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Pre-flight experiments for the unmanned aerial monitoring system (UAMS) radioactive detection feasibility

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Abstract

In this study, an unmanned aerial monitoring system (UAMS) was designed and fabricated. The final goal is to map environmental radioactivity and extract radioactive concentration points; therefore, preliminary experiments were performed to reach a robust detection system and also to study effective flight altitudes that the UAMS is able to detect anomalies. The UAMS consisted of a detection system including a two-inch sodium iodine crystal, a data-acquisition system and a mini-computer that all were installed under a drone body. One cesium and two cobalt source were used for the initial monitoring of the UAMS. The results showed that the system is able to detect the sources in the height range of 80 cm to 3 meters.

Keywords: Drone, Aerial monitoring of radioactivity, Detection, Feasibility

Introduction

Over the past few years, drones have become a popular tool for a variety of applications related to nuclear activities, including outdoor and indoor surveys and dose mapping. Drones have been employed by the industry in terms of improving worker safety, saving time and reducing costs. One of these involves the use of the technology to detect radiation levels during post-accidents and repetitive monitor in nuclear industry and facilities. Companies around the world are currently developing aerial radioactive monitoring systems. Best drone manufacturers such as the Charlotte UAV and FlyCam are working with manufacturers of radiation monitoring equipment to develop robust systems that capable of carrying the required detection system. Some nuclear facilities now use this technology to detect radiation level. Furthuremore, due to the advantages of this method, in some countries, the National Institute for Nuclear, Chemical and Biological Protection has developed a method for aerial measurement of environmental radioactivity using a drone equipped with ionization radiation counters. Companies like NuEM DRONES G use the most advanced technology for aerial surveillance. These systems offer excellent environmental radiation monitoring performance and is designed to explore small areas, finding orphan radioactive sources, potential contamination. In summary, application fields of UAMS include routine monitoring, nuclear sites, facilities, strategic sites, mapping and monitoring of mining area, nuclear accident management, infrastructure protection, emergency response management, terrorist incidents, nuclear accidents and health physic [1,2].According to the approach of recent activists at application of the drone-based radioactivity monitoring, controlling and health physics of nuclear sites, an aerial radiation monitoring system equipped with a radiation detection tool was designed and evaluated. Our future goal is to map environmental radioactivity and extract hotspots. Preliminary experiments were performed by gamma-ray emitting radioactive sources to tune the UAMS under common disturbances and show that it is able to detect radioactive anomalies.

Experiments

The UAMS consisted of a DJI drone (Matric 600) and the detection system to map the gamma ray over suspicious areas.

Figure 1. Detector pack

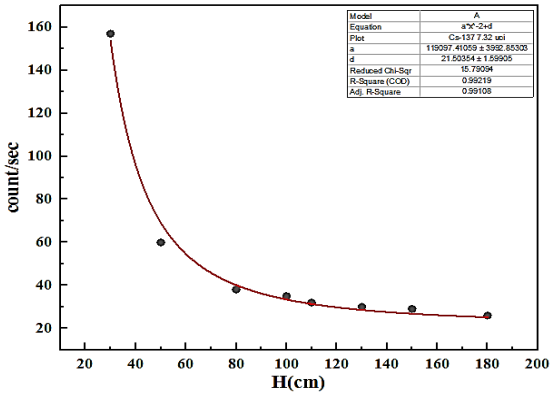
The detection system consisted of a 2-inch sodium iodine crystal with a high voltage circuit and a single-channel data acquisition system. A mini-computer (Odroid-XU4) and the Ubuntu distribution (Linux) helped us to manage the data acquisition process. The user commands run via the SSH protocol based on an Ethernet connection. An image of the detection system was shown in Figure 1. The power of high-voltage system and other electronic parts was provided by the drone batteries and they consumed a current of 500 milliamperes. An image of a detection system mounted on the drone was shown in Figure 2.

Figure 2. The UAMS is above a radioactive source

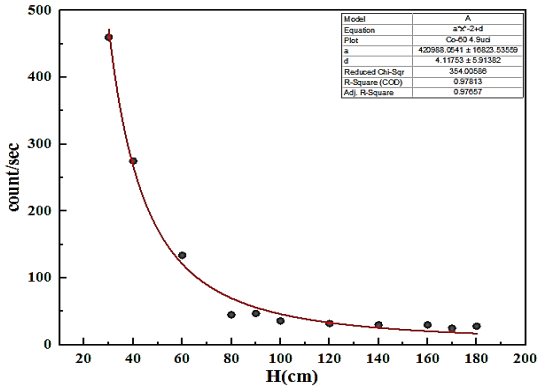
In this Figure, the UAMS is flying vertically over one radioactive source.. In this expriment, flying height of the UAMS were from 30 cm to 3 meter. By hovering of the UAMS above each source, the detector was able recorod the count at different height.
Two cobalt 60 with different activity and a cesium-137 sources were placed. In Figure 3, the counts were average of 3 values and they were recorded under drone disturbances, so the promising results shows that the UAMS was able to sweep an area and to give a radiation map.

Results and discussion

The measurement results for the three sources are shown in Figure 3. The background count in this experiment was about 23 CPS[1]. Figure 3 shows the count recorded by the detection system for different heights above the radioactive sources.



a



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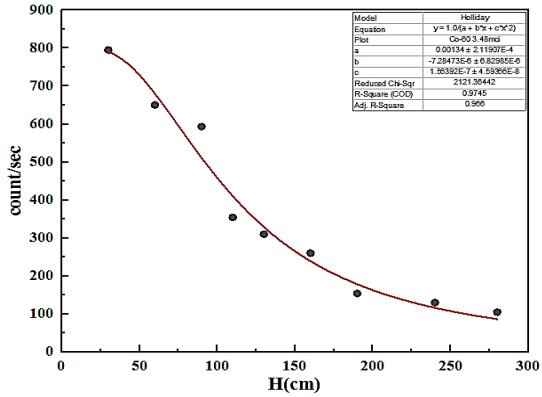

c

Figure 3. Count Vs. Height a) No1 source (Cs-137, 7.32 µCi), b) No.2 source (Co-60, 4.9µCi), c) No.3 Source (Co-60, 3.48mCi)

Although the UAMS had disturbances such as some little side movements and vibrations, but it recorded counts decreased over the height.

Conclusions

In this study, pre-flight experiments of the UAMS was created to shows a capability of this system in future fast mapping and radioactive hotspots detection. For this purpose, a compact detection system including a scintillator detector and data-acquisition system was built and installed under the drone. Three weak gamma radioactive sources were used to evaluate the UAMS ability. The results showed that, the UAMS is able to detect sources No. 1 and 2 up to a height of 80 cm and source number 3 to a height of 3 meters under drone disturbances.

References

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[1] Counts per second