The first step for developing a realistic rescue robot

Tetsushi Kamegawa, Toru Kawai, Yoshiyuki Semba, Takaaki Nakano,
Kenta Kinoshita, Tatsuhiro Yamasaki, Michiko Nagai and Fumitoshi Matsuno

Department of Computational Intelligence and Systems Science
Tokyo Institute of Technology
4259 Nagatsuta, Midori, Yokohama, 226-8502, Japan
{kamegawa,tkawa,semba,nakano,kinosita,yamasaki,nagai,matsuno}@cs.dis.titech.ac.jp
http://www.cs.dis.titech.ac.jp/matsuno-lab/index.html

Abstract. This report describes our motivation and preparation for participating the RoboCupRescue Robot League competition. This is the first experience that we participate in the RoboCupRescue Robot League competition. Thus products on the market are used for each element of the robot and the rescue robot is constructed by combining them. A big aim for us in this competition is to know limitations and problems of the developed robot in order to design a realistic rescue robot in future.

1 Introduction

Hanshin-Awaji Earthquake occurred in Japan in 1995 cleared the emergency measures problem in information technology and robotic technology for a large-scale disaster [1][2]. At the NY World Trade Center collapse affair that occurred in 2001, robots for searching victims were dispatched and performed rescue operation. The robots searched victims from a heap of rubble. From this experience, we find that the robots has possibility for solving a part of the emergency measures problem. However, the robots were not dispatched as soon as the affair occurred. Usefulness of a rescue robot is not recognized generally.

Aims of the RoboCupRescue competition are encouragement to develop search and rescue robot system, and enlightenment of emergency measures for a large-scale disaster. It is also important that the contribution of robotics to disaster measures problem is appealed to the general public [3]∼[5]. We agree on the idea and participate in the RoboCupRscue Robot League competition.

This report describes our motivation and preparation for participating the RoboCupRescue Robot League competition. This is the first experiences that we participate in the RoboCupRescue Robot League competition. Thus products on the market are used for each element of the robot, and the rescue robot is constructed by combining them. In the first step, we aim to ascertain effective functions for a rescue robot. A big aim for us in this competition is to know limitations and problems of the developed robot in order to design a realistic rescue robot in future.

2 Outline of the developed rescue robot

In the RoboCupRescue Robot League competition, searching victims is treated as a target mission. Required functions of the robot for a victim search problem are "moving" and "sensing".

Several methods of moving of robots have been developed, for example mechanism with wheel, caterpillar, legs and so on. As mobility and adaptability are important in irregular environment such as the disaster field, we apply the caterpillar mechanism which can ensure both characteristics. Actually, it is widely adopted as the locomotion mechanism of rescue robots, and we find its effectiveness.

About sensing, many kinds of sensors should be installed as equipments of a rescue robot such as infrared sensor, ultrasonic sensor, tactile sensor, collecting sonic reflection sensor and visual sensor. In the first version, we decided to equip the robot with only a CCD camera as a visual sensor. However, in the next version several kinds of sensors should be equipped and sensor fusion system should be constructed in order to accomplish the automatic victim search.

The information from the CCD camera is transmitted by radio and an operator controls the robot remotely. Therefore the image from the CCD camera is desired as clear as possible, and high picture quality is required. Moreover, it is desirable that the orientation of the CCD camera can be controlled to get more information around the robot so that the operator can perceive circumstances easier.

Overview of our rescue robot system is shown in Fig. 1.

