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Rescue Robotics in Japan

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President, International Rescue System Institute

Japan MEXT DDT Project on Rescue Robots

FY2002-2006, PI: Prof. S. Tadokoro, Intl. Rescue System Inst., Budget: US$20M

Information Integration

Protocol and Database

- Protocol standardization (MISP)
- Disaster info. database (DaRuMa)
- Network integration and operation

Overview Info. Gathering

Surveillance from Sky

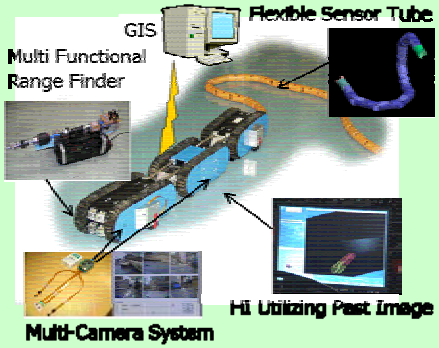
- Small-size helicopter (automatic surveillance)
- InfoBalloon (monitoring from fixed points)

Distributed Sensors

- Rescue Communicator (victim search sensor)

Advanced Rescue Instruments

Surveillance in Rubble Pile

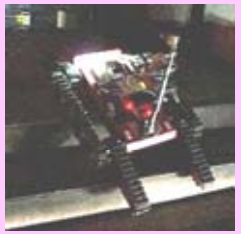


- ActiveScope Camera
- Integrated serpentine robot
- Rescue tools (jacks, search cam, power tools, etc.)
- Wireless triage tag (for rescue logistics)

Surveillance in Underground

- Integrated UGV
- Connected mobile mechanism
- Jumping robot
- Human interface for teleop. (virtual bird-eye view, 3D map, standardization, etc.)
- UWB human body sensor
- Adhoc network

Verification, Training, Demonstration



- Tokyo FD training site
- Niigata Chuetsu EQ.
- JICA Intl. Rescue training
- FEMA training site
- Collapsed House Simulation Facility in Kobe Lab.
- Firefighters unit, IRS-U

NEDO Strategic R&D PJ on Advanced Robot Components
High-Speed Search Robots for Confined Space

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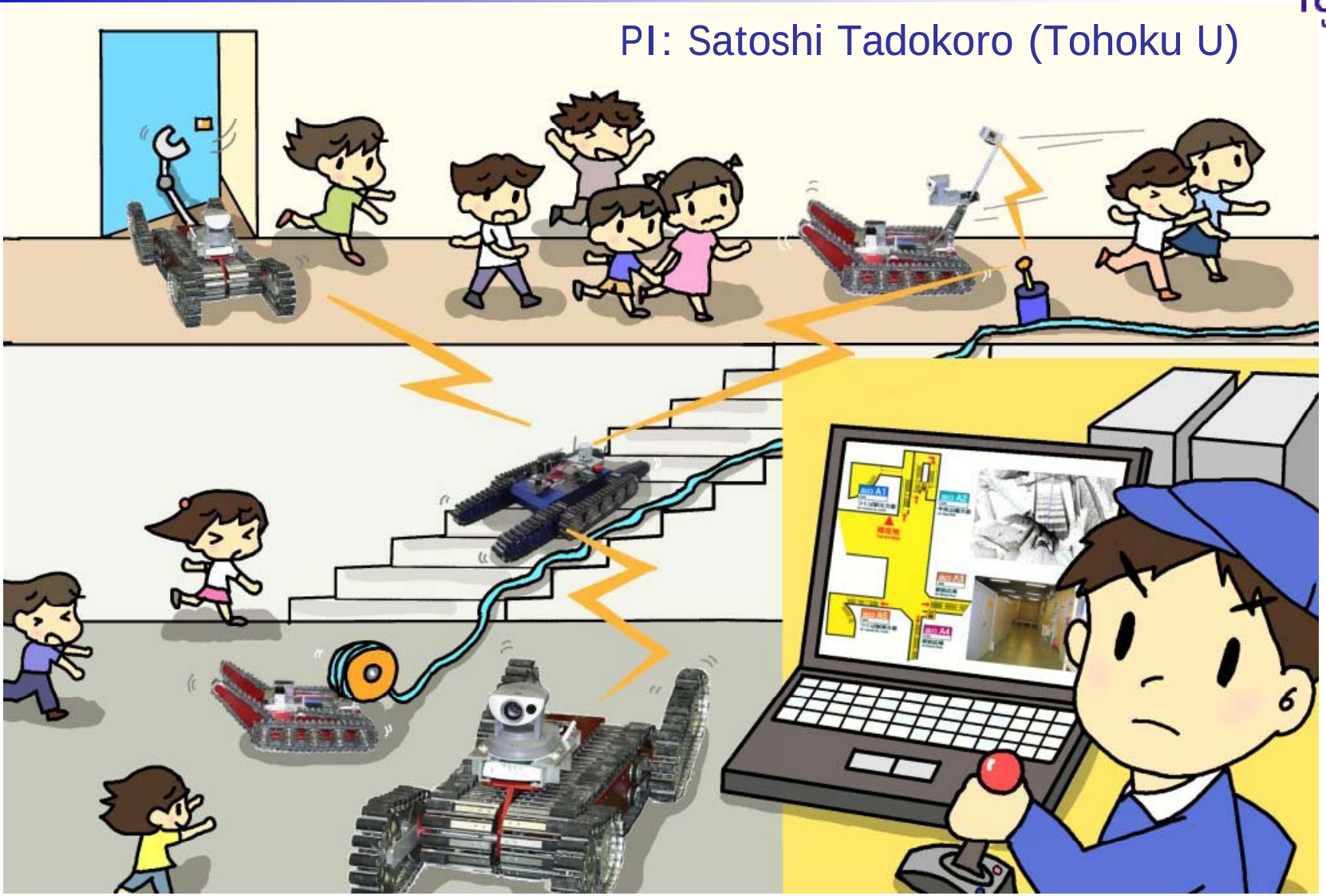
PI: Satoshi Tadokoro (Tohoku U)



