

RoboCup German Open 2021 Rescue Robot League Competition – DRZ Edition – Rules

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In November 2020, the testing hall of the “German Rescue Robotics Center e.V.” (“Deutsches Rettungsrobotik-Zentrum e.V.”, DRZ e.V., <https://rettungsrobotik.de/>) opened officially. This non-profit association was founded in 2018. It aims to promote the development of intelligent robotic systems that support the rescue and protection of humans as well as property. It is focused on research and development in the field of rescue robotics, vocational training in this field, rescue from life-threatening danger, fire protection, occupational safety, civil protection and accident prevention. The association also promotes the networking of the task forces, users, companies and research institutions active in these fields and is open to membership for them (see <https://rettungsrobotik.de/information-in-english/>).

As part of this year’s rescue robotics days the DRZ e.V. will host the RoboCup German Open 2021 Rescue Robot League Competition. The rules for the competition are based on the official RoboCup Rescue Robot League rules ([Rulebook Version 2.4](#)¹). The standard test methods are complemented by a final mission called “DRZ Challenge”, which integrates the capabilities of the current test suites in an innovative application scenario in realistic conditions meeting the requirements that were specified by first responders.

Details of the rules and adaptations are as follows.

Test Suits

As mentioned before, the competition is based on the current RoboCup Rescue Robot Rulebook ([Rulebook Version 2.4](#)). However, the test suits are reduced to the following elements; each is mandatory for each team:

- Maneuvering: MAN 3(Traverse), MAN 4 (Crossover), MAN 6 (Curb)
- Mobility: MOB2 (Sand/Gravel Hills), MOB 4 (Elevated Ramps), MOB 5 (Stair Debris)
- Dexterity: DEX 2 (Omni-Directional Pipes), DEX 4 (Door Opening)
- Exploration: EXP 3 (Recognize Objects), EXP 4 (Avoid Holes)

The performance in each task will be accounted for the final scoring (Tasks which are not performed will receive 0 points.). For the Exploration tasks, only autonomous repetitions score points. The normalized score of each of the four categories accounts for 1/5 of the final score.

¹ https://rrl.robocup.org/wp-content/uploads/2019/06/rrl_rulebook_2019_v2.4.pdf

The teams must provide an HDMI connection at their operator station so that an external monitor can be connected during a mission.

The points for each test element is normalized, so the best team gets 100 %.

Each team has 12 time slots (2 days with 6 slots) to complete the 10 test methods. This means that there are 2 extra time slots that teams can use to repeat specific tests.

DRZ Challenge

The DRZ challenge describes the final mission. It will be performed on the last day of the competition (Thursday) and accounts for 1/5 of the final score.

Motivated by the requirements of first responders, the challenge aims to provide a realistic, application-oriented mission requiring the capabilities demonstrated in the standard test methods. The operator station is located in the [DRZ emergency vehicle](#), the vehicle equipment is available for the teams (e.g. using the monitors via HDMI).

Scenario:

“An accident in a chemical laboratory with explosive substances has been reported. The team arrives with the robot in the DRZ emergency vehicle. Workers provide information about an open container with explosive substances in the storage room, which needs to be closed as fast as possible. A fast exploration and response in the hazardous environment is needed.

As a first step, the door to the laboratory needs to be opened. As the automatic emergency ventilation system has failed, two valves need to be opened manually to activate the ventilation system. Due to structural damage in the ceiling, debris is blocking the way and needs to be traversed. The following hallway towards the storage room is filled with smoke. The storage room contains multiple containers. The critical container is heated up. It has to be identified and needs to be closed with a cone.”

DRZ Challenge mission procedure:

Setup and start of the robot from the DRZ emergency vehicle. A ramp from the vehicle to the ground is provided. Operator station has to be set up inside the vehicle. A table and 230 V power plugs are provided.

The following sequence of tasks has to be executed by the robot (each for 1 point):

Element 1: Door opening

Element 2: Valve² closing (2 valves, 0.5 points per valve, Rotation by 90°)

Element 3: Debris traversal

Element 4: Navigation through smoke

Element 5: Thermal investigation of containers

² Lever-operated ball valve (similar to

<https://www.bauhaus.info/absperrentile-kugelhaehne/kugelhahn/p/13083282>) and globe valve (similar to <https://www.bauhaus.info/absperrentile-kugelhaehne/durchgangsventil/p/13082252>).

