World Robot Summit
Disaster Robotics Category
Standard Disaster Robotics Challenge
Rules for 2018 Pre-competition Ver. 1.0

2018/9/18

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 (USAR) and explosive ordinance disposal (EOD).

1.2 Robot

- Robots in the competition can be in any form (provided that the maximum weight of the robot is 130 kg and the maximum size at start is in 1.2m x 1.2m x 1.2m cubic).
- The number of robots is one.

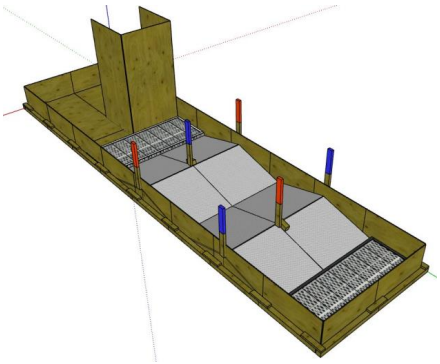
1.3 Competitions

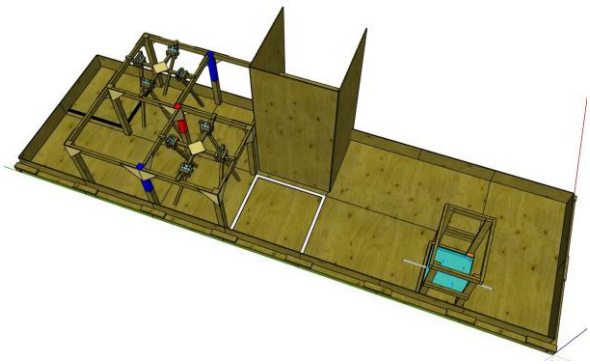
For the pre-competition in 2018, New STM tasks developed in the New STM challenge will be performed. Note that, for the WRS main competition in 2020, in addition to the New STM tasks in the pre-competition, existing STMs and associated prototypes will be performed to evaluate comprehensive robot performance.

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 Field

A square pallet of 1.2 m side is used as the basic component of the competition field. Examples of the field are as follows:





3. Competition Tasks

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.

(MAN1) Negotiate
(MOB1) Catwalk (inspection deck)
(MOB2) Grating/Checker plate
(DEX1) Meter/Valve
(DEX2) L-shaped obstacle
(EXP1) Large-area inspection
(EXP2) Duct/Culvert
(SEC1) Secret

In the competition, all or some of these tasks will be performed. The tasks can be combined (e.g. perform DEX1 in MOB2 environment).

- General

The white box is the start zone.

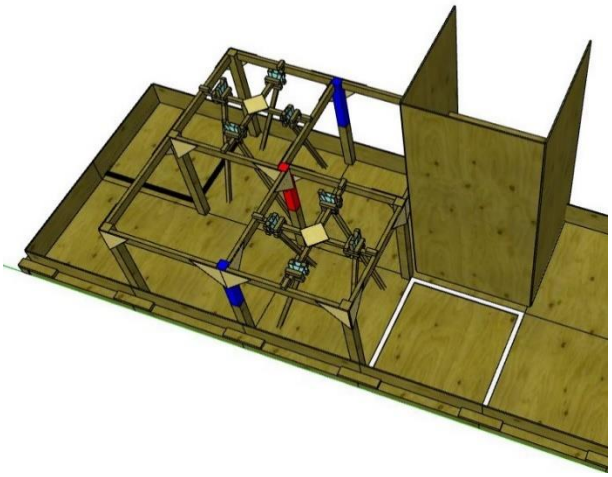
"Reach" to the box means the center of gravity of the robot should be inside the boxes.