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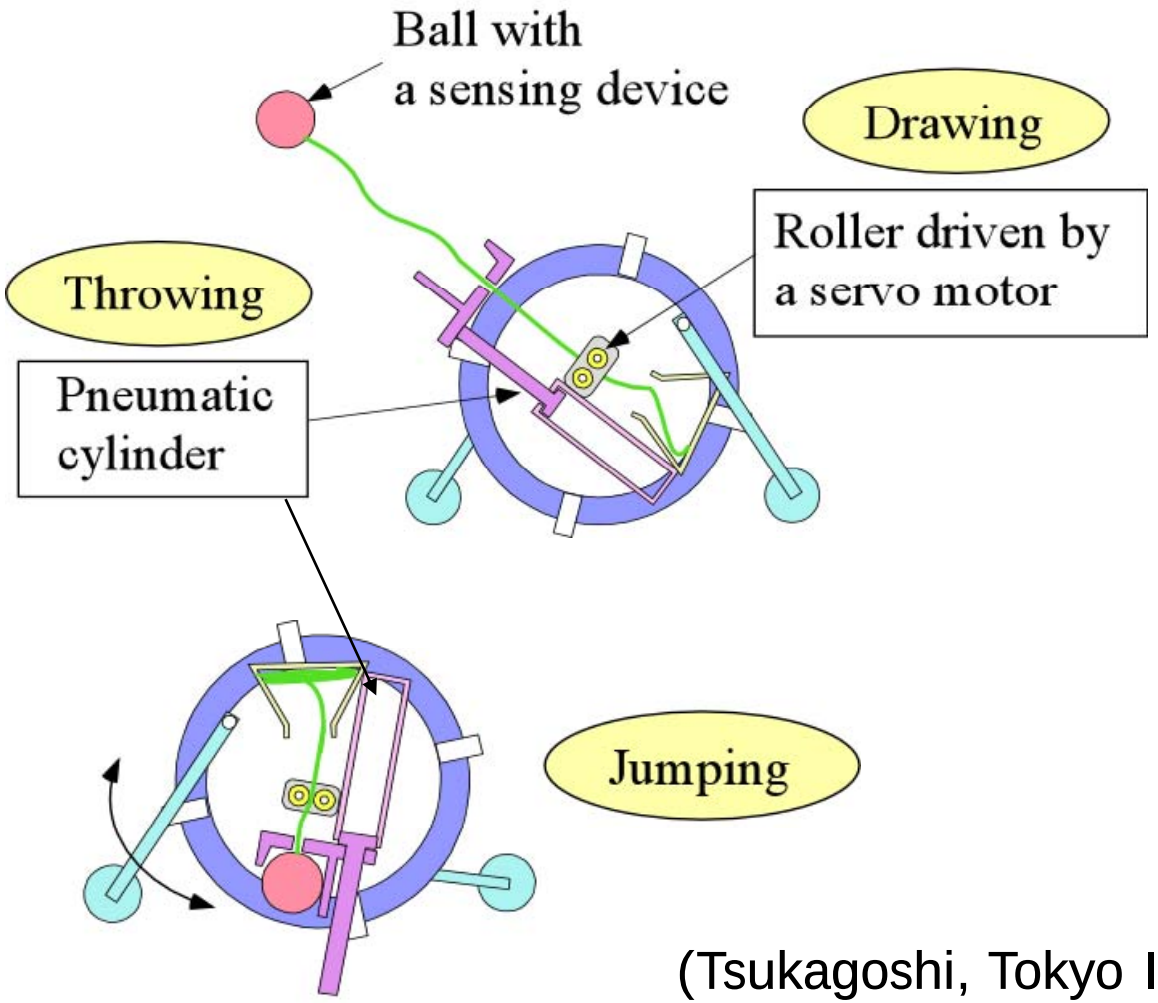
HELIOS Carrier (Matsuno, UEC)

climbing up stairs (single)

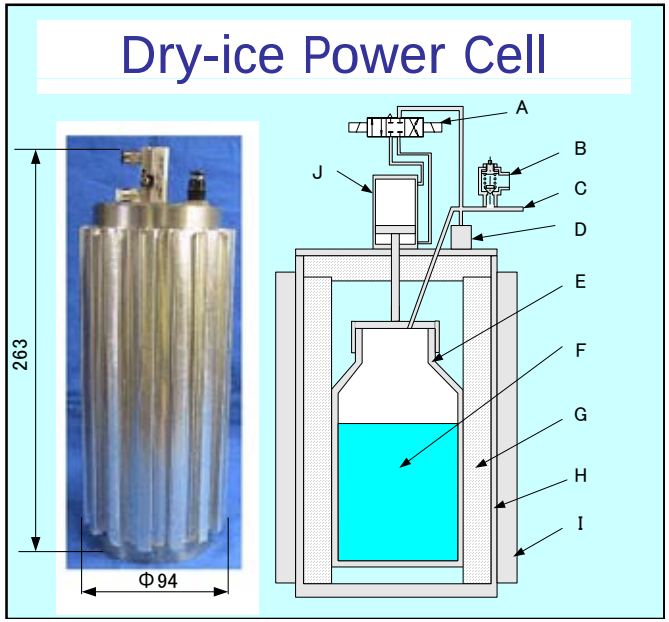
climbing up stairs (connected)

Front-Rear Steering

Jump Robot for Rough Terrain



(Tsukagoshi, Tokyo Inst Tech)



Super High Mobility Robot ‘Kenaf’

