

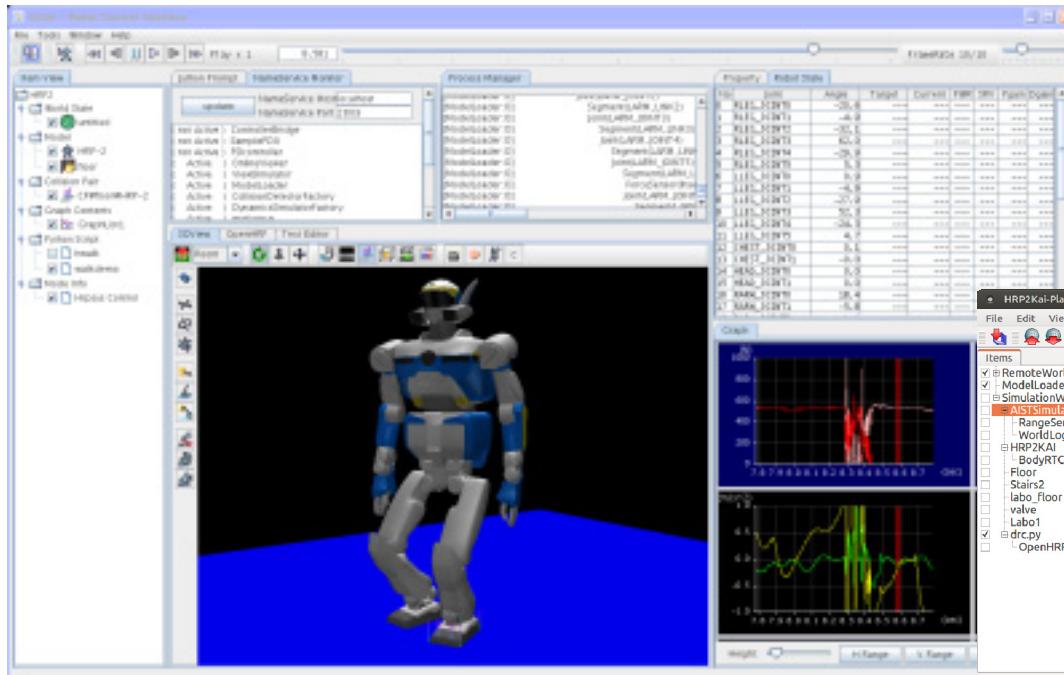
SIMPAR2016 simulation grand challenges workshop

My work and the challenges
in robotic simulation

Shin'ichiro Nakaoka

AIST

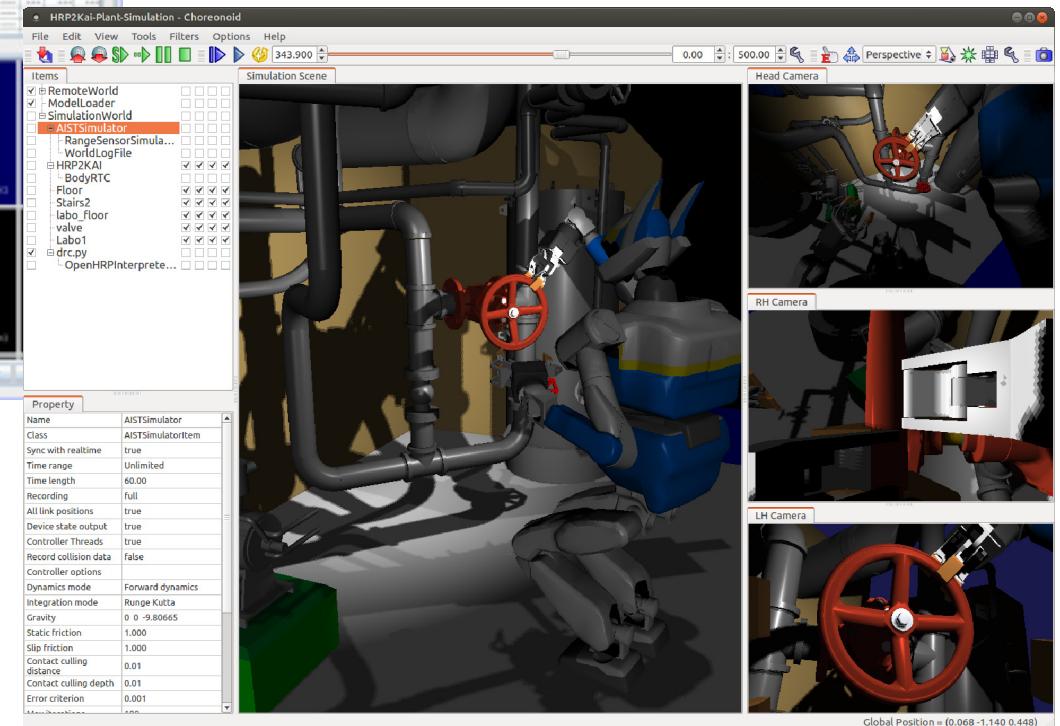
Robot simulators I contributed / developed



