

Japan Virtual Robotics Challenge  
and  
RoboCup Rescue Virtual Robot League

2016.3.1

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Meijo University

# Outline

1. Presentation of 2020  
International Robot Competition  
from NEDO
2. JRVC
  - i. Points of My Talks
  - ii. Introduction of JVRC
3. Lesson from JVRC
  - i. Standard task of Rescue robots
  - ii. To research activity

# the International Robot Competition : introduction by NEDO

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# Points of Today's my talk

- Introduction of JVRC
  - A part of a US-Japan collaborative project organized by the NEDO
  - a competition of robots by computer simulation
    - Combination to Real Robots
  - Task from Sasago Tunnel Ceiling Collapse
- From JVRC to RoboCup Rescue Virtual Robot League
  - Research themes from task based development of Robot
  - Maintenance and Disaster response in the social infrastructures

# Japan Virtual Robotics Challenge(JVRC)

<http://jvrc.org/en/index.html>



HRP2



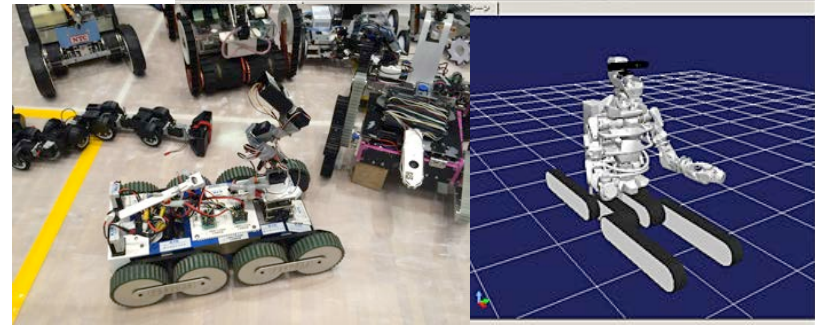
JAXON



Hydra



JVRC-1



QDR-VR1

MIDJAXON

2015 Oct. 7-10

2 ordinary tasks

5 rescue tasks



2015 Dec. 2-5



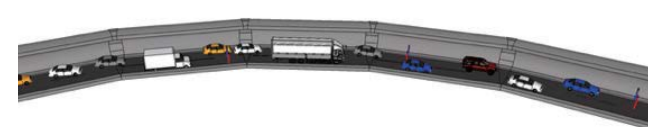


# Japan Virtual Robotics Challenge

## JVRCダイジェスト動画 JVRC Digest Movie

2015/10/7~10

会場(Location):CEATEC JAPAN 2015



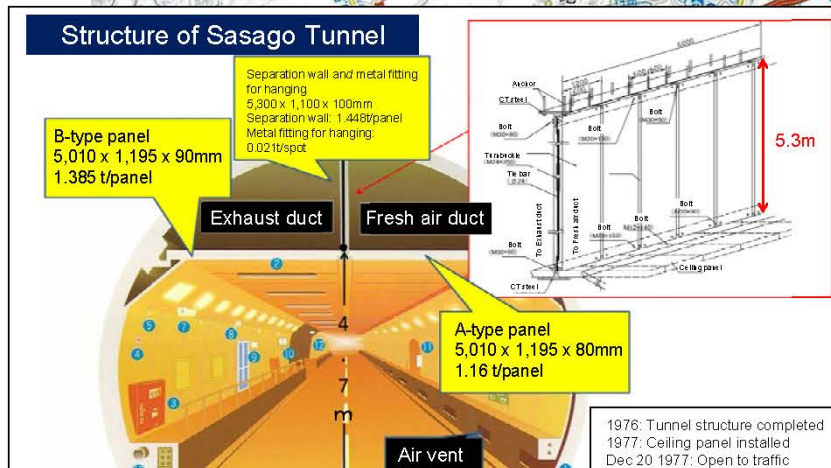
	R1	R2	R3	R4	R5
1. Vehicle					
2. Terrain		✓			
3. Ladder			✓		
4. Debris				✓	
5. Door					
6. Wall			✓		
7. Valve					✓
8. Hose					✓

Teasm	O1	O2	R1	R2	R3	R4	Total
1 MID	57	6	59	85	10	54	271
2 TEAMNADO	18	0	17	61	0	30	126
3 ODENS-B	13	13	54	0	0	15	94
4 TERAKOJI	21	3	18	5	0	0	47
5 TSML	18	0	7	0	0	0	25
6 Hydragon	9	0	12	0	0	0	21
7 ASURA	9	3	7	0	0	0	19
- AIST-NEDO	20	6	64	54	10	29	182
- NEDO-JSK	29	12	62	15	10	30	158
- NEDO-Hydra	20	0	34	0	5	12	71

# Sasago Tunnel Ceiling Collapse

(Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of Japan)

- Date : Sunday, December 2, 2012 at 8:03am
- Location: Tokyo-bound Sasago Tunnel
- Incident: 130-meter-section of ceiling panels fell at 1.7km from the east portal of the 4.7km-long-tunnel, crushing three vehicles and catching two of those on fire. Nine people were killed and two others were injured.
- Road closure: Both the in-bound and out-bound roads were closed until the re-opening of the out-bound lanes for all traffic at 1pm on Dec.29th. All lanes in both directions were re-opened on Feb.8<sup>th</sup>.



