RoboCupRescue 2006 - Robot League Team <Toin Pelican (Japan)>

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Abstract. This document describes the "Toin Pelican" entry into the 2006 RoboCup Rescue competition. We will operate three robots by teleportation at the competition: All robot have six shape changeable type crawlers. The robot is originally assumed to be used for reconnaissance operation of underground town after big earthquake. It can be expected that participation with this robot will be a good opportunity to evaluate its ability through the view scope of the RoboCup Rescue competition.

1. Team Members and Their Contributions

Please use this section to recognize all team members and their technical contributions. Also note your advisors and sponsors, if you choose.

- Eiji KOYANAGI — Team leader, Mechanical design
- Yoshiyuki OBA — Operator
- Jun KATO — Controller development
- Naoya SAKURADA
- Tomoaki YOSHISA
- Yasuo HAYASHIBARA

2. Operator Station Set-up and Break-Down (10 minutes)

When rescue activities are developed in the stricken area, and it is demanded that equipment goods are miniature, light weight, and excellent in carrying.And, the loss of the setup time is thought to be fatal by the rescue activities. Equipment except for the robot's own of our team is as follows.
1) Notebook PC: four units
2) Joy pad controller: four units

3) Adapter for the wireless orchid: two units

3. Communications

Three years ago, we joined the F180 league of RoboCup Japanese opening. At that time, because 802.11B (2.4GHz) was being used for the communication system, it did an experience that a robot couldn't control it at all. Because of this, the state of communication which became stable by using 802.11A (5.2GHz) could be secured at Lisbon.
This time, it is two methods that we make preparations.
One is the wireless orchid of 802.11A with the actual results. The other one is Ethernet 100Mbps of the cable. As for the cable form, reliable transmission and reception are possible though there is a problem of the handling of the wire. Specially, when search activities in the large-scale underground market are presumed, the range that a present wireless system functions is limited to very few areas. On the other hand, it may be buried in the debris, and the cable wound around the drum may be stuck, and collection may be difficult. In this case, if it is the possible range of the radio communication, a drum is given up, and only rescue robot thinks that it returns, too.

Rescue Robot League		
Toin Pelican (Japan)		
MODIFY TABLE TO NOTE ALL FREQENCIES THAT APPLY TO YOUR TEAM		
Frequency	**Channel/Band**	**Power (mW)**
5.0 GHz - 802.11a		
2.4 GHz - 802.11b/g		

4. Control Method and Human-Robot Interface

The control of the robot uses the joy pad of Fig-1. Joy pad is easily controllable robot control device. Because the joy pad is commonly used to play a game, obtaining is easy. The operation screen of the robot is Fig-2.All sensor information necessary for the control on the operation screen is presented for the operator. The operator can operate the robot by the game sense on this operation screen. Robots that we developed are common control all interfaces. Therefore, even if it is a different robot, the operator can control easily. Also, the map generation is done in autonomy.

Fig-1 Joy pad and Laptop PC

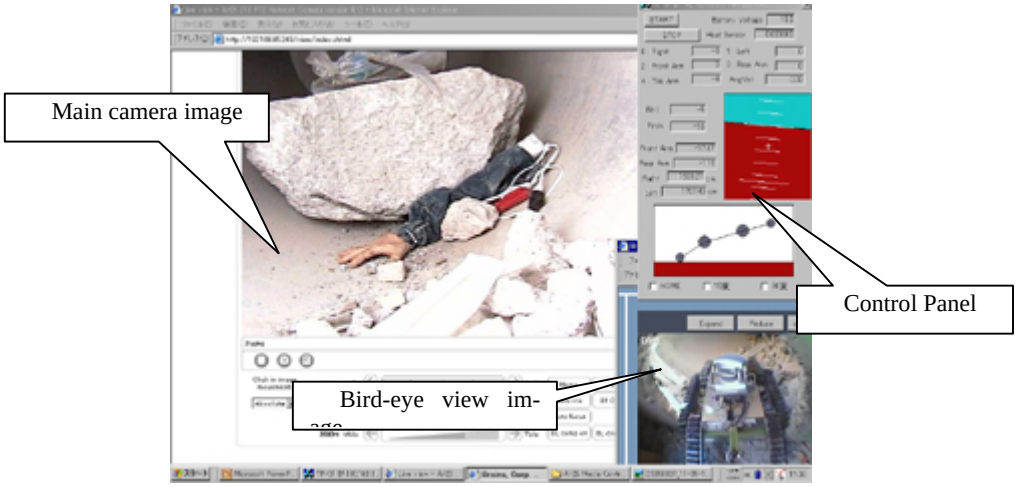


Fig-2 Operation screen

5. Map generation/printing

We can make 2D environmental map as it is semiautomatic.
Also, making a simple 3D environmental map is possible by the change of the posture of the robot.
But, the semiautomatic map generation is large the operator's load.
Also, there is a problem that the generation of 3D environmental map cannot be executed while moving.
The system that generates 3D environmental map in autonomy in consideration of the above-mentioned problem is developed.
It is necessary to rotate the scanning plane to generate 3D environmental map.
As for the distance data with the object, when the sphere is scanned with the laser range sensor, the error margin grows toward the side of the robot.

