Remote-Controlled Robots Used for the Management of Severe Accident of the Fukushima Nuclear Power Plant

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1. Introduction

In this paper, remote-controlled robots, which have been used to stabilize and shut down the three troubled reactors (unit 1, 2 and 3) of the Fukushima nuclear power plant, are presented. From the press materials of NISA (nuclear and industrial safety agency), TEPCO (Tokyo electric power company) and the Yomiuri online news, we investigated the robots, which have been used for the management of severe accident of the Fukushima nuclear power plant [1][2][3]. The military robots provided by USA, Packbot and Warrior, which are unmanned ground robots, have been sent into Unit 1 to Unit 3 to grasp the inside situation of reactor building and to record the radiation from the interior of reactors no. 1, 2, and 3. The Japanese robot, Quince, which was originally designed to be a rescue robot for disaster recovery, were modified and sent to carry out the installation of a water level gauge for the accumulated water in the basement of Unit 2.

Unmanned military aerial robot, T-Hawk, provided by USA was used to check the status of rubbles around reactor building of Unit 1, 2, 3 and 4. And remote-controlled construction robots made by Japan are used to clear outdoor rubbles by wireless remote control to improve working conditions.

2. Unmanned Robots

In this section some of the robots used to grasp the situations of the reactor buildings are described.

2.1 Unmanned Helicopter (T-Hawk)

From April 10 to July 24, unmanned wireless-controlled military aerial robot, T-Hawk, have been sent over Unit 1 to 4 to grasp the situation of reactor building and to collect dust coming out of the rooftop of the reactor building. The activities of unmanned helicopter, T-Hawk, are summarized in Table 1.

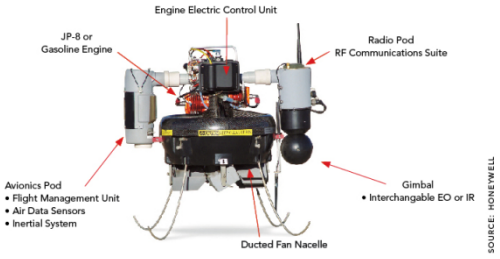

Fig. 1 Unmanned aerial robot, T-Hawk

Fig. 2. T-Hawk flying in the air [4]

Table1. The activities of remote helicopter, T-Hawk

Date	Missions
Apr 10th (15:59~16:28)	Videotaping was carried out in order to grasp the situations of reactor buildings for Units 1 to 4.
Apr 14th (10:17~12:25)	Video shots were taken in order to grasp the situations of reactor buildings for Units 3 and 4.
Apr 15th (8:02 ~ 9:55)	Video shots were taken in order to grasp the situations of reactor buildings for Units 1 to 4.
Apr 21st (11:43~12:50)	Videotaping was carried out in order to grasp the situations of reactor buildings for Units 1 to 4.
May 1st	The conditions of the surrounding area of the south of the station (approximately 5km radius of the periphery) are being monitored.
June 14th (7:52~9:47)	In preparation for the installation of the cover for the reactor building of Unit 1, the status of rubbles around reactor building of Unit 1 are checked.
June 24th Around 06:58	Unmanned helicopter, collecting dust from blow out panel of R/B of Unit2 emergently landed on the top of the reactor building.
July 22th (5:06 ~ 6:02)	Sampling of airborne radioactive materials above the reactor building of Unit 2 was done.
July 23th (4:37~6:08)	Sampling of airborne radioactive materials above the reactor building of Unit 3 was done.
July 24th (4:28~5:57)	Sampling of airborne radioactive materials above the reactor building of Unit 1 was done.

Except June 24th, remote unmanned helicopter, T-Hawk, has executed missions (airborne dust sampling

and aerial observation) successfully. Because of engine trouble, T-Hawk made an emergency landing on the rooftop of the reactor building of Unit 2 around 06:58 June 24.

2.2 Unmanned Ground Robots

From April 17 to Aug 2, unmanned wireless-controlled military robot, Packbot and Warrior, have executed missions 14 times. The military ground robot's activities are as follows.

- An investigation of the status (radiation dose, humidity, temperature, and water leakage from the primary containment vessel, etc.) inside the reactor building of Unit 1, 2 and 3.
- Cleaning work in the reactor building (south west side on the ground level) to decrease dose at the first floor of Unit 3.

Fig. 3. Packbot robot (provided by iROBOT)

Recently Aug 2, Packbot entered into reactor building for investigation. It was confirmed that the air dose rate was higher than 5 Sv/h at around the entrance of the train room for the standby gas treatment system on the second floor of the turbine building of Unit 1.

Place: Near the entrance of the train room for emergency gas treatment system, 2nd floor of Turbine Building, Unit 1

Time: At around 11:19 am, on August 2, 2011

Fig. 4. Detection of high dose-rate place

The Japanese robot, Quince, was delivered to TEPCO on Jun 23. The Quince was created through a joint project between Chiba Institute of Technology and Tohoku University. It originally was designed to be a rescue robot for disaster recovery. Upon the request of TEPCO, it was modified for the setup of water gauge in the basement of Unit 2. A PC and game style controller are used for controlling the robot. From Jun 24 to Jul 26, Quince robot has executed three missions as follows.

- The installation of a water level gauge for the accumulated water in the basement of Unit 2 (suspended).
- Sampling of airborne radioactive dust on the second and the third floors of the reactor building of Unit 2.
- On-site inspection and dose survey inside the reactor building of Unit 3

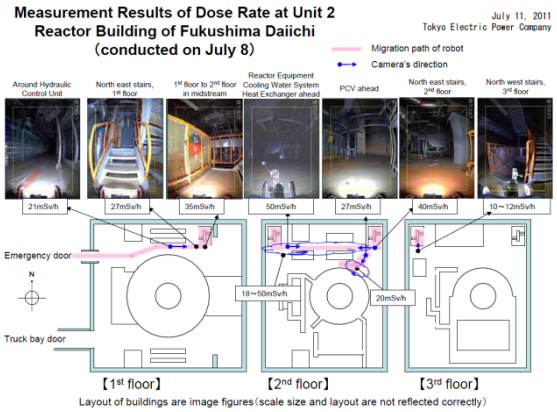

Fig. 5. Dose survey using the Quince robot

REFERENCES

[1] http://www.nisa.meti.go.jp/
[2] http://www.tepco.co.jp/nu/fukushima-np/
[3] http://www.yomiuri.co.jp/index.htm
[4] http://www.robot.t.u-tokyo.ac.jp/asamalab/