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An autonomous UAV-based monitoring device for precision viticulture

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Abstract. Current advancements in proximal sensing for sustainable viticulture focus on integrating autonomous systems, such as UAVs, with miniaturized sensors and machine learning to enhance the efficiency of vineyard monitoring. The study, part of the COLIBRI' project (Collaborative integration of mini-UAV, miniaturized sensors, and machine learning for proximal sensing towards sustainable viticulture), developing an autonomous drone system equipped with advanced sensors to automate vine monitoring. The drone carries a thermal camera to assess leaf water stress and a hyperspectral camera to evaluate grape ripening. The on-board integration of a companion computer (Raspberry Pi) enables real-time data analysis using machine learning models. This approach facilitates instant classification of ripening conditions and water stress levels, supporting vineyard management decisions.

The UAV autonomously collects data from specified targets, processes inputs externally, and executes assigned missions reliably. It is equipped with a flight controller to stabilise flight and control engine functions and a companion computer to manage software and instruct the flight controller. A ground station monitors the mission via telemetry and uploads data to the UAV. The system uses a GPS receiver for navigation, while the object approach relies on artificial vision with Aruco fiducial markers and the OpenCV2 library. Test flights demonstrated reliable mission execution with potential for the future.

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Keywords: Drone, Companion Computer, Optical sensors, Grape quality, Water status, Machine Learning, Agriculture 4.0