Introduction of Mission Unit for Rescue System Infrastructure in Special Project for Earthquake Disaster Mitigation in Urban Areas

Japanese Project on
Robotics for Disaster Response, Urban Search and Rescue
(DaiDaiToku)
- Activity in Infrastructure MU in 2005-

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Itsuki Noda (AIST), Osamu Takizawa (NICT),
Jyunichi Meguro, Kiichiro Ishikawa, Takumi Hashizume (Waseda Univ.),
Tomowo Ohga (Asia Air Survey Co.,Ltd.), Michinori Hatayama (Kyoto Univ.)
Fumitoshi Matsuno (Univ.of Electro-Comm.), and Satoshi Tadokoro (Kobe Univ.)

In cooperation with Hiroshi Nakakomi (Mitsubishi Electric Corp.), Junichi Takiguchi (Mitsubishi Electric Corp.)

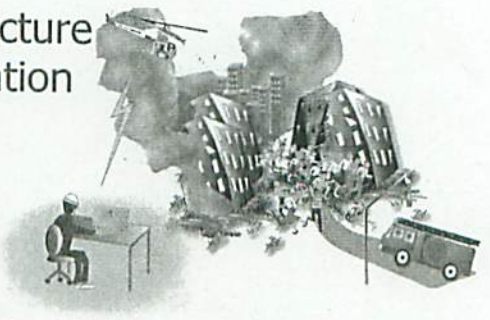
International Rescue System Institute

Motivations

When disasters happen,

- The situation of the disaster should be recognized as soon as possible to determine the strategy for rescue
- Rescue corps, robots, and citizens need to acquire and share information on the damage, evacuation, whether the family are alive or not, where they are, etc. by any means
- The information infrastructure (networks, mobile phones, etc.) will be destructed in a disaster situation

Development of information infrastructure which can be utilized in disaster situation



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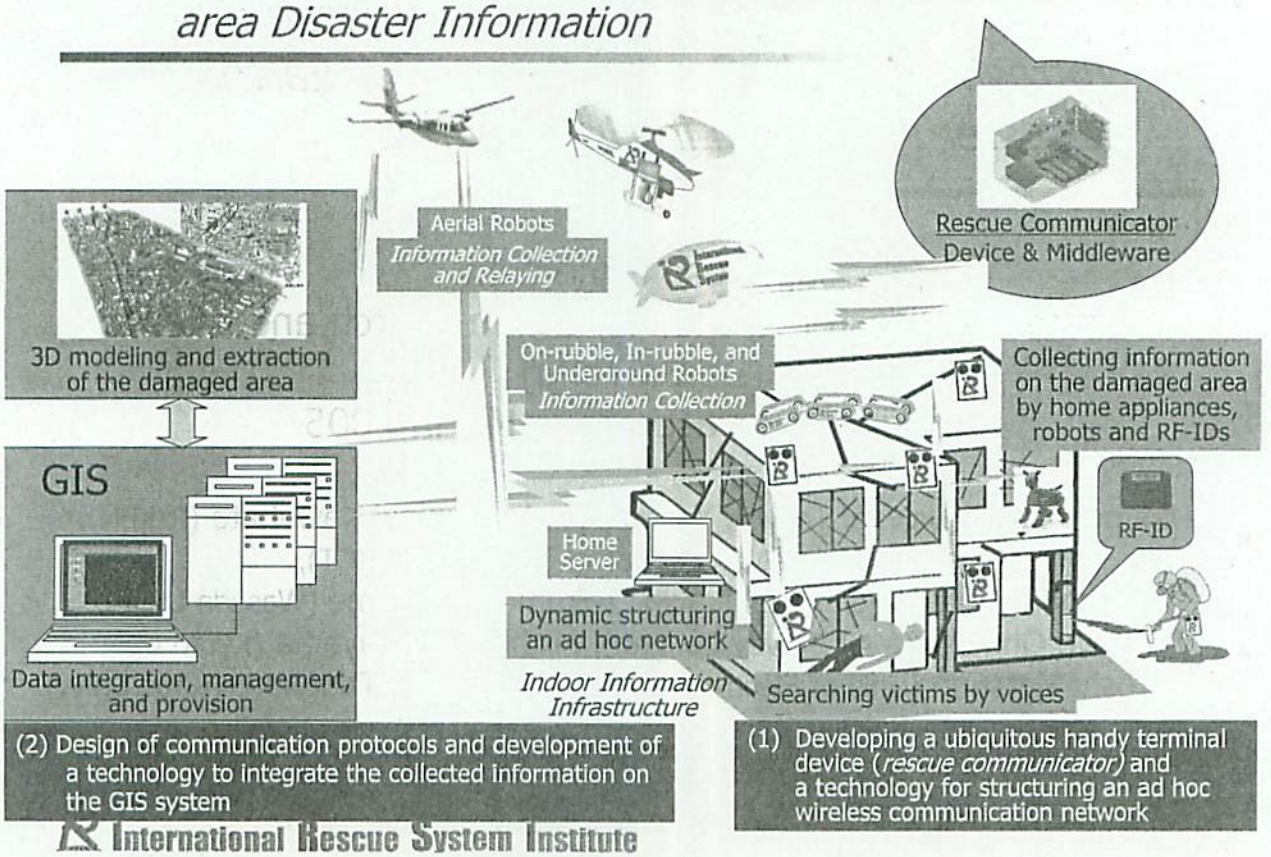
Task Force for Social Infrastructure for Collecting Wide-area Disaster Information



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Current research and development by MU members

- (A) Ubiquitous devices for collecting and providing information
  - Victim Search System using Intelligent Data Carriers for Rescue (RIKEN / Univ. of Tokyo)
  - Information assistance system in disaster using ad-hoc network (AIST)
  - RF-ID based emergency information collecting and delivery system (NICT)
  - Development of Robot-Controllable Communication Device (IRS)
- (B) Formation of dynamic networks for communication on disaster information communication and Data integration
  - System for integration, mapping, and storage of collected global/local information in 3D environment
    (Kyoto Univ./ Univ. of Electro-Comm./Waseda Univ.)
  - Integrated disaster measuring system (Asia Air Survey Co. Ltd.)

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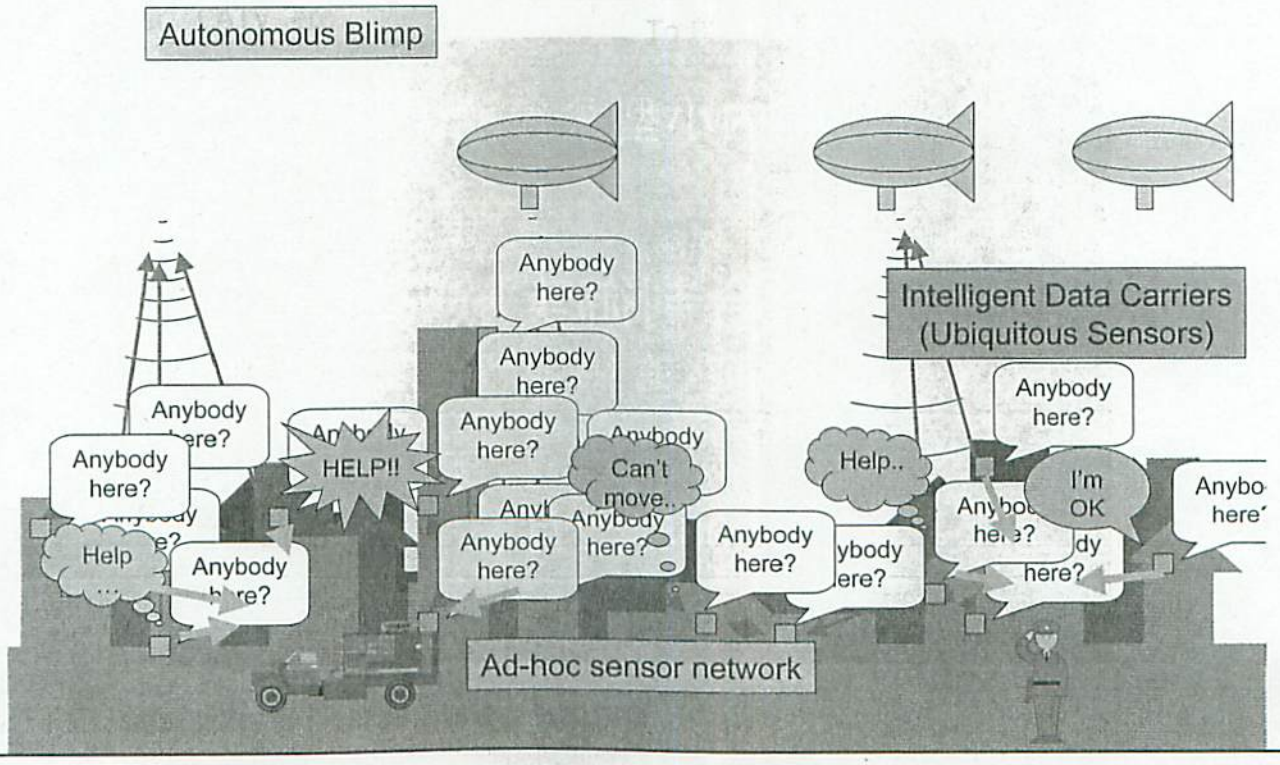
Global Victims Search using Intelligent Data Carriers and Autonomous Blimp



