RoboCupRescue 2006 - Robot League Team <NuTech-R(Japan)>

Wong Choon Vui[1]

[1] Nagaoka University of Technology
1603-1 Kamitomioka
Nagaoka,Niigata,Japan

alexwong@stn.nagaokaut.ac.jp

Abstract. Front and rear sub-crawler type USAR robot, which is similar to RobocupRescue Robot League(RRRL) 2004-5 champion TOIN-Pelican, is newly developed this time. The robot is designed with waterproof level of IP-*4. The operation system is a wearable type, which wins the 3rd place design awared RRRL 2005. The combination proposed here will provide good robot mobility and good mobile operation. Optimization of crawler shoes are also carried out.

Introduction

We have been improved the rear sub-crawler type robot aiming at the stairs. We understood difficult that the rear sub-crawler type robot adapts to unleveled land in the running test repeatedly. Then, we are developing the robot (Nutech-R3) that aims at climbing unleveled land possible by arranging a sub-crawler at the front, back, left and right now.

Moreover, it thinks that prevent the robots from moving against operator's intention when there is an unexpected input to the operation board something knocks operation board and operator drops by the aftershock. This is the concept of safety joystick. It prevents the second disaster from being caused by the rescue robot, and our team develops the safety operation board. In addition, we are developing special carrying case and a mobile attachment to the safety joystick for practical use.

1. Team Members and Their Contributions

- Wong Choon Vui — Team leader
- Toshiko KIYOHARA — Operator
- Shiro YAMADA — Controller development
- Youhei UKAI — Mechanical design
- Kazuya MIYAGAMI — Mechanical design
- Masayuki NAKANISHI — Mechanical design
- Keiishi SHIMODA — Mechanical design

- NAGAOKATEKKOUSEIKEN Sponsor
- ORIENTAL MOTOR Sponsor
- Tetsuya KIMURA Advisor

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

Our operating system aims to use in rescue site. We will take a carry box to operating station, and our system is set up in the box before. We can finish setting up with three steps. One is that connecting LAN cable from a robot. Another is that booting computer. The other is that checking system. Therefore, the set-up and break-down needs a few minutes.

Details:
Our system is composed of the three items.

I1: Carrying Case (6kg)
I2: Controller board (2kg)
I3: Notebook computer (3kg)

Fig. 1 Operation board

3. Communications

The communication system for our robots is tethered mainly. Because radio communication is not so effective to control robots in real-time and obtain high quality image which requires a lot of data transmission. But in case of disconnecting LAN cable, we want to use radio communication too.

Rescue Robot League		
Nutech-R (Japan)		
MODIFY TABLE TO NOTE ALL FREQENCIES THAT APPLY TO YOUR TEAM		
Frequency	**Channel/Band**	**Power (mW)**
5.0 GHz - 802.11a	Following Japanese regulation	Following Japanese regulation
2.4 GHz - 802.11b/g		
2.4 GHz - Bluetooth		
2.4 GHz - Other		
1.2 GHz		
900 MHz		
40 MHz		
27 MHz		
<FILL IN OTHER>		
<FILL IN OTHER>		

4. Control Method and Human-Robot Interface

4.1 Control Method

Our robots are controlled by remote teleoperation. Based on the visual image and the distance information, the operator decides movement of the robot. It is controlled through controlling the motor power by the operator manually. Movement of camera on robot is controlled by operator in order to control position of the camera and zoom level (X16 zoom). The camera is a commercially available IP-camera.

4.2 Human interface

On site use is our main purpose of Human-Robot Interface, which is easy to carry, small and mobile. But carrying case is too large to mobile, and then we develop mobile attachment for operating system (Fig. 2). Using this, we can improve mobile performance according to the situation.

The own-made joystick controller has special feature, that is, it produces OFF signal for larger input (Fig. 3). Such large input could be happened when joystick hits something or the operator falls to floor.

