

World Robot Summit  
Disaster Robotics Category  
Standard Disaster Robotics Challenge  
Rules Ver. 1.0

9/28/2021

Check the latest version at <http://worldrobotsummit.org/>

## 1. Outline

### 1.1 Objectives

In the Standard Disaster Robotics Challenge (New STM Challenge hereafter), the standard performance levels (e.g., mobility, sensing, information collection, wireless communication, remote control on-site deployment, durability, and energy saving) required for disaster prevention and responses are assessed in a robot competition. New Standard performance test methods (STMs) for infrastructure disaster prevention and response are developed here. These STMs are complementary to the current NIST STMs mainly for urban search and rescue and explosive ordinance disposal. Especially, the task of WRS 2021 (new STM) has three-dimensional configuration.

### 1.2 Robot

- The number of robots is one.
- Aerial robots are not acceptable. Other types are allowed.
- Either remote controlled or autonomous robots are accepted. Robots must be controlled without being viewed directly by the operator.
- The maximum weight of the robot is 130 kg
- The maximum size at start is in 1.2m x 1.2m x 1.2m cubic
- Robot Operator: 1 person
- Teams will declare a single primary robot to compete for awards. A sticker will be affixed to it at the configuration identification station (photo booth) to identify it. The sticker has to stay on this robot during the whole competition for test administrators to reference. The robot cannot change its configuration after affixing sticker.
- Extra points will be awarded for robots with environmental resistance.

### 1.3 Competitions

We have extracted standard test methods (STM) from the World Robot Summit Disaster Robotics Category 1. Plant Disaster Prevention Challenge and 2. Tunnel Disaster Response and Recovery Challenge rules. The competition will consist of the following tasks based on these extracted for the New STM.

(MOB1) Negotiate

(MOB2) Catwalk

(DEX1) Meter/Valve

(DEX2) Clearing Obstacles on Uneven Ground

(EXP1) Large-area inspection

Competition Time will be Prep 5 mins, task 15 mins, removal from field 10 mins - total 30 mins.

Acknowledgement: For the development of New STMs in the challenge, we would like to thank the response robot STM development team (team leader: Adam Jacoff) in NIST, US for their valuable technical advice.

## 2. Competition Task and Field

By examining the rules of Plant Disaster Prevention Challenge and Tunnel Disaster Response and Recovery Challenge in the World Robot Summit Disaster Robotics Category, we have extracted particular STMs for plant and tunnel disaster prevention. By using such New STMs, the following tasks will be used for the competition.

(MOB1) Negotiate

(MOB2) Catwalk

(DEX1) Meter/Valve

(DEX2) Clearing Obstacles on Uneven Ground

(EXP1) Large-area inspection

- The basic components making up the competition field are 1.2m square pallets.
- The test methods will be re-modeled into one arena for the finals.
- Generally, the white box is the start zone. "Reach" to the box means the whole parts of the robot should be inside the boxes.
- The figures in following sections are just examples (Scene at WRS2018). At the competition venue, the fields and the procedures of the tasks may be changed little bit due to space, facility, and so on. The changes will be explained in the first team leader' s meeting.
  - You can also see the latest fields (WRS Trail, October 2020) linked in the Q&A site (the WRS Disaster Robotics Help Center). As mentioned in the related post, please note that the difficulty of the tasks in the actual competition may vary from that of the trial.

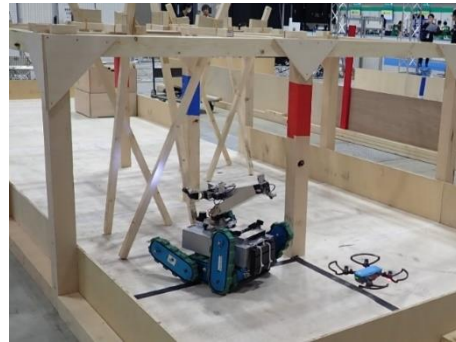
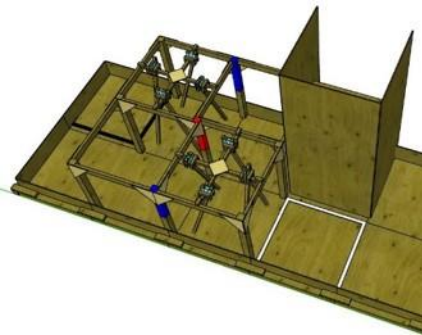
### 2.1 (MOB1) Negotiate

- Outline

Assesses ability to traverse through a narrow space, restricted by sticks positioned to emulate a disaster site. The standard length of one lap of the course is 4.8m. There are 8 sticks in total, positioned at angles to give the robot a leeway of 20% robot' s width. The sticks have been designed so as to come into contact with the robots and will only turn in a specific direction.
- Instructions and Scoring
  1. Start from the white box
  2. White box→Black box: 1 lap equals 1 point.  
Black box→White box: +1 lap (+1 point). Repeat.
  3. Move designated path. (Forward and reverse driving is not necessary.)