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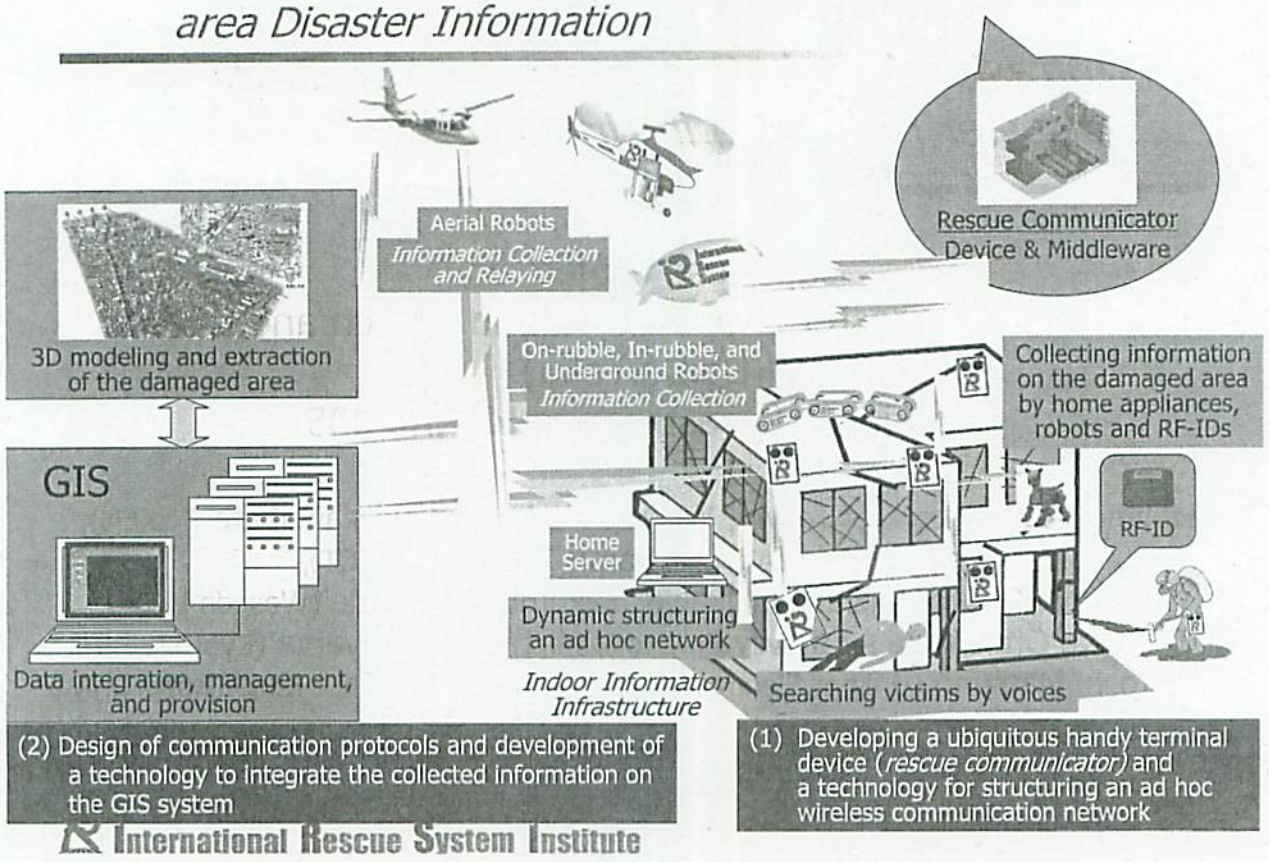

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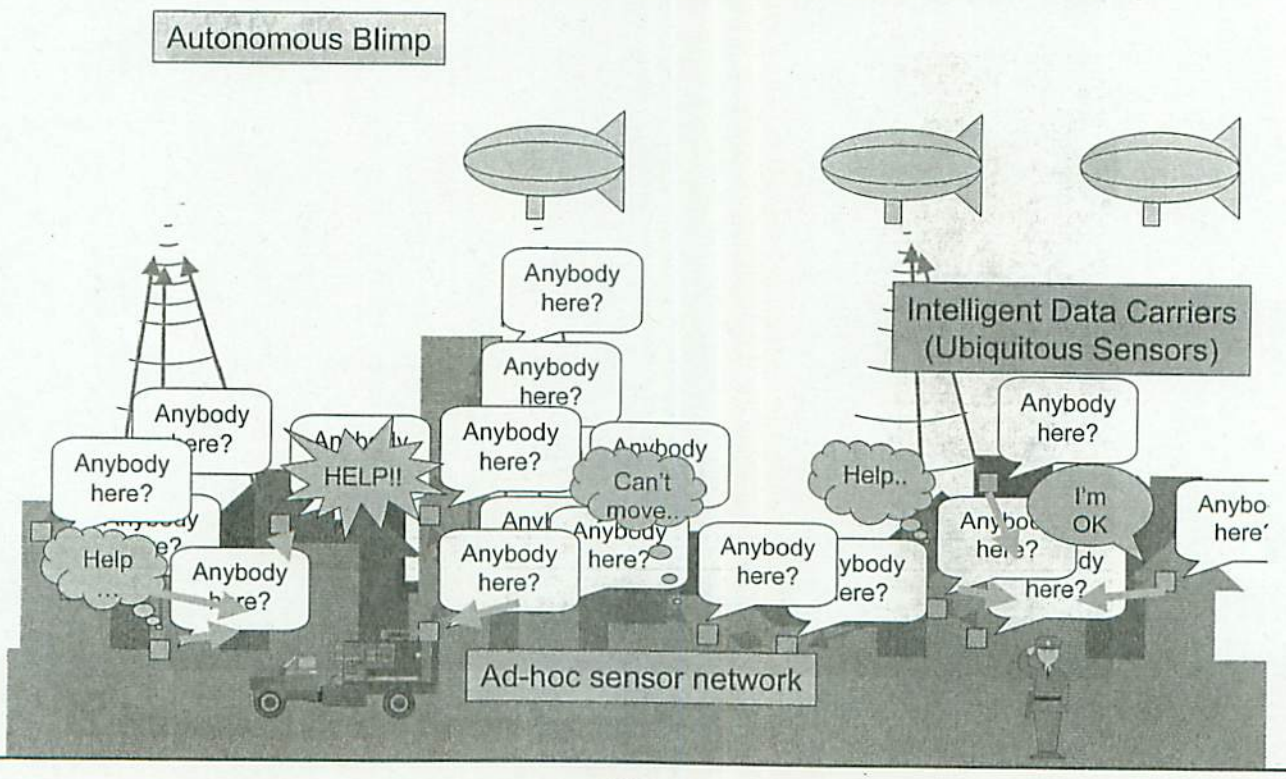
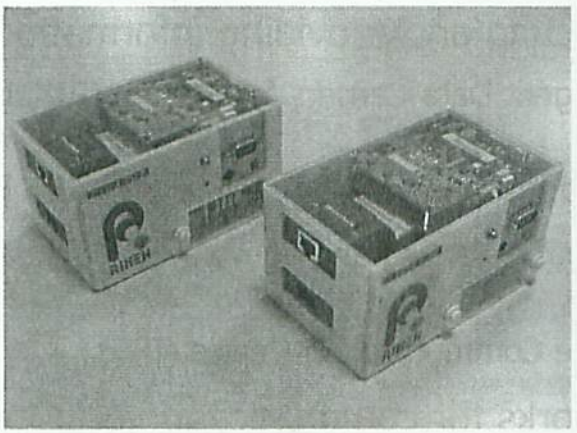
Global Victims Search using Intelligent Data Carriers and Autonomous Blimp



