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Unmanned aerial vehicles are now widely employed for numerous applications including defense, search and rescue as well as within scientific fields such as high-altitude atmospheric sampling and remote sensing. However, their application to the high-altitude detection of radiation anomalies (specifically as part of the routine monitoring on nuclear sites) has been less well explored. In this work, we present the results of the demonstration monitoring via a lightweight aerial platform on an active nuclear site (Sellafield Ltd.), having already deployed the device in the Fukushima-contaminated region. The system employed was able to detect regions of elevated radiation in the sub-meter scale as well as attributing the species responsible. Such a system presents as extremely powerful tool where it is not desirable, nor practical, to send human operators. Results presented show that the platform is easily capable of operating within the challenging and confined settings of a site such as Sellafield (or other similar worldwide).

Abstract

Unmanned aerial vehicles are now widely employed for numerous applications including defense, search and rescue as well as within scientific fields such as high-altitude atmospheric sampling and remote sensing. However, their application to the high-altitude detection of radiation anomalies (specifically as part of the routine monitoring on nuclear sites) has been less well explored. In this work, we present the results of the demonstration monitoring via a lightweight aerial platform on an active nuclear site (Sellafield Ltd.), having already deployed the device in the Fukushima-contaminated region. The system employed was able to detect regions of elevated radiation in the sub-meter scale as well as attributing the species responsible. Such a system presents as extremely powerful tool where it is not desirable, nor practical, to send human operators. Results presented show that the platform is easily capable of operating within the challenging and confined settings of a site such as Sellafield (or other similar worldwide).

Introduction

While much of the world is currently experiencing a renaissance with the construction of fleets of new power-generation facilities, challenges still exist in numerous other sites associated with both the decommissioning and long-term monitoring of contamination and radiation levels respectively.

Detection Payload

The standard radiation mapping platform consists of a lightweight gamma-ray spectrometer (weight 80 g) comprised of a single 1" crystal of cadmium zinc telluride (CZT) semiconductor material (GR-1 from KeVeen Ltd.), a one-meter long telescope tube and a detector electronics unit. The maximum external size of the system is 50 cm, permitting the UAV to reach sites far from its initial position. The UAV consists of an X8 configuration with motors and propellers mounted both above and below the platform to ensure they remained normal to the ground during the operation of the system - regardless of any instability of the wind. The system employed was able to detect regions of elevated radiation at the sub-meter scale as well as attributing the species responsible. Such a system presents as extremely powerful tool where it is not desirable, nor practical, to send human operators. Results presented show that the platform is easily capable of operating within the challenging and confined settings of a site such as Sellafield (or other similar worldwide).

Unmanned Aerial Vehicle (UAV)

The UAV consists of an X8 configuration with remotely operated propellers mounted both above and below the platform to ensure they remained normal to the ground during the operation of the system - regardless of any instability of the wind. The system employed was able to detect regions of elevated radiation at the sub-meter scale as well as attributing the species responsible. Such a system presents as extremely powerful tool where it is not desirable, nor practical, to send human operators. Results presented show that the platform is easily capable of operating within the challenging and confined settings of a site such as Sellafield (or other similar worldwide).

Data Processing & Visualisation

Software was produced to render the new data, presenting the results as a colour-coded overlay across a georeferenced base map. The system was capable of exporting the processed data to enable the results to be subsequently manipulated by third-party geospatial software platforms.

Loc. 1

The radiation map of Loc. 1, the X8 multi-rectangular sensor and laser rangefinder, (a) 3D visualization, (b) rendered scan lines, (c) visualisation settings, (d) radius scaling options, (e) coloured scaling level and (f) 21 point laser rangefinder for determining the actual radiation level. The demonstration monitoring via a lightweight aerial platform on an active nuclear site (Sellafield Ltd.), having already deployed the device in the Fukushima-contaminated region. The system employed was able to detect regions of elevated radiation in the sub-meter scale as well as attributing the species responsible. Such a system presents as extremely powerful tool where it is not desirable, nor practical, to send human operators. Results presented show that the platform is easily capable of operating within the challenging and confined settings of a site such as Sellafield (or other similar worldwide).

Study Site

Testing of the present field trial at various locations on the Sellafield site. These locations included an X8 fixed-wing platform and Loc. 1 and 2 focusing on the aerial monitoring building. Both represent a radiologist hazards to those that would typically undertake routine monitoring.

Loc. 2

The map of Loc. 2 is shown below in Figure 5 (a). The locations of the structures containing the radiation source (the high-level waste storage compounds) is marked. As can be seen within the figure, the radiation dose rate is high, with the radiation dose rate expected, within the confines of the structure, from the containers sides. The data was then able to ensure that the radiation level at the source of the structure is greater than that around the perimeter. This is achieved through the placement of lower telluride detectors from the container sides - a result of the system employed to calculate the potential radiation exposure.

Isotopic Fingerprinting

By employing gamma-ray spectrometers instead of Geiger Muller based detectors, the radiological radionuclides can be identified by the overlying of the UAV.

Conclusions

The demonstration of an unmanned aerial vehicle for autonomous radiation mapping has shown:

GPS positioning is not influenced by large buildings or structures on the site.

Sub-meter accurate accurate and locations with logistical issues can be assessed in a rapid period of time.

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References


