IranOpen 2017
RoboCup Rescue Simulation League
Virtual Robot Competition

Rules Document

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Abstract

The purpose of this competition is to provide a common benchmark to demonstrate scientific progress in the application of robotics to Urban Search and Rescue. The rules of this competition are loosely inspired by the rules of the RoboCup Rescue Robot League and Agent Competition. As in the Rescue Robot League, a devastated area has to be explored for victims by a team of robots controlled by an operator. Compared to the Rescue Robot League, the focus is on exploring larger areas with multiple robots rather than the mobility of individual robots. As in the Agent Competition, the disaster situation is not known before a competition run. The main difference between the two events is our focus on a realistic sensory and actuation in addition to planning.

1 Foreword

The design and implementation of a RoboCup Competition is an ongoing process that is possible thanks to many people around the world volunteering a significant part of their time to this event. Contributions include improvements to the simulation engine, creation of competition worlds, and running the competition itself. The generous contribution of all volunteers in the past is warmly acknowledged. They have enabled a competition that is sustainable without excessive human effort and can remain viable. This is especially true this year, after a big change in simulation platform, scenarios, and, as a consequence, in rules.

The rules described in this document and proposed for IranOpen 2017 Virtual Robot Competition strive to further the progress made on the comprehensive mission. Several years ago the competition also addressed several sub-problems in the form of elemental test runs as a qualification for the final rounds. Since these elemental tests considered very specific capabilities, namely teleoperation, mapping, and deployment of an ad hoc network, they were also easier to score automatically. One problem with such tests, however, is that scores do not always directly relate to performance, i.e., rescued victims, in the comprehensive mission. Furthermore, the setup of such tests enforces the types of approaches teams can take for solving the comprehensive mission. For example, focusing solely on multi-robot coordination

without good mapping, no teleoperation, and no connected communication network could also lead to good performance in the comprehensive mission. Yet a team with such emphasize will fail most elemental tests. To remove these artificial constraints, the Technical Committee hopes that the focus on a single comprehensive mission will be beneficial for the competition, fostering a multitude of approaches that will be judged by a common performance metric. The main goal of this competition is finding victims and teams are evaluated according to the number of victims found and to the time required.

As usual, suggestions, constructive feedback, and volunteer work are welcome and needed.

All teams participating in the 2017 competition agree to follow the latest version of these rules.

2 League Objectives & Background

The major goal of this competition is to encourage intuitive operator interfaces and autonomous and semiautonomous algorithms that can be used to supervising and control multiple heterogeneous robots operating in challenging environments. Additionally, we aim to have a competition with a low barrier of entry for new teams and possibilities for a variety of approaches. In this sense, the adoption of Gazebo as simulation framework allows to easily leverage on the large amount of code available in the ROS ecosystem.

This should allow permanent installations of servers, each with its own world, which can be used for testing in preparation of the RoboCup event. Further, it allows teams to test their approach prior to the competition which lowers the barrier of entry for new teams.

The challenges are then a result of the environments that robots are deployed in, while the metric remains the same. Additionally, to foster the competition aspect the scores are computable in real-time and can be displayed to an audience during each competition run, but won't be announced till all the teams have completed their map runs.

Finally, the scores should reasonably reflect performance for relevant real world problems that are modeled in simulation. Here, the simulation aspect of our league has the advantage of reproducible comparisons since all activity can be logged and ground truth data is readily available.

3 Comprehensive Missions

During the competition, indoor and outdoor search and rescue scenarios may be encountered. Before the run, the teams will be given basic information about the scenario. This will include the location of the disaster (indoor/outdoor) and possible dangers. Teams will be required to search for victims located in different places in the arena.

Technical Committee has the final word on when a victim is located by a robot. Technical Committee informs teams before each run whether a robot must be parked near (less than 1.5m) a victim or it can continue its exploration after detecting a victim. Providing additional information about victim such as life status, location and path on the map will results in extra points.

Technical Committee ask for maps generated by each team to compare their performance and release their outputs to other teams. Scoring will be made according to rules described in section 5.

Only robots validated before the competition will be allowed to be used in the competition. The list of accepted robots and sensors is reported in this document (Section 9). Note that not every combination

is possible. The sensor load will be examined and the Technical Committee reserves the right to disallow any unrealistic combination of robots and sensors. Robot teams will be formed by a number of mobile robots.

4 Running Missions

4.1 Simulation environment

Simulations will run in Gazebo 5 on Ubuntu 14.04.4 LTS (Trusty 64 bit) with ROS Indigo machine. During the competition, the organizers will provide two sets of machines (from now on each set will be called a cluster). Gazebo will be run in server mode on each cluster. Each team has 20 minutes to set up on its cluster. The run starts at the scheduled time. If a team is not ready, time will start anyway. Each competition run lasts 20 minutes (exact time to be announced before the run). Each team will run its client code on their own or provided machine. A single TCP/IP cable will be provided to the team to connect to a cluster.