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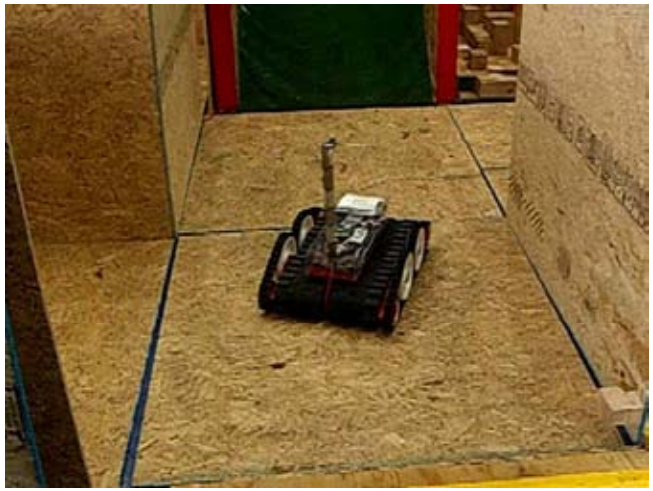


RoboCup 2007 Atlanta Mobility Challenge Champion



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(Team Pelican United)

Mobility Challenge Champion at RoboCupRescue 2007 Atlanta

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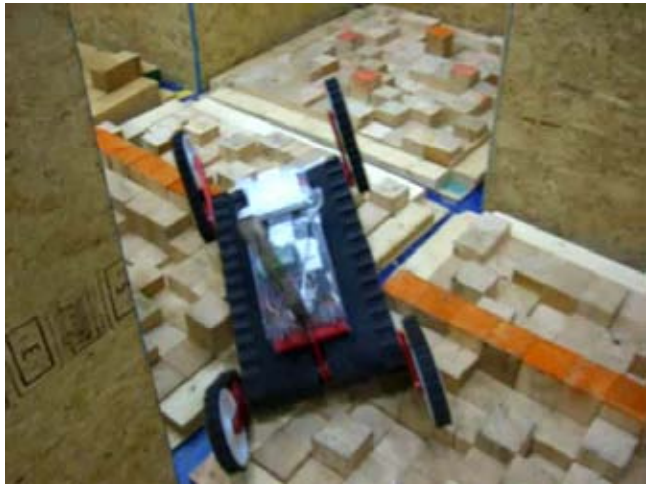

Kenaf showed the best mobility in the world using NIST/ASTM rescue robot evaluation field, which is proposed as international standard.

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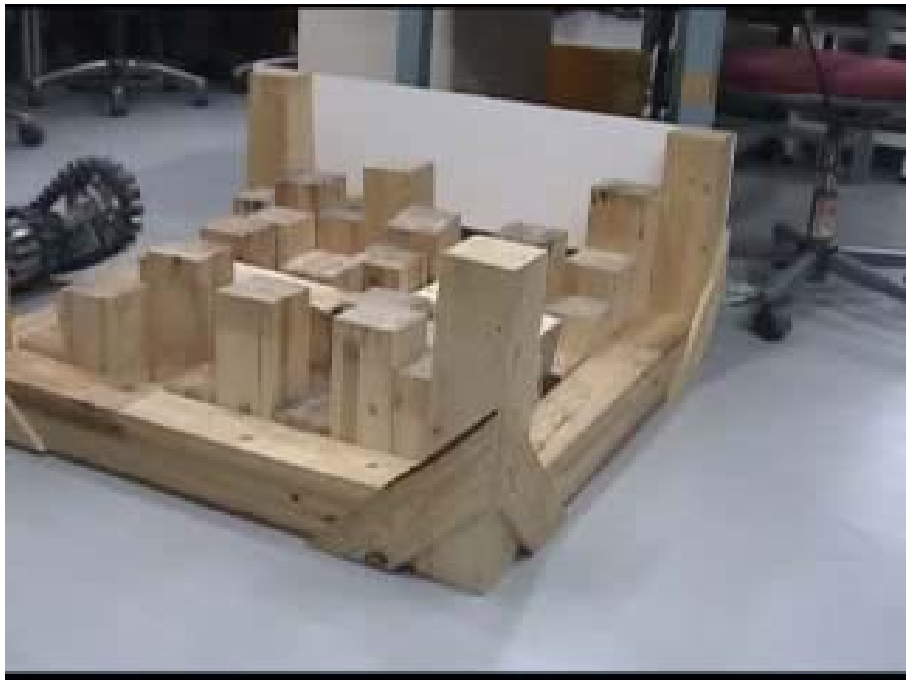
Semi-Autonomy Using Human Skill



Robot autonomously negotiates rough terrain.

→ Operator simply commands

‘Go forward, backward, turn right....’

(Ohno, Tadokoro, Tohoku U)