OpenHRP3 (Since 2007)

AIST Physics Engine

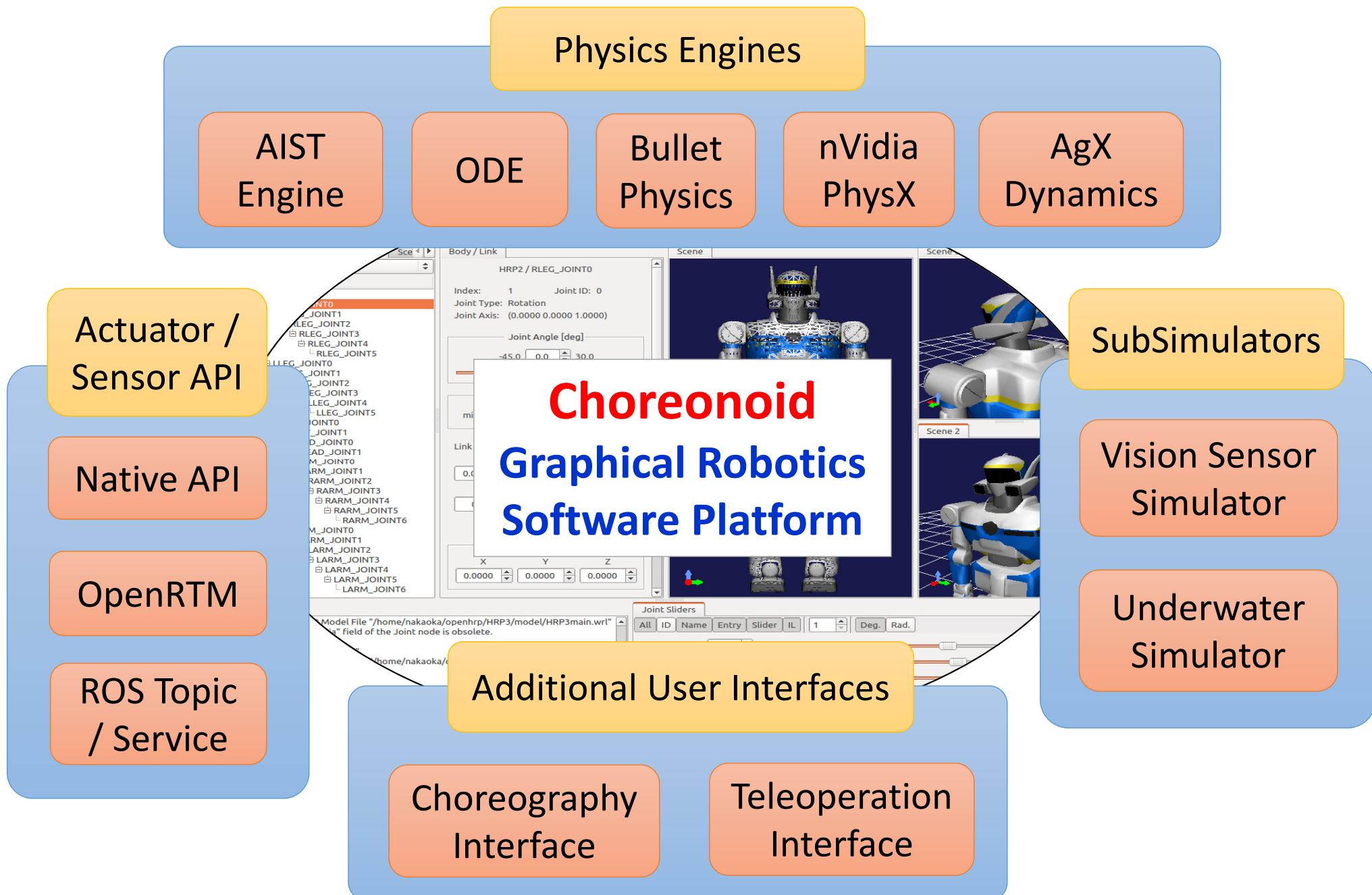
- Featherstone ABA
- Constraint based method
- Generalized coordinates
- Non-convex shape support



