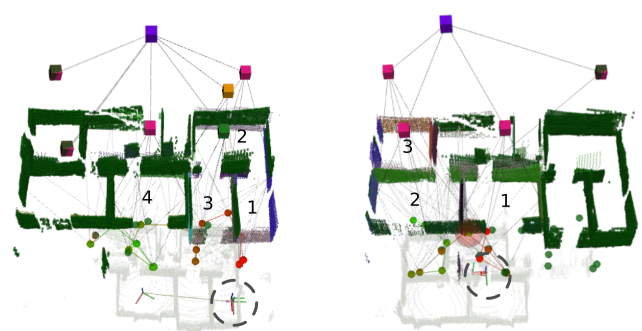

Fig. 1: Collaborative maps created by two robots, displaying green Rooms and Planes provided by the other agent. Dotted circles indicate the initial position of each robot, while room numbers indicate their navigation order.

It can be seen that both robots can integrate the information collected by the other robot into its own graph, and both robots optimize its own graph by considering the information provided by the counterpart.

References

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