Rescue Communicators (Ubiquitous Sensors) and Experimental Blimp Robot



Rescue Communicator

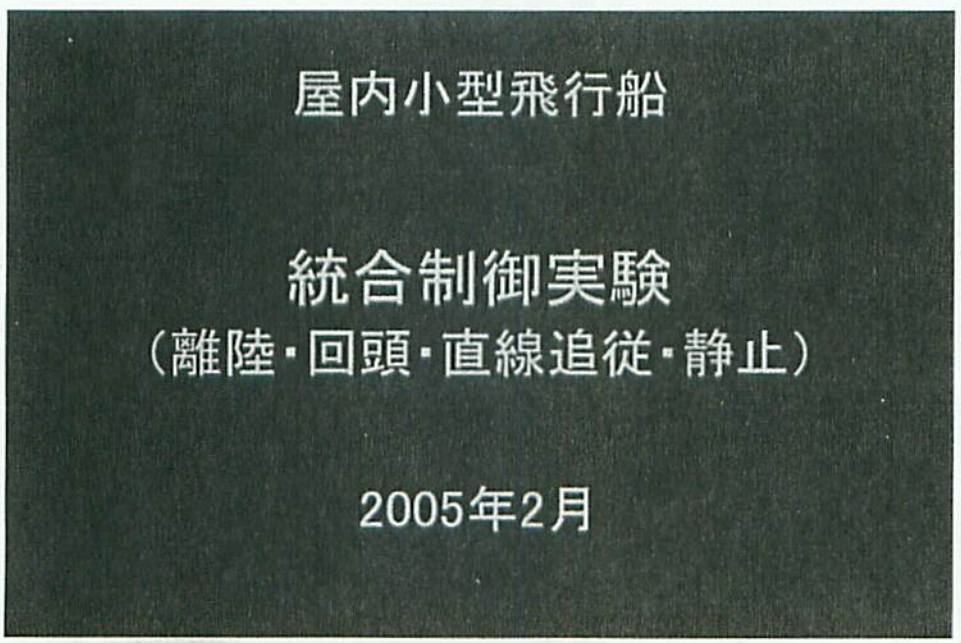
Size	:	87.5mm*142.5mm*79.9mm
I/O	:	Wireless LAN(802.11b)
	:	Microphone (voice recorder)
	:	Speaker (voice synthesizer)
	:	RS232C*2, Parallel Port, etc.
OS	:	Linux
Battery	:	72hours (intermittent)

Autonomous blimp robot

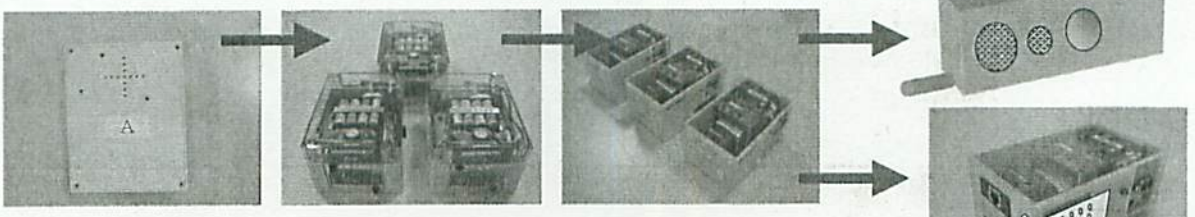
Size	:	L6.5m*W3.0m*H4.1m
Propulsion	:	800g (back/forth)
	:	800g (left/right)
	:	100g (yaw)
Payload	:	8kg
OS	:	Linux

Total demonstration

(autonomous blimp and one rescue communicator)



Intelligent Data Carriers for Rescue (IDC-R)



1st model (2002)
(basic function ver.)
RF communication
Voice playback
and recording
Data transmission

2nd model (2003)
(Blimp collaboration ver.)
Extension of
Wireless comm.
(2800times speed ,
133times distance)
Anti-shock, Dust-proof

3rd model (2004)
(Research integration ver.)
Downsized, long buttery life
(1/3 size, 9 times longer)
Extension of communication I/O
(LAN, waveLAN, modem)
(Ad-hoc network)
Detection of earthquake,
power failure, water leak, etc.

Compact Flash, modem,
LAN,waveLAN, GPS

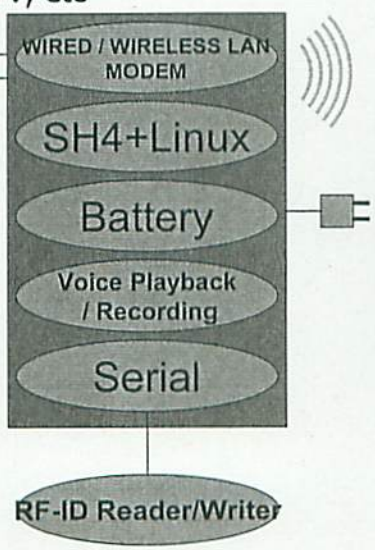
2005 models
(under development)

- Tiny model
  -Small and cheap
- Mobile model
  -Video I/O
- Robot controller

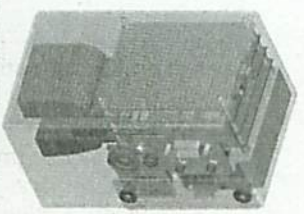
Rescue Communicator

Opt. Fiber, CATV, etc
(Internet)

Telephone line
(ADSL)



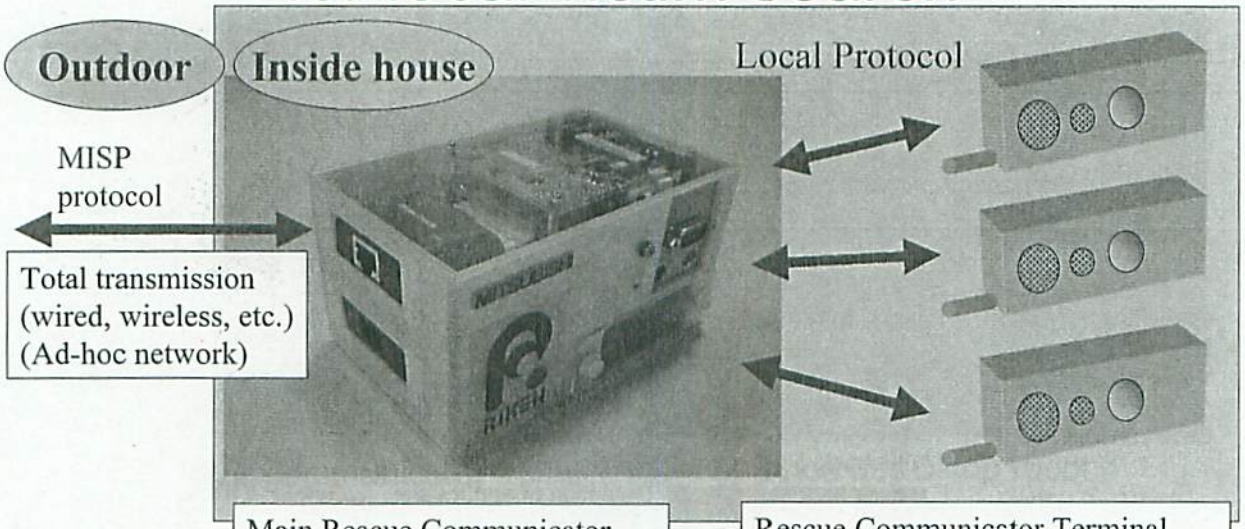
To Blimp, Other Rescue-Communicators
(Wireless ad hoc network)
To information appliances, RF-ID, PDA
(Infrared com.)



CPU:	Renesas SH4 (100MHz)
Memory:	32MB
Extension slot :	Compact Flash * 3, RS-232C * 2
Communication:	Wireless LAN, InfraRed, RS-232C)
Other interfaces:	AD/DA/voice
Size:	985/635cc, 500g
acting time:	4hrs(continuous)
	72hrs(intermittent)

International Rescue System Institute

Home Rescue Network for local victim search

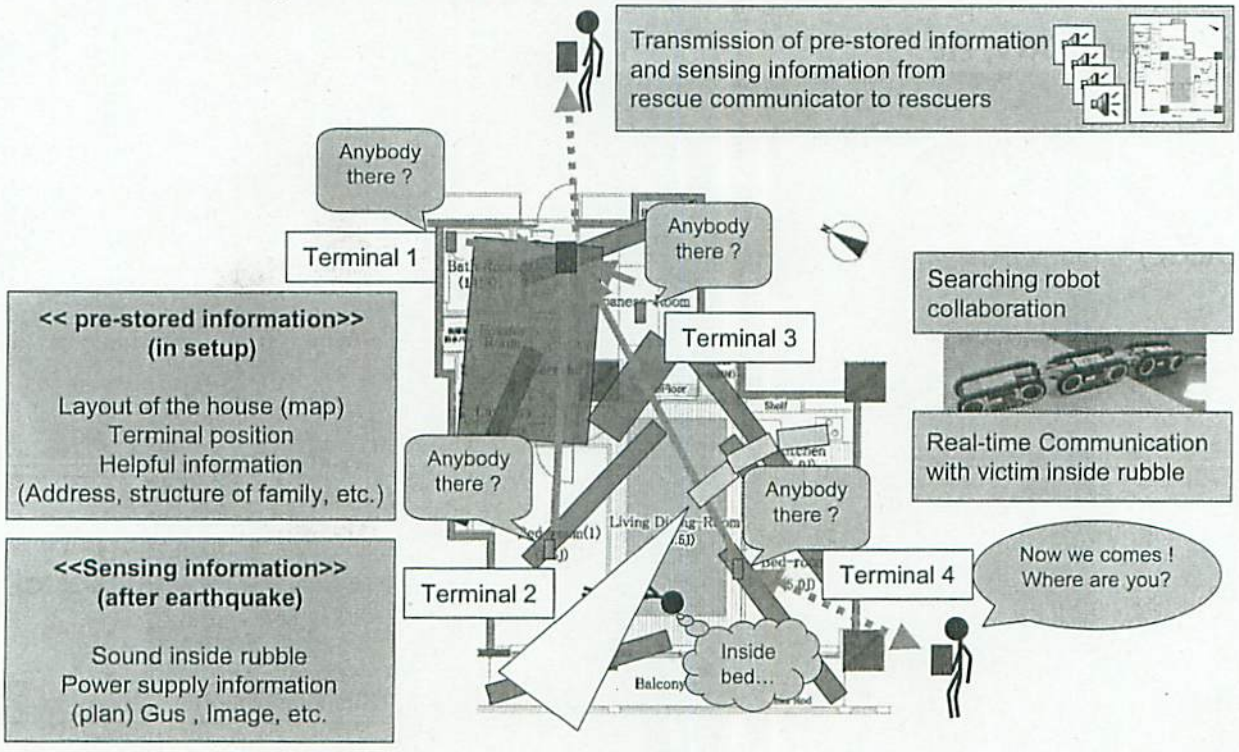


Main Rescue Communicator
(Storage and gateway)
- detection of earthquake
- transmission of activation
- information storage
- gateway to outdoor

