

Global Variable Team Description Paper RoboCup 2018 Rescue Virtual Robot League

Tahir Mehmood¹, Dereck Wonnacot², Arsalan Akhter³, Ammar Ajmal⁴, Zakka Ahmed⁵, Ivan de Jesus Pereira Pinto⁶, Saad Ullah¹, Harron Ikhtlaq⁸, Haider Ali⁵, Irfan Shah⁷

Hochschule Bonn-Rhein-Sieg (H-BRS) - Germany¹, ADD Engineering, USA².
Worcester Polytechnic Institute- USA³, Bahria University – Pakistan⁴, Iqra University– Pakistan⁵, Federal University of Maranhão, Brazil⁶, Preston Univeristy, Pakistan. Politecnico di Torino, Italy⁸.

tahir1069@gmail.com
<https://www.globalvariable.tk/>

Abstract. This paper describes the team Global Variable's contributions for RoboCup 2018 Rescue Simulation League, Virtual Robot Competition. The main aim is to provide development of computer-simulated rescue schemes for a virtual catastrophe area. A novel approach is presented employing Gazebo environment in the Robot Operating System (ROS) framework for the tasks of Autonomous Navigation, Multi Agent Mapping and Victim Identification.

Keywords: ROS, Gazebo, Multi Agent Systems, Autonomous Navigation, Convolutional Neural Networks, Cost maps

1 Introduction

In the field of Robotics and Machine Intelligence, Service Robots are drawing more and more attention of researchers. Intelligent rescue robots with high accuracy and advanced capabilities have been expected to mitigate disaster damages in catastrophe areas. The common goal of designing such rescue robots is to enhance the research efforts and solve challenging real-world problems to serve humanity in a better style. Research in the field of Robotics and Machine Intelligence is moving at a rapidly increasing pace, but there are certain areas which are to be addressed on a greater scale. Design and development of capable cooperating Service Robots pose a real technological and scientific challenge to the designers due to the multi-faceted nature of the problem including but not limited to planning, learning, and information exchange tasks. The rescue robot should be able to plan its actions based on the information perceived from its environment through the on-board sensors. This includes acquisition, filtering and interpreting the right information to take rational

decisions in different scenarios under different constraints. Another important aspect of rescue robots is cooperative information exchange keeping its autonomy in perspective. It also includes the most important aspect of Human Robot Interaction (HRI). In recent years, RoboCup has become one of the best avenue for researchers and enthusiasts to exhibit and share their expertise and skillsets. RoboCup Rescue [1] provides researchers with an excellent platform that focuses on different aspects of Service Robots for catastrophic situations.

Team *Global Variable* was formed in 2017, which consists of individuals from four different parts of the globe. Members of team *Global Variable* participated in RoboCup@Home 2016 at Leipzig, Germany [2], and European Robotics League, @Home league 2017 at Lisbon, Portugal. The team has gained considerable gains and exposure from the two International competitions and have identified the right midst of skillset and chemistry to be used constructively for robotic perception, navigation and other tasks of this rescue league.

In this paper we have discussed our approach for developing a rescue simulation robot for a disastrous situation. This is our new venture are the theme of the league is concerned so the team will focus on Autonomous Navigation and Victim Identification tasks for the rescue robot.

2 Our Goal

The tasks of utmost importance for the team *Constant Variables* revolves around these three challenges:

1. Dividing arena between different robots
2. Merging maps from different robots
3. Victim identification

3 System Overview

The modern innovations in the robotics domain has enabled us to use advanced simulators to represent the real world virtually along-with testing the designed algorithms and mechanisms. Gazebo is a 3D simulator which is used to communicate to the Robotic Operating System (ROS) framework for performing the tasks of Autonomous Navigation, Exploration and Victim Identification. In our system a map is generated by each robot which is simultaneously incorporated in a master costmap,

which is in turn shown to the human operator. The system employs P3AT Robot, laser range finders, along-with GPS and cameras.

4 Navigation

Rescue Robots must be able to navigate in both dynamic and static environments especially through narrow and cluttered paths. So, localization is a fundamental aspect of an autonomous rescue robot. For localization, an autonomous robot needs map of its surroundings, which is not known a-priori.

The figure 1 shows the map building in ROS using Gmapping technique of an environment.