We let you do precession movement of a laser range sensor to make 3D environment map.
We can scan 3D space of a wide range by precession movement uniformly. The map is generated automatic based on obtained information.

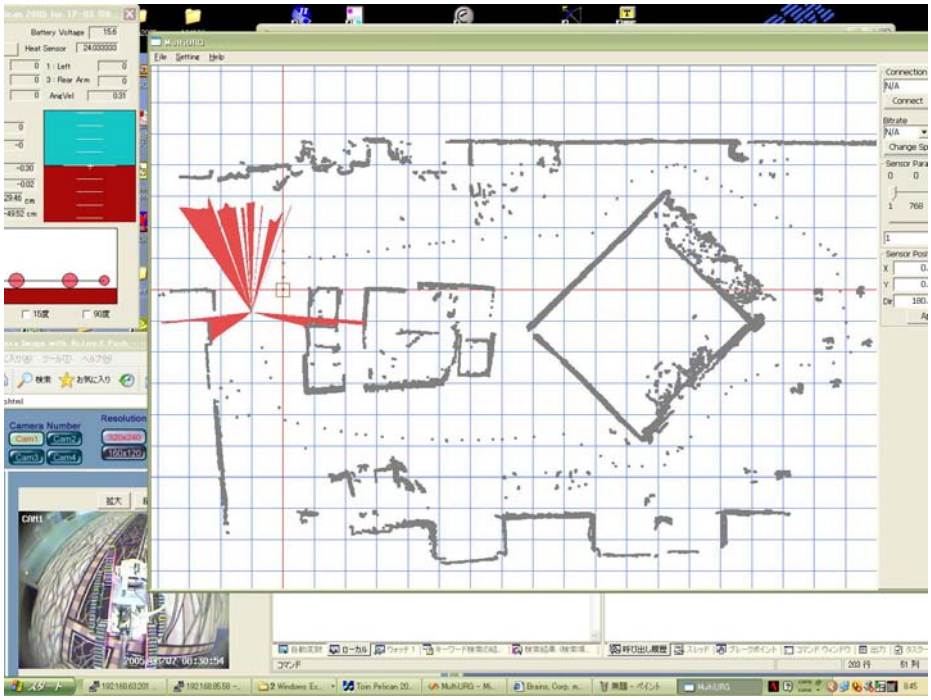


Fig-3 2D environmental map

6. Sensors for Navigation and Localization

6.1 Sensors for Navigation

1) Rotary encoder: the movement speed of the robot
2) 3 ch gyro sensor: The rolls of the robot, a pace and an angular velocity on the corner of yaw are detected.
3) 2 ch angle of inclination sensor: The posture of the robot is detected.
4) The front monitoring camera: The environment of the running way is confirmed.
5) Back monitoring camera: The watch of the communication cable and the environment of the running way in the younger person are confirmed.

6.2 Sensors for Localization

1) Rotary encoder: Running its personal history is acquired.
2) Laser range sensor: building of the three-dimensional environment map
We purchased the very compact laser range sensor which could be carried on the

miniature mobile robot. And implementation is being held at present.

7. Sensors for Victim Identification

1) Stereophonic vision: The conditions of the victim, distance information are recognized by the sight.
2) Themopile detector: The temperature which the victim appears on is detected.
3) Thermography : The temperature which the surface victim appears on is detected. In comparison with the information on Themopile detector a source of heat of the wavelength which is different from the human body is deleted.
4) The wide microphone of pointing: the sound which the victim it thought to be in the neighborhood of the robot started to signal is detected.
5) The small microphone phone of pointing: a source of occurrence is confirmed from the detected sound signal, the victim.
6) Carbon dioxide sensor: Though it will be carried, a model is being selected at present. And, the selection of the model is being done at present.

8. Robot Locomotion

We are developing the robot which has three different crawler systems.
The first is a model (TP03) of six shape changeable type crawlers used in RoboCup2005.TP03 has the flipper crawler front and rear, and has a high movement performance. Also, TP03 has the high-speed movement mechanism, and it is possible to move at a speed of 2[m/s] on smooth ground.
The second is model (TP05) of the waterproof type.TP05 can run depth of water 10m.Also, with the easy, passive type flipper crawler of detaching; it has a very high situation responsive capability.
The third is very small six shape changeable type crawler model (TP07).The basic structure of TP07 is the same as TP03. Therefore, it has a high movement performance though TP07 is small. Also, the invasion to the tight space is as easy as the snake type robot.