【Images of the Incident】





# Lesson from Tunnel Ceiling Collapse

<http://edition.cnn.com/2012/12/03/world/asia/japan-tunnel-collapse-bolts/>

## Road Tunnel Inspection: additional information

- Road Tunnel Techniques Standard [Nov. 1974 (revised in 1985 and 1989) Director-generals of City Bureau and Road Bureau, Construction Ministry]

Prior to actual tunnel maintenance/repair work, inspection/maintenance manual shall be prepared. The actual work should comply with the relevant laws and regulations. Inspectors' security should be ensured during work.

- Road tunnel maintenance guide [1993 Japan Road Association]

Prepared by the Japan Road Association as a technical guide for road administrators to formulate an inspection/maintenance manual.

- Central NEXCO's inspection/maintenance manual (structure section) [Apr. 2012]

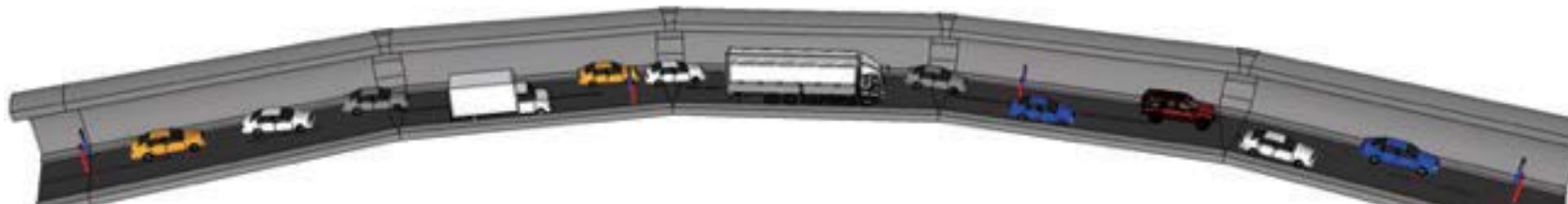
【Daily inspection】 Visual inspection from a patrol vehicle for 4 to 7 days every 2 weeks

【Basic inspection】 Remote or close visual inspection to review the condition of entire structure at least once a year (further inspection depending on the situation)

【Detailed inspection】 Close visual inspection and sound inspection with hammers to review the condition of structural soundness once every 5 to 10 years.

【Emergency inspection】 Inspection to review the structure condition in the event of an earthquake or other disaster, depending on the situation.

Note: "basic inspection" and "detailed inspection" together are called a "periodical inspection."



# Maintenance & search disaster tasks

## Inspection

- Target: Tunnels with ceiling panels suspended by metal fitting for hanging (segments with the ceiling)
- Items: Metal fitting for hanging & fixing bracket, soundness of concrete lining near the anchored metal fitting for hanging, deformation/damage of ceiling panels
- Method: Close visual inspection, sound check with hammers and palpation (inspection will be conducted behind the ceiling panels in the structure of upper tunnel)

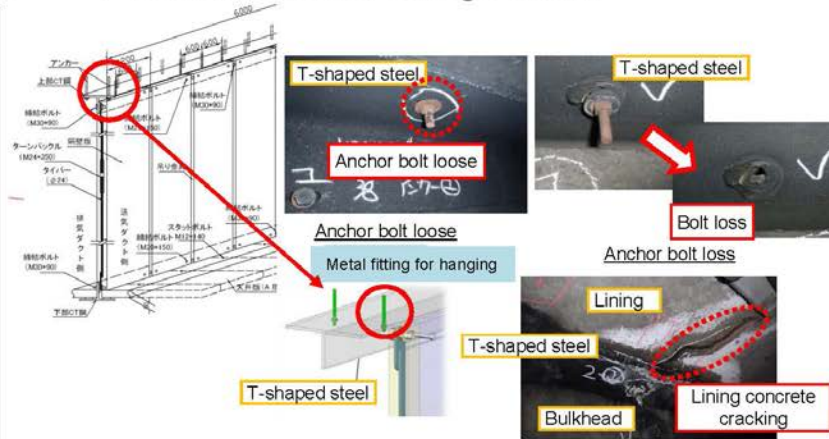
## Findings (Dec. 13 release, except for Jan. 9 findings for in-bound Sasago Tunnel inspection)

- <59 tunnels, except both directions of Sasago Tunnel on Chuo Expressway>
  - Found defects in 16 tunnels, but none of them were critical. Repairs were carried out immediately (or are planned to be carried out)
- <Out-bound Sasago Tunnel on Chuo Expressway>
  - Found 632 anchor-bolt-related defects. Tunnel's safety was secured by removing the ceiling panels
- <In-bound Sasago Tunnel on Chuo Expressway>
  - Found 1,028 anchor-bolt-related defects. Tunnel's safety was secured by removing the ceiling panels

