Cigr Eurageng 2026
Emerging Technology and Innovation in Biosystems
Polytechnic of Turin, Italy, 24-26 June 2026

Paper ID: 280

Development of a Cost-Effective Hyperspectral Proximal Sensing System for Precision Viticulture within the O4A Project

Alessio Tugnolo[1], Valentina Giovenzana[1], Arianna Cusmai[1], Riccardo Guidetti[1], Maria Luisa Amodio[2], Roberto Beghi[1]

[1] Department of Agricultural and Environmental Sciences – Production, Landscape, Agroenergy (DiSAA), Università degli Studi di Milano, via Celoria 2, 20133, Milano, Italy.
[2] Department of Agricultural, Food, Natural Resources and Engineering (DAFNE), University of Foggia, via Napoli 25, 71122, Foggia, Italy.
Corresponding author (e-mail): roberto.beghi@unimi.it

Abstract. Recent advances in optical sensing technologies are fostering the development of innovative, affordable tools for precision agriculture, enhancing the monitoring of crop physiological status across spatial and temporal scales. Within the framework of the PRIN2022 O4A project (Optics for Agrifood), an ongoing research initiative, a compact and cost-effective hyperspectral imaging system is being developed for in-field assessment of grapevine water status and ripening dynamics.
O4A aims to design and validate optical sensing solutions tailored to agrifood applications, with particular attention to robustness, portability, and economic sustainability. The proposed hyperspectral system operates in the visible–near infrared range and enables the extraction of spectral indices correlated with key indicators of water stress and berry composition. Preliminary tests have shown promising potential in discriminating different levels of vine water status and grape maturity under controlled conditions.
The project is currently in progress, and its main experimental campaign is scheduled for summer 2026, when field trials will be conducted in vineyards to consolidate calibration models and validate system performance across different environmental conditions. By integrating optical design, sensor optimization, and advanced data analysis, O4A seeks to bridge the gap between laboratory-grade spectroscopy and practical agricultural applications, supporting more informed and sustainable decision-making in viticulture.

Keywords: Hyperspectral imaging, Precision viticulture, Optical sensing, Grapevine water status, In-field monitoring.