Teams should use direct ROS control using robot_state_publisher ROS node. The teams know the IP address of the server. To ensure the fairness of the competition and the fact that teams are not cheating in communicating with the server, for which the set of commands that can be sent to the simulator is not constrained, the Technical Committee reserves the right to inspect the code of the team at any time to ensure that the client controlling robots exchange with the simulator only data compatible with realistic situations. Reading data from sensors mounted on robots is realistic, sending commands to robot actuators is realistic. The Technical Committee reserves the right to decide about the interpretation of the term "realistic".

At the prescribed start time, the robots will be instantiated in the world. Starting poses of the robots forming a team will be provided as follows: Just before the run, the Technical Committee will provide a launch file built starting from a template provided by the team (and including the robot configurations the team would like to use) and modified with the starting poses of the robots (decided by the Technical Committee). All robots must be spawned at the start of a run, though teams can decide to activate them at their convenience. As long as no such alternative is available for ROS-nodes, the teams may assume unlimited communication.

4.2 Technical challenge

To be announced …

5 Performance Metrics

For scoring purposes a team member is counted as a human operator as soon as the human operator:

- starts a robot, enters initial points,
- actively drives a robot around,
- stops a robot before the run is over (for example, to prevent it from bumping into victims),
- is involved in any way in the victim recognition process.

Each team can have only one human operator for each run. Let v_r be the number of victims a team detected right and v_w be the number of victims a team detected wrong, V be the number of all victims (maybe more than robot numbers), av_r be the number of alive victims a team detected correctly and av_w

be the number of alive victims a team detected wrongly and let AV be the number of all alive victims, P be the number of specified paths to victim and L be the number of specified locations of victim The score of a team is calculated with the following formulas:

$$Score = \left[\lambda_s \frac{s}{S} + \lambda_v \left(\frac{v_r - 2v_w}{V} + \max\left(0, \frac{av_r - 3av_w}{4AV}\right) + \frac{P + L}{8V}\right)\right] \alpha$$

Where α ($0.1 < \alpha < 2$) is proportional to the difficulty level of the map, defined by the map designer, $\lambda_s > 0$, $\lambda_v > 0$ are constants that balance the weight of finding victims and of exploring the environment.

Each map has a number S of "invisible portals" that represent important points of the environment and that are defined by the map designer (for example, invisible portals are intersections of corridors and other relevant points according to the environment), but unknown to the teams. Let s be the number of invisible portals that are in the map of the portion of the environment explored by robots of a team.

To encourage safe robot behavior any contact between a robot and a victim causes the team a 20% score penalty for that victim (instead of 1 points, the team gets 0.8 points after a first contact, 0.6 points after a second contact, ..., down to 0). Besides, before each run, the Technical Committee can communicate to the teams that operators are not allowed to control the robots manually (hands-off period) for k minutes, during which robots are supposed to explore automatically.

6 Open Source Policy

The winning teams are required to provide a fully functioning copy of their software to the organizers before the final ceremony. Failure to do so will result in team disqualification. All other teams are also requested to provide their code, though not before the awards event. The software will be posted on (or linked from) http://www.robocuprescue.org/ giving proper credit to the authors. Source code for previous competitions is available at the aforementioned web page.

All data logs collected during the competition can be made available on the web for public use, including, but not limited to, scholarly work devoted to performance evaluation and benchmarking.

7 Base Code

With the aim of facilitating the process of getting ready for the participants and also encourage new volunteers and bring them forward with ROS/Gazebo structure, the basic implementations of ROS and related Package/Configurations beside sample robot model with mounted camera/laser and corresponding gazebo/ROS plugins which are quite operational in the Gazebo simulation environment alongside with setup tutorials is provided by the *Team S.O.S. vr* and its ready to use as a base structure.

The source code is available on the github repository of *Team S.O.S vr*[1] .

8 Summary

The intention of the competition is to stimulate research in robotics that allows for autonomous and safe exploration of significant parts of the environment providing aid to first responders to rescue victims. The organizing committee has the obligation to make the competition a fair challenge.

[1] https://github.com/SOSVR/base_code

9 Allowed Robots and Sensors

Teams can use combinations of the following robots (whose models are available in Gazebo) with following sensors which are currently tested and work properly:

P3AT (odometry, camera, battery, sonar, gps, laser range finder)

P2DX (odometry, camera, battery, sonar, gps, laser range finder)

Turtlebot (odometry, camera, battery, sonar, gps, laser range finder)

Quadrotor (camera, battery, gps, laser range finder)

any self-created (or modified) model.

Sensor data can have added noise. Sensor load will be examined. The Technical Committee reserves the right to disallow any unrealistic combination of robots and sensors. Prior to the competition, the technical committee can publish a number of reasonable configurations that can be used during the competition. Additionally, when during the competition unrealistic behavior is detected for a robot or sensor, this device can be excluded for further usage during the rest of the competition.

10 Acknowledgments

This document is based on rules of RoboCup 2016, Rescue Simulation League, Virtual Robot Competition.