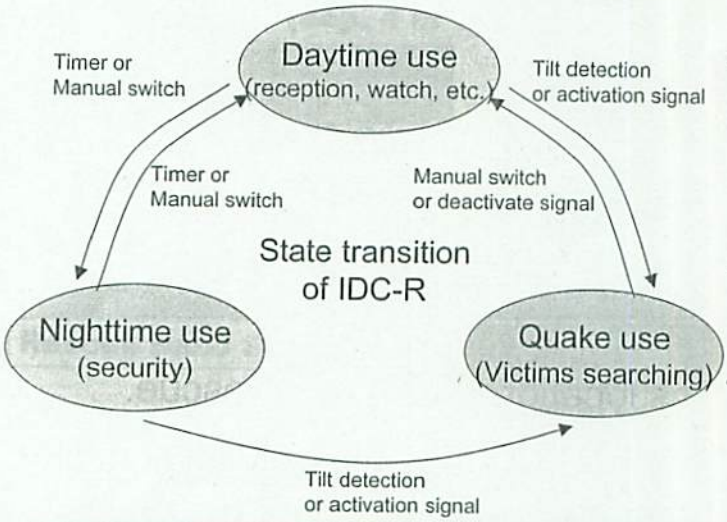
Rescue Communicator Terminal
(Terminal for each room)
- reception of activation
- sound playback and recording
- sound transmission
- (Ad-hoc network)

Local collaborative victim searching

(IDC-Rs, rescue robots, and rescuers)

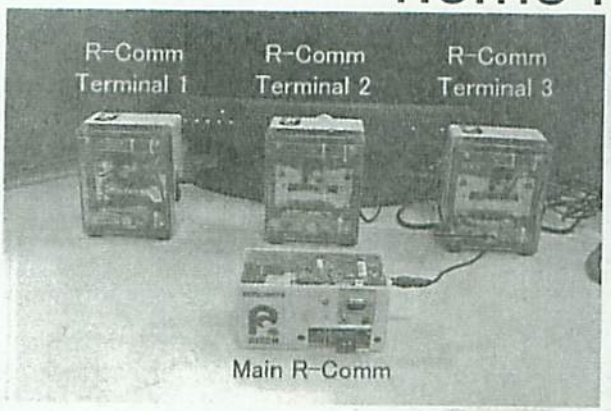


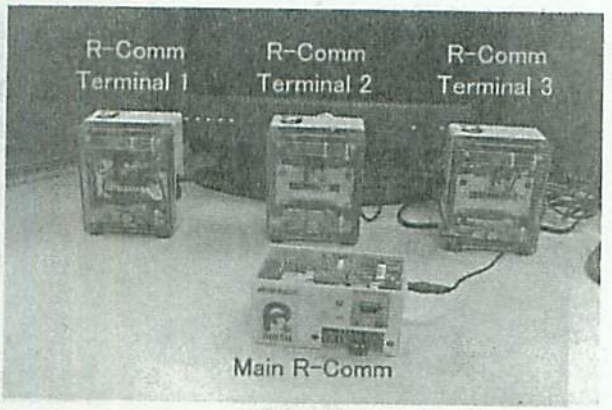
State transition of IDC-R



- In daily use (daytime)
  - Guest reception
  - Childcare watch
    - Using microphone and infrared sensors, etc.
  - Gus and electricity watch
- In daily use (nighttime)
  - Intruders detection
  - Make emergency call
- In quake use
  - Open network
  - Victims searching
    - Using microphone and infrared sensors, etc.
  - Victims information transfer
    - Using Ad-hoc network

Collaboration between IDC-Rs in home network





Main IDC-R server (rescue communicator)
Earthquake (tilt) detection
Transmission activation signal to 3 terminals
Transmission voice data to rescuers or blimp.

Terminal IDC-Rs
Voice playback and recording
transmission voice data to server

Main IDC-R server (rescue communicator)
Power-cut detection
Transmission activation signal to 3 terminals
Transmission voice data to rescuers or blimp.

Terminal IDC-Rs
Voice playback and recording
Transmission voice data to server

Global and Local Victims Search

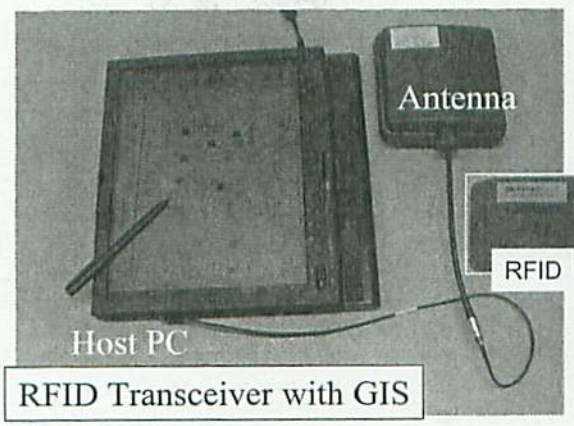
- Global Victims Search
  - to decide target rubble for rescue staff deployment.
  - Wide area (km~), thousands of sensors.
  - High expansion of social infrastructure is needed.
- Local Victim Search
  - to survey of victims location and how to rescue.
  - Small area (~100m), a few sensors
  - Available with a low cost
- At first global search, and then local search
  - using common Rescue-Communicator system

RF-ID based emergency information collecting and delivery system

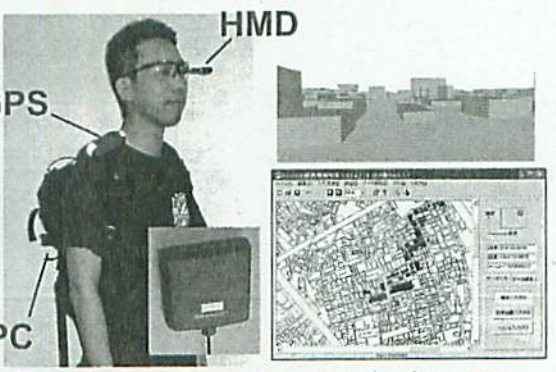
Nat'l Inst. of Info. And Comm. Tech. (NICT)

Disaster Information Collection Using RFID Transceiver and Ad-hoc Network

Means to collect information on damage and states of people using intelligent devices and networks to determine strategies for rescue in disasters.



RFID Transceiver with GIS



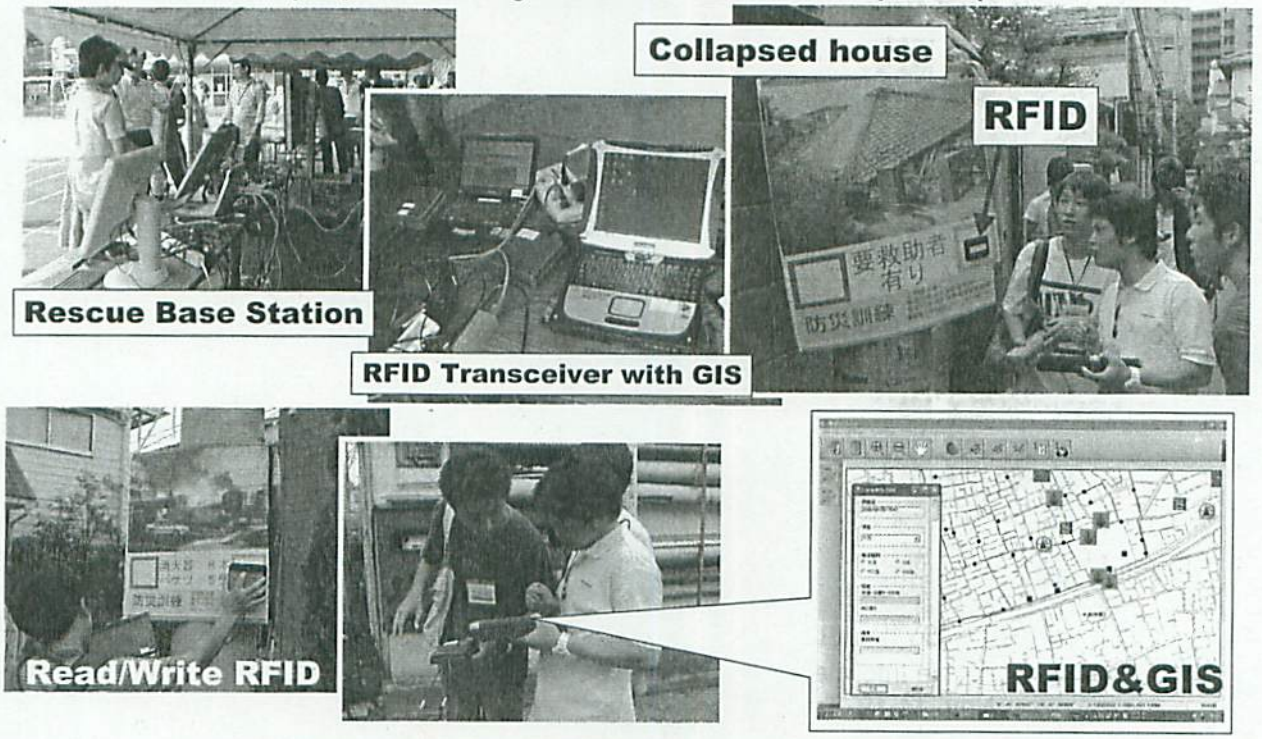
Example of equipment being worn.

