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#07-133 Unmanned Aircraft Systems Based Radiological Mapping of Buildings and Objects

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This paper is focused on the radiological mapping of buildings and structures/objects by utilizing unmanned aircraft systems (UAS), including multicopters in particular. These platforms make possible measuring data in close distance to studied objects and with adjustable altitudes, in contrary to terrestrial and other aerial assets. Tasks such as inspection of illegal transportation or storage of radioactive nuclear material, search for uncontrolled radioactive sources, detailed survey of buildings and objects for possible contamination, monitoring of nuclear facilities (e.g., nuclear repositories) require accurate and up-to-date topographic information on the area of interest.

Performing the detailed radiological characterization or mapping requires the aircraft to be equipped with a camera and a radiation detection system. The camera is utilized to take a series of aerial pictures of the object in order to reconstruct its three-dimensional (3D) model via photogrammetric techniques. In addition, in the case automatic flight mode is employed, an accurate georeferencing is essential.

The radiation data is preferably acquired following a regular grid around the building/object whenever the circumstances allow it. Knowledge of the model and georeferenced data points enables to project the measured values onto surfaces where they are then subjected to interpolation based on the Delaunay triangulation. The mapping of the gamma dose rate can be superposed to the reconstructed 3D model of the inspected area or building/object. The map may further be converted in the form of isodose areas. Radionuclide identification is also possible when using a detection system with gamma spectroscopy capabilities.

We report in this paper on the development and testing of a radiological mapping system based on the use of a DJI Matrice 210 v2 drone equipped with Zenmuse Z30 camera and a lightweight radiation detection system. The latter device is based on NaI(Tl) and CeBr3 scintillators, coupled with silicon photomultipliers. Its design includes a digital pulse processor, a laser altimeter and a GNSS receiver providing precise synchronization of the dose rate values with position and altitude or distance from the object, respectively. Real-time data processing is also feasible. A built-in RF module and a small battery ensure the complete independence of the detection system from the used aircraft.

The goal of the research is to provide experimental verification of simulation results performed during earlier studies. The utilization of UAS in the field of radiation mapping shows promising results, however, it is still challenging to find an optimal trade-off in the size and weight of the detector. Heavier instrumentation grants better sensitivity, conversely, it reduces the flight time and therefore challenges the data collection process. Poor reception of GNSS signal in the vicinity of walls also remains an open issue.

This work demonstrates the capabilities of using the UAS based radiation detection technology for radiological mapping of buildings and objects with possible applications in areas such as nuclear safety and security, radiation protection and environmental monitoring.

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