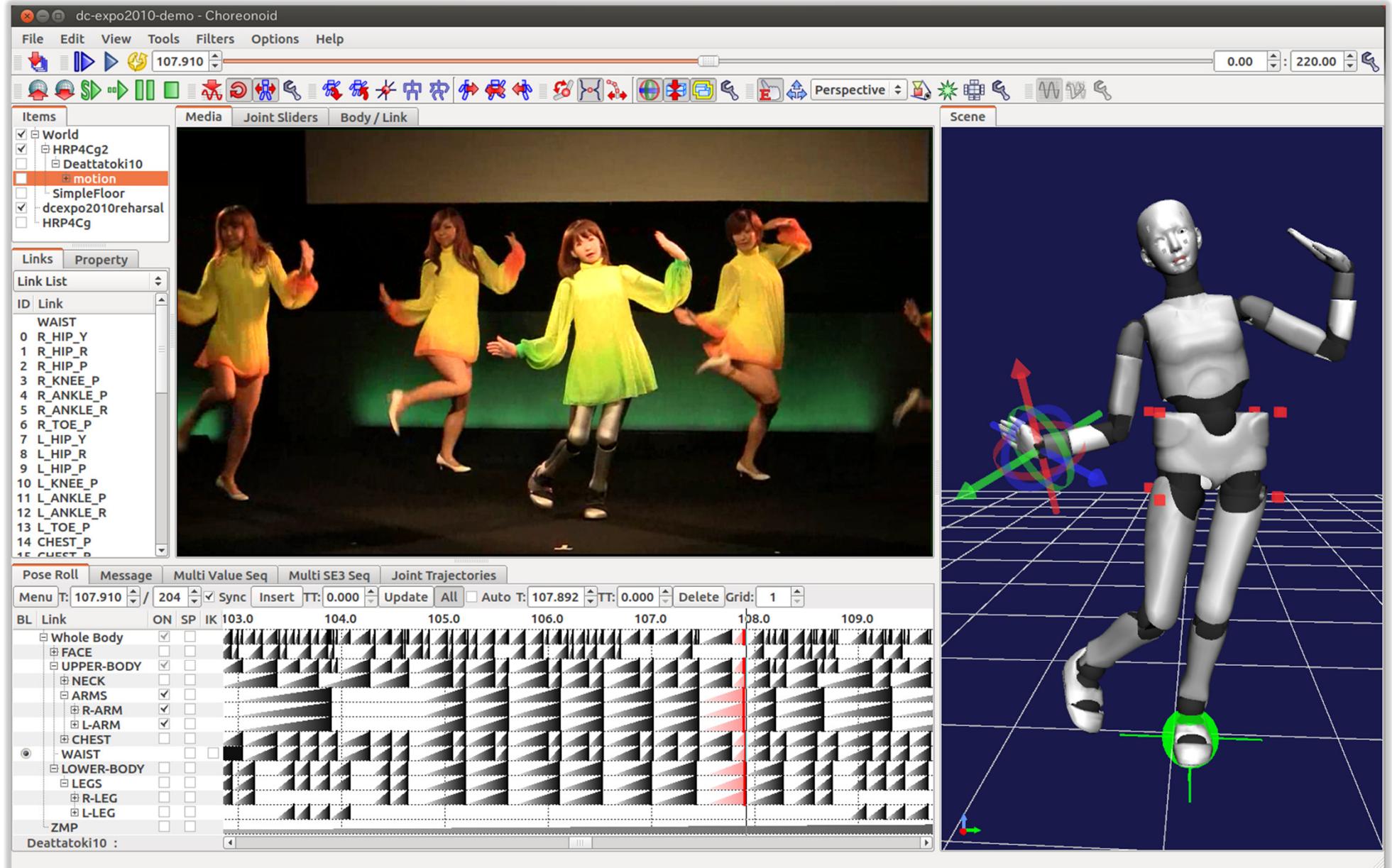
Choreonoid (Since 2010)