- Challenge

Recognition of stick-shaped obstacles. Traversing a narrow space which assumes contact with the surrounding environment.



## 2.2 (MOB2) Catwalk

- Outline

Assesses the ability to traverse a catwalk (inspection deck), constructed with flooring typical of a plant, and a skeleton staircase. It is constructed from the following components.

- Walkway

- ✧ Width 600-1000mm

- ✧ Rail: Height 0-1100mm

- Skeleton Staircase

- ✧ Step 150-250 mm, Width 600-1000 mm, Incline 30-60 deg

- ✧ Rail: Height 0-1100mm

- Instructions and Scoring

1. Start from the white box

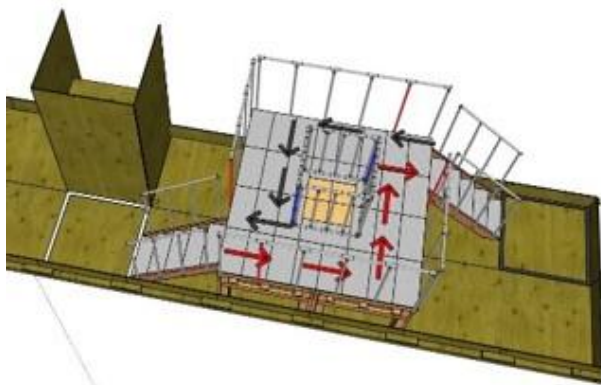
2. White box->Black box: 1 lap equals 1 point.

Black box->White box: +1 lap (+1 point). Repeat.

3. Move designated path. (Forward and reverse driving is not necessary.)

- Challenge

Move quickly and accurately in an environment that emulates a plant.



## 2.3 (DEX1) Meter/Valve

- Outline

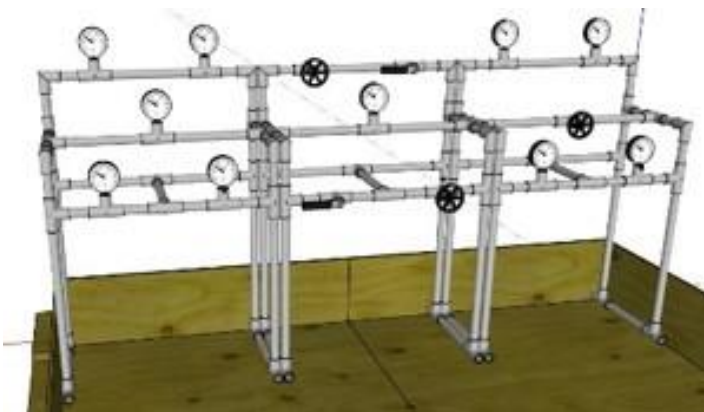
Assesses the ability to take meter readings and operate valves. One part of the task is feedback style, where a valve must be operated to set the meter to a specified reading. Meters and valves are set at heights of less than 2.2m. It is constructed from the following components.

- Meter: JIS B 7505-1 based on “Bourdon Pressure Gauge”
- Gate Valve: KITZ Corp. Class 125 Brass Gate Valve FR 1B (25A). Torque required to rotate 0.8Nm.
- Ball Valve: KITZ Corp. Type 600 Brass Ball Valve TK 1B(25A). Torque required to rotate 2.0Nm.

- Instructions and Scoring

1. Start from the white box.
2. Read a meter: 1 point.  
Turn a valve handle/lever 90° : 1 point
3. Once all the meters and valves have been completed, return to the start and begin again.

- Challenge: Quickly and accurately manipulate complex targets. A feedback style task involving observation and control.

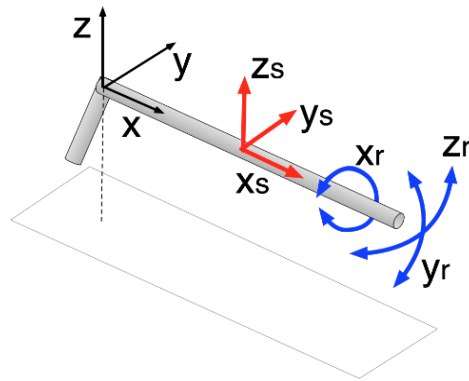


## 2.4 (DEX2) Clearing Obstacles on Uneven Ground

- Outline

Assesses ability to move and control an obstacle while on ground emulating a disaster site. It is constructed from the following components.

- Ground Surface: Surfaces set at  $15^\circ$  angles emulating a plant's floor.
- Obstacle: Pull out L-shaped, or several parts forming an L-shape, to a specified place in a specified direction. Pull along x, y, and z axes ( $x_s$ ,  $y_s$ ,  $z_s$ ), and rotate around the x, y, and z axes ( $x_r$ ,  $y_r$ ,  $z_r$ ).



- Instructions and Scoring

1. Start from the white box.
2. Move to designated area and pull the obstacle out to the edge of the white tape: 1 point.
3. Move again to another designated area and pull the obstacle out to the edge of the black tape: 1 point. Repeat.

