NAVIGATION PLANNING FOR A MULTI ROBOT SYSTEM EXPLORING AN UNKNOWN ENVIRONMENT SUPPORTED BY VOLUMETRIC DATA

R.M.K.V. Ratnayake

208005L

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Department of Computer Science & Engineering

University of Moratuwa

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DECLARATION

I, Kalana Ratnayake, declare that this is my own work and this dissertation does not incorporate without acknowledgment any material previously submitted for a Degree or Diploma in any other University or institute of higher learning, and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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The above candidate has carried out research for the Masters thesis/dissertation under my supervision.

Name of Supervisor: Dr. Chandana Gamage

Signature of the Supervisor: Date: 28/01/2022

Name of Supervisor: Dr. Sulochana Sooriyaarachchi

Signature of the Supervisor: Date: 29/01/2022

ABSTRACT

Exploration and navigation in unknown environments can be done individually or as a group of robots. The current state-of-the-art systems mainly use frontier detection-based exploration approaches based on occupancy grids and are available as either single robot systems or multi-robot systems.

In this research, we propose a two-stage octomap-based exploration system for multi-robot systems that improve multi-robot coordinated exploration. We also present a prototype robotic system capable of exploring an unmapped area individually or while coordinating with other robots to complete the exploration fast and efficiently. During single robot exploration, the proposed system only uses the first stage of the two-stage system to evaluate the octomap of the environment. This stage utilizes the state of voxels to calculate target locations for navigation using a distance-based cost function. During multi-robot exploration, the proposed system uses both stages of the two-stage system to explore the given area. The second stage uses maps created by individual robots to create a merged map. The merged map can be used to evaluate the environment using octomaps to identify target locations for exploration and navigation.

We have also proposed a performance evaluation criterion for exploration systems considering the robot's operation time, power consumption, and stability. This criterion was used to evaluate the system and compare the performance of the individual robot system against the multi-robot system as well as against the state-of-the-art Explore-Lite system. Results of experiments show that the individual robot system proposed in this paper is about 38% faster than the Explore-Lite system, the multi-robot system using two robots is 48% faster than the individual robot system, and the multi-robot system using three robots is 38% faster than the individual robot system.

Keywords: multi-robot system; exploration; path planning; navigation; octomap based exploration; unstructured environment;

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LIST OF ABBREVIATIONS

SLAM	Simultaneous Localization And Mapping
ROS	Robot Operating System
ORB	Oriented FAST and rotated BRIEF
PRM	Place Recognition Module
ICP	Iterative Closest Point
SD	Standard Deviation
2D	Two Dimensional
3D	Three Dimensional
BFS	Breadth-First Search
BGS	Basic Goal Seeking
MGS	Modified Goal Seeking
GSI	Goal Seeking Index
LIDAR	Light Detection and Ranging
EKF	Extended Kalman Filter
RGB-D	Red Green Blue - Depth