



Developing an Algorithm for 3D Map Construction Using Multi-robots

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To Mohammad and my precious Noor.

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Abstract

THE idea of making a team of mobile robots perform a collaborative task has numerous benefits in many applications, especially in search and rescue missions and fire fighting.

In this operation scenario a dense three dimensional map of the operation environment will be of great use, but usually it is either not present or it has been changed because of the fire or the collapses in the building.

This research addresses the problem of three dimension map construction using a team of cooperative mobile robots each equipped with a visual sensor. A framework for a collaborative map construction system is proposed along with a comprehensive overview of the state-of-art visual simultaneous localization and mapping algorithms.

Depending only on the vision sensor to perform the complex task of localization and mapping introduces many challenges in the proposed algorithm because usually the data provided by the sensors are noisy and sometimes they interfere with the map updating process resulting in false matches. The use of a team of robots also introduces many challenges such as maintaining a coherent team behaviour, communication between team members, complex tasks decomposition, subtasks assignment and aligning and merging the partial maps constructed by individual robots into one coherent map which is the focus of this study.

The research problem was divided into two parts: first building three dimensional maps using the observations of a single mobile robot applied many times on different parts of the environment, second aligning and merging the m maps constructed by individual robots with different views into one global consistent map.

The map building algorithm was divided into three main parts: registration, loop closure and global optimization. In registration two successive observations of a single

robot were aligned together. This resulted in an erroneous map due to the accumulation of small errors in the registration algorithm and errors in the sensed data causing the resulting map to drift over time. These errors are detected when the robot visits a location that has already been mapped before. The loop is closed and the drift is calculated. Finally global optimization is applied and the drift is corrected along the whole path covered so far.

The aligning and merging algorithm takes the m maps produced from the mapping algorithm and work in pairs aligning and merging them together using the robots starting positions as an initial guess.

The proposed system was evaluated on standard datasets of indoor environments. The evaluation showed that the absolute relative pose error between the estimated robot poses could be reduced to 0.01 meters and 0.56 degrees. Furthermore the results were compared with other state-of-art algorithms showing the strengths and weaknesses of the proposed system.

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List of Publications

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