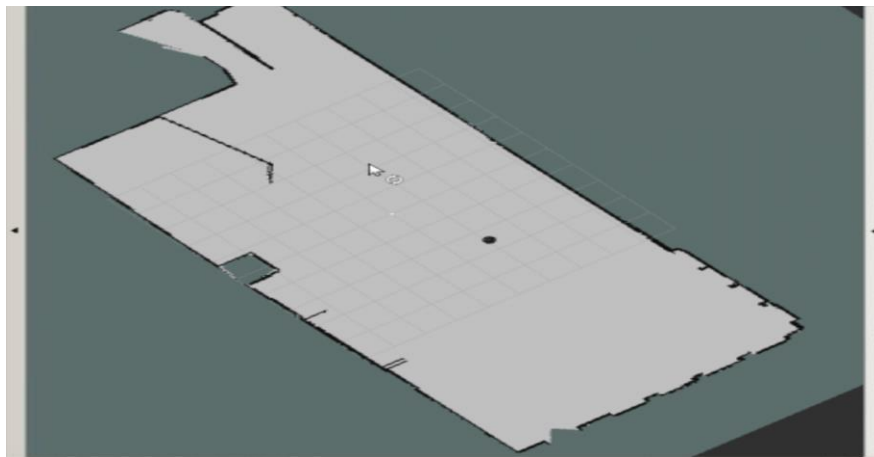


Figure 1: Map building using **Gmapping**

For robot mapping we have used Gmapping ROS package. GMapping provides laser based simultaneous localization and mapping (SLAM) [3]. In the ROS wrapper, it contains `slam_gmapping` node, using which an occupancy grid based 2D map is created. The main requirement of this mapping technique is laser scans and odometry of the Robot.

In order to navigate around a map autonomously, a robot needs to be able to localize itself into the map. And this is precisely the functionality that the `amcl` node (of the `amcl` package) provides. In order to achieve the said task, the `amcl` [4] node uses the MCL (Monte Carlo Localization) algorithm.

A map is a fundamental part of the robot navigation task, but still it can't really navigate without localization. So, the localization process is the vital part of Robot Navigation in ROS environment.

The move_base package contains the move_base node. The move_base node is one of the major elements in the ROS Navigation Stack, since it links all of the elements that take place in the Navigation process. The main function of the move_base node is to move the robot from its current position to a goal position.

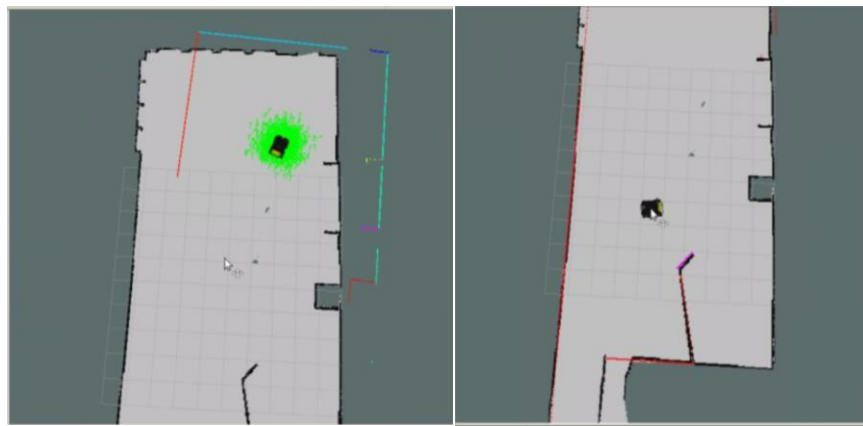


Figure 2:

(a) Robot pose without localization

(b) Robot Pose with localization

The Figure 2 demonstrates a simulation of a Robot pose without and with localization in its environment respectively.

5 Map Integration

We are using the divide area algorithm to divide the arena for mapping between the robots. The Divide Areas Algorithm for MultiRobot Coverage Planning (DARP) divides the grid-based region almost equally among all the robots. The algorithm first generates voronoi regions for each robot as a start. It then introduces an idea of "fair share", where the goal is to assign each robot its fair share of the total grid cells. In other words, it starts assigning grid cells to each robot such that eventually, all robots have almost equal no of grid cells. This is done by using a monotonically increasing function to optimize over the number of grid-cells assigned to each robot. The algorithm also ensures that the final region assigned to each robot is convex, by rewarding grid cells directly connected to the existing region. Once the regions are defined, a minimum spanning tree (MST) is computed through the assigned area for each robot which the robot then uses for completely covering its assigned area.

For map integration we have introducing a new costmap layer in which we have updated the map data from every single robot on runtime basis. This newly added costmap has the dimensions equal to the dimensions of arena. Depending on the location of robot the corresponding area is updated in the arena costmap [5]. Figure 3 as shown below, demonstrates the map integration using costmap visualization in the RVIZ setup of the Robot Operating System.

