A proposal on more advanced Robot Rescue Simulation challenges for Robotics Education*

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https://github.com/IntelligentRoboticsLab/Joint-Rescue-Forces/wiki/RoboCup-2019

Abstract. This paper is aimed to provide a bridge from the RoboCup Junior to the RoboCup Rescue Simulation League. The intent of building the bridge would be to have a gradual increase in the complexity. This paper provides a 'game field' version of the rescue simulation competition suitable for students at different points along the learning curve.

Keywords: Educational kit · Search and Rescue · Simulation

1 Introduction

One of the major visions of RoboCup is to pave the way for the next generation to solve more complex problems. Hence, the RoboCup Junior was initiated to educate the primary and and high-school students [3]. The RoboCup Junior leagues include competitions in soccer, rescue, and dance. The Rescue was introduced to promote research in socially significant issues [6], while its' educational potentials were found afterwards. Students willing to continue in the rescue field can go for RoboCup Virtual Rescue and then for RoboCup Robot Rescue League.

As there is a gap between RoboCup Junior and Virtual Rescue League [2], there is a rising demand on adding a new step in this bridge. This step should be a cost effective one, with a low barrier to entry, and designed for secondary students and undergrads to provide more educational benefits. Due to the gradual increase in difficulty this step could be designed introduce students ready to quite specialistic knowledge needed to enter the real Rescue League.

In this paper, a new 'game field' rescue simulation platform suitable for high-school students will be introduced, which fulfills most of the prerequisites to build the bridge to RoboCup Rescue League.

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2 Shaping The Learning Curve

Due to gradual nature of education, a step-by-step process of learning is needed. Hence, it is recommended for the primary students eager to participate in RoboCup Robot Rescue League in the future to start with the RoboCup Junior Rescue, continue with RoboCup Junior Rescue Simulation, followed by the RoboCup Virtual Rescue competition, and afterwards enter to the RoboCup Robot Rescue League. Although Virtual Rescue seems successfully to fulfill its' promise to provide an affordable and reproducible experimentation platform [5], it is not designed to have a step-by-step process for learning an other bridge is needed to complete the learning curve.

2.1 Requirements & Methods

In order to have a good evaluation of different possible solutions for the problem, it is first necessary to define the requirements on the simulation platform from both an education standpoint and a research perspective.

Requirements

- Being free and fully accessible to students to use,
- Ease of installation even on low-spec PCs,
- Interface that is intuitive to use.
- The ability to serve from fundamentals to higher complexity concepts,
- Easy transition to research-based platforms from educational-focused platform.

Regarding the requirements a number of free open source 3D robot simulators were studied. I.e., the simulators Gazebo, Webots and V-rep are considered, which each have different advantages and disadvantages. Overall, Gazebo is a typical platform for the higher age group, and Webots is one for the younger age group [2].

3 Prototypes

In this study three prototypes where proposed respectively based on Gazebo, Webots, and V-REP. In this section, a review of the prototypes is provided.

3.1 Gazebo Prototype

As Gazebo supports many integrations, a Gazebo environment has been developed, which recreates many of the elements which can be found in a CoSpace arena (see Fig. 1).

Gazebo also supports a variety of research robots [1], but has no model for the small direct-drive robots typically used in education. Because the size of

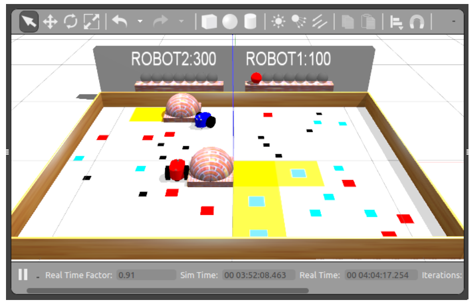

Fig. 1. The creation of a simple CoSpace world in the Gazebo environment.

the robot directly has an influence on the design of the challenges (both objects and obstacles), a new model of a small direct-drive robot was created for this challenge. This robot not only has the size but also contains the sensor suite used in education (see Fig. 2). To recreate the important elements which define the interaction with the world in a CoSpace-like challenge different functionalities were also added to Gazebo.

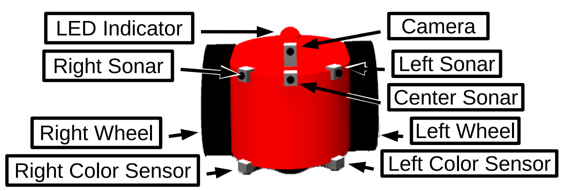

Fig. 2. The Robot functionality.

The robot is also enhanced with a webcam mounted on the simulated robot (see Fig. 3), a sensor which is not part of the current CoSpace-like challenge, but could facilitate an interesting challenge for the age 14-18.

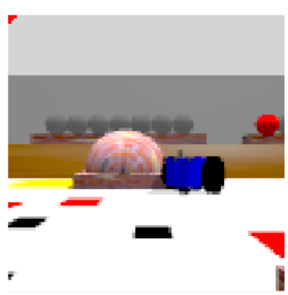

Fig. 3. A view image from the webcam on the robot.

The camera feed allows introducing Computer Vision and Pattern Recognition to those students. An example of such an assignment would be the recognition of a few landmarks on the walls by combining a simple artificial neural network with a backpropagation algorithm.

The result is a world which resembles one of the CoSpace worlds, which can now be controlled with standard ROS-commands as `cmd_vel`(See Fig. 4).

