Moving a Robot in Unknown Area Using Robot Operating System and Gazebo Simulator

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Dedication

I would like to give my deepest gratitude to Mr. Samantha Rajapaksha, who is the course coordinator of the Master of Science in Information Technology degree program and my supervisor of the research project. Thanks a lot for the patient guidance, encouragement, and advice given throughout this research work. Also, I would like to thank the lecturers who are Dr. Anuradh Jayakodi and Mr. Prasanna Sumathipala who gave support and advice during the progress reviews presentations. It is a great pleasure to have proper guidelines during the research work.

Also, I would like to give my thanks to my dear parents, my brother, and my sister for giving me all the inspiration and support which I needed. All of your support becomes an encouragement factor to do this research project successfully.

Again, thanks all for the endless support which I gave during this research project work.

Declaration

I hereby declare that the project works entitled Moving robots on an unknown area, done by me, under the guidance of my Supervisor Mr. Samantha Rajapaksha and this is submitted to the Sri Lanka Institute of Information Technology. This proposal documentation is submitted for the fulfillment of the requirement for the award of the Degree of Master of Science in Information Technology. This proposal document has not been submitted to any other University or Institution for the award of any diploma or degree program. I have understood the university's policy on plagiarism in Sri Lanka Institute of Information Technology (SLIIT) and this research work is done according to the guidelines. Also, all the published and unpublished references which I used to do this research project work have been acknowledged in the list of references section which is given at the end of the documentation.

Abstract

Nowadays robots have become a most important asset. With the development of technology, we can do so many things using modern robotic technology. Normally, we can see most of the robots can identify a known area. From this study proposes the mechanism to move a robot in an unknown area. This has become a most important fact in day to day life. Because we can use this kind of robot in hazardous environments, and we can use this robot in several ways. The unknown environment in this sense, does not have an identified map. In that case, robots should have the capability to make decisions dynamically. When we implement this system, the robot needs to use the Artificial Intelligent (AI) Knowledge and decide whether there is a chance to move forward or not. The AI process is just like the heart of this robot. Because the robot has to identify if there is an object or not, check whether there is a chance to move forward or not, how the robot can move, does the robot should by-pass something without colliding, and does the robot should by-pass something, those kinds of decision-making part happen using this AI Process. The proposed system is based on the Robotic Operation System (ROS) and the simulator, which is going to be used is Gazebo. This project hopes to detect the object using a laser sensor or 2D LiDAR or vision base. Detected object avoidance part also can be done using the laser sensor 2D LiDAR sensor. After that, there should be a direction changing mechanism in the developing algorithm. That can be implemented with looping. Because after the robot changes direction it again needs to check whether another object is there in the navigated location. After that algorithm should have a proper navigation mechanism. Just moving the robot, we can not get an idea about the area in which we can do the movement safely. In that case, in the proposed system, I will generate a map using Simultaneous localization and mapping (SLAM). To do the mapping part, I need to use the Rviz application. That map will help to identify the areas which can do the movements without having any crashes. Another important function of this research study is reverse navigation. If in any case, the road ends up, then the robot will be able to do the reverse navigation and continue its journey. In this proposed algorithm I have written a method to do the reverse navigation. This study will be useful to have autonomous navigation in unknown areas.

Index Term: Robotic Operation System (ROS), Gazebo, 2D LiDAR, 3D LiDAR, Artificial Intelligent (AI), Turtle bot 3, Simultaneous localization and mapping (SLAM), Rviz

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My sincere gratitude goes to my supervisor Mr. Samantha Rajapaksha who is course Coordinator of M.Sc.in IT of Sri Lanka Institute of Information Technology. Thanks for the guidance, encouragement, and support provided throughout this research work. I am lucky to have a supervisor who cared so much about my research work. Also, I would like to thank my dear parents who supported me during my Master of Science degree program. All of you gave me great support to achieve this journey successfully. Also, I would like to thank the Sri Lanka Institute of Information Technology (SLIIT) to provide me with this opportunity. This is a great opportunity which I found during my carrier.

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List of Abbreviations and Acronyms

ROS	**:**	Robot Operating System
SLAM	**:**	Simultaneous Localization and Mapping
BGS	**:**	Basic Goal Seeking
FNN	**:**	Fuzzy Neural Networks
HOG	**:**	Histograms of Oriented Gradient
GUI	**:**	Graphical User Interface
SLAMMOT	**:**	Simultaneous Localization and Mapping and Moving Object Tracking
DUE	**:**	Dynamic Uncertain Environments
AI	**:**	Artificial Intelligent
SRHC	**:**	Stochastic Receding Horizon Control
HMO	**:**	Higher Moving Order robot
LMO	**:**	Lower Moving Order
PSA	**:**	Path-space Search Algorithm
HALAS	**:**	Hierarchical Adaptive and Learning Architecture
FPFH	**:**	Fast Point Feature Histogram
AMCL	**:**	Adaptive Monte Carlo Localization
Omni-WMR	**:**	Omni-directional Wheeled Mobile Robots
PCW	**:**	Powered Caster Wheel

WMR	**:**	Wheeled Mobile Robots
PRM	**:**	Probabilistic RoadMap
URDF	**:**	Unified Robotic Description Format
RRT	**:**	Rapidly-exploring Random Trees
CFS	**:**	Collision Free State
CCS	**:**	Conservative Collision State
WNN	**:**	Wavelet Neural Networks
LOD	**:**	Left Obstacle Distance
FOD	**:**	Front Obstacle Distance
ROD	**:**	Right Obstacle Distance
HA	**:**	Heading Angle
SA	**:**	Steering Angle
RBF	**:**	Radial Basis Function