## Number of tunnels with suspended ceiling panels

Maintained by	Number of tunnels	Number of defects
East NEXCO	14	0
Central NEXCO	3	2
West NEXCO	12	2
Metropolitan Expressway Company	6	2
Hanshin Expressway Company	3	2
National Government	9	3
Pref/Ordinance-designated cities/Road corporations	12	5
<b>Total</b>	<b>59</b>	<b>16</b>

## Defects found in Sasago Tunnel



maintenance robots

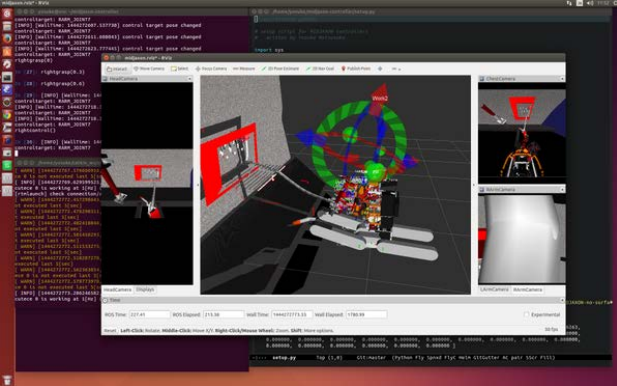
rescue robot

when  
where  
function

everyday  
on the scene  
ordinary tasks

emergency  
deployed from distant area  
rescue tasks

Maintenance robots + Rescue robots



**JVRC**

# Japan Virtual Robotics Challenge

7-10 October, 2015

Location: CEATEC JAPAN 2015

Qualification: individual, team or corporation  
(Non-disclosure agreement is available only for corporation)

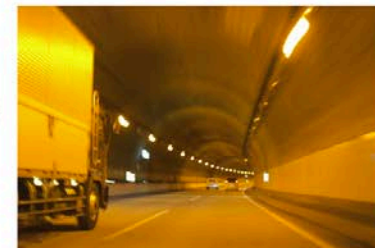
Free Application Fee

TOP | Rule | Tutorial | Team | Download | Result | FAQs | Contact Us

## 1. Introduction: Background for the development of the JRVC competition tasks

The tunnel disaster was chosen as a scenario for the development of the JRVC (Japan Virtual Robotics Challenge) competition tasks.

In Japan, the social infrastructures developed during the rapid growth period will become 50 years old after 20 years from now. Appropriate maintenance is necessary to avoid a huge impact on human life and society by collapse or failure of the social infrastructures. However, aging maintenance workers and a lack of skill transfer to younger workers would cause many problems of infrastructure maintenance in Japan. Though periodic inspections of major infrastructure are conducted every few years, this frequency would not be



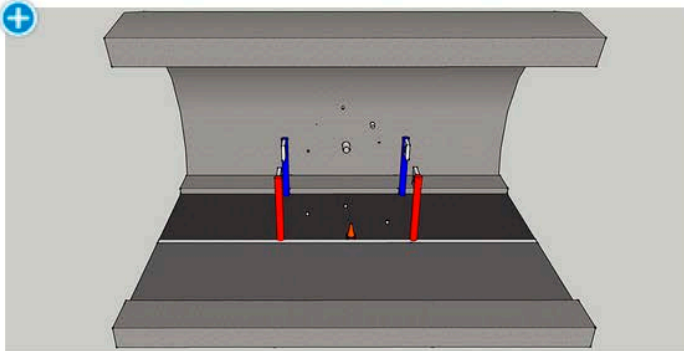
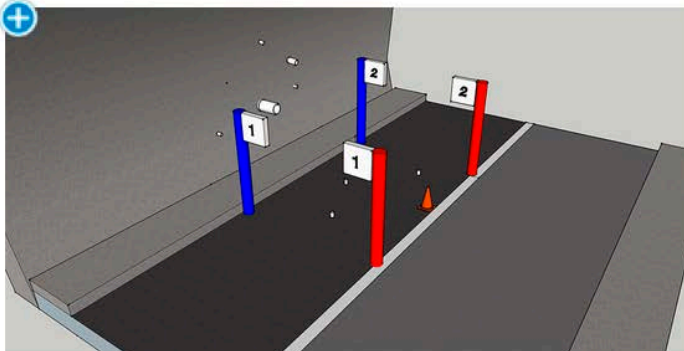

