Unmanned Radiation Detection System for Nuclear Terrorism Investigation

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1. Introduction

Nuclear terrorism is one of the most serious threats of the present. Even a single nuclear terror will permanently bring mass destruction, tremendous suffering and unwanted changes. Nuclear terrorism has been a series of events since the 1990s, including the discovery of dirty bombs in Russia's National Park in 1995, and the 2003 Al Qaeda dirty night testimony [1].

Currently, there is not decent system capable of responding to nuclear terrorism. Although stationary radiation surveillance equipment is operated nationwide, such equipment is not transferable to the accident area. Each nuclear power plant has a radiation detection vehicle in case of a radiation emergency. However, in actual situations, there is a risk of radiation exposure of the driver.

Therefore, in case of nuclear terrorism situation, an unmanned system that can monitor and detect radiation level of the damaged area. To deal with the problem, we propose a robot system that combines a ground and aerial vehicles.

2. Unmanned Radiation Detection System

In this study, we propose a joint operation system of unmanned ground vehicle and unmanned aerial vehicle to perform rapid ground to aerial accident monitoring.

2.1 Unmanned Ground Vehicle

An unmanned ground vehicle (UGV) should be capable of traversing various terrains such as inside / outside of nuclear facilities and surrounding areas. In addition, the ground vehicle should be easily controlled, durable, highly mobile and capable of carrying a sufficient payload for mounted sensors and instruments. To meet these requirements, an all-terrain vehicle (ATV) was selected as the UGV [2].

The ATV has excellent maneuverability and can quickly access to the nuclear reactor building in a distance. The ATV was robotized to be controlled. The overall ATV system mainly consists of a communication unit, a control unit, and an actuation unit.

The communication unit transmits the control command remotely and utilizes the frequency band of 400 MHz. The control unit is composed of a microcontroller and control algorithms, and generates control commands for the actuators. Finally, the actuation unit performs the operation of the ATV mechanisms.

2.2 Unmanned Aerial Vehicle

Unmanned aerial vehicles (UAV) are divided into fixed-wing and rotary-wing aircrafts depending on the type of wings. Rotary-wing aircrafts are relatively slower and less efficient than fixed-wing aircrafts. However, it is suitable for acquiring data in a stable position thanks to its attitude control algorithm and hovering ability.

Quadcopters are the representative type of fixed-wing aircrafts and have excellent maneuverability and flight stability. For the aerial monitoring tasks, we chose a quadcopter as an UAV.

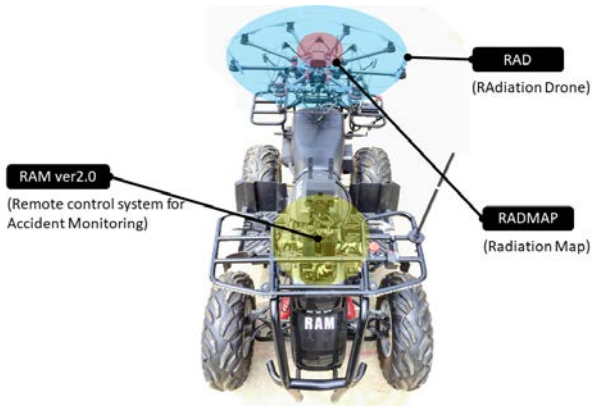

Fig. 1. Remote control system for accident monitoring (RAM)

Fig. 2. Remote operation scenario for nuclear terrorism

2.3 Specifications and Operation scenario

The proposed UGV-UAV combined system, RAM (Remote control system for Accident Monitoring) was built as shown in Fig 1. The RAM runs at a maximum speed of 60 km/h with a payload of 160 kg. Operation duration is over 5 hours in the distance of 1 km. Thanks to the PTS, the quadcopter can fly continuously without any restrictions to the operating time and can fly within a radius of 50 m from the UGV

The RAM can be operated as the scenario shown in Fig. 2. When a nuclear terrorism occurs, the RAM will acquire information by approaching to the accident site rapidly, and then the quadcopter will be deployed to monitor accident consequences in the air. The collected data from the ground to the air will be sent to the operator to make crucial initial decision-makings.

3. Conclusions

In this study, we discussed an aerial and ground remote control system, which can be applied to the nuclear terrorism situation. Based on the characteristics of the nuclear attack, we selected the specific types of UGV and UAV, which can be used for accident site monitoring. In the future, we will verify the performance of the RAM through the mock-up environment, and improve the sensor and control systems.

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