RoboCupRescue 2009 - Robot League Team <Pelican United(JAPAN)>

Kazunori Ohno[1], Tomoaki Yoshida[2]

[1] Tohoku University
Graduate School of Information Sciences, Tohoku University
6-6-01 Aramaki Aza Aoba, Aoba-ku, Sendai, 980-8579 Japan
http://www.rm.is.tohoku.ac.jp/

[2] Chiba Institute of Technology
Future Robot technology center
2-17-1 Tsudanuma Narashino Chiba 275-0016 Japan
yoshida@furo.org

Abstract. This paper describes our team organization and our new robot 'Kenaf2' that is a successor of crawler robots with flippers such as TP07, Hibiscus, and Kenaf. In this year, our team will compose of 3 sub-teams. The new robot "Kenaf2" has 6 DOF: a whole crawler body and four flippers. It will be more stable, more powerful, and easier to operate in rubble. We've done much on-site training of our robot with people from fire depot, and found flaws to be improved. The Kenaf2 is the answer to it. We will also improve the ability of map construction and autonomy.

Introduction

This paper describes our team organization and our new robot 'Kenaf2' that is a successor of crawler robots with flippers such as TP07, Hibiscus, and Kenaf [1]. In this year, our team will compose of 3 sub-teams: Chiba Institute of Technology, Tohoku University and AIST. The new robot "Kenaf2" has 6 DOF: a whole crawler body and four flippers. It will be more stable, more powerful, and easier to operate in rubble. We've done much on-site training of our robot with people from fire depot, and found flaws to be improved. The Kenaf2 is the answer to it. We will also improve the ability of map construction and autonomy.

1. Team Members and Their Contributions

Our team "Pelican United" is organized with members from Tohoku University, Chiba Institute of Technology, and Advanced Industrial Science and Technology.

- Eiji Koyanagi Mechanical design
- Itsuki Noda Integration of sensing information into GIS

- Keiji Nagatani High level locomotion command system
- Satoshi Tadokoro Adviser
- Kazunori Ohno 3D Mapping and autonomous control algorithm
- Tomoaki Yoshida System and Software architecture design
- Daisuke Inoue Rollover and fall avoidance algorithm
- Ken Sakurada Automatic sub-crawler control algorithm
- Sasushi Hata Autonomous control algorithm
- Masashi Yamazaki Autonomous control algorithm
- Eric Rohmer Automatic sub-crawler control algorithm
- Eijiro Takeuchi Multi-robots SLAM
- Seiga Kiribayashi Mechanisms assembly
- Yoshito Okada Automatic sub-crawler control algorithm
- Naoki Tokunaga Autonomous control algorithm
- Hidehisa Akiyama Integration of sensing information into GIS
- Masatsugu Kawamoto Mechanisms assembly
- Hidehisa Akiyama GIS and Multi-robots SLAM
- Student member Mechanisms assembly
- Ikuko Tanimura Travel and Video Support

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

The operator station is packed in one middle size Pelican case, and the robot is also packed in two middle size Pelican cases. Total weight will not exceed 100kg, and considering that the pelican cases are equipped with wheels and handles, it is possible to carry by an operator himself.

Most time consuming step of the set-up process in the operator station is to boot up the PCs , and establish wireless connection between the station and the robot. We will save a map data as some electrical data, and will submit it. It is easy for Robocup stuffs to share the victim’s information.

We will plan that the number of operator is only one. The operator will control some robots during the competition.

3. Communications

We use IEEE 802.11a (5.2GHz Band) for both control and sensing (including video, Laser Ranger Finder etc) communications. In Japan, all WLAN RF power is restricted to 10mW. Therefore our robots and operator station are also use 10mW of RF power.

Rescue Robot League
Pelican United (Japan)

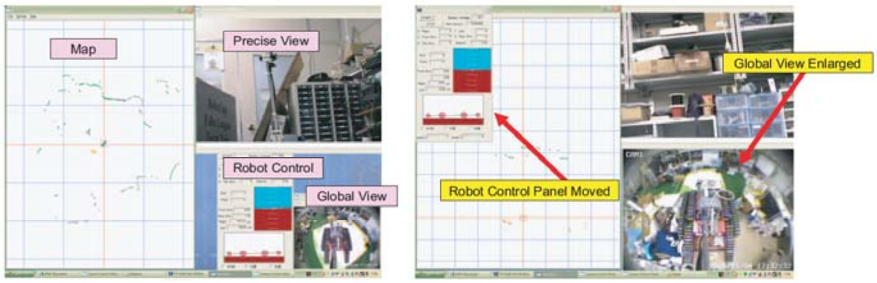
MODIFY TABLE TO NOTE ALL FREQENCIES THAT APPLY TO YOUR TEAM		
Frequency	**Channel/Band**	**Power (mW)**
5.0 GHz - 802.11a	36-64	10mW
2.4 GHz - 802.11b/g		
2.4 GHz - Bluetooth	-	
2.4 GHz - Other	-	
1.2 GHz	-	
900 MHz	-	
40 MHz	-	
27 MHz	-	

4. Control Method and Human-Robot Interface

The locomotion of the robot is controlled with single popular joy-pad equipped with 2 analog stick and 12 digital bottoms. The operator recognizes a surrounding environment of the robot trough video information of a bird view camera, and range data from laser range scanners. With the baseline system, all decisions should be made by the operator, and no autonomous mobility. However, we are working on autonomous control of sub-crawlers and autonomous exploration system. We will use these new technologies on the RoboCup competition in China.