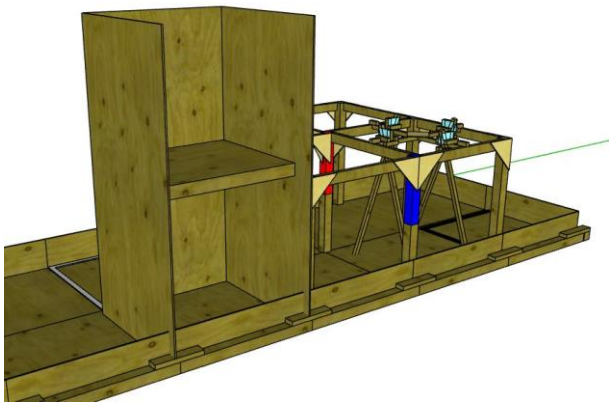
- (MAN1) Negotiate

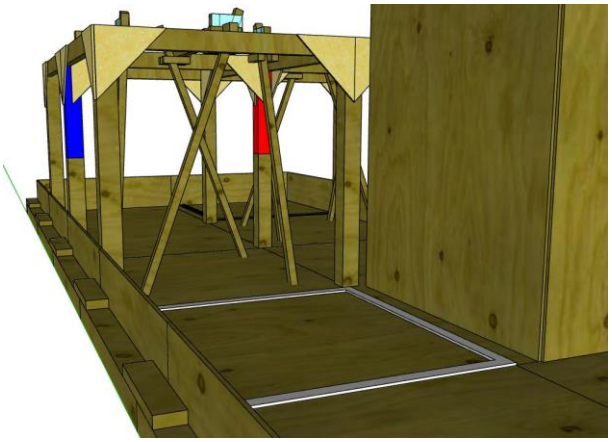
Task: Pass through a way of a set of movable vertical and diagonal sticks while pushing through (without breaking the sticks) or avoiding them.

The white box and the black box correspond to the start and end of the lap, so the robot should travel from one box to the other to complete a lap. The robot should go between the blue pole and the red pole with the blue pole on the left.

Scoring: One point for passing through each way(lap).







● (MOB1) Catwalk (inspection deck)

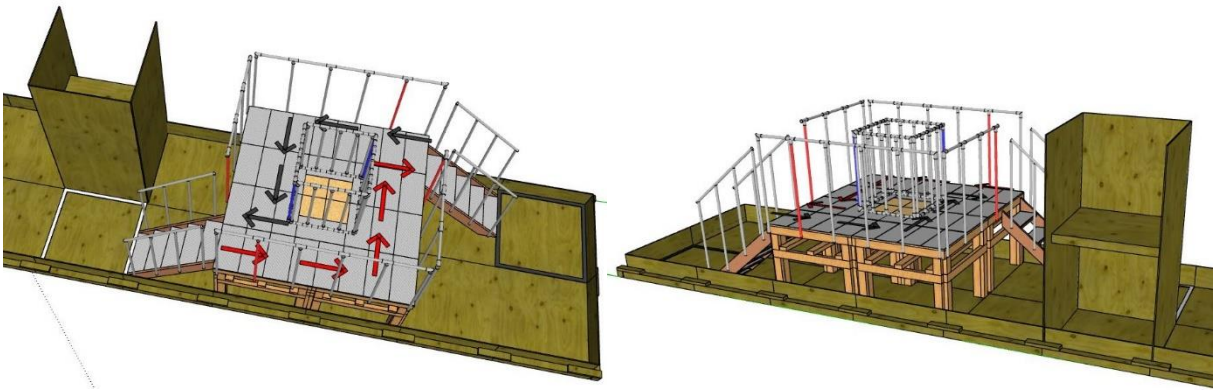
Task: Move on a catwalk (inspection deck) composed of a grating floor and skeleton staircase, where

Walkway: width 600-1000 mm, handrail height 0-1100 mm.

Skeleton staircase: step depth 150-250 mm, width 600-1000 mm, inclination 30° -60° , handrail height 0-1100 mm.

The white box and the black box correspond to the start and end of the lap, so the robot should travel from one box to the other to complete a lap. The robot should go through between the blue pole and the red pole with the blue pole on the left, where "go through" means the center of gravity of the robot should go through (not go above) the poles.

Scoring: One point for passing through each way(lap).



● (MOB2) Grating/Checker plate

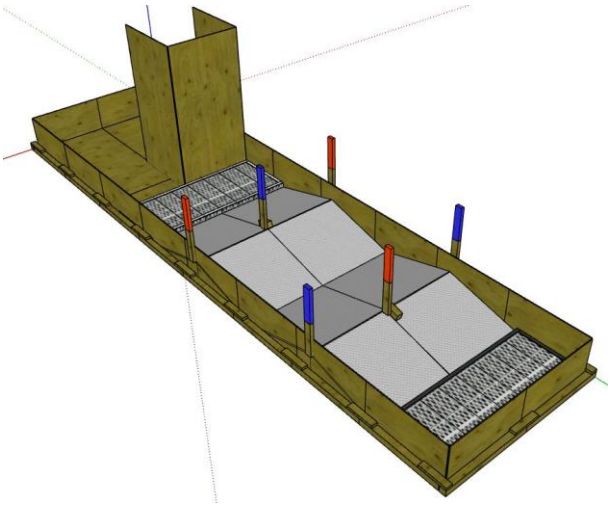
Task: Move on a road surface composed of a grating and/or checker plate, where the surface shape can be as follows:

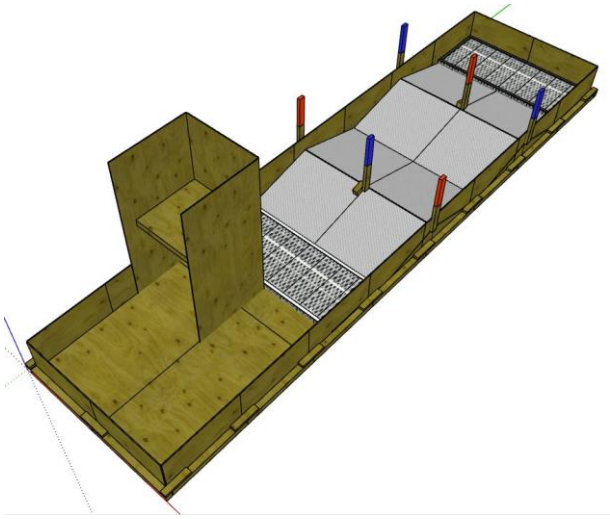
- Flat
- Continuous ramp (ASTM E2826: Standard Test Method for Evaluating Emergency Response Robot Capabilities: Mobility: Confined Area Terrains: Continuous Pitch/Roll Ramps)
- Crossing ramp (ASTM E2827: Standard Test Method for Evaluating Emergency Response Robot Capabilities: Mobility: Confined Area Terrains: Crossing Pitch/Roll Ramps)

Surface of ASTM E2826

Surface of ASTM E2827

The white box is the start zone and the black box is the mid-way point of this figure-of-8 course. Travelling from one box and reaching the other is one lap. The robot should go through between the blue pole and the red pole with the blue pole on the left, where "go through" means the center of gravity of the robot should go through (not go above) the poles.





Scoring: One point for passing through each lap.

・ (DEX1) Meter/Valve

Task: Read meters and manipulate valves. Some valves are manipulated using feedback such that the meter acquires a specified value. The meters and valves are located in three-dimensional coordinates with a height less than 2.2 m. The height of the meter-valve unit will be adjustable.

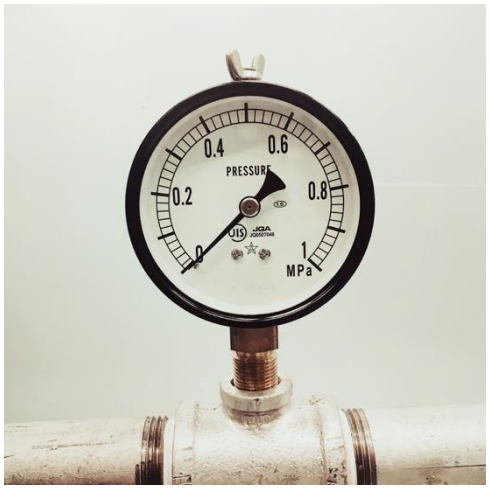
a) plain

b) C-frame

c) depth

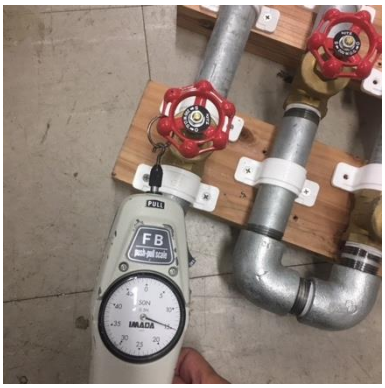
Examples of locations of meters and valves

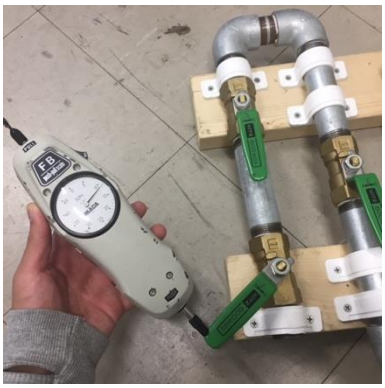
・ Meter: JIS B 7505-1 "Bourdon tube pressure gauge."



Example: General-purpose pressure gauge made by MIGISHITA SEIKI MFG. Co., Ltd.
S - 31 - 1 MP (A frame standing type・ ϕ 75)

- Valve (handle, lever): gate valves and ball valves, as shown in the picture below, will be used.