Participation ter

# JVRC

## inspection



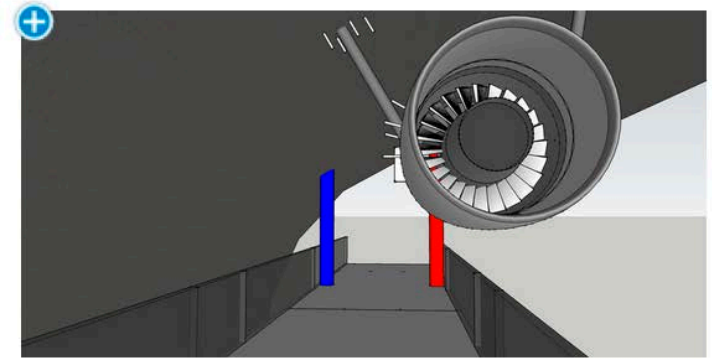
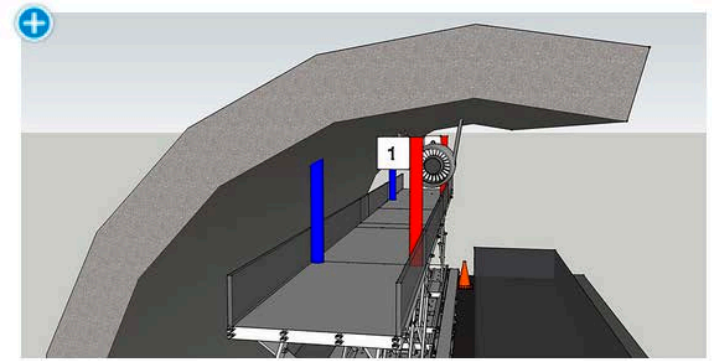
### Task O1 : Visual Inspection

<b>Purpose</b>	Conduct visual inspections of cracks on the tunnel wall and road.
<b>Subtasks</b>	<ul style="list-style-type: none"><li>● Conduct an investigation of targets in the tunnel and report the result.</li><li>● The inspection report should be submitted in compliance with the format of the "Inspection Report" in the "Road tunnel regular inspection manual"</li><li>● The following items are to be investigated.<ul style="list-style-type: none"><li><b>[O1-1]</b> Cracks on the wall, swell, leakage.</li><li><b>[O1-2]</b> Cracks on the wall, sag, leakage.</li></ul></li></ul>
<b>Field Conditions and Specifications</b>	<ul style="list-style-type: none"><li>● A tunnel approximately 3.6m in width.</li><li>● Targets are placed on the tunnel wall at a height of between 0mm and 2400mm.</li><li>● The targets contain information associated with "Road tunnel regular</li></ul>   

# JVRC inspection

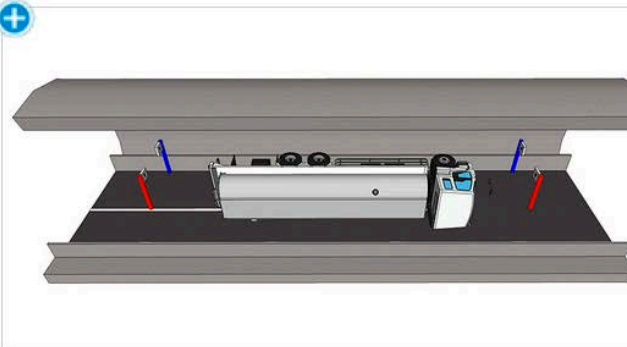
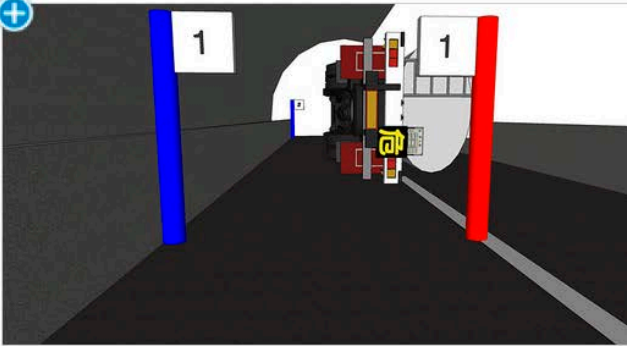



<p><b>Purpose</b></p>	<p>Conduct a hammering test on fastener components and damaged wall to check the condition of attachments located near the roof.</p>
<p><b>Subtasks</b></p>	<ul style="list-style-type: none"> <li>● Conduct an investigation (health diagnostics) of targets located near the attachment of the tunnel and report the result.</li> <li>● The inspection report should be submitted in compliance with the format of the “Inspection Report” in the “Road tunnel regular inspection manual.”</li> <li>● It is necessary to avoid colliding with the structures during the investigation of targets.</li> </ul>
<p><b>Field Conditions and Specifications</b></p>	<ul style="list-style-type: none"> <li>● The tunnel is approximately 3.6m in width.</li> <li>● The attachment is installed to the tunnel roof with fastener components.</li> <li>● Targets for inspection are located near the fastener</li> </ul>