Element 6: Sealing of an open 20l DIN61 container³ with a cone⁴

Element 7: Detect hazmat signs automatically and provide a map with the location of the signs

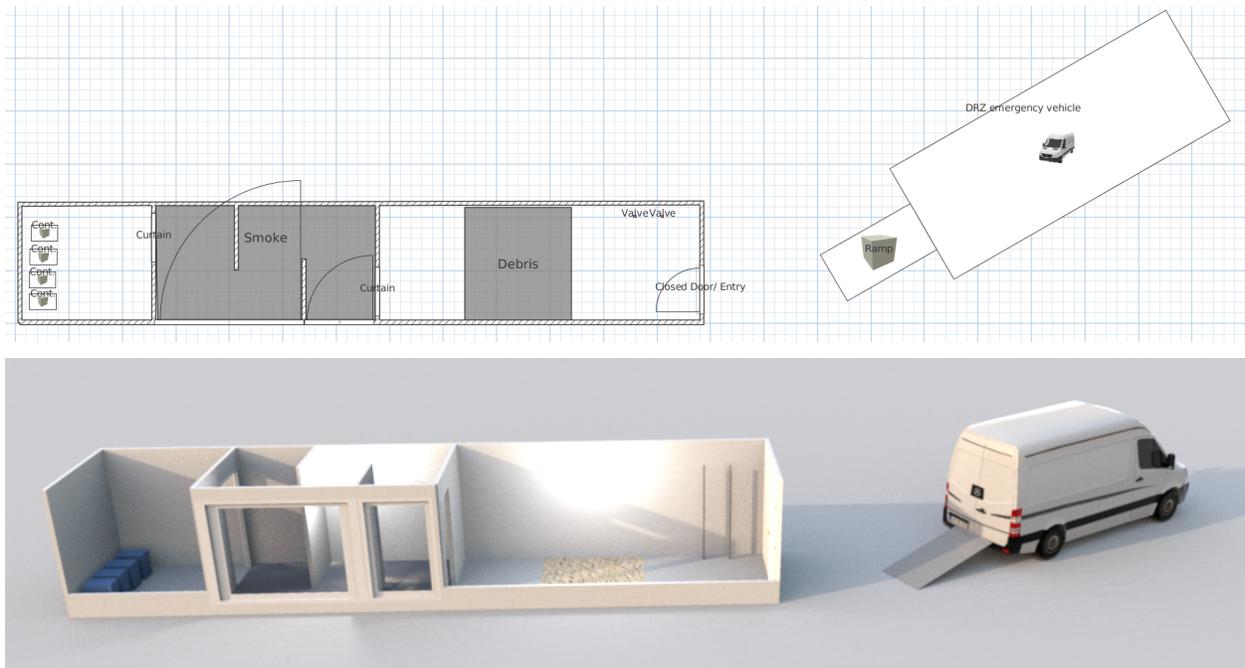


Figure: Exemplary mission setup. Layout, tasks and objects are subject to change.

Scoring:

The successful completion of each element gives 1 point. There are bypasses (no point) for door opening, debris traversal, and navigation through smoke.

As for the preliminaries, the total points for the DRZ challenge are normalized, so the best team gets 100 %.

Experiment: Performance with realistic communication limitations

Operating a robot in a building from the outside in a real disaster provides limitations to network communication such as a reduction of bandwidth and increased latency. To mirror these limitations we are investigating evaluation methods in cooperation with TU Dortmund.

³ Container DIN61, Volume 20l, Opening 48mm, Width, 290mm, Depth 259mm, Height 386mm e.g. fasswulf.de

⁴ Cone, length: 300mm, Ø 60/10 mm, e.g. meier-medizintechnik.de. The teams are allowed to bring modified cones e.g. adding a notch to improve grasping properties. Unmodified cones will be provided by the organizers.

Example for illustration with a larger container:

<https://rettungsrobotik.de/wp-content/uploads/WST-5-1024x768.jpg>

As a potential method, TU Dortmund will provide a device to mimic realistic network limitations. The device will be inserted into the network via ethernet between the router and the notebook and induce configured latency and bandwidth to all traffic passing through. Please be prepared for a 30-60 min slot on Monday to evaluate the device in order to achieve an absolute score bonus of a 50 % challenge score.

Overall Scoring

The overall scoring will be determined by summing the normalized performance in each category (MAN, MOB, DEX and EXP) and the normalized DRZ challenge score. Thereby, each of the five scores is weighted equally. There is no other preliminary or final round.

An absolute score bonus of a 50 % single challenge score can be achieved by participating in the "Performance with realistic communication limitations" experiment.

So a team that dominates all categories (MAN, MOB, DEX, EXP and the DRZ challenge) *and* participates in the communication experiment will achieve $500\% + 50\% = 550\%$.