Rescue Robots: Now & Future
– Current State & Problems –

By Koyanagi Eiji

1. Introduction

When it comes to rescue robots being developed in Japan, I would like to invite attention to a project undertaken since 2002 by the Ministry of Education, Culture, Sports, Science and Technology. The five-year special project seeks to minimize damage from a massive metropolitan-area earthquake. The project, known as the DDT Project after its Japanese acronym, aims to develop techniques for drastically reducing damage in case of a major metropolitan temblor and, in this context, calls for, among other things, the development of rescue robots. Based on lessons learned from the Great Hanshin-Awaji Earthquake of January 17, 1995 that claimed more than 6,400 lives, it consists of the following:

I Research on the crustal structure of metropolitan areas to help forecast seismic vibration (strong shock)
II Research on the drastic improvement of resistance against a quake using a vibrating platform
III Research on the optimization of anti-disaster strategies, including the rescue of quake victims
1) Development of a comprehensive quake disaster simulation system
2) Development of cutting-edge techniques for disaster simulation with full regard to the characteristics of metropolitan areas
3) Development and utilization of a comprehensive simulation of disaster response for large-scale conurbations located along the Pacific coast to cope with great quakes and tsunami
4) Development of basic next-generation anti-disaster techniques, including rescue robots
IV Incorporation of research results into actual measures against quake disasters

The International Rescue System Institute (IRS), a special nonprofit organization, is playing a central role in the development of rescue robots.

2. Aim of DDT Project

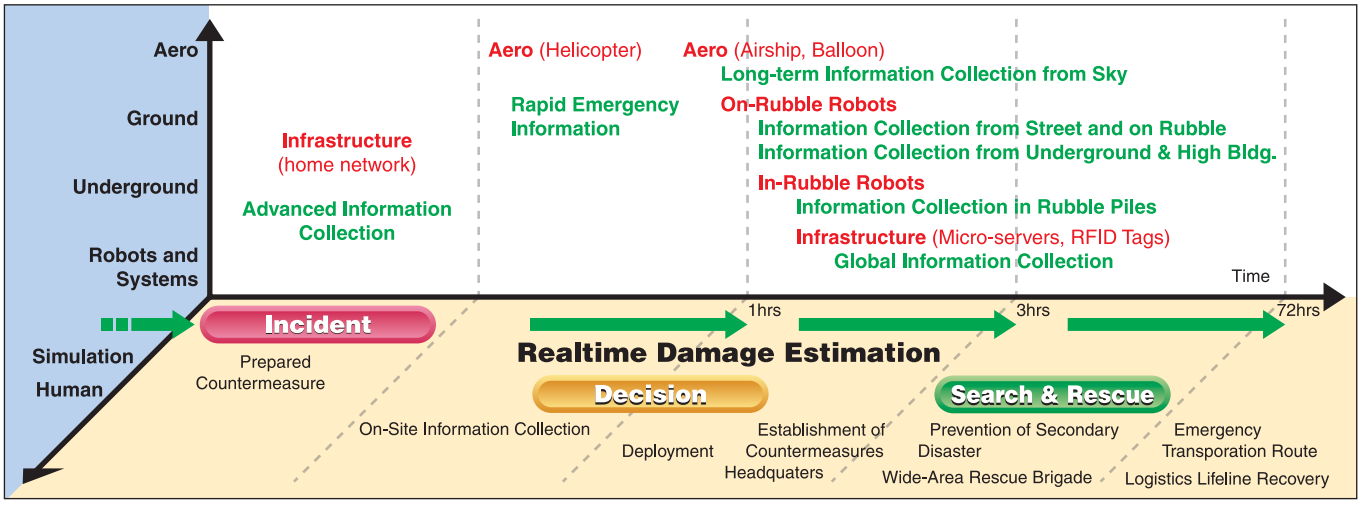
The IRS is developing "robots," "intelligent sensors," "ubiquitous terminals" and "human interfaces" for emergency operations in time of a major quake disaster, including the rescue of disaster victims. By developing these devices, it aims not only to prevent rescue personnel from getting involved in a secondary disaster, but also to facilitate the confirmation of disaster victims and collect their information expeditiously and efficiently.

3. Road Map of Project

Research results of the DDT Project will be used mainly for the collection of information in the event of a disaster as shown by Chart1. The first half of the five-year DDT Project envisages the trial of various techniques with great potential. The second half is devoted to the integration of individual techniques thus tried and the development of practical test devices, accompanied by the verification of their effectiveness. The process of their practical application involves dispatching them to actual disaster scenes, conducting field tests, cooperating with firefighters and medical quarters, and making a positive approach to the industrial community. Moreover, related academic meetings and exhibitions, and international symposiums are held.

Chart 1

Source: DDT Project



Supposed data gathering from air, ground & underground

Under the DDT Project, practical application means "demonstrating the effectiveness of those devices through their actual use at disaster scenes and establishing techniques for their on-the-spot use." It also means ensuring "the commercial production of developed devices (so that they can be purchased at any time)" and "their deployment for actual use at any time (including the establishment of a relevant organization)." A scenario for the utilization of the DDT Project's research results is indicated in Chart 1.