# JVRC

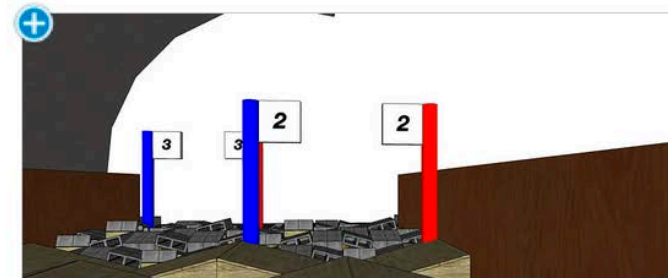
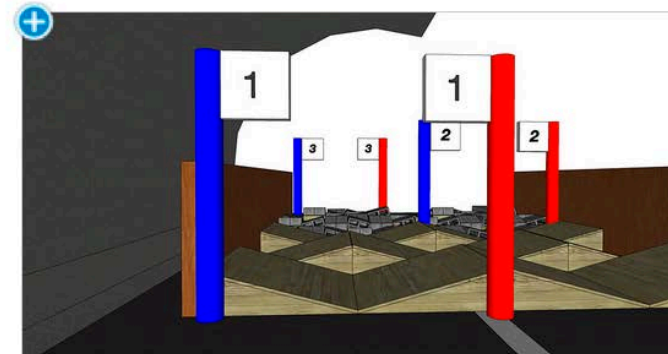
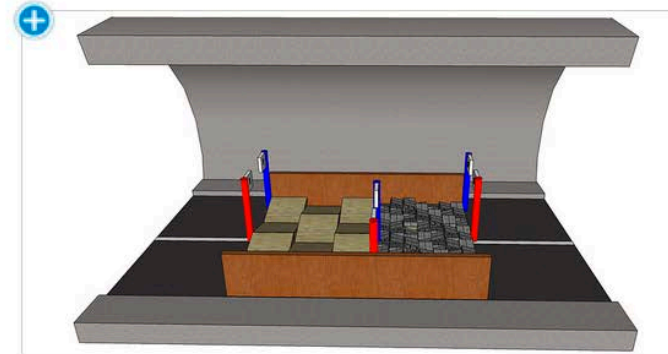
## search & rescue

<b>Purpose</b>	Check the appearance of the vehicles and surrounding conditions to examine the vehicle damage, leaking fuel and survivors outside the vehicles.
<b>Subtasks</b>	<ul style="list-style-type: none"><li>● Start from the specified location, locate and inspect the following 3 search categories (1)-(3) of each vehicle, report the result and head to the goal.</li><li>● 3 categories are as follows:</li></ul> <p><b>[R1-1] Condition outside the vehicle</b></p> <ul style="list-style-type: none"><li>• Identify 4 targets placed outside the vehicle and report the findings.</li></ul> <div>A top-down perspective diagram of a white vehicle on a road. Four red arrows point to targets on the road surface: two on the left side and two on the right side. A blue circle with a plus sign is in the top right corner.</div> <div>A perspective view of a vehicle on a road. Two vertical bars, one blue on the left and one red on the right, are labeled with the number '1' in white boxes. A blue circle with a plus sign is in the top left corner.</div> <div>A close-up view of a circular target on a road surface. A blue circle with a plus sign is in the top left corner.</div>

# JVRC

## search & rescue

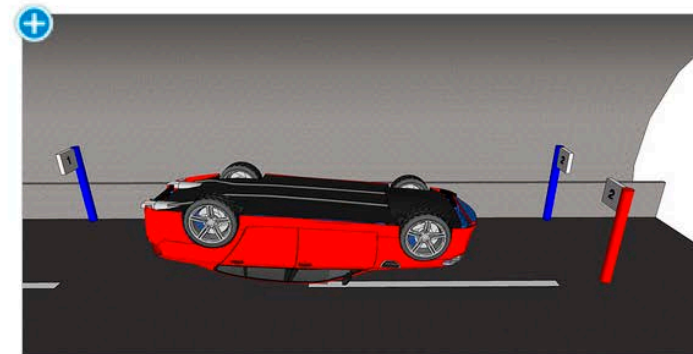
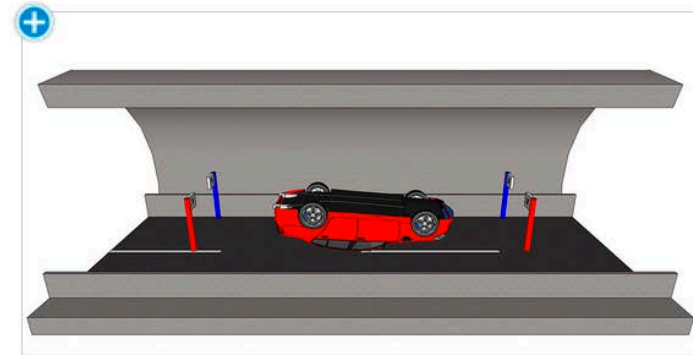
<p><b>Purpose</b></p>	<p>Traverse rough terrain.</p>
<p><b>Subtasks</b></p>	<p>Start from the specified location, traverse obstacles, or in the confined space formed by obstacles, and reach the goal.</p>
<p><b>Field Conditions and Specifications</b></p>	<p>Traverse 3 different fields along with the specified route.</p> <p><b>[R2_A]</b>  <b>Crossing Ramp field</b>                  Obstacles consisting of ramps with 150 degree top and valley angle.</p> <p><b>[R2_B]</b>  <b>DRC Stepfield</b>                  Obstacles consisting of 40-square-cm blocks with 15 degree ramp.</p>