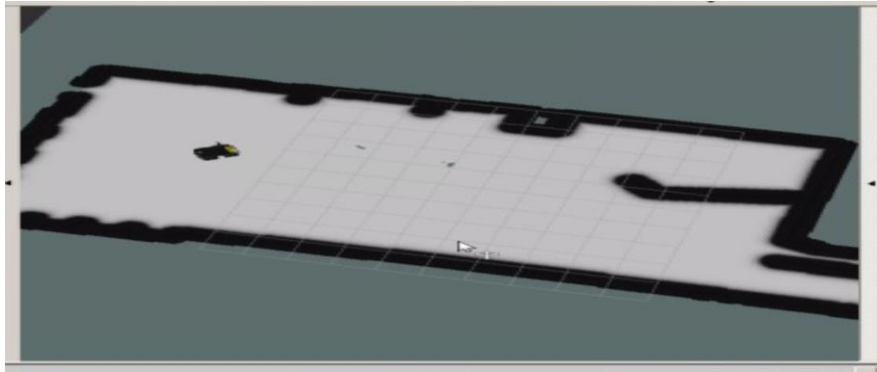


Figure 3: Costmap visualization in RVIZ

6 Victim Identification

The main purpose of a rescue robot is to identify victims in disaster situations. Identifying type of victim (either dead or alive) and marking its location on the map is

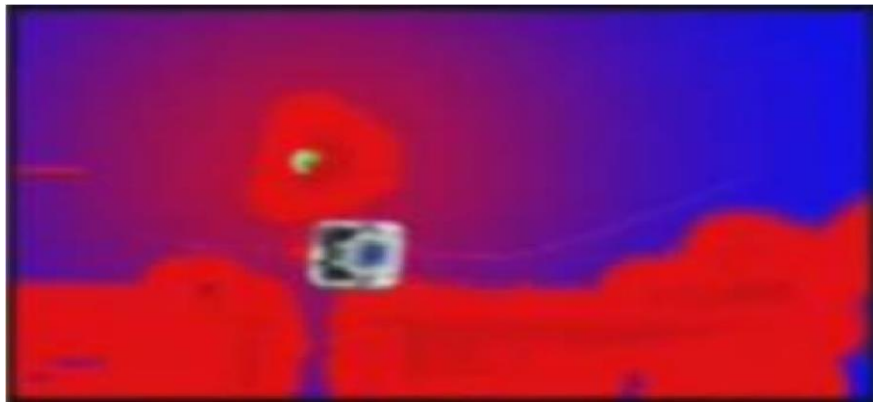


Figure 4: Social Navigation

a desirable and one of the most important tasks. A social costmap layer is used to identify victims in this scenario, which is represented in Figure 4.

The key idea of using costmap layer is that it has Social Proximic Space. Social Proximic Space means that robot differentiates between obstacle and humans [6]. To implement this a Gaussian distribution is added whenever people are detected. This method is integrated in to the actual costmap object. By adding this new Gaussian distribution around the detected person, the planner was able to create a path further around the person. We are using this idea to identify victims in simulated environments.

7 Future Works

This year we are mostly working on ROS Navigation Stack for different situations like Autonomous Navigation, Map Merger and Victims detection. In future we intended to work on Deep Learning for Victims Detection and Tracking. Also including a UAV to our robot's fleet will further enhance the mapping by creating a 3D map and later on locating and identifying victims easily and accuately.

8 Release Schedule

We will release our system on a github repository linked from our site by the end of June 2018.

References

1. Akin, H. L., Ito, N., Jacoff, A., Kleiner, A., Pellenz, J., & Visser, A. (2012). Robocup rescue robot and simulation leagues. *AI magazine*, 34(1), 78.
2. Wisspeintner, T., Van Der Zant, T., Iocchi, L., & Schiffer, S. (2009). RoboCup@ Home: Scientific competition and benchmarking for domestic service robots. *Interaction Studies*, 10(3), 392-426.
3. Thrun, S., & Leonard, J. J. (2008). Simultaneous localization and mapping. In *Springer handbook of robotics* (pp. 871-889). Springer Berlin Heidelberg.
4. Fox, D., Burgard, W., Dellaert, F., & Thrun, S. (1999). Monte carlo localization: Efficient position estimation for mobile robots. *AAAI/IAAI, 1999*(343-349), 2-2.
5. Lu, D. V., Hershberger, D., & Smart, W. D. (2014, September). Layered costmaps for context-sensitive navigation. In *Intelligent Robots and Systems (IROS 2014), 2014 IEEE/RSJ International Conference on* (pp. 709-715). IEEE. 6. Dan Lazewatsky, retrieved from: "<http://wiki.ros.org/people>", accesed on: 14.March.2018