Reference: Torque required for rotation

(1) Handle: approximately 0.8 Nm

Class 125 Brass Gate Valve (brass gate valve) FR 1 B (25 A) manufactured by KITZ Corporation

(2) Lever: approximately 2.0 Nm

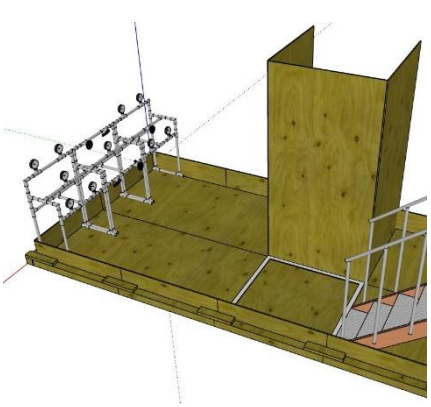
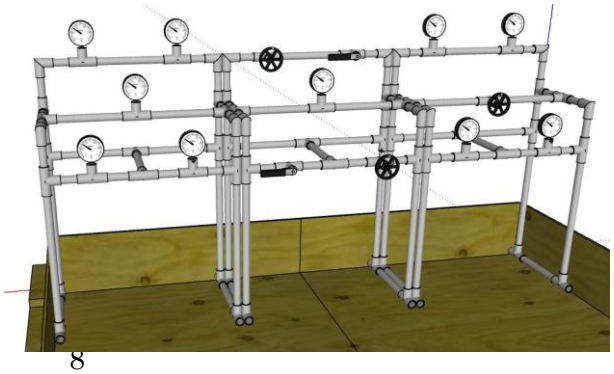
Type 600 brass ball valve manufactured by KITZ Co., Ltd. TK 1 B (25 A)

KITZ Corp.

http://www.kitz.co.jp/english/

Scoring:

- Obtain one point for each meter read and each valve manipulated.
- When all meters and valves are completed(25pt), return to start and can try the task(valves are reset) to get more points.

· (DEX2) L-shaped obstacle

Task: Move, stack, and pull out an L-shaped obstacle.

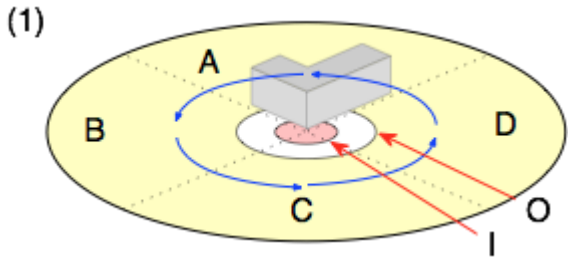
· Move obstacle (1)

➢ Move an obstacle through A → B → C → D in order.

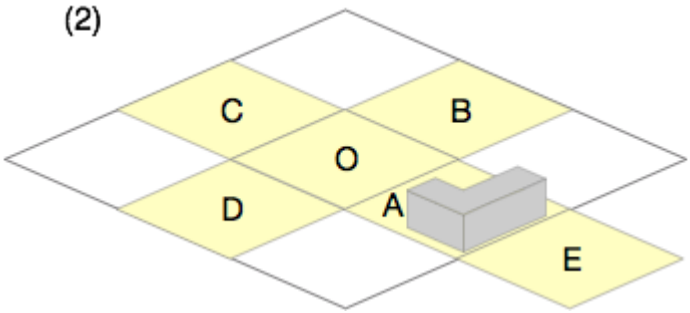
➢ Movement method α: Rotate the L-shaped obstacle while the top corner of the L shape remains in the circle I.

➢ Movement method β: Rotate the L-shaped obstacle around the circle O.

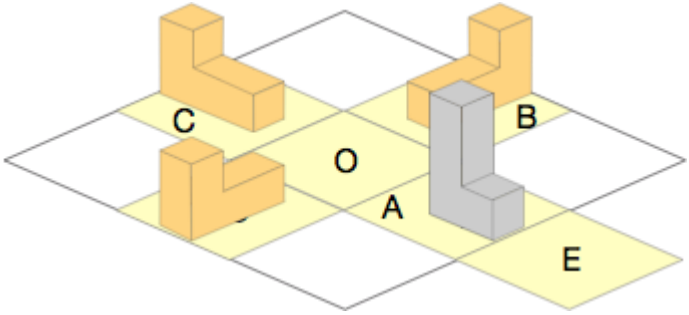
➢ The movement must be realized by pushing and/or pulling.