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Human Interface

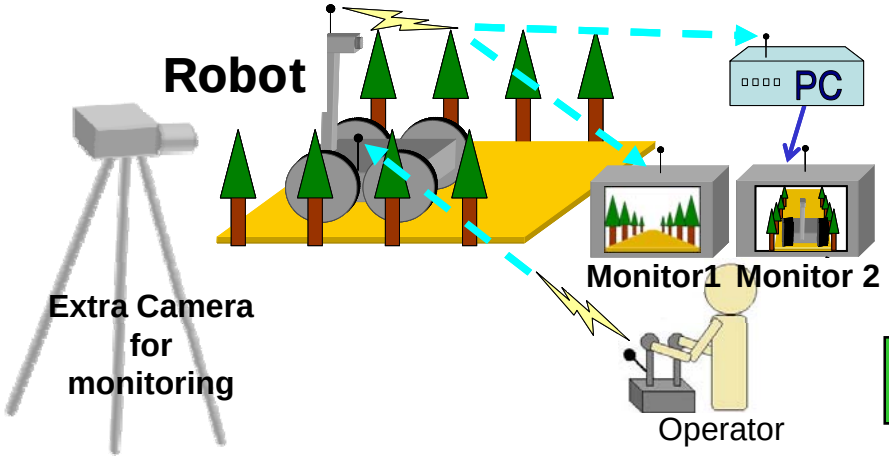


Image from Extra Monitoring Camera

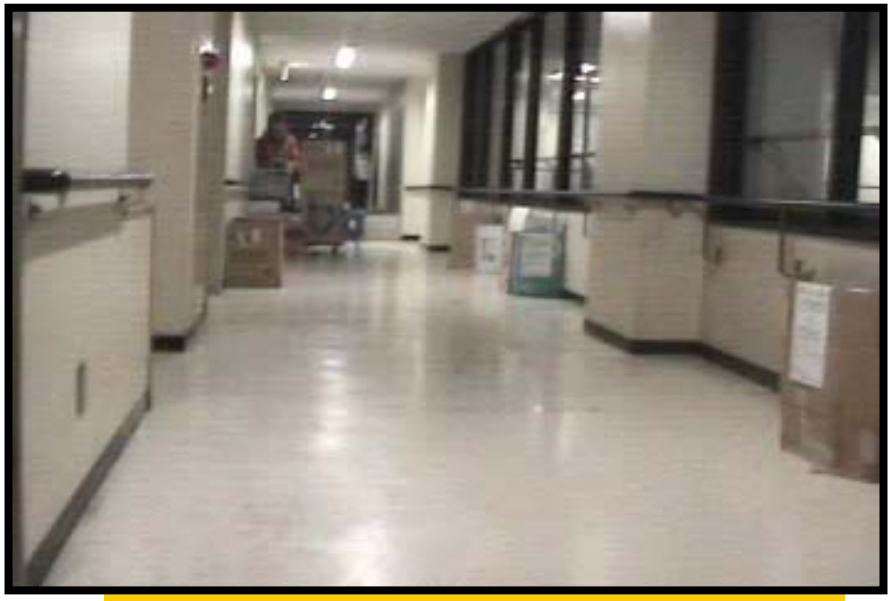


Image from Camera Mounted on Robot

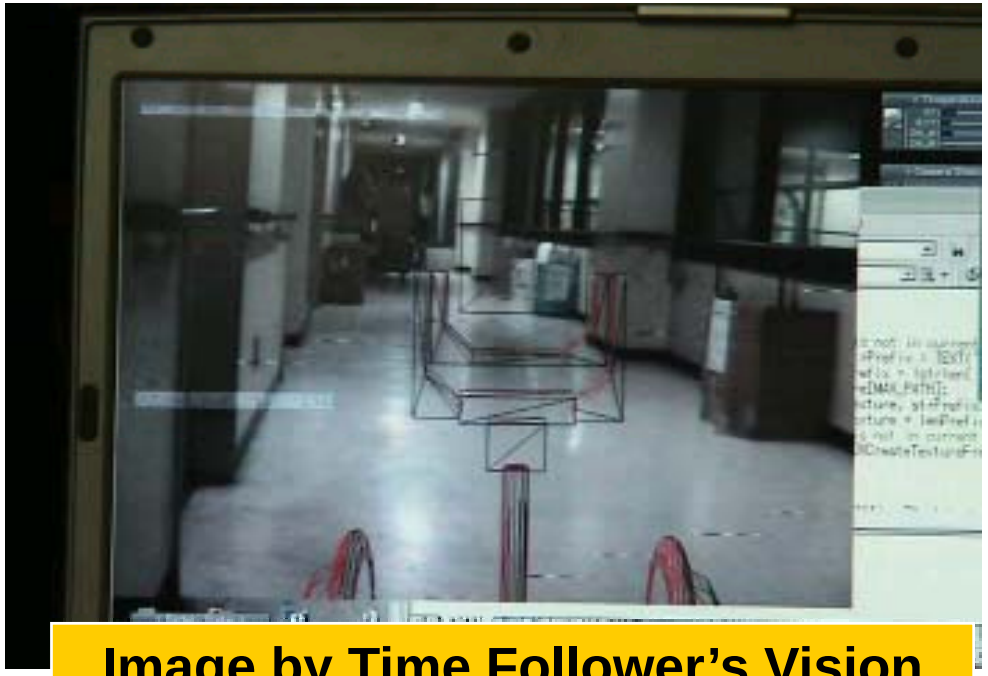


Image by Time Follower's Vision

(Shiroma, Matsuno, UEC)

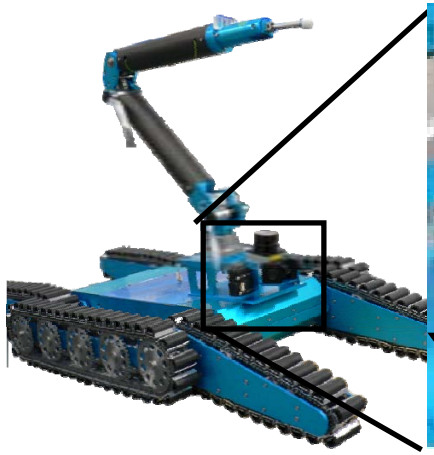
Image Stabilization

Stabilized image **Original image**

International Rescue System Institute (Shiroma, Matsuno, UEC)

3D Scanner and 3D Scan Matching Method

(Ohno, Tadokoro, Tohoku U)