Fig. 2 Mobile attachment

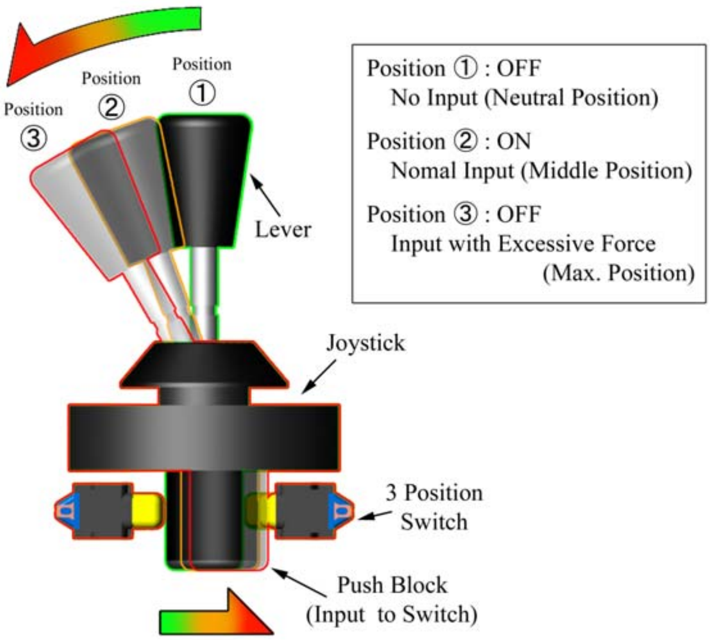

Fig. 3 joystick

5. Map generation/printing

The operator inputs the measured data to a CAD system manually. A mobile printer prints out the result.

We will use a Laser Range Finder and Ultrasonic Sensor in order to measure the distance, which improves map quality.

6. Sensors for Navigation and Localization

Visual sensors are used for navigation and localization. Our team is composed of two robots. Each robot's cameras see each other.

7. Sensors for Victim Identification

A color network camera with remote control of pan (plus-minus 100degree), tilt (-30 to +90 degree) and zoom (x16) or equilibrant is used.

In addition to the sensor described in section 5, an infrared-type thermometer will be installed front of our robot. By measuring temperature, we can examine the condition of victims.

8. Robot Locomotion

We are developing the robot that has two kinds of crawle, one is attached under body of robot to move. Another we call flipper is attached outside body to climb stairs and obstacles. It is similar to the TOIN-Pelican, but differs about wide crawler and that shoes have various shape rubbers to catch unleveled land. The former feature prevents body from being caught to the obstacles. The latter improves mobility.

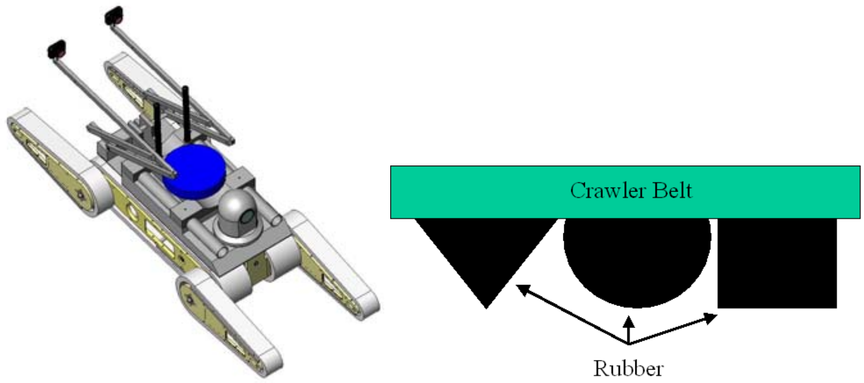

Fig. 4 Nutech-R3

9. Other Mechanisms

Considering use of outdoor, our robots have the waterproof level of IP-*4. The secret of robot is improved, the circuit parts can be protected from drop of water that flies from all directions.

Our team has two robots, where both robots have equilibrant mobility and have cameras that can watch each other. Such cooperation is the same as human rescue operation. Both robots are tethered so that the operation in order to avoid the wire confliction is difficult, but this would be overcome by the training of the operators.

10. Team Training for Operation (Human Factors)

10.1 Training to use our system

Our system is very simple and easy to understand the whole system. The human interface is also simple; a few minutes might be enough for training. However, the effective use of flipper, avoiding unexpected dump and wire confliction will need longer training.

