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Multi-robot localization and orientation estimation using robotic cluster matching algorithm

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HIGHLIGHTS

- A new algorithm for multi-robot localization and orientation is introduced.
- Clusters of nodes scanned by distance IR sensor to estimate their location and orientation.
- The location and orientation of invisible robots are computed by using location estimation algorithm.
- Several simulation scenarios are implemented to indicate the performance of suggested algorithm.

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ABSTRACT

In this paper, a new algorithm, called cluster matching, is introduced for multi-robot localization and orientation. This algorithm deals with the case in which each robot has the capability to estimate the relative orientation of those robots (called neighbors) that are within its transmission range. Furthermore, the environment is equipped with a distance IR sensor scanning the robots and estimating the absolute positions and orientations of a number of the team robots without knowing their IDs. The IDs of these robots are reconstructed by matching the orientation obtained by the distance IR sensor with the relative orientation measured with on-board sensors. The localization and orientation of robots not visible to the distance IR sensor are obtained by collecting the information coming from the on-board sensors and thus reconstructing a complete map of the team distribution. The accuracy in the estimation of the location of these robots is enhanced by introducing a new algorithm which relies on the localization of neighbor robots. Several simulation scenarios are implemented on tens of robots to show the performance of the introduced algorithm.

1. Introduction

Multi-robot systems have several advantages over single robot systems. They can localize themselves more efficiently [1], improve the speed of search and exploration missions [2,3], accomplish task in shorter times, and also increase accuracy and fault tolerance. Multi-robot systems consist of simple homogeneous robots that have low computational capability due to cost constraints [4,5]. The problem of localization, that is, the determination of the robot position in a given map of the environment, is a central issue of mobile robotics in general and, in particular, of multi-robot systems. Localization may be absolute or relative [6]. Localization is absolute when makes use of landmarks, global maps, beacons, or satellite signals to determine the position and orientation of the robot. Absolute localization methods require that the environment is known or mapped with great accuracy. Methods based on satellites, such as for instance GPS, can be used only with outdoor environment and have poor accuracy in indoor environment. Relative localization is usually preferred during movement, because absolute localization methods are more time consuming. One widely used method for relative positioning is for instance odometry (that is, the distance from a starting location is computed by

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