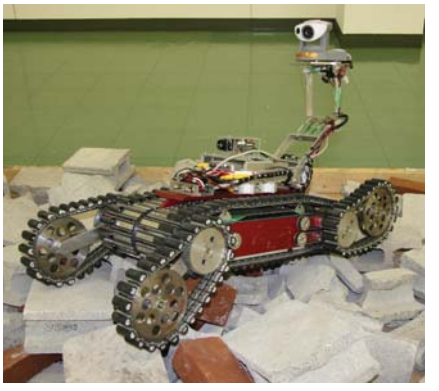
4. Rescue Robot "Hibiscus"

The rescue robot "Hibiscus" as shown in Photo 1 was made on an experimental basis in June 2006 and is now being studied as a platform for a project to develop strategic advanced component robotic technologies, which will be undertaken with a five-year budget of the New Energy and Industrial Technology Development Organization (NEDO) from fiscal 2006.

Based on expertise and data obtained under the DDT Project, Hibiscus will be equipped with travel ability, including high-speed movement in areas where disaster damage is light, and movement through rubble-strewn areas and up and down staircases; the function of confirming disaster victims, including a high-resolution camera, an infrared thermographic device, a carbon dioxide sensor and an ammonia sensor; and interface for operation, including a multivision screen for the operator.

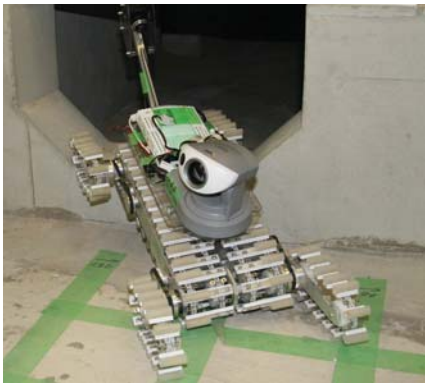
Hibiscus is being developed with a view to coping with not only quake disasters in metropolitan areas, but also NBC (nuclear, biological and chemical) terrorism. Accordingly, for the purpose of contributing to investigation in vast underground malls, research is being conducted regarding the installation and operation of devices for information transmission without delay, concerted operation of several robots, high-speed movement and indication of its routes, and display of a 3D map of a disaster-stricken area.

Photo 1 Source: Koyanagi Eiji



Rescue robot "Hibiscus" was the runner-up in the rescue league of RoboCup 2006 held in Bremen, Germany.

Photo 2 Source: Koyanagi Eiji



"Iris" is a downsized version of "Hibiscus" intended for home underfloor inspection.

5. R&D on Rescue Robot & "Iris"

The robot shown in Photo 2 is "Iris" for inspection under home floors, jointly developed by Daiwa House Industry Co., the Chiba Institute of Technology and the University of Tsukuba. It was subsidized by a budget for the Ministry of Economy, Trade and Industry's publicly invited project supporting the creation of a service robot market. Iris was announced as a platform in October 2006.

Iris, while incorporating the basic structure and functions of the rescue robot Hibiscus, has been greatly reduced in size to operate for inspection under home floors. It measures 270 mm in width, 400 mm in length, 250 mm in height and 6 kg in weight.

Basically, as is the case with Hibiscus, Iris is a traveling robot of the crawler type with a travel system of six degrees of freedom. At the center of the robot is a center crawler, which is so arranged as to cover the whole body. Moreover, subcrawlers, each independently controlling its posture, are installed on the front, in the rear and on either side of the body. Each of them is capable of moving on an endless track, making it possible to easily negotiate a level difference of about 15 cm, obstacles such as piping under the floor, and heaps of rubble.

Research on rescue robots is not unrelated to robots for inspection under home floors. The latter's job of detecting fissures in the concrete foundation, damage by termites and leakage of water is similar to functions required of rescue robots at disaster scenes. Therefore, in the event of a disaster, under-floor inspection robots can be used as rescue robots by simply replacing sensors for under-floor inspection with those for searching for disaster victims. Furthermore, the daily work of operators for under-floor inspection robots is comparable to the training of operators for rescue robots. Therefore, in case of a disaster, inspection operators can be dispatched as excellent operators of rescue robots.

6. Conclusion

I have dealt with the framework and technical problems of rescue robot development in Japan. There may be cases in which the current level of robot technology cannot ensure adequate functions, depending on conditions in disaster-stricken areas. Nevertheless, tools (i.e. rescue robots) can be expected to achieve progress through their actual use.

Rescue robots, now under development, are being used by rescue personnel for their drills in simulated situations, and practical models have been developed by incorporating the opinions of on-the-spot users. Henceforth, great expectations are being placed on international cooperation in the development and operation of rescue robots, such as for the creation of a "Rescue Team without Frontiers." JS

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