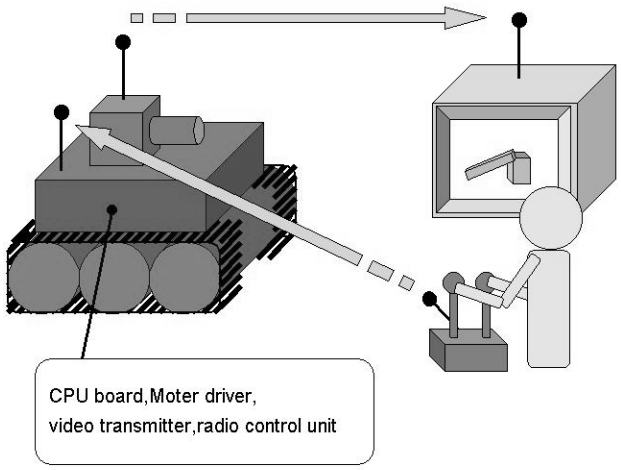

Fig. 1. Overview of the system

3 The specification of the system

A picture of the assembled robot is shown in Fig. 2. The robot has a length of 500[mm], width of 230[mm], height of 250[mm], and weight of about 5[kg]. Robot has a drive component with two motors (RS-380 motor, gear ratio 36.98:1) so that the side caterpillars are driven independently. Power source of motors is two NiCd-batteries (7.2[v], 1400[ma]), and it is active about an hour. The robot can move on a plane about maximum speed 10[km/h], go up a slope with 40 degrees elevation, and can climb up a step with about 100[mm] height. It has a CCD camera on upper frame of the drive component and video transmitter system in the body. The CCD camera can be controlled by H8 CPU board, and the image data from it is transmitted by video transmitter system for remotecontrol. An operator of the robot uses control sticks and remotecontrols the robot with watching a monitor that the scene from the viewpoint of the robot is projected.

In the first version of the robot, products on the market are used for each element of it. A radio-controlled miniature tank is used as the main body. The miniature tank which we chose is suitable for moving in the irregular environment because suspension is attached to a caterpillar, so the robot is robust against the irregularity of the environment. The part of a battery of the tank can be used as the movable stand that controls the direction of the CCD camera. The CCD camera mounted on the robot is an all-in-one color module that features high speed pan (movable range ± 3.0 degrees) and tilt (movable range ± 15 degrees) motion. Three times zoom and auto focus mechanisms are also included. We can control many parameters of the camera by H8 CPU through a RS-232C serial connection. As the body of the camera can rotate about z-axis and change the direction of the viewpoint of the camera, a wide view can be achieved.

Fig. 2. Picture of the robot : CCD camera on the main body

4 Conclusion

In the first version of our rescue robot, products on the market are used for each element of the robot and the robot system with minimum equipment is developed in order to investigate problems. For robots which are useful in a real disaster field, suitable body design for the disaster field and suitable mechanism for movement in the disaster field should be considered. And the robots which collect information and search the victims in the cullapsed building are demanded to be autonomous because human power is insufficient in a real disaster situation. There are many problems that should be solved for performing such robot system and search algorithm. Combining mechanical engineering, control engineering, AI, IT and robotics should be necessary. We think that the participation in RoboCupRescue Leage competition is a good motivation. We wish to make the best use of experiences from this competition in our future research.

References

1. S. Tadokoro, T. Takamori, S. Tsurutani and K. Osuka: "On robotic rescue facilities for disastrous earthquakes – form the Great Hanshin Awaji (Kobe) Earthquake –", J. Robotics and Mechatronics, vol.9, no.1, pp.46-56 (1997).
2. F. Matsuno, M. Hatayama, H. Takahashi, T. Kaneda and T. Matsui: "GIS and Disaster Simulators in a Prototype System of the RoboCup-Rescue Simulation Project", ICMAS Workshop Working Notes, pp.49-58, (2000)
3. H. Kitano and S. Tadokoro: "RoboCup-Rescue: A grand challenge for multi-agent and intelliget systems", AI Magazine, vol.22, no.1, pp.39-52 (2001).
4. A. Shultz: "The 2000 AAAI Mobile Robot Competition and Exhibition", AI Magazine, vol.22, no.1, pp.67-72, (2001).
5. A. Jacoff, E. Messina and J. Evans: "A standard test course for urban search and rescue robots", Proc. Performance Metrics for Intelligent Systems Workshop, (2000).