<http://choreonoid.org/>

Extensible design of Choreonoid

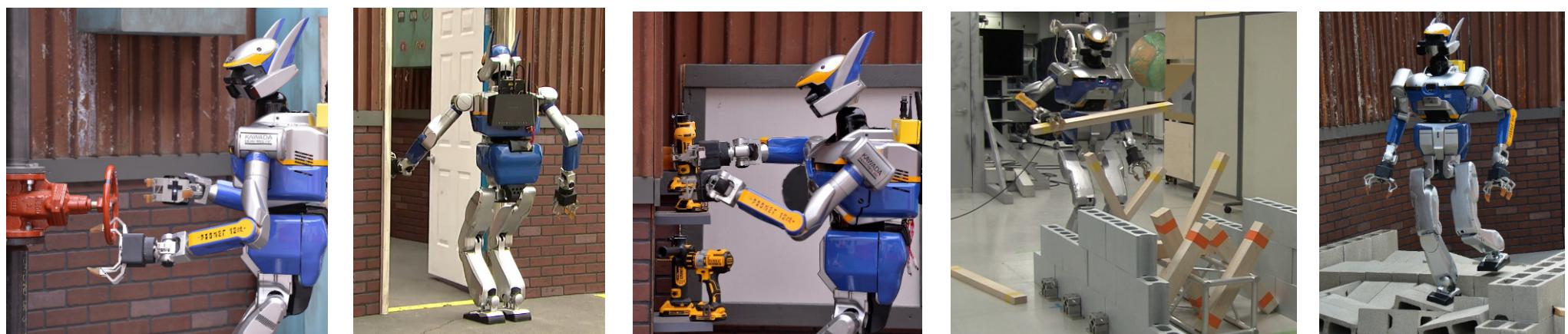
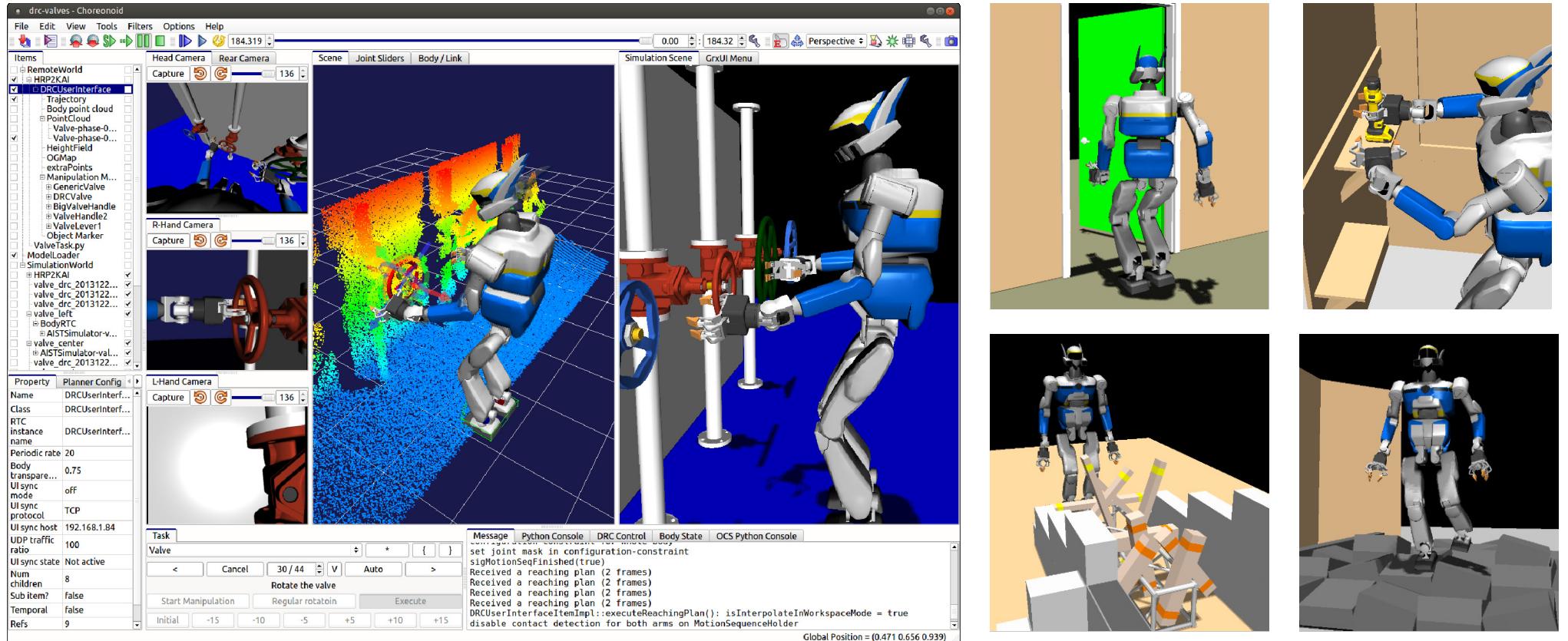


