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Abstract

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

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Abstract: Currently, the main goal of agriculture is to support the achievement of food security in a sustainable way through the improvement of use efficiency of farm resources, increasing crop yield and quality, under climate change conditions. Farm resources use improvement, as well as the reduction of soil degradation processes, can be realized by means of high spatial and temporal resolution of field crop monitoring, aiming to manage the local spatial variability. In the case of high incomes crops, as the vineyards for high-quality wines, the monitoring of spatial behavior of plants during the growing season represents an opportunity to improve the plant management, the farmer incomes and to preserve the environmental health. However, because the field monitoring is an additional cost for the farmer, its diffusion is slow down and with it the achievement of sustainable agriculture. In the last decades, the satellite multispectral images have been widely used for the management of large areas, with a limitation in observation due to the pre-defined and fixed scale with relatively coarse spatial resolution, resulting in restrictions in their application. This paper presents a modified multiscale full-connected convolutional neural network (CNN) as a practical tool 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, providing a multitemporal evaluation of plant responses through a set of 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 evaluate with high spatial and temporal resolution the plant responses, combining the pro and cons of space-borne and UAVs data, 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