## JVRC

## search &amp; rescue

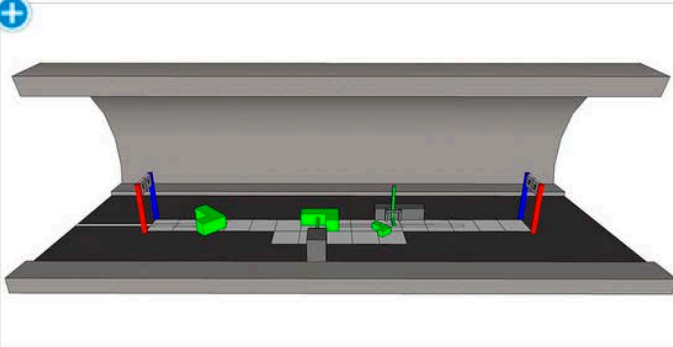
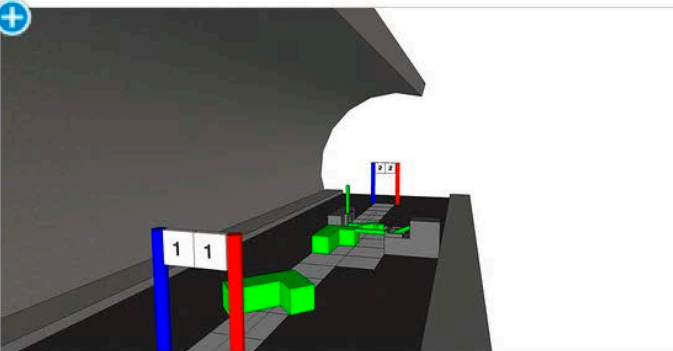
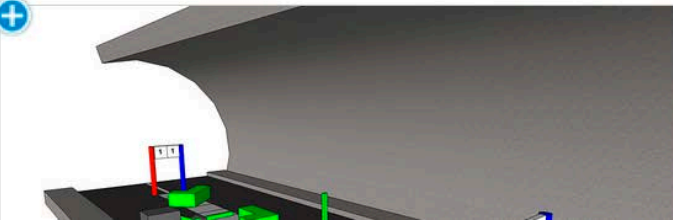
<b>Purpose</b>	Investigate condition inside the vehicle by using tools commonly used by humans.
<b>Subtasks</b>	<ul style="list-style-type: none"> <li>● Investigate the inside condition of the vehicle by using tools.</li> <li>● The following tools are used and available in the field.             <ul style="list-style-type: none"> <li>• Spreader</li> <li>• Ladder</li> </ul> </li> <li>● Investigation tasks are as follows.</li> </ul> <hr/> <p><b>[R3_A]</b></p> <p><b>Deformed vehicle</b></p> <ul style="list-style-type: none"> <li>• Pick up the spreader and move to the vehicle.</li> <li>• Open the vehicle door with the spreader.</li> <li>• To open the door with the spreader, manipulate the switch while placing the spreader at the specified location and direction.</li> <li>• Identify a target through the opened door. Report the findings.</li> </ul>





# JVRC

## search & rescue

<p><b>Purpose</b></p>	<p>Remove the obstacles on the specified route to secure the route for operation and evacuation.</p>
<p><b>Subtasks</b></p>	<ul style="list-style-type: none"> <li>● Remove the obstacles from the specified route to secure the route.</li> <li>● The shape and weight of the obstacles are as follows. <ul style="list-style-type: none"> <li><b>[A]</b> Obstacles to remove is "L" shaped and weighs 3kg.</li> <li><b>[B]</b> Obstacles to move is "L" shaped and weighs 10kg.</li> </ul> </li> </ul>
<p><b>Field Conditions and Specifications</b></p>	<ul style="list-style-type: none"> <li>● The specified route for object removal is designated by color in the field.</li> </ul>  <ul style="list-style-type: none"> <li>● Fixed structures surrounding the specified route impose constraints on the movement of the robots and the obstacles.</li> </ul>  

