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UAV LiDAR and Photogrammetry for Accurate 3D Mapping and Modeling in Environmental Physics

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UAV-based LiDAR equipment was designed as a high-performance drone equipped with a LiDAR system, which operates on electric batteries with a period of flight up to 45 minutes (with a payload) and can transport equipment with an operational weight of 27 kg, the maximum weight of take-off being up to 50 kg. The drone control is done through an advanced system that allows monitoring its position and image processing in real time. The drone can be manually piloted, assisted or fully autonomous within a range of about 50 km. The drone is incorporated with a Geosun GS 100C LiDAR system, which is a complete and compact air LiDAR solution specially designed for UAV integration. Equipped with Livox Avia sensor, this system offers a detection ray of up to 450 meters, multiple returns and an accuracy of up to 10-15 cm at average flight altitudes. With a high precision GNSS/IMU and an integrated 26 MP camera, Geosun GS 100C allows the simultaneous processing of LiDAR data and georeferential images, being ideal for mapping, topography, infrastructure inspection and 3D modeling. The drone was built to operate under difficult weather conditions such as winds up to 12 m/s and temperatures between -20 ℃ and +55 ℃.

The technology offers high-resolution mapping, vegetation penetration, and the ability to generate accurate 3D terrain models by leveraging integrating UAV LiDAR terrain mapping with real photogrammetry data, and its application in terrain mapping and 3D photogrammetry modeling, fast creation of precise digital elevation map models and in monitoring based on the airborne LiDAR and photogrammetry measurements for rapid inspection, assessment, and environmental data collection and analysis.

We present a detailed analysis based on a 3D model generated and visualized in the CloudCompare, an open-source software for processing 3D point clouds. The obtained precise image represents a developing urban area, located in the vicinity of the "Alexandru Ciubotaru"National Botanical Garden (Institute) in Chisinau city, the image being obtained through photogrammetry and LiDAR scanning. The study highlights the characteristics of this point cloud and its potential applications in urban and environmental analysis. We were able to underline two distinct areas: an urban area that contains several tall buildings, some under construction, and a second area represented by the National Botanical Garden, which contains well-defined paths, trees of various sizes and a terrain with varied relief. The model retains a high degree of detail for this natural habitat, which allows precise topographic analysis. Using aerial imagery and LiDAR scanning have proved to be an accurate method for digital reconstruction of the urban and natural environment, in environmental monitoring and urban ecosystem management, as well as in the analysis of terrain changes caused by natural or anthropic factors.

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