Ali-Baba

3D Scanner

Environment

3D Scan Data

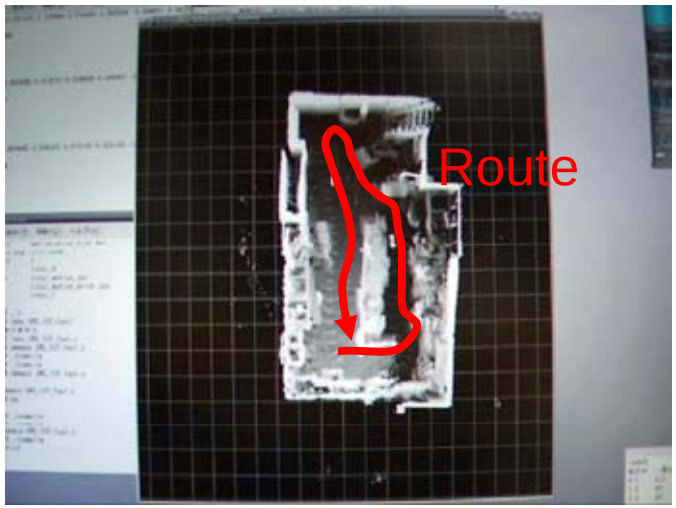
3D Scanner

- 2D LRF
- Color Camera

3D Scan Match

- Fast ICP
- Gravity Condition

Environment



Scan Matching

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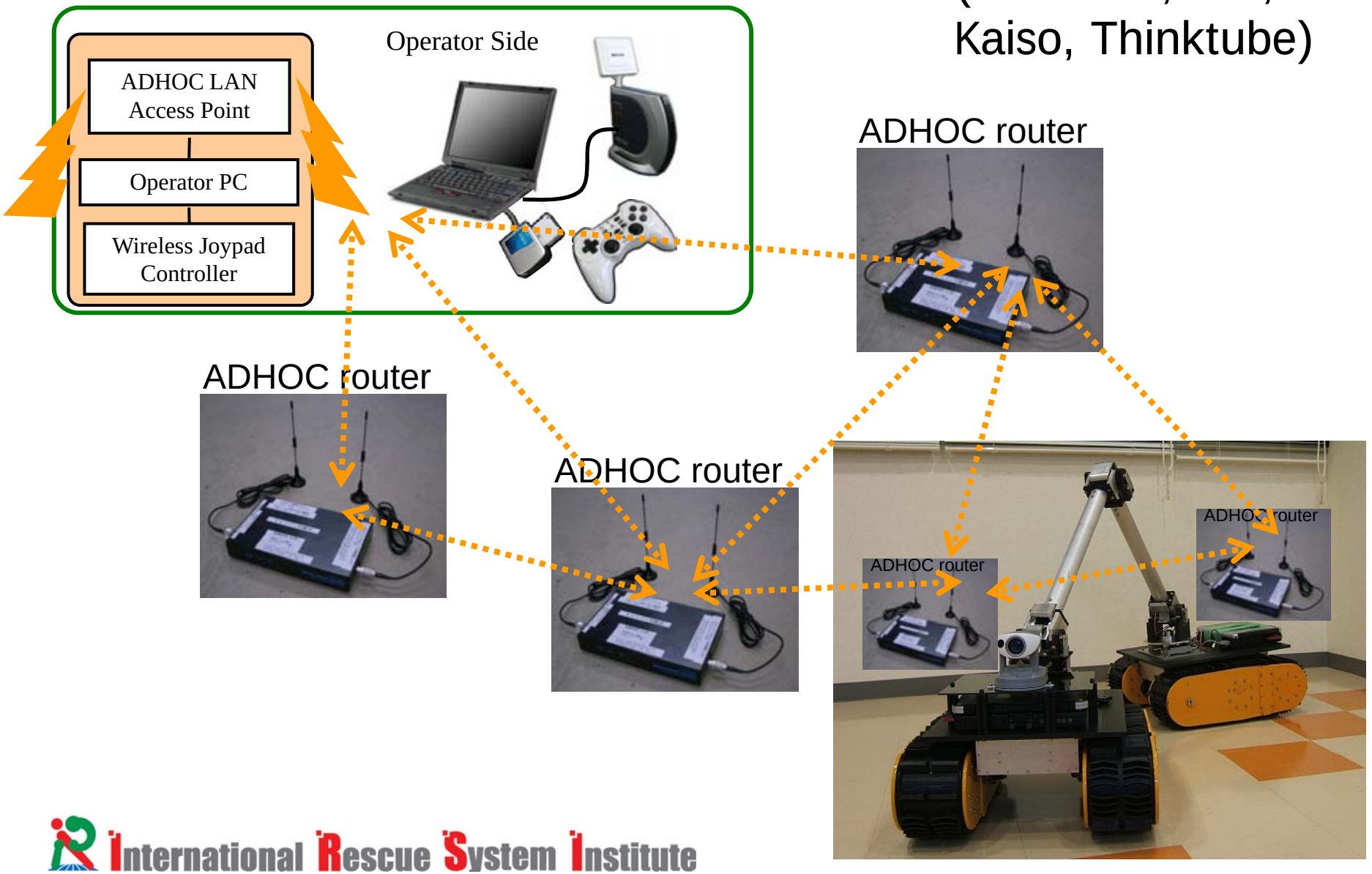
ADHOC Network

(Takamori, IRS, Kaiso, Thinktube)

