Carbon Fiber Drone for Advanced Radiation Mapping With CsI Scintillation Source Spectroscopy & MDE Techniques, 31 wt% Nano-Boron Carbide Aluminum Lithium-ion Battery Neutron Shielding, and Polyurethane Foam Decontamination

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Since 1993, the IAEA has reported 4,243 radioactive accidents, causing deaths due to radioactive lost/stolen sources and leaks. Therefore, surveying contaminated areas using a UAV-based platform is vital. Existing literature shows that current radiation mapping drones cost exceeds $35,000 with 1°–5° directional accuracy, but lacks integrated shielding or decontamination techniques after localization. This project introduces a 3D Radiation Localization/Mapping Platform (LAMP) with CsI Spectroscopy identification and Decontamination systems mounted on a DJI F450 Carbon Fiber Drone body. Performance: 90 km/h, 120 m altitude, 3 kg payload, and 34-minute endurance. The LAMP is based on an optimization model considering background radiation. An airborne system locates category 3–4 radioactive sources (Co-60/Cs-137 mixed-nuclides), according to the IAEA standards, supported by 12 experimental trials at Alex. University and NPPA. A sensor bundle, comprising a CsI Scintillator and NightVision IR Camera, uses path planning and Monocular Depth Estimation (MDE) to mitigate LiDAR gamma interference while the 3D SDF yields 0.99 positional linearity and 0.52–1.19 mm resolution; SNR ranges from 0.95 to 5.63 with 2.3 to 7 m altitude-based error. A 250 ml polyurethane foam generator is used to decontaminate radiation spots with up to 95% Co 60 removal, reducing exposure and airborne contamination. We shielded the Li Battery from neutron capture-induced capacity loss through designing a 31 wt% nano boron carbide aluminum shielding box (1.02 mm thickness). Lab tests showed 90.9–95.6% thermal neutron attenuation. The drone achieves ~94% cost efficiency, applications in nuclear remediation and lost/stolen source recovery with novel decontamination, shielding, and MDE techniques.

Awards Won:

Fourth Award of $600