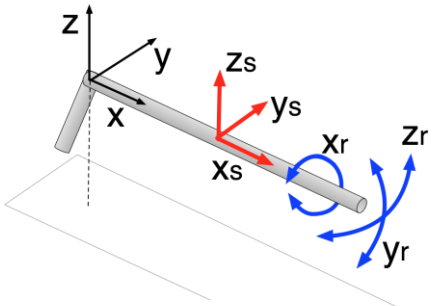
· Move obstacle (2): A robot (placed in the pallet O or E) moves an L-shaped obstacle (placed in the pallet A) through B → C → D in order.



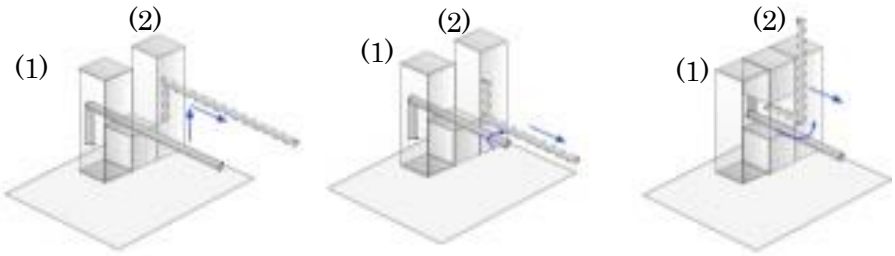
Stack obstacle: A robot (placed in the pallet O or E) stacks an L-shaped obstacle (placed in the pallet A) through B → C → D in order without placing the obstacle on the floor.



- Pull out obstacle: A robot pulls out an L-shaped obstacle with translational motion along the x, y, and z axes (x_s, y_s, z_s) and rotational motion around the x, y, and z axes (x_r, y_r, z_r). The height of the L-shape obstacle unit will be adjustable.



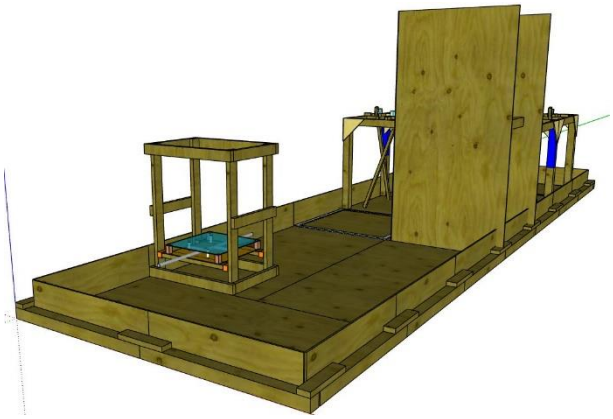
Pull-out method

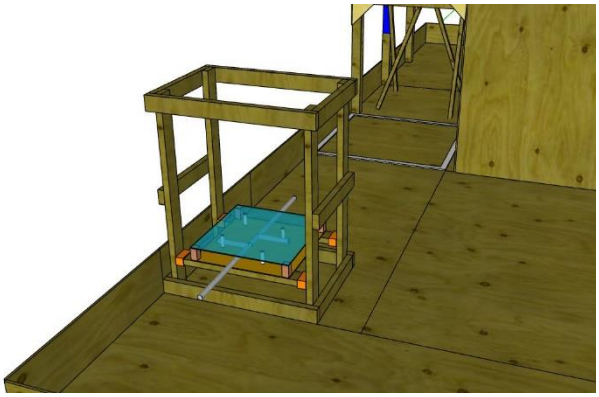


a) lift b) rotate (around x-axis) c) rotate (around y-axis)

Example for pulling out the L-shaped obstacle

Scoring: One point for each movement, stacking, and pull out.





● (EXP1) Large-area inspection

Task: Identify the targets widely placed on a cylinder and/or a flat wall and generate a map of the targets. The targets are placed at a height less than 5 m and in an area of approximately 4-40 m^2.

The white box is the start zone and has the mapping coordinates (x, y, z)=(0, 0, 0).

