Technical issues of MRL Virtual Robots Team RoboCup 2016, Leipzig – Germany

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Abstract. In this paper we describe MRL Virtual team preparation to take part in RoboCup 2016. Regarding new WorldCup 2016 challenges, we tried to design a new base code to four wheels robots based on ROS framework [1]. We plan to release our base code for new teams to help them starting easier with virtual robot league.

1 Introduction

In the virtual robot competition a disaster environment is simulated which could be explored with a team of rescue robots. It based on USARGazebo[1] plugin, a high fidelity simulator on the Gazebo simulator [2]. Within this plugin users can simulate multiple agents whose capabilities closely mirror those of real robots. This plugin currently features wheeled as well as some sensors and actuators. Moreover, users can easily develop models of new robotic platforms, sensors and test environments. Validation experiments have shown close correlation between results obtained within the USARGazebo and the corresponding real robots.

The Virtual Robot Competition of this year comes after The Future of Robot Rescue Simulation Workshop[2] that has set a new milestone and designed an environment and scenario which are planned to be used inside the competition for some years.

MRL Virtual Robot have participated since 2006 in various RoboCup completions such as: IranOpen, Kharazmi and WorldCup. Our major focus is on developing four Wheels and Aerial robots. We have been champion on 2013 and 2014 [7, 8] WorldCup competitions and our base research area is on: Autonomous systems, SLAM and Multi Agents systems. MRL team consist of M.Sc. and BC.s students in different fields such

[1] https://github.com/m-shimizu/RoboCupRescuePackage
[2] https://staff.fnwi.uva.nl/a.visser/activities/FutureOfRescue/

as Artificial Intelligent, Software Engineering and Information Technology Engineering. Most of mentioned researches area are defined as thesis's topics. Mechatronic Research Laboratory is depend on Islamic Azad University of Qazvin.

2 Team Members

The team members and their contributions are as follows:

- Mohammad H. Shayesteh: Base Code, Multi Robot Exploration
- Edris Esmaeili Aliabadi : Multi Robot Exploration
- Mahdi Salamati : ROS, Base Code
- Adib Dehghan : Graphical User Interface
- Danial Jafarymoghadam : Navigation

3 Base Code

With the latest changes in Virtual Robot league, all teams can use "ROS" to create better modules for SLAM[3], navigation, etc. to develop a suitable program to manage multi robots. So due to these basic changes we prepared to design a new base code to be a dependable program for use ROS capabilities and add other modules in the future.

This new system is based on Ubuntu OS and C++ language and tried to use QT for Com Station part. One of the first goals of this new base code is to be available for new teams in this league. So they can run their programs easier and faster. On the other hand MRL team can research and develop their new studies. We try to develop a reliable base code that other researchers be able to easily create and implement their algorithms. In this TDP we show the most important of software abilities and options of base code.

Application Sections

- *Robot Application*: This application is as controller and provides fundamental tasks, autonomous system and navigation modules for each robot.
- *Com-Station Application:* A software with suitable GUI for control the robots by driver and merging all gathered information from all robots.
- *Debugger:* A separate software for monitor probable errors in the system.
- *Visualizer:* A complete graphical UI for modeling alternative multi-robot exploration strategies.

[3] **S**imultaneous **l**ocalization **a**nd **m**apping

System Architecture

The Virtual Robot league is consist of two main services, one for simulating the disaster environment based on Gazebo engine that presented by Masaru Shimizu et al. from Meijo University and Chukyo University, Japan[4]. The other one is WSS[5] was developed and documented by Max Pfingsthorn. which with that robots are able to communicate via networking with each other, in other word WSS is a wireless network simulator in disaster environments that carry packets between robots.

With these systems we present two application to control robots and also Com-Station based on ROS:

[4] http://sakura.meijo-u.ac.jp/ttakaHP/Rescue_index.html

[5] http://usarsim.cvs.sourceforge.net/viewvc/usarsim/usarsim/Tools/WSS/

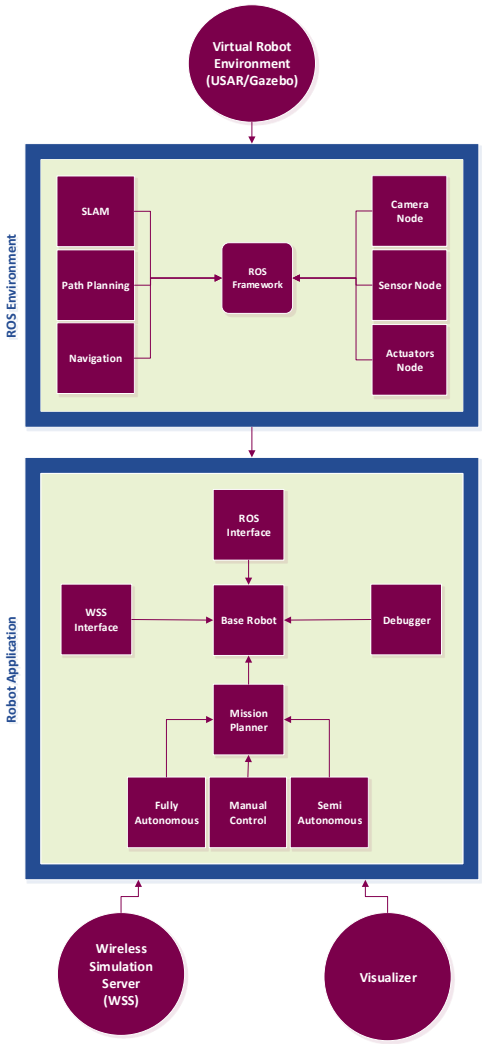

Fig 1: Robot Application Architecture

As shown in Fig 1, robots communicate to simulation environment without user interface and gather the information from sensors to have control of the its robot. Also it is connected to WSS via TCP connections and transfer data packets to other robots and/or Com-Station. In this architecture each robot uses the ROS framework to have a stable navigation and they connect directly to Gazebo from its ROS instance.

