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DEVELOPMENT OF A NEURAL NETWORK FOR THE RECONSTRUCTION OF VIS-NIR SPECTRA FROM SENTINEL-2 SATELLITE IMAGES.

Abstract

The reconstruction of visible and near-infrared (VIS-NIR) spectra from satellite images, an emerging research field, leverages artificial intelligence to extract spectral information from soils and regions of interest. This project utilizes Sentinel-2 satellites from the Copernicus program, equipped with multispectral sensors that capture 12 spectral bands (442 nm to 2200 nm) at a spatial resolution of up to $100\,\mathrm{m}^2$ per pixel. This variety enables accurate VIS-NIR spectra reconstruction, essential for detailed studies of soil composition. Accurate knowledge of the spectral signature in biodiverse zones is crucial for identifying agricultural areas, natural reserves, detecting illegal mining, managing water bodies, promoting sustainable energy, and addressing climate change. Higher spectral resolution data improve understanding of physicochemical soil conditions, offering tangible benefits for farmers, such as increased productivity through optimized pesticide and fertilizer usage. The identification and monitoring of deforestation and soil degradation areas enable early interventions for biodiversity conservation.

The project develops an artificial intelligence algorithm using “continuous” spectra from ground samples to reconstruct satellite images (Sentinel). The methodology comprises two stages: computational and experimental. In the computational phase, an algorithm simulates satellite measurements using continuous spectrum data, generating 12 spectral bands based on the precision of Sentinel-2 sensors. The aim is to increase spectral resolution through in-situ measurements; hyperspectral images serve as training and reference for the algorithm, with satellite images as inputs. The neural network, trained on this dataset, reconstructs original spectra with an average error of 1.2%.

In the experimental phase, hyperspectral data were acquired using a SPECIM IQ camera with a spectral resolution of 204 bands between 400 nm and 1000 nm. Various zones in Bogotá, Colombia, were selected to enrich experimental data. Non-georeferenced colorimetry samples, with variations in shape and color, strategically enhance the neural network’s ability to distinguish features in spectra. Georeferencing of hyperspectral images allows effective comparison with those generated by satellite images. This comprehensive methodology ensures the model’s robustness and practical applicability.

Successful implementation will address emerging challenges, offering new opportunities, and contribut-

ing to a better understanding of climate change effects on critical areas, including monitoring and managing soils, crops, and natural reserves.