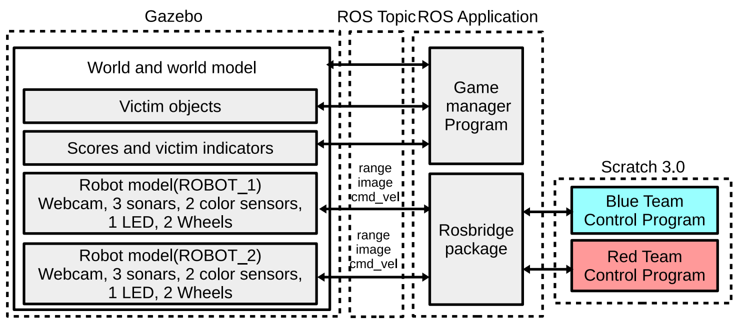

Fig. 4. A connection diagram between the robot models and the team control programs.

3.2 Webots Prototype

For the Webots prototype, a rescue scenario environment has been created using Python and the concept of a supervisor node in Webots. Within this environment, two E-Puck robots- which are especially designed for educational purposes [4]- are active (one for each team), see Fig. 5. The environment is more complicated than the current CoSpace challenge because there are now also crate based obstacles (which could be pushed out of the way). The victims are now also no longer 2D locations, but 3D objects (balls) which could be 'saved' by moving them to a deposit area (representing a medical post). In addition to the environment, a GUI for the scoring has been created using Tkinter, see Fig. 6.

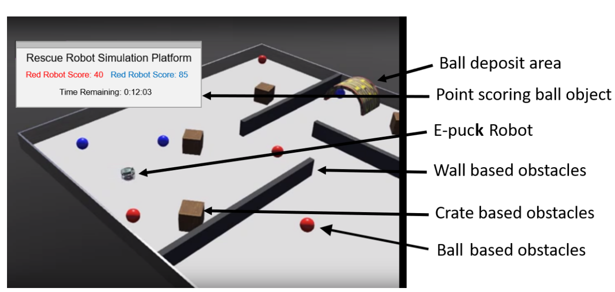

Fig. 5. Webots simulation environment created.

Going forwards, this platform will be tested with student groups to explore and test how best this meets the requirements. In particular, this process will investigate the level of complexity, to explore if it has a sufficiently low entry barrier, yet lets students explore high-level concepts.

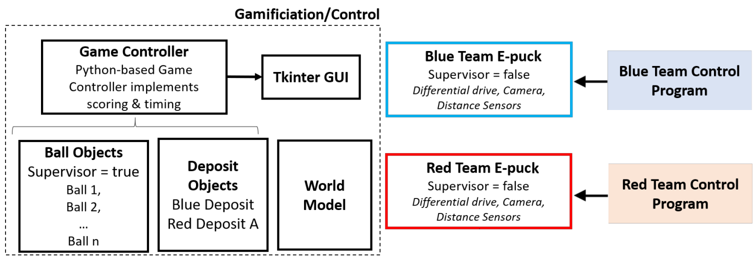

Fig. 6. Summary of the different components to implement the simulation.

3.3 V-REP Prototype

An other simulator qualified for further developments is V-REP, which provides a free license for educational purposes and accepts seven programming languages. The scheme of developed environment can be found in Fig. 7, for which E-Puck robots were used. As aforementioned, using E-Puck enables students to face challenges in mobile size robots which has a great academic importance.

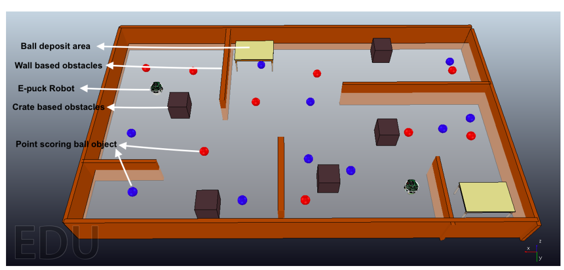

Fig. 7. V-REP simulation environment created.

In order to serve robots, either Python based API or ROS Application could be used, see Fig. 8 for further information on the proposed structure of the V-REP prototype.

4 Discussion & Conclusion

This paper is focused on the rescue robot simulation and its' robotics education potentials. To realize the long learning, new simulation platforms are necessary to bridge education to research in a gradual manner, specifically targeted

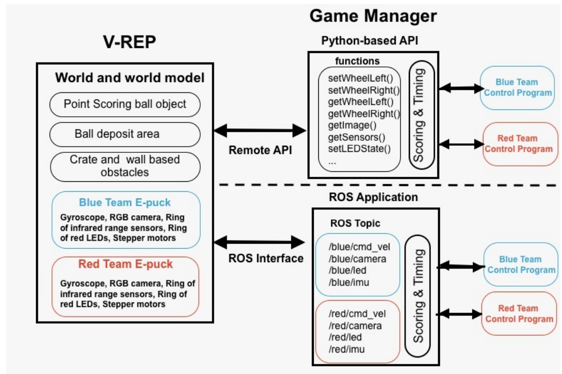

Fig. 8. A V-REP platform connection diagram.

at older secondary students (14+) to undergraduate university students. This could assist in engaging students into Rescue Robotics Research and encouraging participation in leagues such as the RoboCup Virtual Robotic Simulation Competition. Also, three prototype game fields were also developed based on Gazebo and Webots each having different benefits. Development is made in a manner that new feature and challenges could be added to the environment to educate students by the platforms.

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