A Smart Multi-scale and Multi-temporal System to Support Precision and Sustainable Agriculture from Satellite Images

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In this century, one of the main objectives of agriculture is sustainability addressed to achieve food security, based on the improvement of use efficiency of farm resources, the increasing of crop yield and quality, under climate change conditions. The optimization of farm resources, as well as the control of soil degradation processes, can be realized through crop monitoring in the field, aiming to manage the local spatial variability (time and space) with a high resolution. In the case of high profitability crops, as the case of vineyards for high-quality wines, the capability to manage and follow spatial behavior of plant during the season represents an opportunity to improve farmer incomes and preserve the environmental health. However, any field monitoring represents an additional cost for the farmer, which slows down the objective of diffuse sustainable agriculture. Satellite multispectral images have been widely used for production management in large areas. The observation is limited by the pre-defined and fixed scale with relatively coarse spatial resolution, resulting in limitations in their application. In this paper, encouraged by recent in multiscale full-connected convolutional neural network (CNN) is constructed for pan-sharpening of Sentinel-2A images by UAV images. The reconstructed data are validated by independent multispectral UAV images and in-situ spectral measurements. The reconstructed Sentinel-2A images provide a multitemporal evaluation of plant responses using selected vegetation indices. The proposed methodology has been tested on plant measurements taken either in-vivo and through the retrospective reconstruction of the eco-physiological vine behavior, by the evaluation of water conductivity and water use efficiency indexes from anatomical and isotopic traits recorded in vine stem wood. Such a methodology, able to combine the pro and cons of space-borne and UAVs data to evaluate plant responses, with the high spatial and temporal resolution, has been applied in a vineyard of southern Italy by analyzing the period from 2015 to 2018. The obtained results have shown a good correspondence between the vegetation indices obtained from reconstructed Sentinel-2A data and plant measurements obtained from tree-ring based retrospective reconstruction of eco-physiological behavior.
Keywords: CNN image reconstruction, pan-sharpening, vineyard status, precision agriculture