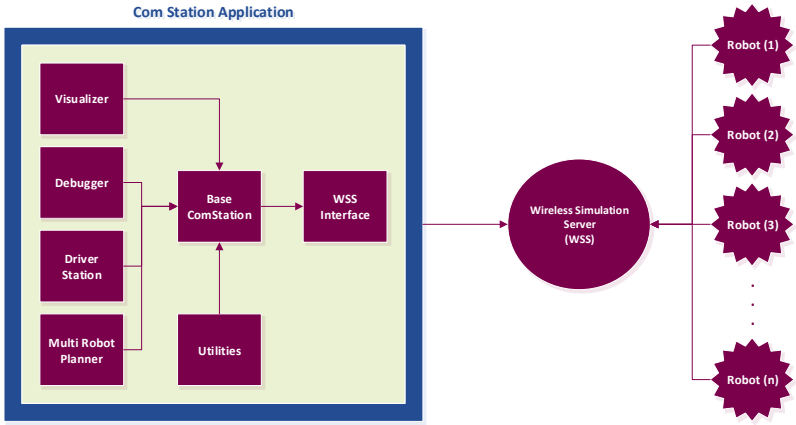

Fig 2: Com-Station Application Architecture

As shown in Fig 2 we tried to develop a program to control all robots with reliable autonomous behavior to give a complete control for driver. Also we tried to prepare some required modules like map integration in Utilities part to using for Multi Robot Exploration and decision making.

4 Multi-Robot Exploration

One of the most important elements of rescue robots is cooperation between them and improved exploration to reduce time. So we are trying to work on some algorithms like "ICE" and "MLEGM" that are researched at this laboratory.

"ICE" algorithm for finding the key nods in search

"ICE" algorithm [3] is an efficient way for positioning robots in unexplored environments. The intention of this algorithm is to estimate the location of robot. If this module don't completely do its role, other parts of the system will be disordered too. It is evident that if a robot do not know its location the navigation system will be completely confused and it cannot go to its destination. In many situation robot cannot use the GPS and have to use its sensors so errors are unavoidable. These kinds of algorithms are responsible for reducing the number of errors that might occur while the sensors are operating. With due attention to these challenges, presenting a fast and reliable method for localizing robots is an essential part of a successful exploration.

"MLEGM" algorithm for multi robot exploration

With the properties extracted from "ICE" some points are selected to explore. Now advancing to these points and the method of weighting of pints using "MLEGM" algorithm [4] will be explained. The "MLEGM" is responsible for find a secure path and weighting them for a robot to reach its destination. Finally these paths and processed data will passed to a deciding module. In the deciding part presented method manage the multi robot exploration based on robots communication. After choosing the best points for exploring by deciding module, a generated road map will be transferred to the robot's navigation module, thus the presented algorithm is completed.

Multi-Robot Exploration Architecture:

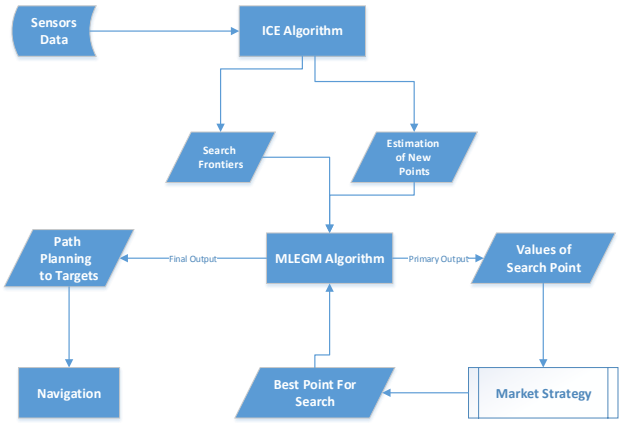

Fig 3: Multi-Robot Exploration based on ICE, MLEGM, and Market Strategy algorithm

As shown in Fig 3, we design a system based on "ICE" algorithm that provides localization and finding frontiers [5].it is also using "MLEGM" system to find best targets for navigation with participating in a distributed decision making system.
These two modules using the Market Strategy [6] as a distributed decision maker system such value setter to their goals and finally assign a weight to their tasks, after that we can set the final points to robots for reaching them with a recursive plan.

5 Conclusion

In this paper we are designed our new base code based on ROS framework which are needed for autonomous systems. On the other hand, we tried to design an autonomous systems for wheeled robots to search in the disaster environments. Our future task is to design a Multi-Robot Exploration system to navigating a group of robots parallels based

on ROS framework. This part helping us to make better decision in autonomous rounds and explore wide area in indoor environments.

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