RoboCup 2014

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 inspired by the rules of the RoboCup Rescue Robot League and Agent Competition. As in the Robot League, a devastated area has to be explored for victims by a team of robots controlled by an operator. Compared to the 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 the sensory and actuation level in addition to planning. From last year the Technical Committee has made some changes in the rules encouraging teams to develop autonomous exploration systems and focus less on manual driving of robots.

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.

Rules proposed for RoboCup 2014 competition strive to further the progress made on the comprehensive problem. 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. Therefore, the main goal in this competition is finding victims, but to reduce the role of chance in the competition the Technical Committee (TC) also decided to add a new term called "Total Explored Area Ratio" to the scoring formula.

As usual, suggestions, constructive feedback, and volunteer work are welcome and needed. All teams eventually participating in the 2014 competition agree to follow the final version of the rules.

2 League Objectives & Background

The major goal of this competition is to encourage intuitive operator interfaces and autonomous and semi-autonomous algorithms that can be used to monitor and control multiple heterogeneous robots in a challenging environment. Additionally, we aim to have a competition with a low barrier of entry for new teams and possibilities for a variety of approaches. A straightforward, simple, and automated scoring metric is hence proposed to support this goal. 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 and park their robots "near" each victim (somewhere in radius of 1.5 meters around the victim). Differently than in previous years, teams do not to submit any material to the referees for scoring, but we may ask for maps generated by each team to compare their performance and release their outputs to other teams. Scoring will be made according to number of robots parked near victims and total area explored by each team. Scores will be reported using two automated tools developed by the Technical Committee and the results will be shown on screen. These scoring tools are available on the sourceforge USARSim Git site.

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 7). Note that not every combination is possible. The sensor load will be examined, which can lead to a reduced battery-lifetime of the combination. The referee reserves the right to disallow any unrealistic combination of robots and sensors.

4 Running Missions

During the competition, the organizers will provide two sets of machines (from now on each set will be called a cluster). USARSim will be run in server mode on each cluster. Each team will run its client code on its own machines. A single TCP/IP cable will be provided to the team to connect to a cluster. One of the two clusters will be used by the team currently competing, while the second one will be used by the team setting up for the following competition round. Each team has 20 minutes to setup on its cluster. The run starts at the scheduled time. If a team is not ready, time will start anyway. Robots are provided with batteries that will operate for about 20 minutes (time to be announced before the run). At the prescribed start time, the robots will be instantiated in the world. Teams have to retrieve robots position and orientation directly from USARSim using the GETSTARTPOSES command. The robots are responsible for monitoring their battery condition. All robots must be spawned at the start of a run, though teams can decide to activate them at their convenience. All communications (operator-robot and robot-robot) will use the Wireless Communication Server WSS[1]. This version (0.6.1) is tested with UDK (version 2012-05). All

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[1]The WSS is developed and documented by Max Pfingsthorn. The WSS simulates wireless network links in a disaster setting. In a disaster settings network links are not guaranteed, which forces robot-control developers to deal with the

communications go via the WSS and include the connection to the image server[2]. This version is also tested with UDK. In this way the operator base station can send commands to a robot and will obtain measurements and video images from a robot only when that robot is in radio contact. The location of the operator base station and the wireless cutoff strength are provided as *a priori* data. During the competition all socket communication to the robots is logged. Therefore, we are able to check for TCP-packages that bypass the Wireless Communication Server. Teams that violate this policy are immediately disqualified, and the reason for the disqualification will be posted on the web.

5 Performance Metrics (Victims + Explored Area)

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 m be the number of victims a team detected successfully and t be the completion time for the team, i.e., the time until either all M victims in the arena have been found or the maximum mission time T is exceeded. The score of a team is calculated with the following formulas announced by TC members before each run:

$$\text{Score} = 50 * \left[10m + \left(1 - \frac{t}{T}\right)\right]\alpha$$

$$\text{Score} = [10m + 10\beta MS]\alpha$$

Where $\propto$ $(0.1 < \propto < 2)$ is proportional to the difficulty level of the map, defined by the map designer. β is another constant $(0.1 < \beta < 1)$, and S is the total area ratio explored by robots.

This automatically ranks all teams by their number of victims and their completion time/explored area ratio. To encourage safe robot behavior any victim crashed into by a robot, causes the team to lose 20% of the total score.

Besides, in each run, the operator is not allowed to control the robots manually (hands-off period) for **k** minutes (specified by TC members), and robots are supposed to explore the area automatically during this period.

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.

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main issues of unreliable wireless links, such as either multi-hop routing to the operator or autonomous behavior of the robots. The latest version 0.6.1 is available on http://usarsim.cvs.sourceforge.net/viewvc/usarsim/usarsim/Tools/WSS/

2 The new image server is developed and documented by Prasanna Velagapudi. With this version you run the USARSim camera client in higher resolution, and request rectangular regions of the full image for each robot. The latest version of the source code is available on http://usarsim.svn.sourceforge.net/viewvc/usarsim/Tools/ImageServer/

7 Résumé

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.

7 Allowed Robots and Sensors

Teams can use combinations of the following robots with following sensors which are currently tested and work properly:

- ✓ P3AT (Odometry, INS, Camera, Battery, Sonar, Laser range finder)
- ✓ AirRobot (Camera, Battery)
- ✓ Kenaf (Odometry, INS, Camera, Battery, Sonar, Laser range finder)

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 will publish a number of logical 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.

8 Acknowledgments