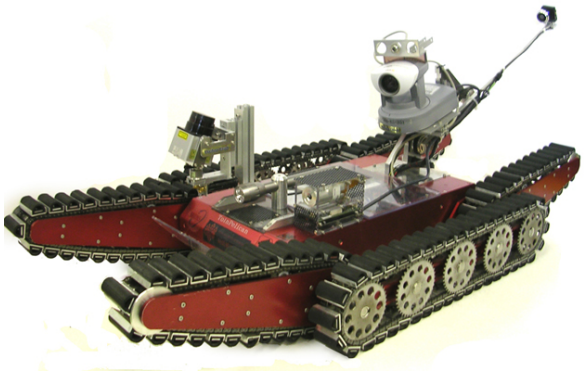


Fig-4 TP03

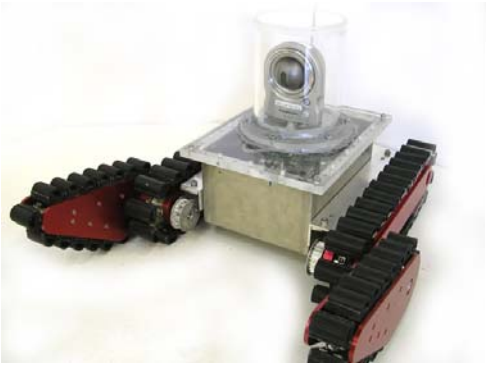


Fig-5 TP-05

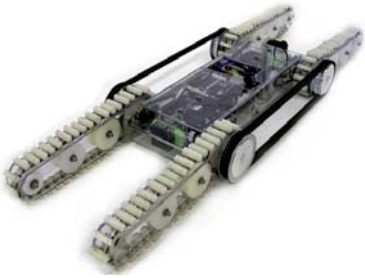


Fig-6 TP-07

9. Other Mechanisms

About 1DOF camera arm.TP03 has the 1DOF camera arm. The main camera and the bird's-eye view camera are mounted in the camera arm. The bird's-eye view camera functions as a rear camera when the angle of the camera arm is changed.

10. Team Training for Operation (Human Factors)

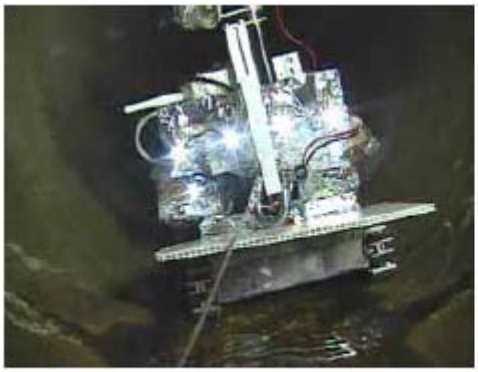
Our system is very simple, and it can operate a robot with a game sense. Information such as an angle of inclination of the necessary robot is indicated on the operation screen for the operation.

Vivid image information makes the discovery of the point victim easy with the operation, too. On the other hand, a response gets bad when the delay of the communication occurs.
Training should be necessary the operation that this time delays occurred.
Well, though it is the plan of the training, I want to prepare the field which is a simple target within the campus. The operation practice of the robot is done in the experiment field prepared in the campus.

Fig-7 experiment field

11. Possibility for Practical Application to Real Disaster Site

A large-scale earthquake disaster appeared on Japanese Niigata Prefecture October 21, 2004.
For about two weeks rest, we visited a stricken area, and did the damage conditions investigation of a drain pipe to lay underground. Rescue robot used for this investigation participated in the RoboCup of two years ago.
A robot was equipped with the lighting machine and the camera to investigate in the spot. And, the waterproof management which was an urgent target was given, too.
The damage of the part of the joint of the pipe way was discovered as a result of the investigation. Rescue robot proved that it was useful for not only the lifesaving but also the restoration support activities after that by this.



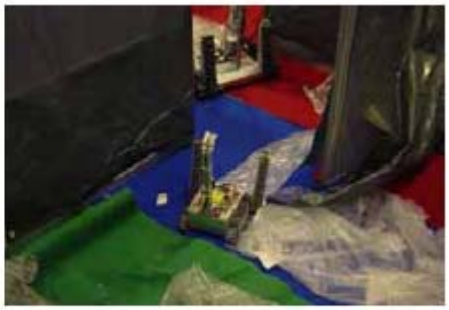


Fig-8 Rescue robot which probes a sewer pipe

Fig-9 Lisbon yellow arena

12. System Cost

At present, there are a few things which we can introduce to the public very much. But, all equipment will be equal at the end of March.
From now on, after system construction is finished, we will introduce all the information which contains the drawing of the robot to the public on the homepage.

http://www.cc.toin.ac.jp/haya-lab/