RoboCup 2012

RoboCup Rescue Simulation League
Virtual Robots competition
Rules document

Technical Committee;
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Initial version 1.1: January 13, 2012

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 competitions. 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 then 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. The automatic scoring procedure to provide teams with the ability to run and score complete runs at their institutions. In addition, it allows real-time display of scores by teams during the competition.

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 robot models, the design 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 man power and can remain viable.

Rules proposed for the 2012 competition strive to further the progress made on the comprehensive problem. In previous years 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 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 an emphasize will fail all current elemental tests. To remove these artificial constraints the Technical Committee has in 2011 decided to 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.

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As usual, suggestions, constructive feedback, and volunteer work are welcome and needed. All teams eventually participating in the 2012 competition agree to follow the final version of the rules that will be finalized after the regional competition in Iran and the Netherlands (April 2012).

2 League Objectives & Background

The major goal of this competition is to encourage intuitive operator interfaces, 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 developed 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.

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 urban search and rescue scenarios may be encountered. The day before the run, the teams will be given basic information about the scenario. This will include the origin and location of the disaster (i.e. chemical spill in a large terminal), possible dangers (i.e. a mud slide made part of the area difficult traversable).

Teams will be required to search for victims located in different places in the arena and park their robots "near" each victim. The distance at the end of the mission counts. If the victim starts moving during the mission, it is the task of the robot to follow the victim. Differently than in previous years, teams do not have to submit any material to the referees. Scoring will be made according to number of robots parked near victims at the end of the run. The team with the highest number of parked robots near victims will be the winner. Scores will be reported using an automated tool developed by the Technical Committee and will be shown on screens. This tool will soon be available on the sourceforge USARSim git-repository.

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 as Appendix B. 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*). 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 the cluster. A time schedule for team setup and run is determined the day before. Each team has 20 minutes to setup on the cluster currently not being used. 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 typically 20 minutes (time can be extended for larger mission, which will be announced together with the time schedule). At the prescribed start time, the robots will be instantiated in the world. The robots must wait for a 'start' command to be issued before beginning their exploration. The robots are responsible for monitoring their battery condition. All robots must be spawned at the same time, 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 is tested with UDK December 2011.

All communications between commstation and robots (including video images) has to be made via the WSS. The robots make the connection to the image server[2]; the operator only receives images when they are relayed by the robots via the WSS. The latest version of the image server code is also tested with UDK December 2011. 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

5.1 Comprehensive mission

To compute the overall score S, the collected points are divided by H^2, where H is the number of human operators. For scoring purposes a team member is counted as a *human operator* as soon as a human:

- Starts a robot, enters initial points, or perform any operation needed for the successful start of the rescue mission
- 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

According to the above definition, each team will be charged at least one human operator for the robot setup, which means that $H \geq 1$ is guaranteed. 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:

$$S = 50 * \frac{m/M + 1 - t/T}{H^2} \tag{1}$$

The maximum score ranges between 0 and 100. Only teams that find all M victims before time T can reach a score of 50 or higher. This automatically ranks all teams by their number of victims. If multiple teams find all of the victims, they will be ranked by the completion time. An important criterium in this equation is the measure to decide that a victim is found. The criterium is based on the distance between the victims head and the center of the robot. Depending on the victim and the situation a different threshold on this threshold can be chosen: typically between $1m$ and $2m$.

To encourage safe robot behavior any victim crashed into by a robot will not be counted towards the saved victims.

[1]The WSS is developed and documented by Max Pfingsthorn. The WSS simulate 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 main issues of unreliable wireless links, such as either multi-hop routing to the operator or autonomous behavior of the robots. During the competition, the WSS will operate with the *ObstaclePropagationModel*. The latest version 0.6.1 is available on http://usarsim.cvs.sourceforge.net/viewvc/usarsim/usarsim/Tools/WSS/

[2]The image server is now a thread inside USARSim, thanks to Sander van Noort. The code is equivalent with the image server developed and documented by Prasanna Velagapudi. http://usarsim.git.sourceforge.net/git/gitweb.cgi?p=usarsim/usarsim;f=Development/Src/USARBotAPI/classes/Multiview.uc

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 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.

High quality maps and demonstrating the capability to actively search and localize victims (or clear environments) using robot models consistent with the state of the art. This year the maps are indirectly used as metric; teams with better maps can coordinate their effort better. The organizing committee has the obligation to make the competition a challenging but fair challenge. NIST personnel neither involved nor affiliated with any of the participating teams and institutions are part of the organizing committee. In case of protests or objections, after having consulted the relevant parties, the final word is up to them.

8 Acknowledgments

Special thanks to Stefano Carpin and Andreas Kolling, who were co-authors of the rules of the previous years.

Appendix A: File Formats

Start locations

Start locations will no longer be provided. Instead, teams have to retrieve this information directly from USARSim using the GETSTARTPOSES command.

A priori maps

A priori maps are no longer provided. Instead, teams have to create those maps themselves.

Appendix B: Allowed robots and sensors

Teams can use combinations of the following robots:

- P3AT
- AirRobot
- Nao
- Kenaf (when validated)
- AR.Drone (when validated)
- TeleMax (when validated)

Teams can use combinations of the following sensors:

- AcousticArraySensor
- Tachometer
- Odometry
- INS Sensor
- Encoder
- Camera
- Sick
- Hokuyo URG04LX
- Battery
- Sonar
- GPS

Sensor load will be examined. The functionality of the Battery sensor has improved this year and reduced battery-lifetime can be simulated by additional discharges. 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.