# JVRC

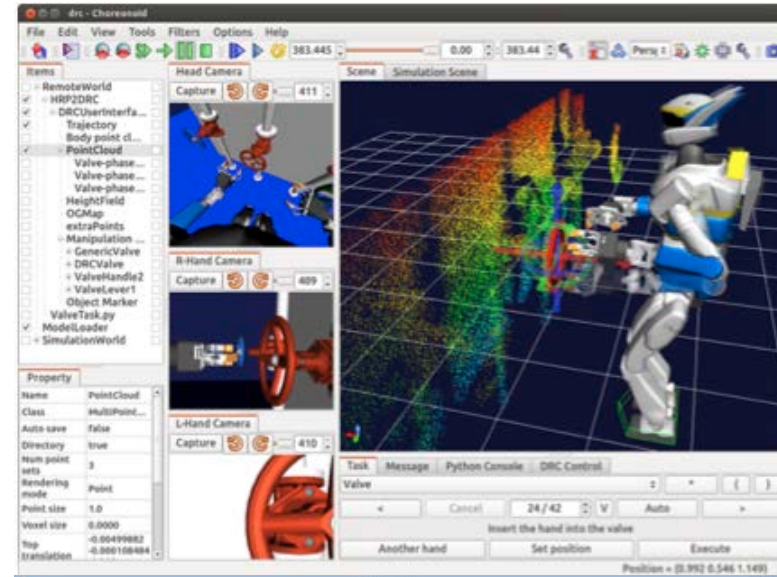
## search & rescue

<p><b>Purpose</b></p>	<p>Support in fire extinguishing</p>
<p><b>Subtasks</b></p>	<p>Subtasks are as follows.</p> <ul style="list-style-type: none"> <li><b>[R5-1]</b> Open the door of firefighting equipment cabinet.</li> <li><b>[R5-2]</b> Pull out the entire hose.</li> <li><b>[R5-3]</b> Remove a nozzle.</li> <li><b>[R5-4]</b> Connect the nozzle to the hose.</li> <li><b>[R5-5]</b> Open the valve. (Check the water flow)</li> </ul> <div> </div> <div> </div> <div> </div>

# Choreonoid

(Choreograph+Humanoid)

Kinematics, sensor simulation  
Tele-operation interface  
Choreography



# DRC and JVRC

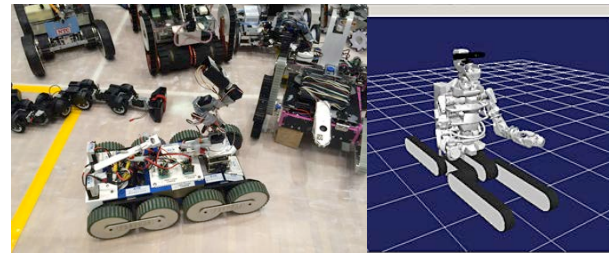
- Target  
(Tunnel & Nuclear Plant)

	maintenance robots	rescue robot
when	everyday	emergency
where	on the scene	deployed from distant area
function	ordinary tasks	rescue tasks

- Tasks

	R1	R2	R3	R4	R5
1. Vehicle					
2. Terrain		✓			
3. Ladder			✓		
4. Debris				✓	
5. Door					
6. Wall			✓		
7. Valve					✓
8. Hose					✓

- Robots  
(humanoids & crawler type robots)



# O1, O2, R1

- O1: Visual inspection
- O2: Hammering test
- R1: Vehicle inspection



## introduction of equivalent task

### Task R1 : Vehicle Inspection

Equivalent tasks in the JVRC are defined as visual inspection of "targets" consisting of QR codes and pipes. The size of QR codes and the length of pipes is one of the followings:



The width of QR code (corresponding diameter = diagonal dimension of QR code)

140mm(200mm), 35mm(50mm), 7mm(10mm)

The length of pipe

100mm, 50mm, 0mm

※Reference: Target's "field of view" (angle to see the entire QR code at the bottom of a pipe)

		QR code width (corresponding pipe diameter)		
		140mm(200mm)	35mm(50mm)	7mm(10mm)
Pipe length	100mm	90°	30°	6°
	50mm	126°	52°	12°

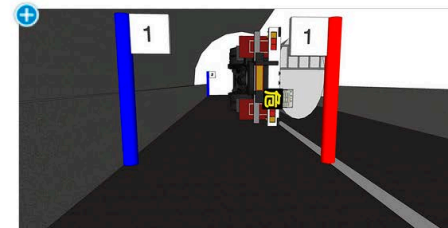
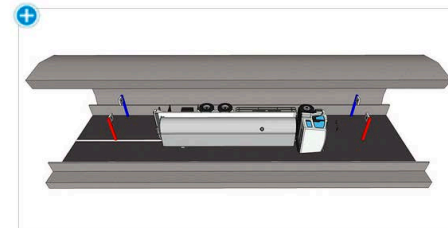
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- 3 categories are as follows:

#### [R1-1] Condition outside the vehicle

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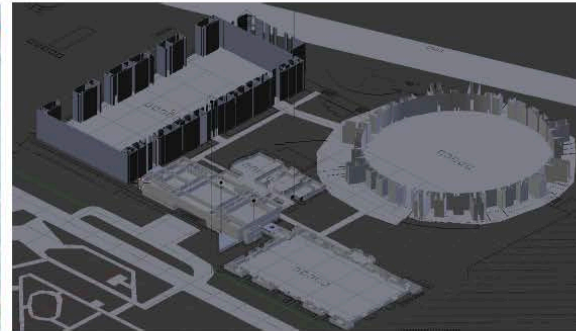
# Our proposal to you;

(Answers to our paper Rpbocup 2014 Symposium)