The visual sensor (IP-camera) is our main sensor. In addition, by using the ultrasonic distance meter, the distance of any point in the visual image can be measured. This helps the operator to understand the environment in detail. This is carried out through GUI, so the operator can use it intuitively.

10.2 Cooperation

The operator's cooperation is necessary to make the rescue operation succeed. Then, it is practiced to take communications each other by using two robots.

10.3 Simulation

We are developing rescue simulation with using our system (Fig. 5~6). This can change the site and robots, we can practice various rescue operations. Though it’s developing now, and is not complete, we want to produce a past Robocup competition field in the near future.

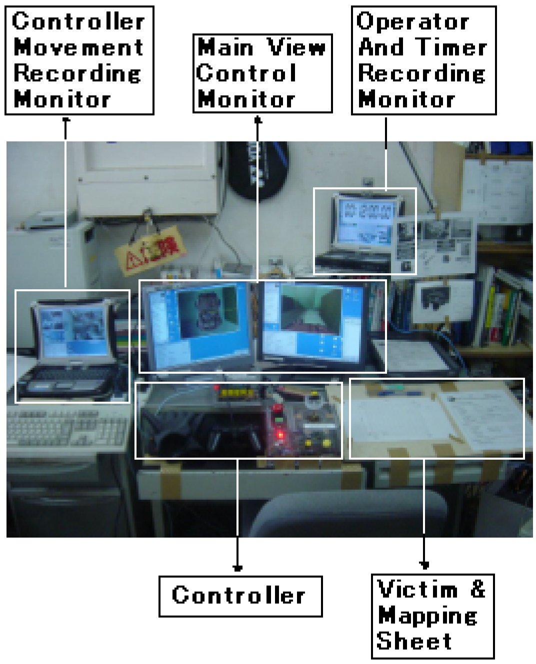

Fig. 5 Simulation system configuration

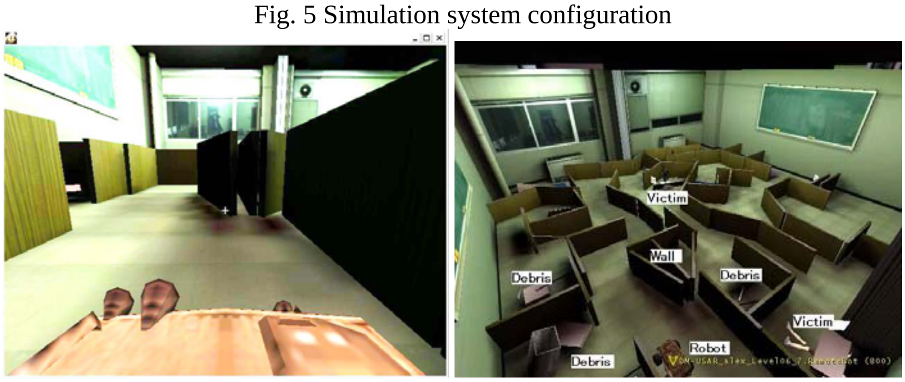

Fig. 6 appearance of simulation

11. Possibility for Practical Application to Real Disaster Site

The operation board with a safety joy-stick composed of three position switches, which avoid the robot reaction due to unintended command input, will be applicable to a real disaster site with minor modification because the main parts of the board is used in tough environment in many heavy industry factories, e.g., with oil, water and dust. According to our study so far, this joystick reduces the error to 13% and has 80% controllability comparing to a normal joystick.

12. System Cost

・ Crawlers: 30,000 yen, a standard product of TSUBAKIMOTO Co. http://www.tsubakimoto.co.jp/

- Visual sensor: 120,000yen Network camera KX-HCM180 of Panasonic
- Ultrasonic distance meter: 1,500yen
- Infrared thermometer: 2,000yen
- Three position switch: some thousand yen. IZUMI ELECTRIC Co. http://www.idec.com/

TOTAL SYSTEM COST (per robot): 500,000yen

References

1. Tetsuya KIMURA, Masahiro ISHIZAKI: Development of an Operating Board for Rescue Robots Considering Safety and Misuse of Operators. Proceedings of the 2005 IEEE International Workshop on Safety, Security and Rescue Robotics, (SSR2005), 66/68, (2005)