RoboCup – US Open 2005

Rescue Robot League Competition

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Toin Pelican

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1. Team Members and Their Contributions

• Team Leader	Eiji KOYANAGI
• Operator	Yoshiyuki OBA
•	Masaya HIKOKUBO
• Mechanical design	Ryou FUSHIMI
• Controller development	Tomoaki YOSHIDA
	Mitoko NAKAJIMA

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 unit
2) Joy pad controller : four unit
3) Adapter for the wireless orchid : two unit

3. Communications

Two 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		
TEAMNAME (COUNTRY)		
MODIFY TABLE TO NOTE ALL FREQENCIES THAT APPLY TO YOUR TEAM		
Frequency	**Channel/Band**	**Power (mW)**
5.0 GHz - 802.11a		

4. Control Method and Human-Robot Interface

The basic experiment of the autonomy movement is being done to reduce the burden of the operation staff.
A self-position can be estimated by odometry when it runs through flat

Fig-1 Small type

ground with the mobile robot which used a wheel.
On the other hand, a result to show in the figure – 1 can get it by the autonomy movement of the mobile robot which used crawler.
The moving distance error of the mobile robot with crawler is bigger than the robot with wheel though it is the corridor of the flat inside.
It predicable that an error grows big in the debris due to the slip and so on.
At present, an autonomy movement due to the fusion of odometry and the laser distance sensor is examined.
The controller which shows it to the robot during the development shown in the figure -1 in the figure – 2 is carried.

Specification of the Electro Circuit▼

Size 120mm x 120mm
CPU Renesas Technology SH-4 (200MHz)
ROM Flash Memory 4MB (8MB)
RAM SDRAM 32MB (64MB)
OS NetBSD (UNIX Compatible)
Software WWW Server, Mail Server/Client, PPPoE, ▼DHCP Client/Server, VPN
LAN 100Base-T
Serial RS232C x 1ch (Console)
CF Card Slot x 2 CF(32MB) x 1, Wireless LAN/Other x 1
2.5”HD Connector x 1
I/O 120pin High Speed Extended 32Bit Bus (100MHz)
Motor Driver SGS LC6203 x 6ch (Generating Pulse by FPGA)
Kick Device Applying High Voltage Condenser (450V)
A/D Converter MicroChips MCP3208 (8ch)
Gyro Sensor Murata ENC-03J (Max. 300deg/sec x 3ch)
Acceleration Sensor Analog Devices ADXL202
Video Capture CONEXANT Bt829B (4ch)
Power Supply DC9-20V

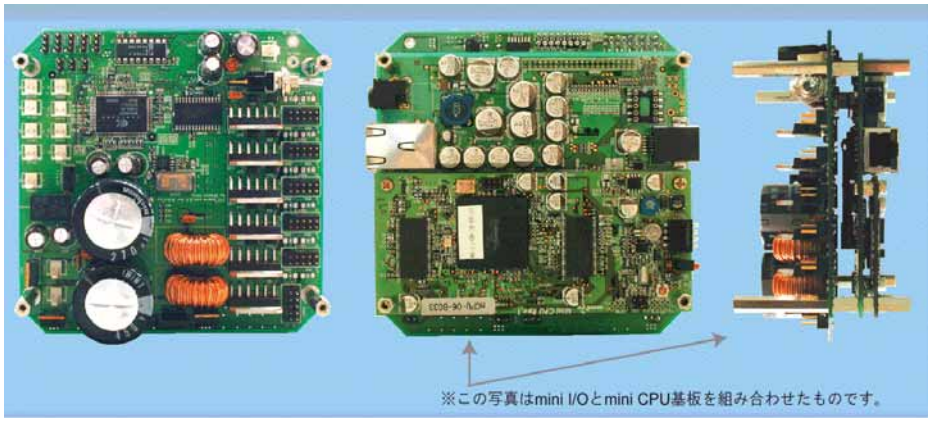

Fig-2 Robot controller

A robot is operated by the joystick which showed it in the figure -5, and

4 DOF sensor head is operated by the joy pad by the actual operation.

Figure -3 A joystick for the robot control and a joy pad for the manipulator control