Design and simulation of dancing motions (2010)

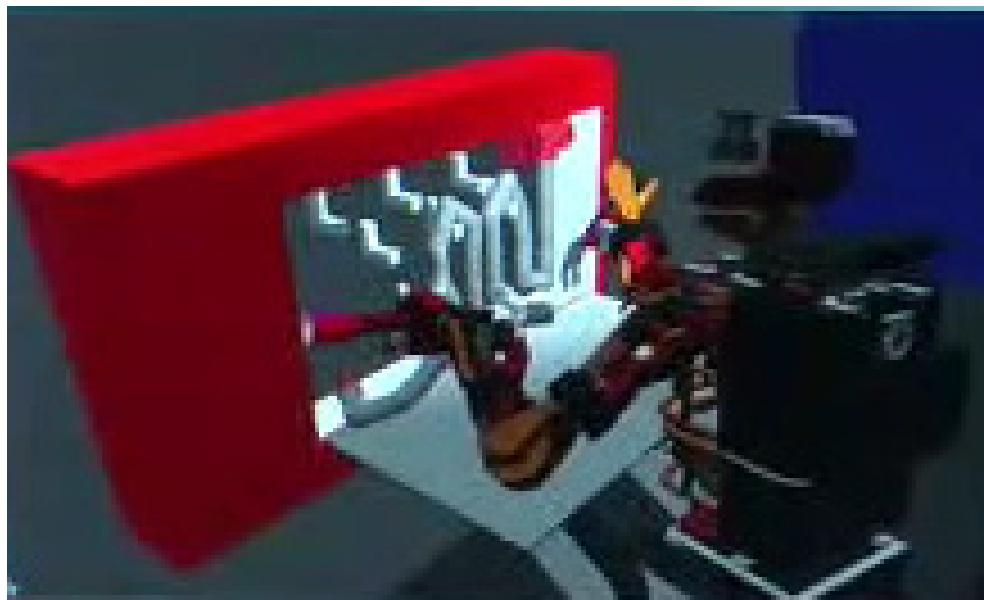
