Quince for Surveillance in the Reactor Buildings

Chiba Institute of Technology

1. Overview

On March 2011, a serious nuclear accident was happened. We developed a remote controlled mobile robot named Quince for surveillance in the reactor buildings. Quince accomplished multiple missions in the buildings. Quince was formerly developed in a R&D project by our joint research group supported by the New Energy and Industrial Technology Development Organization(NEDO). The project aimed to develop a robotic surveillance system for underground cities or subway stations. Applying Quince to the missions in the reactor buildings showed up several new problems, such as mobility, reliability and communication.
We worked on these problems and developed new Quince for surveillance in the nuclear reactor building.

2. Technical Details

Important features of Quince is its mobility(Fig1), its weight and its size.To accomplish surveillance tasks on the upper floors, a robot must have an ability to climb staircases. Quince has such an ability.
However, we had following issues to use Quince(Fig2) in the reactor buildings. The issues were radiation tolerance of electrical components, and communication system from an operator console to the robot.
Moreover, we needed to verify its mobility whether it can go up and down the staircases in the buildings.
We built a mock up model of the staircases in the reactor buildings for verifying mobility of Quince. After several trials and reconfiguration of tracks, it was verified that Quince can use staircases in the reactor buildings.
Radiation tolerance of electrical components on Quince was verified by gamma-ray irradiation tests in cooperation with JAEA. Main electrical components of Quince were verified to operate normally even after gamma-ray irradiated 200Gy in total.
At first, we planned to control Quince via a wireless communication device.
We went Hamaoka Nuclear Power Plant to test whether our wireless devices(2.4GHz and 500MHz) are usable in the reactor building or not, and we concluded to give up using wireless devices. As a result, we developed a wired communication system which is composed with a VDSL modem and thin twisted pair cables. It enables the operator console to communicate with Quince in 25Mbps band width from 500m away.
Additionally, wireless LAN modules are attached on Quince No.2(Fig3) and No.3 as a secondary data link. When the wired connection with the first Quince is lost, the second Quince is deployed to establish new data link, via wired connection on the second Quince and wireless connection between two Quince.
Quince needs to avoid turning around even on the way from a dead end.
Quince is equipped with wired communication system and the wire must not be damaged by Quince itself. It was very stressful task for the operator to control Quince moving backward direction. We implemented switch back function on the operator console to assist the operator in such situation(Fig4). Two identical cameras are attached on Quince facing forward and backward direction. When the operator activates the switch back function, the console swaps the direction of Quince logically to avoid turning 180 degrees.

3. Summary

Quince have acquired a lot of information from the reactor buildings. Some of them were very important and significantly contributed to the restoration work of the site. We believe that the remote controlled robots such as Quince will play important roles in the work, and related technology also will contribute on safety and growth of Japan.

Fig1 Quince running over wooden rubbles

Fig2 Quince No.1

Fig3 Quince No.2

Fig4 Screen shot of the console. Normal mode(left) and reverse running mode(right).