A portable microwave receiver/transmitter that reads/writes information from/ onto long-range, battery-less RFID tags that are placed along roadsides. The tags store disaster information, e.g. inspection of damaged buildings.

RF-ID based emergency information collecting and delivery system

Nat'l Inst. of Info. And Comm. Tech. (NICT)

Field Experiment at Disaster Prevention Training Day
(Sep. 4 in Tokyo and Nov.20 in Aichi, 2005)



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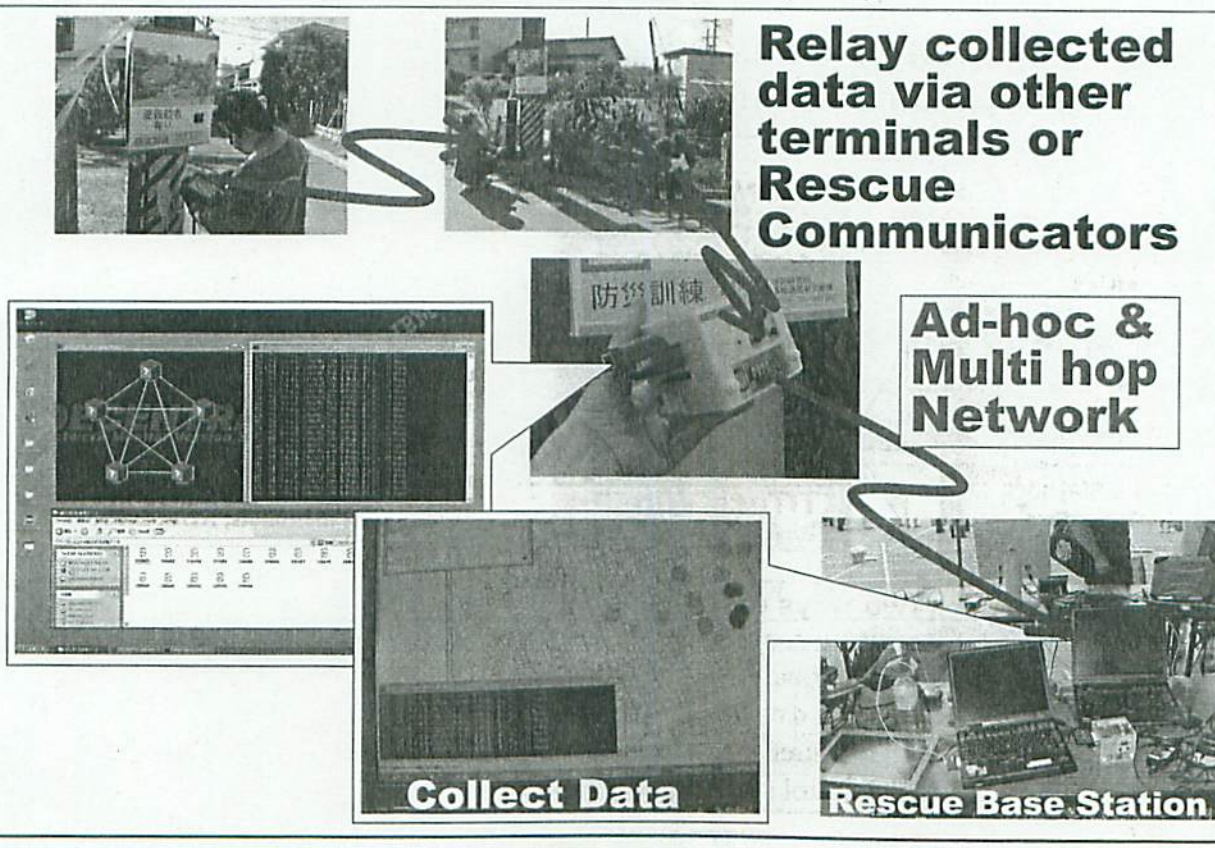
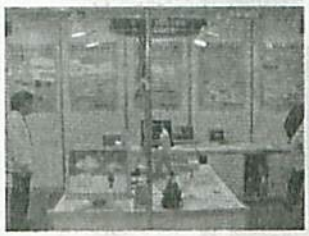
Nat'l Inst. of Info. And Comm. Tech. (NICT)

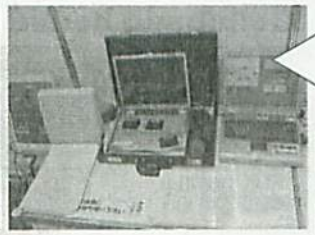


RF-ID based emergency information collecting and delivery system

Nat'l Inst. of Info. And Comm. Tech. (NICT)

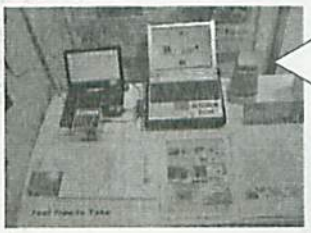
Our research activities have been introduced in major international conferences and many domestic exhibitions in 2005.





The United Nations World Conference on Disaster Reduction, Jan.18-22, Kobe, Japan.

6th APEC Ministerial Meeting on Telecommunications and Information Industry, May 29 – Jun. 3, Lima, Peru.



7th International Conference on Ubiquitous Computing (UbiComp), Sep. 11-14, Tokyo, Japan.

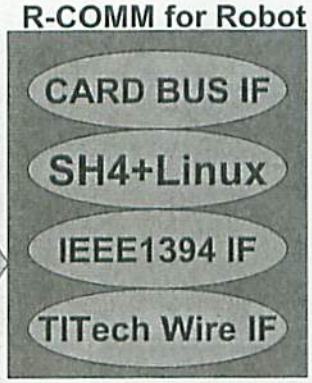
The World Summit on the Information Society, Nov. 14-19, Tunis, Tunisia.

Rescue Communicator as Robot Controller

•R-COMM can be regarded as the device sending the information acquired by robots to GIS server

Original R-COMM

R-COMM for Robot



CARD BUS IF: giving high expandability to add various function; USB, Wireless LAN(54Mbps)

IEEE 1394 IF: controlling image acquiring device such as camera.

TITech Wire IF: giving high expandability to add function to control the robots; ADC, DAC, Counter, Motor Drive…

Two ways of installation

- As a controller : R-COMM controls robots and sends the acquired information to the GIS server
- As a data logger: R-COMM hooked to sensor data lines sends the acquired information with the least change of the conventional control system