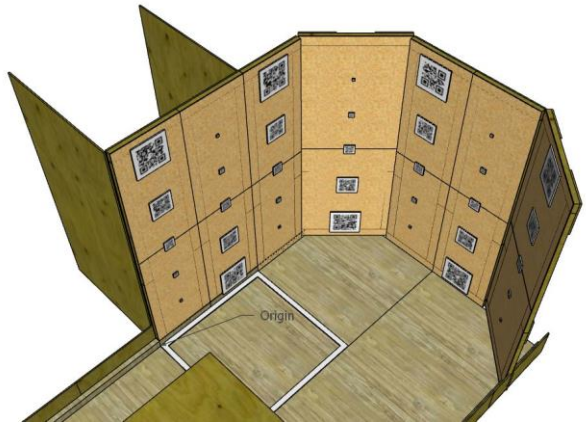
The target consists of QR codes and pipes. The QR codes used in the target are of version 1 (number of cells: 21 x 21), and the error correction level Q is 25%. The size of QR codes and the length of pipes used as the target are as follows.

Table: Type and symbol of target

Target Symbol		Width of QR code (mm)		
		140	35	7
Length of Pipe (mm)	0	140-0	35-0	7-0
	50	140-50	35-50	7-50
	100	140-100	35-100	7-100

Target (140-50)

Scoring: Obtain points for target identification and map accuracy by following the corresponding descriptions in sections 5 and 6 of the Tunnel Disaster Response and Recovery Challenge Rulebook.



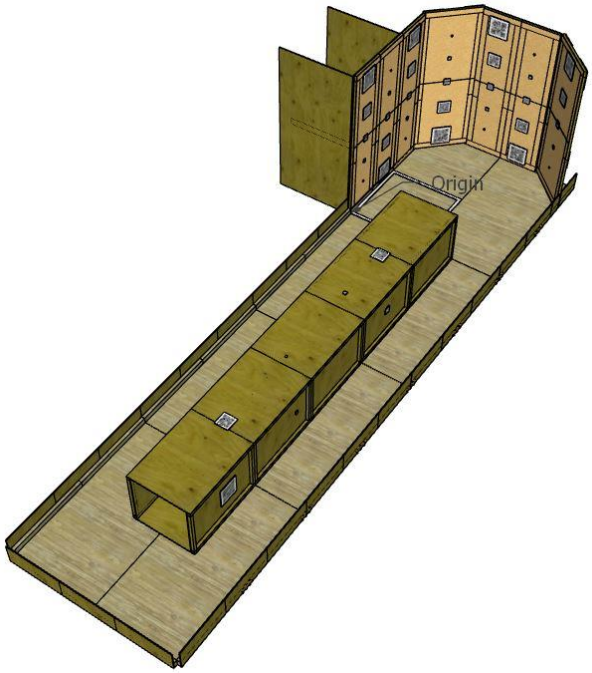
- (EXP2) Duct/Culvert

Task: Identify the targets placed on the inside and outside of a duct and/or culvert and generate a map of the targets, where

- Duct: circular cross section (diameter 600-1200 mm) , straight or twisted.
- Culvert: rectangular cross section (short side of length 600-1200 mm), straight or twisted.

The white box is the start zone and has the mapping coordinates (x, y, z)=(0, 0, 0).

Scoring: Obtain points for target identification and map accuracy by following the corresponding descriptions in sections 5 and 6 of the Tunnel Disaster Response and Recovery Challenge Rulebook.



- (SCR1) Secret

By considering the performance of the teams, a secret task will be provided to make the competition more attractive. The details of the task will be provided immediately before the competition.

4. Competition schedule

Setup (robot inspection): 2 days, preliminary competition: 4 days, final contest: 1 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.

5. 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.

6. 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).

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).

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.

7. Competition robot

· Robots can be in any form, such as crawler type, drone type, humanoid type, leg type, and snake type.

· The number of robots used for the competition shall be one.

- At the start of the competition, the volume of the robot shall 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.

8. 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 must 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 competition.

9. 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).

10. Award

The ranking is determined according to the score calculated based on Chapter 5.

11. Other

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

Revision record

Ver.0.64(January 8, 2018): 1st draft

Ver.0.9(September 3, 2018):

-replace figures.

-add details of the tasks.
-change weight limit from 100kg to 130kg in Sec.1.2 and Ch.7.
Ver.1.0(September 18, 2018):
-(EXP1)(EXP2) Scoring of the targets are determined “by following the corresponding descriptions in sections 5 and 6 of the Tunnel Disaster Response and Recovery Challenge Rulebook.”
-(DEX1) add “When all meters and valves are completed(25pt), return to start and can try the task(valves are reset) to get more points.”
-Competition time: add “5 min for setup, 15 min for operatio2n, 10 min cleaning arena.” in Section 4.
- Penalty of restart is changed from 5 min to 2 min in Section 8.