- Challenge

Traverse uneven ground, quickly and accurately manipulate an obstacle.



## 2.5 (EXP1) Large-area inspection

- Outline

Assesses the ability to recognize targets\* spread widely over flat or curved surfaces and generate a map of these targets. Targets are placed at heights of less than 2.5m, over an area of approx. 4m<sup>2</sup> to 40m<sup>2</sup>.

- Instructions and Scoring

1. Start from the white box

2. Investigate the arena and create a map of the QR codes.

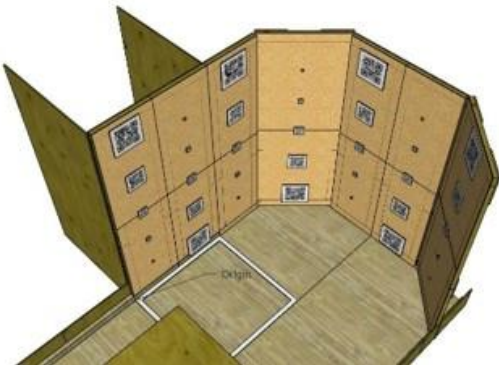
3. Output format should be the same as RoboCup Rescue Robot competition:

- [https://rrl.robocup.org/wp-content/uploads/2019/06/rrl\\_rulebook\\_2019\\_v2.4.pdf](https://rrl.robocup.org/wp-content/uploads/2019/06/rrl_rulebook_2019_v2.4.pdf)

4. The maps quality and accuracy will be decided based on the map submitted.

- Challenge: Quickly and accurately investigate a large area.

\*Details of QR code and map quality and accuracy are described in the Q&A site.





### 3. Competition schedule

- Outline
  - Setup: 0.5 days
  - Robot inspection and test run: 0.5 days
  - Preliminary: 2.5 days
  - Final: 0.5 day
- Competition time
  - 1 task has a duration of up to 30 min. 5 min for setup, 15 min for operation, 10 min cleaning arena.
  - The teams that will participate in the finals will be selected based on the result of the preliminary competition. Competition time and tasks will be changed in the finals.

### 4. Scoring method

All scores will be normalized per task so that the best team obtains 100 points. This calculation is performed after all teams have completed all tests in the preliminary round. The other teams obtain points proportionally.

### 5. Team members

Team members shall apply in advance by team description paper (TDP) and shall be limited to a maximum of 10 members. Only team members can enter the paddock area (team waiting room). Due to COIV-19, the number of the members who can enter the paddock may be limited.

The roles of team members are as follows.

- Team leader (one person): The team leader organizes the team. Only the team leader can file a complaint regarding the competition results.
- Robot operator (one person): The robot operator operates the robot and is qualified to enter the operator area.
- Network administrator: The network administrator manages the team network.
- Safety manager: The safety manager watches over the robot during robot operation to ensure the safety of the surrounding area (1 person).
- Hepler: Put the robot at the start point and restart point.
- Tether: Manage the cable if the robot communicates by using a wire.

Operator and safety managers must be different. Concurrent roles are possible for the remaining roles. Except for the team leader, the roles may be changed for each task.

## 6. Competition robot

- Robots can be in any form, such as crawler type, humanoid type, leg type, and snake type. (Aerial robots are not acceptable.)
- The number of robots used for the competition must be one.
- At the start of the competition, the volume of the robot does not exceed 1.2m x 1.2m x 1.2m cubic.
  - After the start of the competition, the volume of the robot may exceed the 1.2m x 1.2m x 1.2m cubic.
- The maximum weight of the robot is 130 kg.
- The robot and maneuvering system are limited to those described in the team description paper (TDP) submitted in advance.
- The robots and maneuvering systems are subjected to tests in advance and are limited to those that pass the tests.
- Robots cannot change their configurations during the competition.
- Use batteries that are guaranteed to be safe.
- Prepare for emergencies and consider team responses to robot abnormalities such as fire.
- Comply with the laws of the competition country (Japan) such as the radio act.
- Extra points will be added for robots with environmental resistance. Waterproof +10% (preliminary review by video), explosion proof +10% (submit copy of certificate verifying resistance to explosions).
- Extra points (20%) will be added when the OCU screen is output to the recording/streaming system.

## 7. About the competition procedure

- Definitions of terms
  - Restart: Respond to technical problems, incurring a penalty of 2 min.
  - Abstention: The team can abstain in case the mission cannot be carried out.
  - Implementation of dangerous acts: The team will be disqualified.
- When carrying out the task, safety managers can accompany the robot to act in anticipation of unforeseen circumstances.
- For arbitrating the task results, the team can appeal to the judges through the team leader. Appeals must be lodged by the start of the next task of the team.

## 8. Communication network

For communication between the operator's computer and the robot, either wireless or wired communication modes may be used. The communication network must comply with the regulations concerning communication, separately specified for the entire World Robot Summit (WRS).

## 9. Award

The ranking is determined according to the score calculated based on Chapter 4.

## 10. Other

During the competition, follow the instructions of the executive committee.