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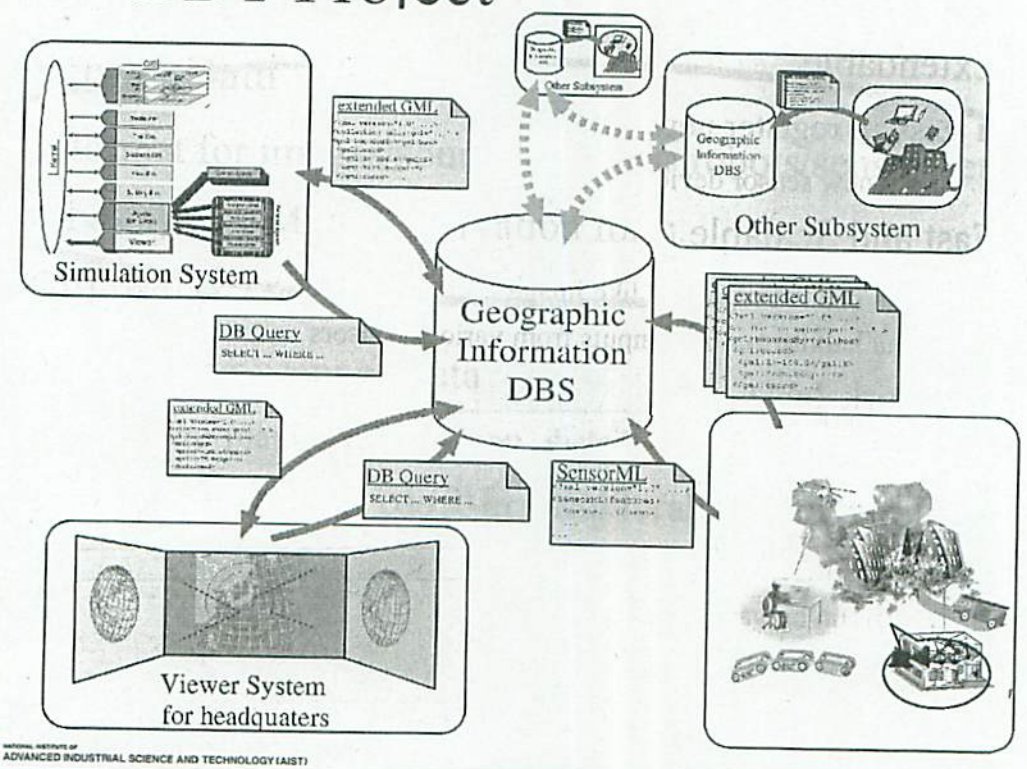
System Overview of DDT Project



AIST National Institute of Advanced Industrial Science and Technology (AIST)

22

Our Goal

- To develop common framework for ...
  - robust networking
    - wireless communication
    - ad-hoc networking
  - flexible information-sharing
    - geographical information system (GIS)
    - common network protocol

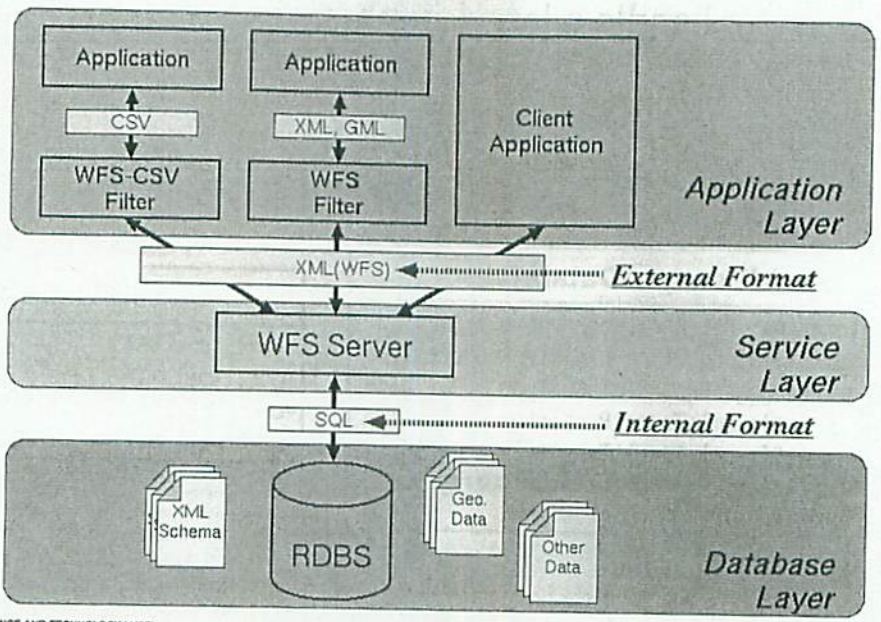
DaRuMa/MISP

DAtabase for RescUe MAnagement /
Mitigation Information Sharing Protocol

- Extendable
  - easy to register new data format
    - for new sensor device, robots, ...
- Fast and Scalable
  - can handle large data like image
  - can handle multiple inputs from various sensors
- Network-base
  - soft integration of robots and information systems
- Various Standards / Platform-free
  - can utilize existing tools
  - can run on various OS/hardwares
  - easy to port to new platforms.

DaRuMa Overview

- DaRuMa:
  - ↗ DAtabase for RescUe MAnagement

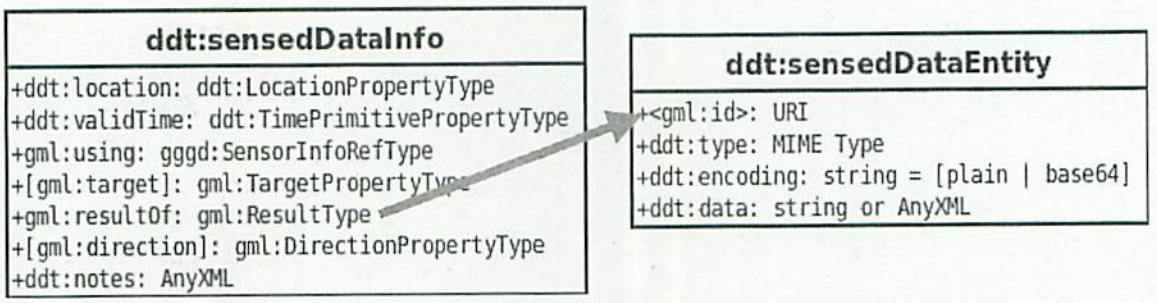


Standard Templates

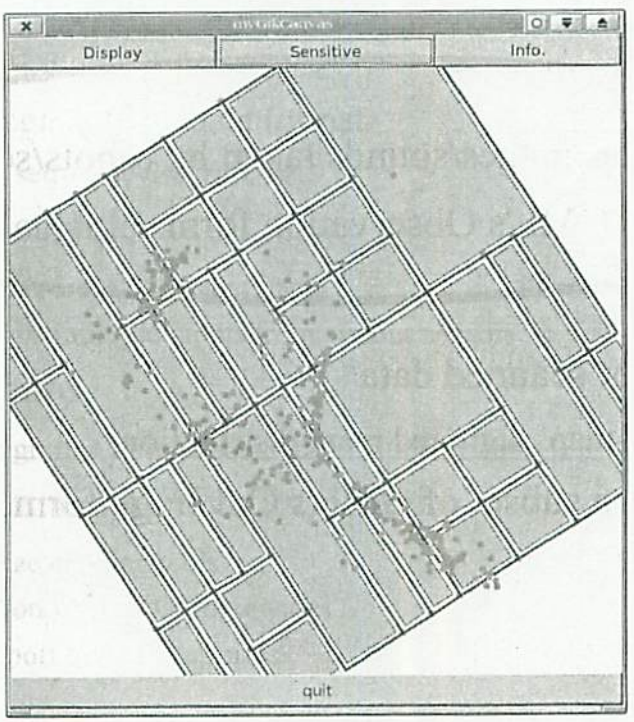
- Sensor Data
  - ↗ format for images/sounds taken by robots/sensor networks
  - ↗ based on GML's Observation form.
- Coverage
  - ↗ format for scanned data
    - thermo-map, digitized map, distribution, ...
  - ↗ based on a subset of GML's Coverage form.

Sensed Data Format

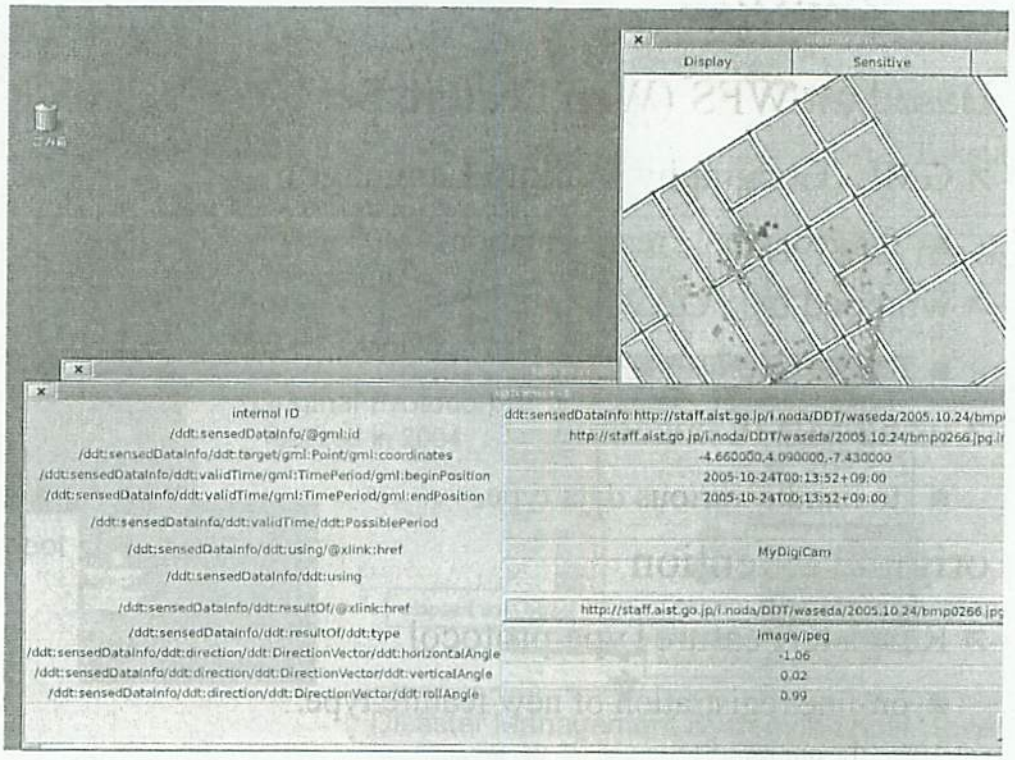
- Separation of meta information and data entity.
  - ↗ easy to handle a large number of sensor data



Demonstration



Simple Viewer (feature info.)