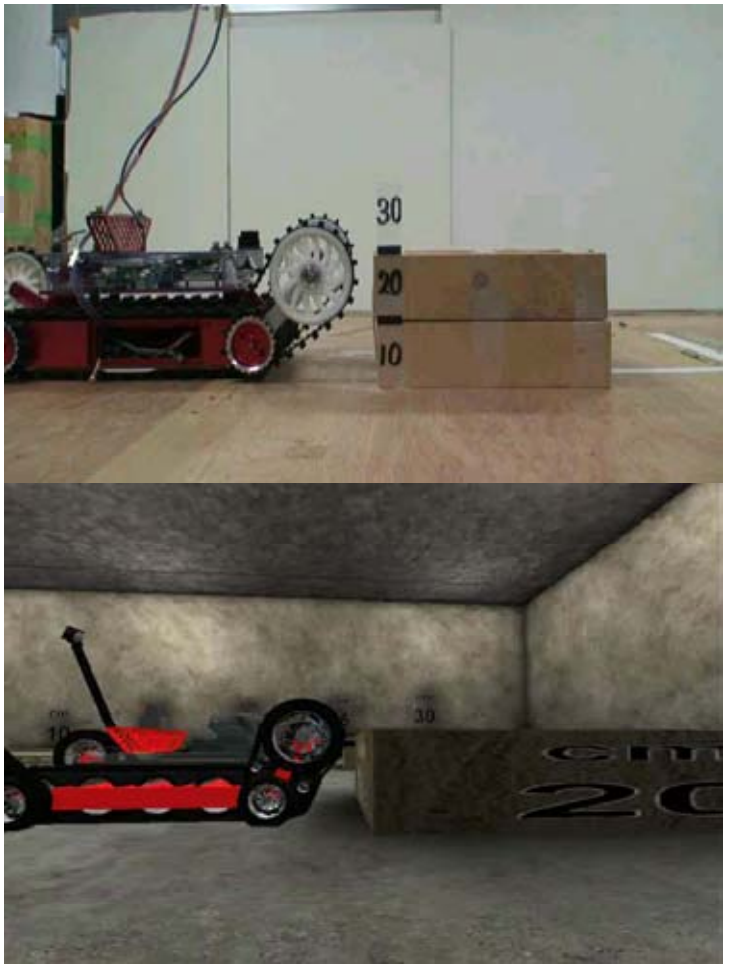


Virtual Exercise

(Saga, Tadokoro, Tohoku U)

Step Climbing

Real Robot vs
Simulation
(Teleoperation)



Motion on
Rough Terrain

On-Board Camera Image

Real vs Simulation (Autonomous)

In-Rubble Information Gathering

(MU Leader: Osuka, Kobe U)

Robotic rescue search from outside to inside of rubble pile

On Rubble Pile

- Advanced tools for search
  - Jack for narrow gap
  - Man-powered search camera system
  - Search cam with advanced sensor head
- Slim search system
  - Cross section < 0.03m × 0.03m
  - Entry depth: 10m
  - Camera, thermo sensor, etc.
- In-rubble search robot
  - Serpentine robot IRS Soryu
  - Length < 1.5 m
  - Cross section < 0.2m × 0.2m
  - Entry depth: 30m
  - Various human body sensors
  - Various environmental modeling

Deep in Rubble Pile

Investigation at Niigata-Chuetsu EQ (2004.8.25 Experiments in damaged house in Nagaoka)

Experiments at Collapsed House Simulation Facility

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IRS Soryu in Collapsed Bldg Simulation Facility

Basic Motion of Joints

Enter Rubble Pile

Climb up Wall

Recovery from Roll-Over

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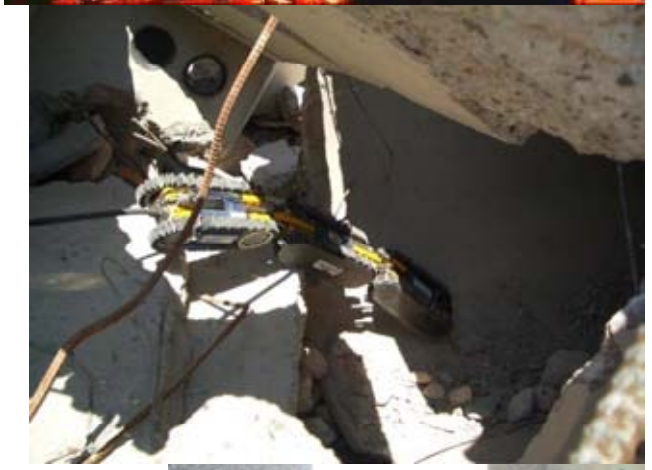
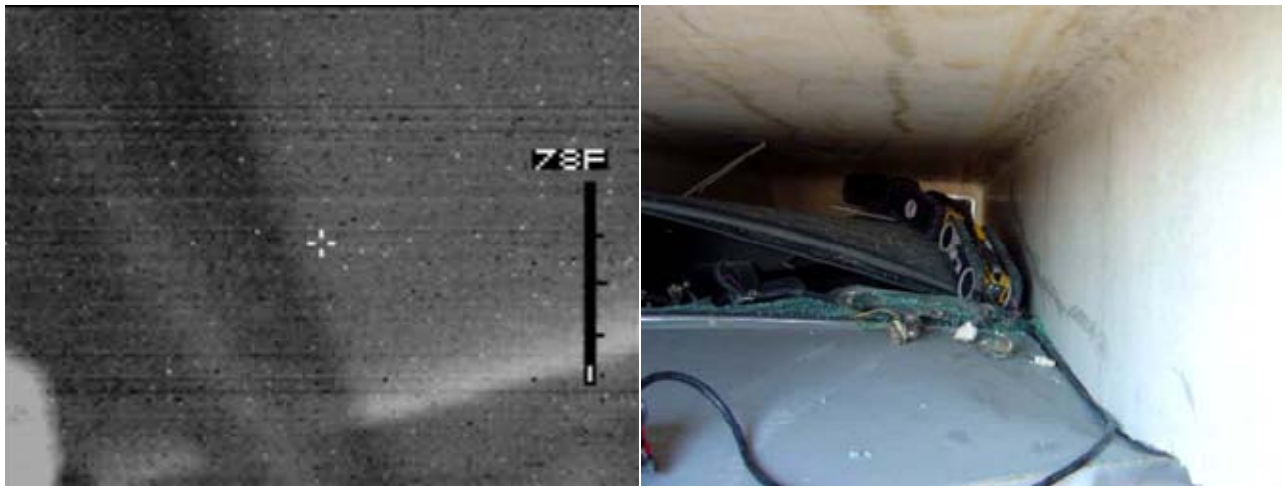
(Kuwahara, IRS)

Demonstration to FEMA USAR



FEMA Nevada TF1 Training Site (Aug. 7, 2005)



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(Tadokoro, Tohoku U)

ActiveScope Camera for Search in Confined Space

Video Scope with Active Surface

(Oct. 3, 2006 @JICA Intl. Rescue Training)