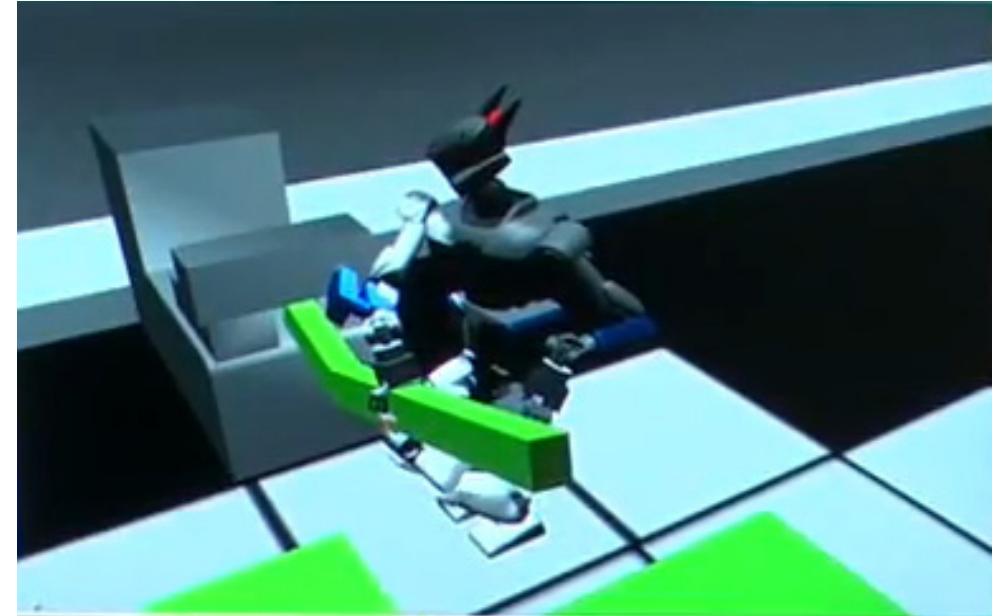
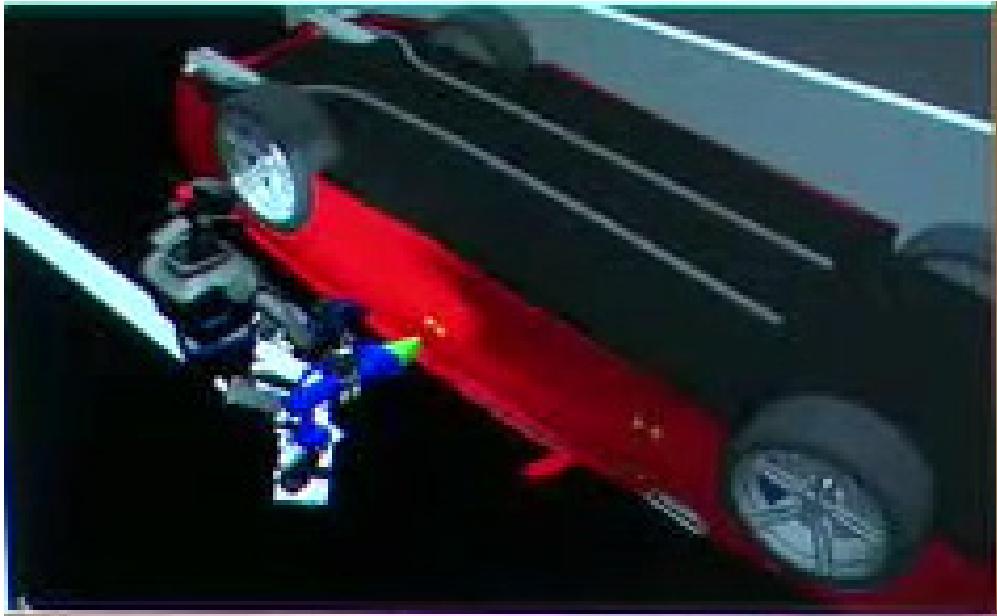