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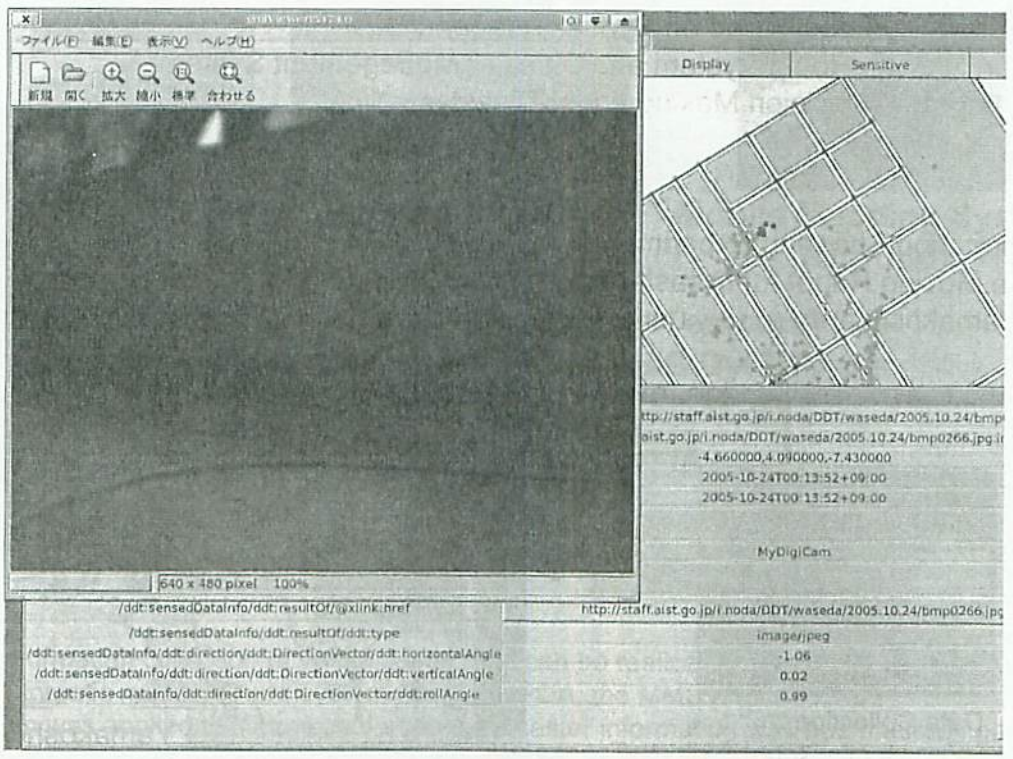


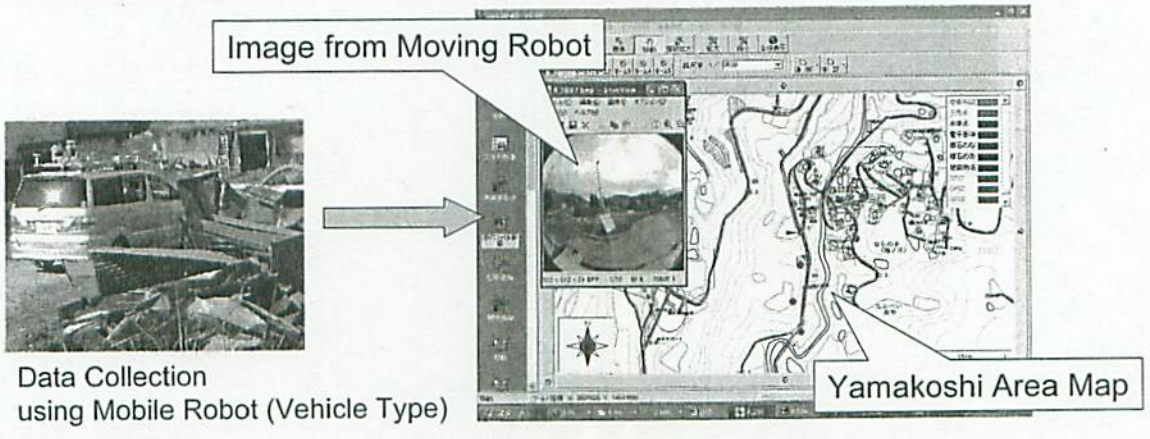
MISP: Mitigation Information Sharing Protocol

- Based on WFS (Web Feature Service)
  - ↗ GML (Geography Markup Language)
    - for geograhpic representation.
  - ↗ wrapped by SOAP
    - for flexible web service
  - ↗ using MIME encoding
    - to handle various data type.
- original extention
  - ↗ ResgisterFeatureType protocol
    - on-line registration of new feature type.
      - for plug-and-play.

Spatial Temporal GIS Group (Michinori Hatayama, Fimitoshi Matsuno)

Main Scheme
Information Shearing based on Spatial Temporal GIS
between Rescue Robot System and Disaster Management System
-- for Integrated Decision Making under Disaster

Issues
(1) Information Shearing Experiments
from Moving Robot for Disaster Information Collection to Spatial Temporal GIS
in Yamakoshi area (Heavy Damaged Area at Niigata Chuetsu Earthquake, 2004.10.23)



Data Collection
using Mobile Robot (Vehicle Type)

(2) Developing Information Exchange Software based on MISP (now ongoing)

PDA

(MISP)
realized in Waseda Group in 2005

DaRuMa

Rescue Robots

Simulators

III-1-1 Takeuchi Gr.

(MISP)
ongoing

(MISP)
on going

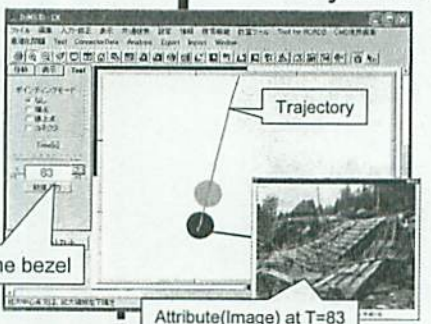
KIWI+

Spatial Temporal GIS Format

DyLUPAs

(Original Protocol)
realized in 2004

Mobile Robot



Disaster Management System in Local Government

III-1-2 Kakumoro Gr.

Ground and Aerial Information Collection System for Spatial Temporal GIS

PDA (Person)

Aerial robot (UAV) (Air)

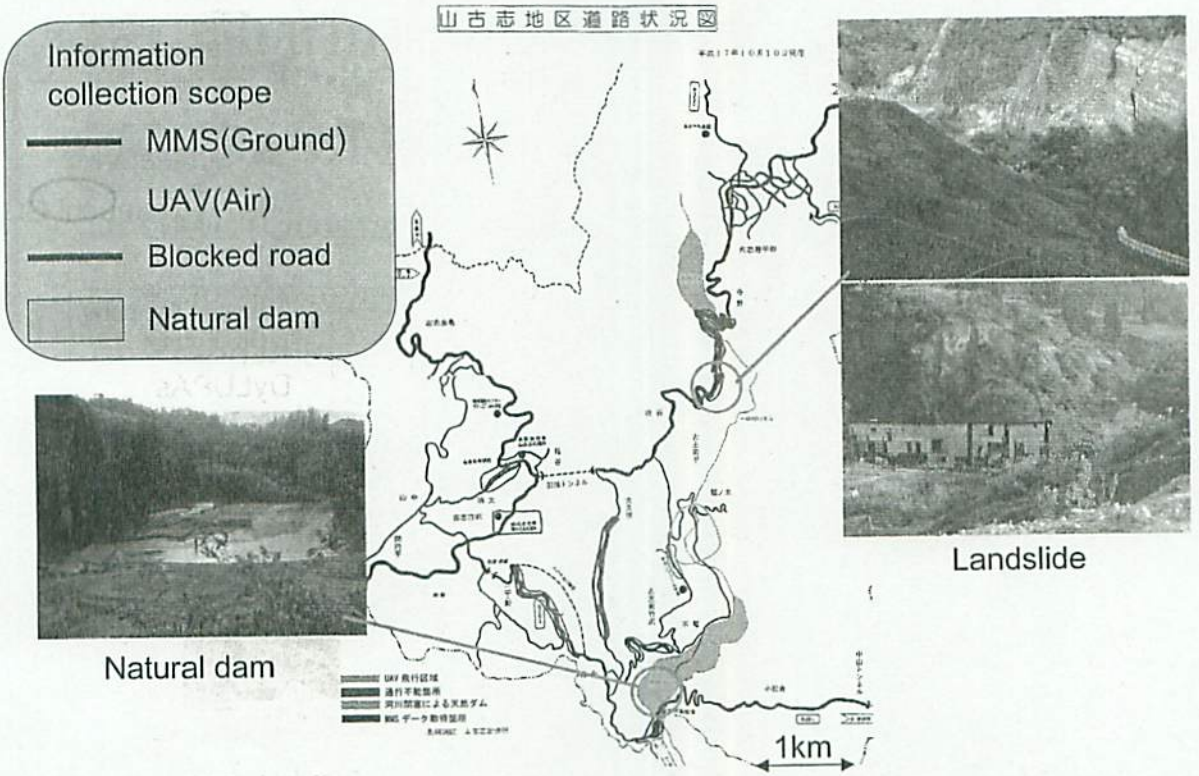
Mobile Mapping System (Ground)

Database based on the MISP (DaRuMa)

Spatial Temporal GIS (DIMSIS/DyLUPAS)

Efficient information collection of vast disaster field can be realize by the cooperation of Air / Ground automatic measurement system using the PDA, the MMS and the UAV.
This system was applied to Yamakoshi and vast disaster information was automatically gathered and updated in "Spatial Temporal GIS(DIMSIS)".