(Tadokoro, Tohoku U)

Search in 3 cm gap

(Intl. Rescue System Inst. Kobe Lab., Collapsed House Simulation Facility)

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Victim Search in Trains

Search under Train

Search in Drain Pipe

Search through Small Hole

Search in RC Rubble Pile

ActiveScope Camera

@ FEMA Texas TF1 Training Site
Disaster City, 6/18-22/2007

(Tadokoro, Tohoku U)

Negotiation with Obstacles

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ActiveScope Camera

@ FEMA Texas
TF1 Training Site
Disaster City
6/18-22/2007

(Tadokoro, Tohoku U)

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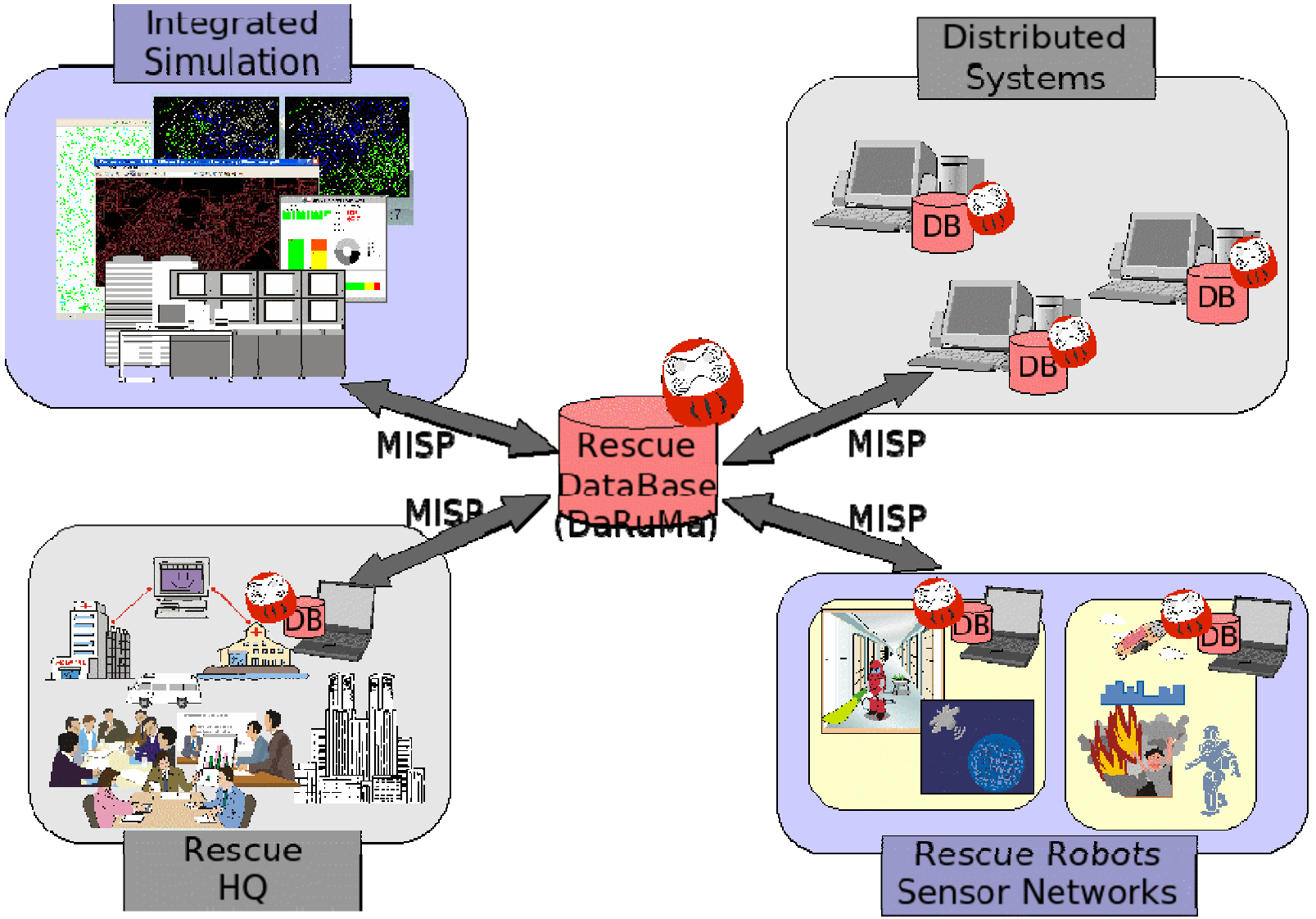
Use for Forensic Investigation

(Tadokoro, Tohoku U
Murphy, USF)

- Jan. 3-7, 2008
- Berkman Plaza II Collapse, Jacksonville, FL, USA on Dec. 6, 2008
- Gathered valuable evidence information
  - Crack shape/direction of concrete
  - Shape/cross-section of broken pieces
  - Internal structures
- Deep narrow gaps in rubble pile
  --- Impossible by other equipment

Data Integration in DDT Project



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(Noda, AIST)