A pan-tilt-zoom camera on the robot will be controlled using touch panel on the video display. The touch panel seems very handy than usual pointing device such as mouse or trackball, especially when the operator is not sit down on a chair.

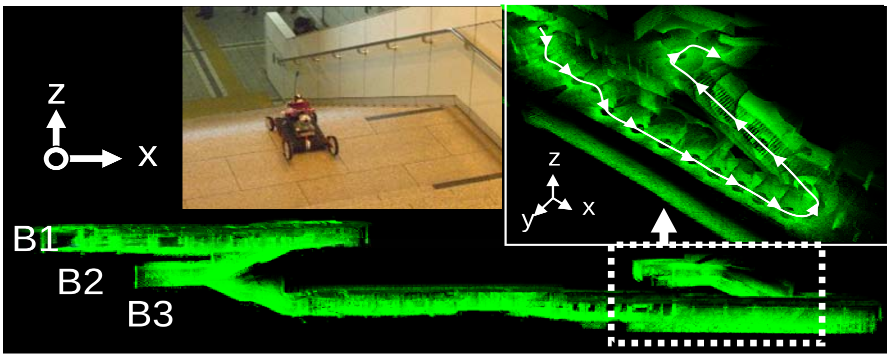
Information expected to be shown such as video from several cameras, range data, gradient sensor readings, is too much for single LCD panel. We organize this information fit with two LCD panel, and built such operator station.



An Example Layout of Our Control Interface: Layout can be changed for the situation (Search or Control).

5. Map generation/printing

The robot will be equipped with at least two laser range scanners, one for horizontal scan and another for vertical scan. With range data from such range scanners and posture information from the IMU such as gyro sensors and gradient sensors, our robot will be equipped with a semi-automatic 2D/3D hybrid mapping system (2D SLAM with 3D range data).



An Example for 3D Map using Kenaf: Sendai Subway 2007

6. Sensors for Navigation and Localization

For odometry based navigation, each motor is equipped with incremental encoder. Also, 3-axis gyro sensor, 3-axis gravity sensor are placed inside the robot. To compensate odometery error, 2D SLAM using horizontal laser range scanner will be performed beside with manual compensation by the operator himself. To recognize environment by the operator, a bird-view camera, and pan-tilt-zoom camera is used. The configuration of these cameras is almost same as last year model.

7. Sensors for Victim Identification

A pan-tilt-zoom camera is used for victim identification. For supplemental use, a thermal camera and CO2 sensor are also mounted on top of the robot. Bi-directional audio communication will be implemented until the competition.

8. Robot Locomotion

The robot is equipped with 2 full-body crawlers and 4 sub-crawlers for locomotion. We recognize the problem with last year model, and re-design to improve mobility on rough terrain. Main improvements are as follows: Powerful motors are used for locomotion. The center of gravity of Kenaf2 is lower than one of Kenaf. Material of Crawler is changed new one. The new model of our robot should work better than kenaf, “which is winner of 2007 RoboCupRescue mobility competition”, on step fields.

Kenaf: 6DOF Crawler Robot with Flippers

9. Other Mechanisms

The structure of our robot is designed the maintenance task in mind. We use safe and powerful batteries for the Kenaf2, which can be carried by airplane.

10. Team Training for Operation (Human Factors)

Our operator is trained on the training facility of fire depot periodically. In such event, volunteers from fire depot also operate our robot. They operate our robot well, with a few minutes instruction. The fact shows our robot requires almost no training to operate.

11. Possibility for Practical Application to Real Disaster Site

We’ve already used a base model of our robot on the site at the Mid Niigata Prefecture Earthquake in 2004. Our robot was used to check damages of underground pipe from inside of it.

12. System Cost

Now, we sell base system of Kenaf2 at about $22000(US) for Japanese researchers in JAPAN, because the system is still improved in our team, and we can only support them in Japanese. However, we are making Kenaf2 with a Japanese company as product. We are planning to sell the Kenaf2 at cheaper price in the world.

13. Lessons Learned

In the last competition, we modified our hardware and software for the debug and the improvement. We think that the our robot will change according to the field and the rules during the competition. Especially, software will change drastically because the rules often change during the competition.

References

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