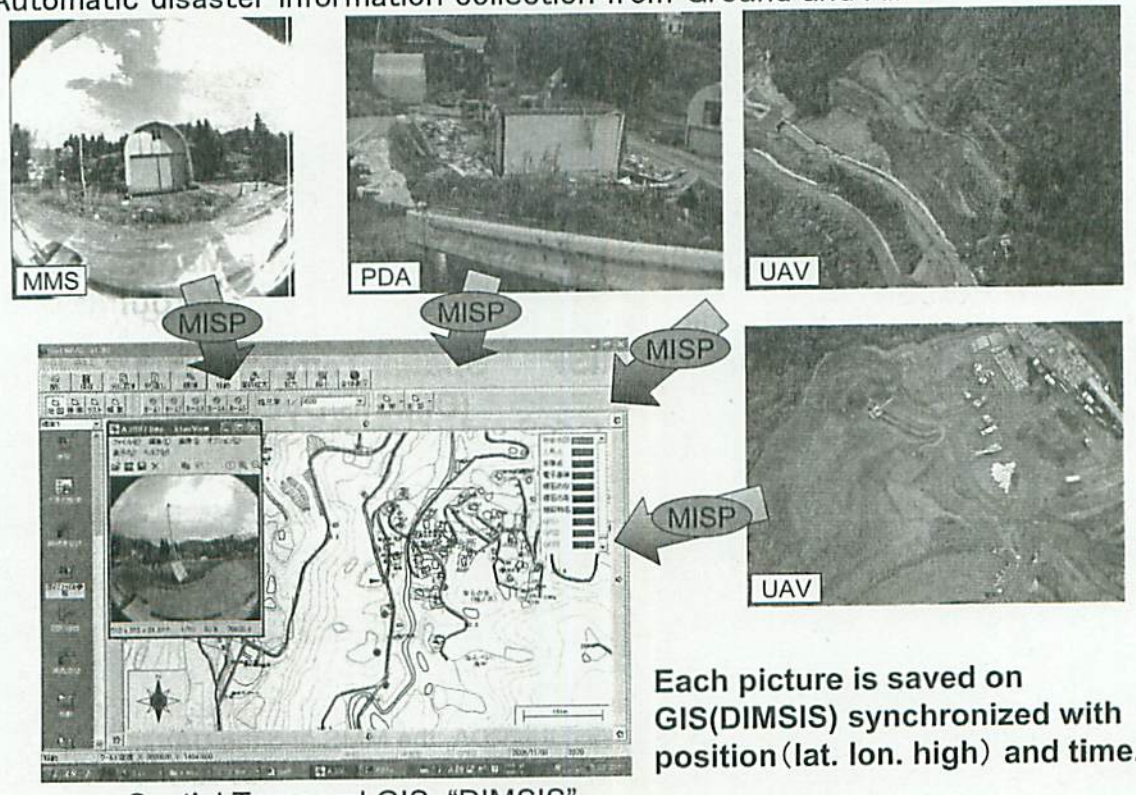
Disaster information gathering experiment at Yamakoshi



Location based images were collected at Yamakoshi in 10th November.

Experimental Result

～Automatic disaster information collection from Ground and Air～

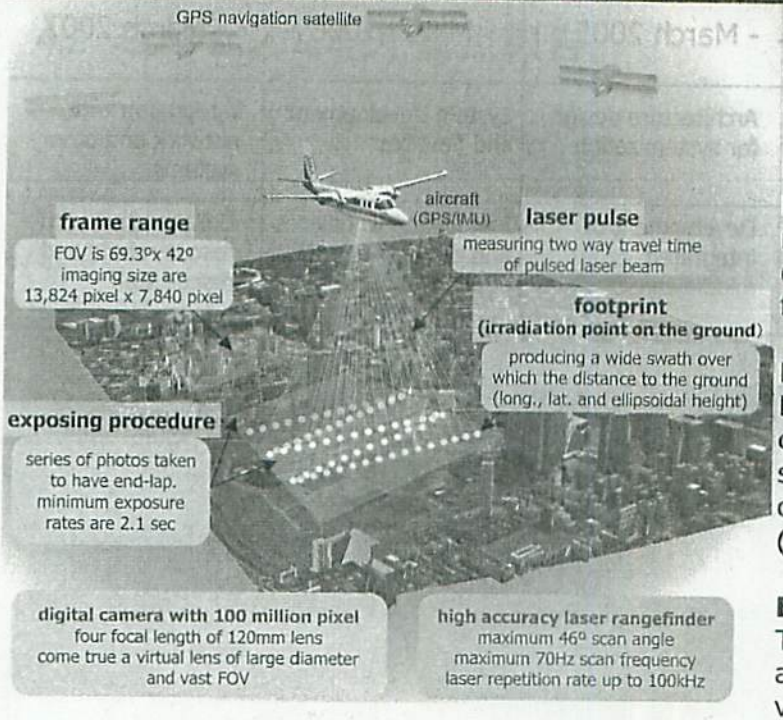


Spatial Temporal GIS "DIMSIS"

Each picture is saved on GIS(DIMSIS) synchronized with position（lat. lon. high） and time.

Construction of urban 3D model by the next day

Asia Air Survey Co., ltd.



To detect disaster damages
Comparison between before and after data of 3D urban model.

Equipment on the aircraft
Laser rangefinder and high-resolution digital camera mounted over an opening in the aircraft floor.

Mapping at ordinary time
Both heights and images of collapsed buildings, housing units, sagged roads, and other features over downtown Kawasaki City (figure in left).

Expected effect
These activities will reinforce other activities conducted by emergency vehicles or rescue robots.

Emergency initial response at Niigataken Chuetsu Earthquake

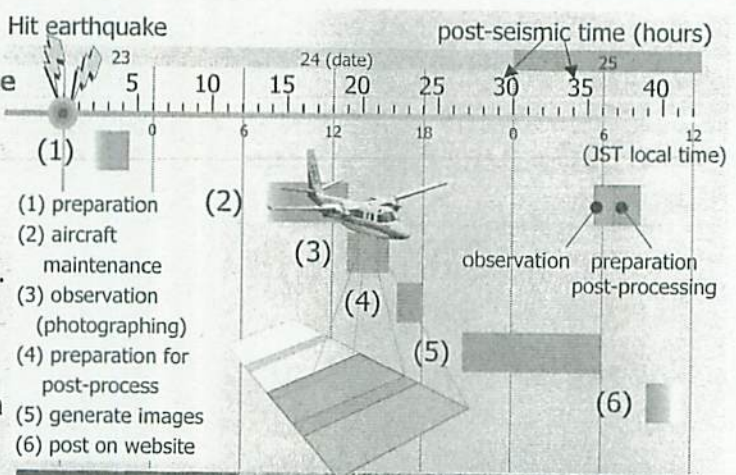
Initial response
Five observations on the next day.

Aerial camera system
1 digital, 4 film-based analog camera.

Advantage on digital system
Film-free system brings benefits to post-flight workflow, which will lead a much time saving.

Flash-report on our own website
40 hours after the disaster (this time). Aim for 12-18 hours after the disaster in the future.

Versus other platforms
No match for the helicopter in mobility and swiftness, however it's ability obtaining large area in a short time which is compare favorably with satellite job.



Kajigane landslide, Nagaoka (former Yamakoshi), Niigata Pref. at Oct. 24, 2004

Future plan

	- March 2005	- March 2006	- March 2007
(a) Development of a device for gathering and distributing information	Architecture design for systemization	System development and field test	Integration with network and other systems
(b) Formation of a dynamic network, and development of a means of disaster information communication	Development of integrated middleware	Installation to devices and development of application	Collaboration with rescue robots and rescue staff

International Rescue System Institute