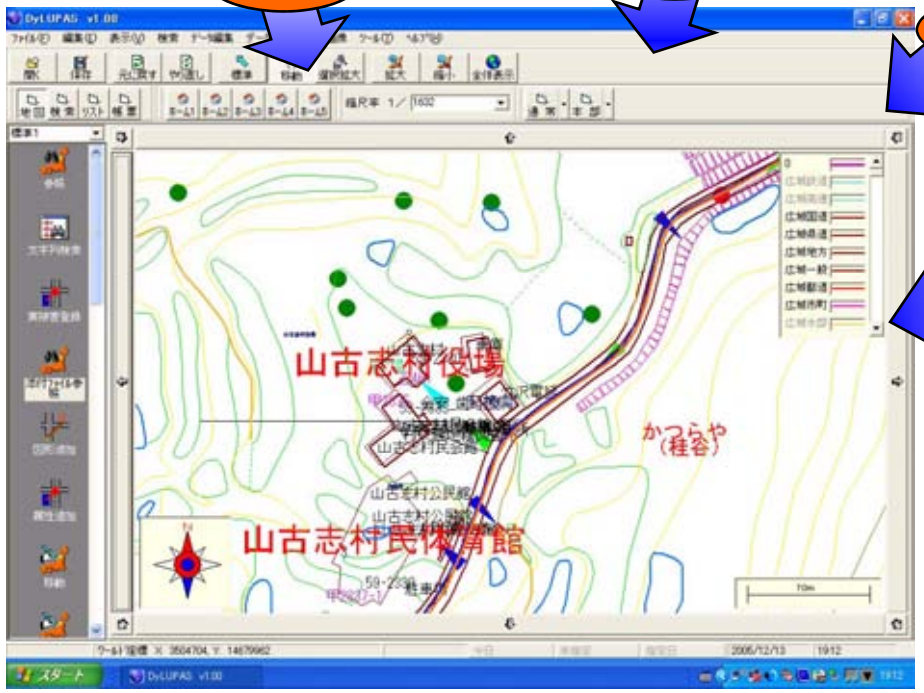
Experiment ～Vast Disaster Field (Yamakoshi)～

MISP

MISP

MISP

MISP



Each picture is saved on DiMSIS/DyLUPAS synchronized with position（lat. lon. high）and time.

Spatial Temporal GIS “DIMSIS/DyLUPAS”

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(Meguro, Waseda U
Kakumoto, Kyoto U)

Robot Exercise by IRS Unit

(1) IRS-U started rescue.

(3) Multi-sensor head measured shape of the hole and obstacles.

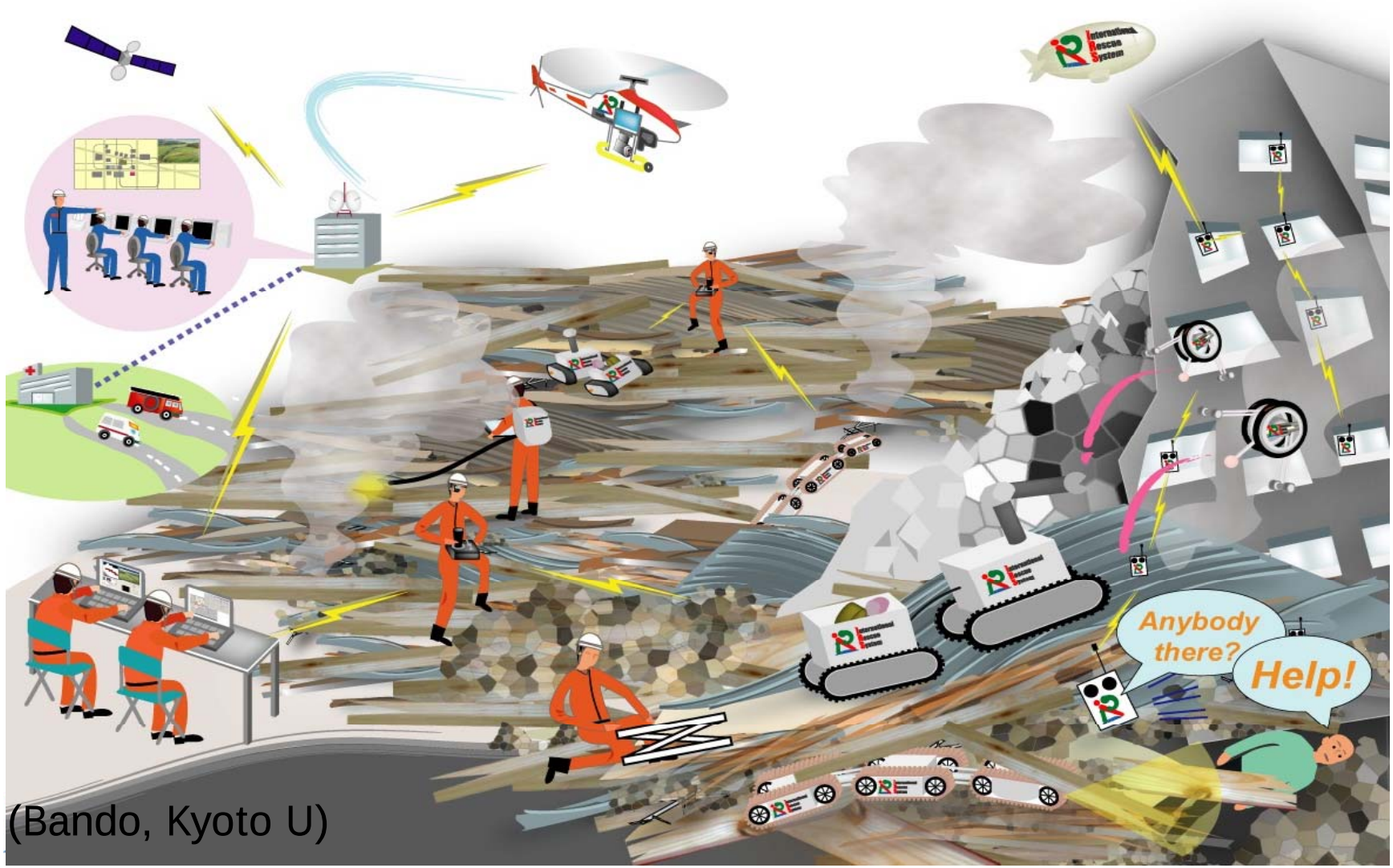
(2) Jack-up Robot removed obstacles.

(4) Cutter Robot cut reinforcing bar.

(4/22-23/2006 Tokyo FD Tachikawa Training Site of Hyper Rescue)

(Makabe, IRS-U)

Future Advanced Infrastructure for Safe Secure Social System



(Bando, Kyoto U)