5. Map generation/printing

At present, the technique of SLAM (Simultaneous Localization And Mapping) [1] is realized with building of the environmental map and the estimation of the self-position in the two-dimensional environment. The sensor information which it got newly with the well-known three-dimensional environment information is compared, and correlation operation is done, and we are developing the technique to estimate a current position for the three-dimensional environment.
Building of this three-dimensional environment map and self-position estimation are realized by the next process.
1) A robot is made to run from the place where a three-dimensional environmental map is being built.
The environmental map being built is called a global map here.
2) A fixed distance makes a robot run.
3) A laser range sensor is scanned, and it gets three-dimensional distance information.
4) A local map is made from the data which it got.
5) The correlation of the global map and the local map is taken.
6) The self-position of the robot is estimated in the top of the global map.
7) Information on the local map is added to the global map based on the estimated self-position.
8) The movement of the 2)～7) item is repeated.
Many memories and the computer power are necessary to build a three-dimensional environment map.

There is DEM (Digital Elevation Map) [2] as a technique of the environment expression of the un-leveling of land.
On the other hand, the inside of the building which collapsed is the space closed by the wall which crumbled, the beam, and so on.
So, Sphere-DEM [3] is used from the distance information to scan a laser range sensor and which it can get directly, and it is the plan to build a three-dimensional environment map.
9) And, a made map can be printed through the printer.

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 roll of the robot, a pace and an angular velocity on the corner of ヨー 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) The stereophonic vision carried on the 5 DOF manipulator : A running way from the high position and the condition of robot is 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

We get the information of the victim by the multi-sensor head carried on 4 DOF manipulator from the various position, postures.
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 making the model which has four different movement forms.
One is the new model of 6crawler which won the championship at Lisbon convention of last year.fig-4
A miniature type has a passive flipper arm though it is 6 crawler type.
This robot has a waterproof function.
If it is a cable form, even the depth of water 10m can run.
The robot of the snake type is making penetration into the small place easy.
The robot of the wheel type which has a planet wheel has the role to support the operation of the robot.

Fig-4　6crawler type (Lisbon Red arena)

9. Other Mechanisms

4 DOF manipulator (figure –5) which a multi-sensor head was carried on
This mechanism is being developed for the purpose of the discovery of the victim and the information gathering for running of the robot.
The free occasion of the manipulator is as the next.
1) Turn base
It is equipped on the sliding mechanism.
HarmonicDrive is used with ±200degree in the operating range.
2) The first arm
It is the arm of the length 300mm.
HarmonicDrive is used with ±120degree in the operating range.
3) The second arm
It is the arm of the length 300mm.
HarmonicDrive is used with ±120degree in the operating range.
4) Turn head
A multi-sensor head is installed on the tip.
An operating range is driven by DC motor　with ±200degree.

Figure –5 4 degree of freedom manipulator which has a multi-sensor head

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 delay occurred.
Well, though it is the plan of the training, I want to prepare the field which is a simple target within the campus.
So, after fundamental practice is finished, it considers going to the real experiment field.
An experiment field is in Kawasaki and Kobe, and that is used, and the training of the verification of the fundamental performance of the robot and the operation staff is given in Japan.

11. Possibility for Practical Application to Real Disaster Site

A large-scale earthquake disaster appeared on Japanese Niigata Prefecture last October 21.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 last year.
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.

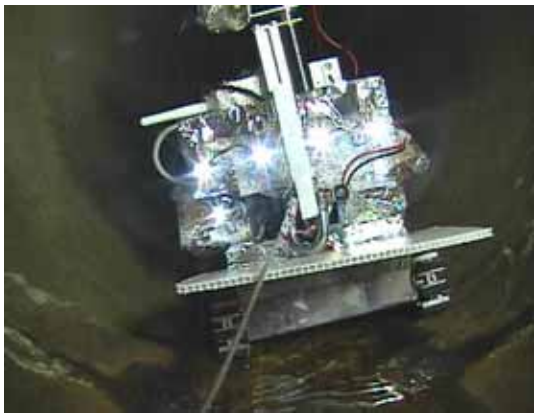

Fig Lisbon yellow arena

Fig Rescue robot which probes a sewer pipe

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.

References

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［3］T.Yoshimitsu, T.Kubota, I.Nakatani Path Planning for Exploration Rovers over Natural Terrain Described by Digital Elevation Map. Journal of the Robotics Society of Japan,18,7p.1019-1025(2000)