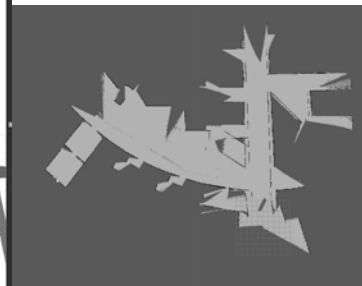
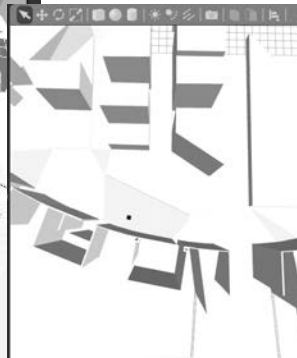
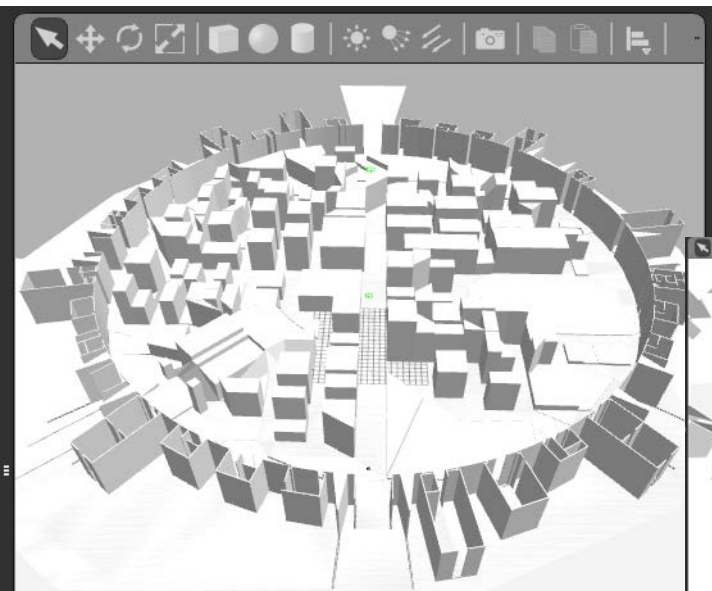
## Convention area



(a) overview of Protmesse Nagoya

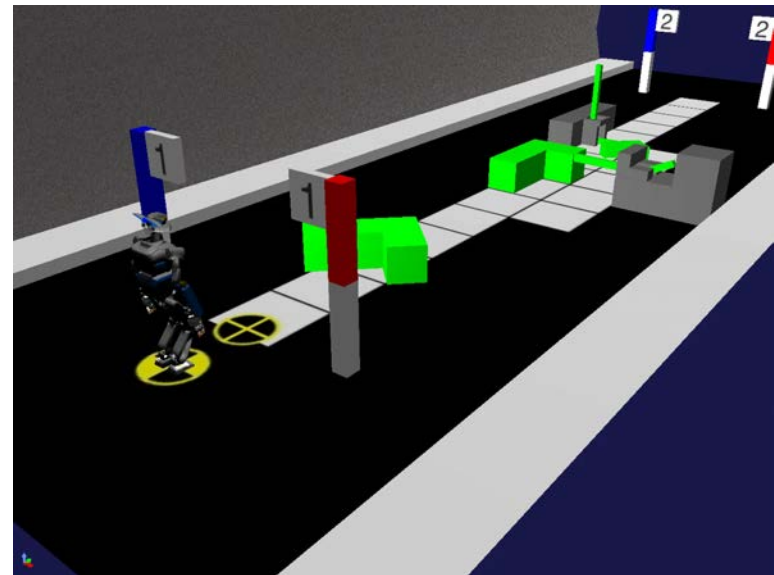


(b) 3D CAD model



# In this work shop

- Task R4(Secure the roads)
- 2 kinds of systems





# Themes in future tasks

Tunnel



Fukushima

(Decommissioning Plan of Nuclear Plant)

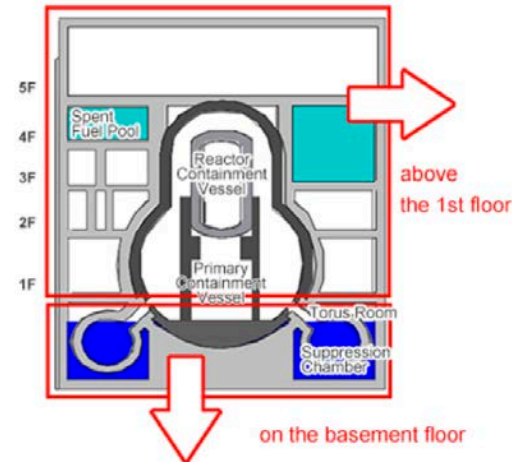
01



02



## Robots inside the reactor buildings



Robots applied mainly above the 1st floor



Robots applied mainly on the basement floor



# from other applications



## Second-stage Major Initiatives



Courtesy of Toyota

# collaboration with service robots