http://www.aist.go.jp/aist_e/list/latest_research/2010/20101105/20101105.html

Teleoperation and simulation of the DRC tasks (2015)



Japan Virtual Robotics Challenge (2015)



Grand challenge: simulation of actual disaster response tasks

- **Demands for disaster-response robots are increasing**

- Natural disasters
 - Earthquakes, heavy rains, typhoons, etc.
- Plant disasters
 - Accident of the Fukushima I nuclear power plant
- Infrastructure disasters
 - Tunnels, highways, bridges, etc.



- **Need for the simulation**

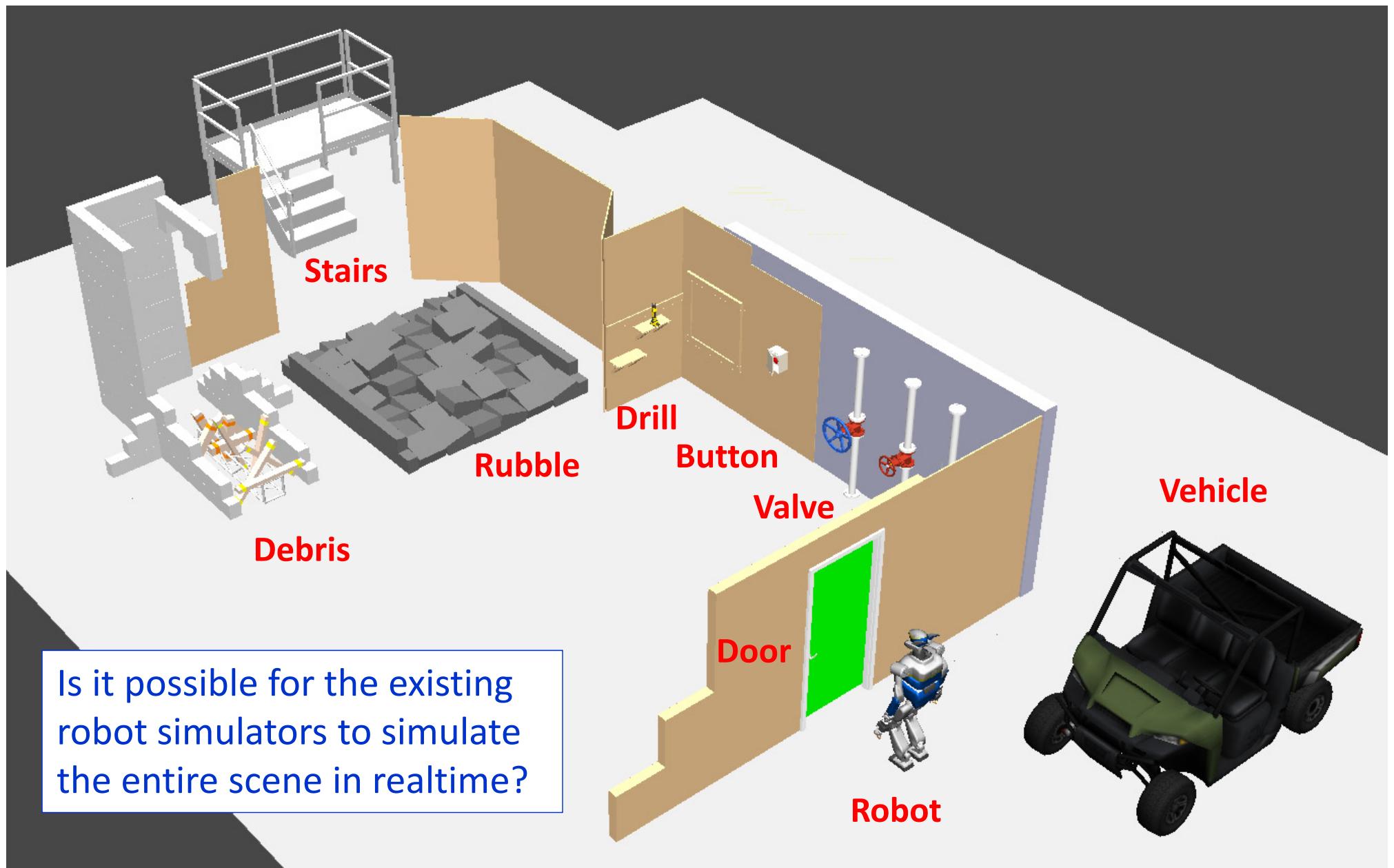
- Disasters cannot be reproduced in the real world
- Training in the real world is expensive in terms of money, time, resources, etc.

- **Issues**

- Various types of robots
- Various environments and objects
- Various natural phenomena
- Large scale



Example 1: Integrated simulation of the DRC tasks



Example 2: Simulation of a tunnel accident



Collapse



Fire and smoke



Hydrant cabinet



Fire fighting



Debris



Rescue the victims

Required simulation functions

Physical / Natural Phenomena

- Fire
- Smoke
- Wind
- Radiation
- Sound
- Radio Wave
- Rain
- Snow
- Flooding
- Earthquake
- Landslide
- Radiation

Objects

- Water
- Gas
- Oil
- Debris
- Victim

Special Operations

- Destruction
- Making a hole
- Digging
- Fire extinction
- Decontamination
- Hammering test

Robots

- Legged
- Crawler
- Tire
- Multi-copter
- Underwater
- Snake-type
- Humanoid

Sensors

- Camera
- Laser range sensor
- Thermometer
- Infrared camera
- Gas sensor
- Mic
- Gamma-ray camera

Tools / Devices

- Wire
- Cable
- Hose
- Drill
- Screw drivers
- Hydra spreader
- Speaker

Issues in implementation

- Algorithms
 - Physics computation
 - Rendering
 - Sensor simulation
- Modeling
 - Data structure
 - File format
 - Scripting
- Software architecture
 - Parallel Processing
 - GPGPU
 - Rendering API
 - Middleware
- Integration
 - Consistency
 - Scalability
 - Extensibility