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Efficient and Robust Localization using Hybrid Environment Model

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Abstract:

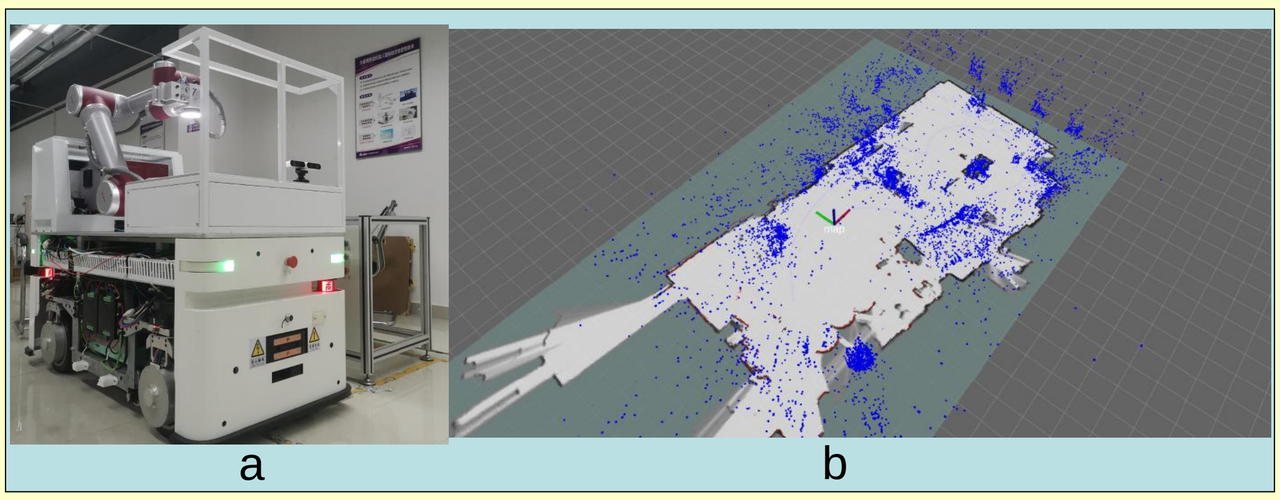
Localization, including pose tracking and global localization, is a fundamental technique for autonomous mobile robotics. It is the prerequisite and one of the most challenging problems for mobile robot autonomous navigation. Single type of sensor always contains insufficient information and the fusion of heterogeneous sensors information has been the main focus of environment perception. This paper first introduces a new type of hybrid environment model which integrates the camera and 2D-Lidar sensor information to build hybrid environment model, which includes the visual features map and occupancy grid map. Then an efficient global localization method is presented to obtain the initial pose of mobile robot and a pose tracking method is proposed to perform robust pose tracking. Besides, we also propose a re-localization triggering strategy to ensure the robustness of localization. The performance of proposed method is validated in real-world experiment in different scenarios.

Contributions:

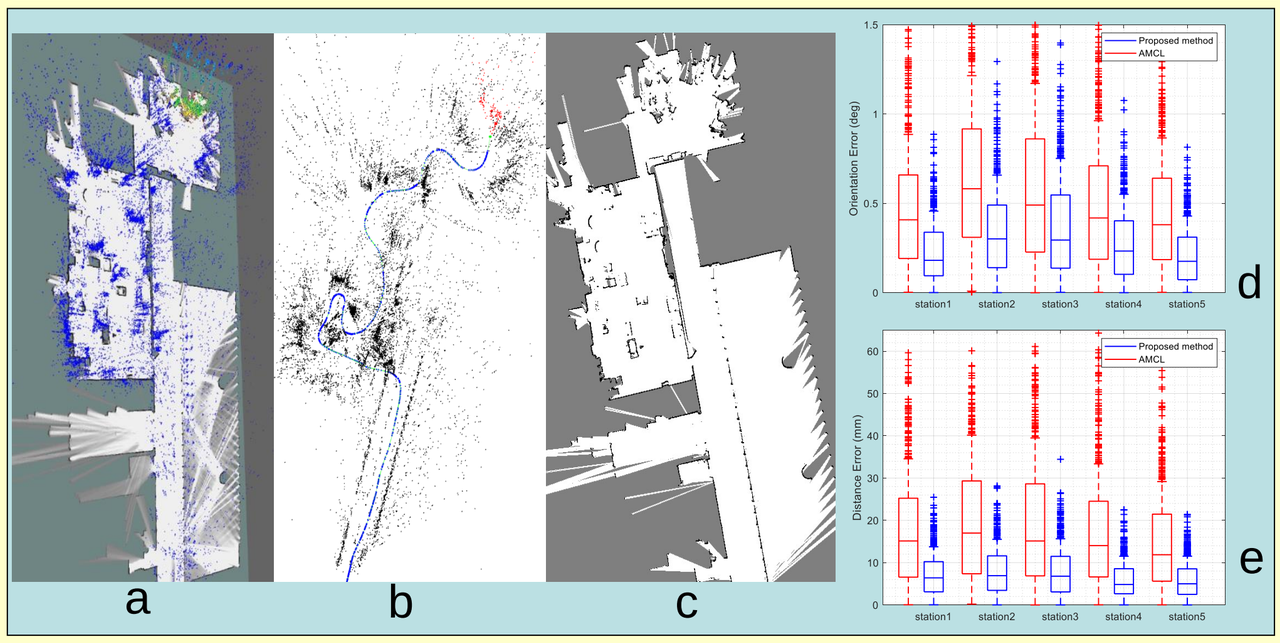
1) By fusing the complementary information from the vision sensor and 2D-Lidar sensor, a new hybrid environment map that contains visual features and occupancy grid map is constructed and applied to support localization , which can greatly enhance the localization performance in complicated environment.

2) Based on the hybrid environment model, a novel method that can fully take advantage of the information collected from the camera and 2D-Lidar sensor system is proposed to support robot localization. By combining the camera and Lidar sensor data, the global localization and pose tracking can be performed with high accuracy and efficiency.

3) A re-localization strategy that can greatly improve the robustness of pose tracking in complicated environment is proposed and integrated in our localization system, which can be triggered automatically and applied to check the correctness of the current pose tracking result by matching the image keyframe with the feature candidates associated with current submap.



Figure(a) : The self-developed mobile manipulator that mounted with 2D-Lidar and camera sensor; Figure(b): The hybrid environment model which contains the visual features and a occupancy grid map.



Figure(a) - (c): The constructed maps of environment scene for different method; Figure(d) - (e): The pose tracking result of AMCL and proposed method.

Summary:

In this work, we introduced a novel solution to estimate the global pose and pose tracking result of mobile robot. Our contributions include the application of a hybrid environment map to estimate the global pose, and a novel method to solve the pose tracking problem. Also, a re-localization triggering strategy is proposed to ensure the robustness of pose tracking. We showed the improvement of application of hybrid map to the performance of global localization. Meanwhile, we proved that the localization method can produce better result than the state-of-art method. Our future work will involve fusing more sensor data to construct the environment model and we will explore to apply the new model for the robot navigation. Besides, the localization method will be further extended to work in the complicated environment.