

ABSTRACT

This dissertation develops a new method to monitor vineyards over the main stages of their productive cycle in order to optimize field management. The core of the methodology is the generation of customized *crop maps* with a user-set local origin, variable resolution, and a global-referenced coordinate system based on Euclidean geometry. In addition, this system allows the fusion of data coming from either manual or automatic sampling, as well as the integration of measurements carried out along the growing season and even over consecutive seasons. The main objective is the enunciation of predictive models on the production of grapes and the assessment of their wine potential. To do so, emergent technologies have been applied through a cost-effective system architecture endowed with the flexibility and versatility required by modest South European growers to make wine production sustainable with conventional farm vehicles.

The system architecture designed, implemented, and field-validated comprises non-invasive perception with machine vision, differential GPS, and an onboard computer that acquires all the information to compose standardized crop maps in real time. The vision system implements a simplified approach based on a grayscale camera sensitive in the range UV-NIR and adapted to different spectral bands by means of optical filters that enhance the performance of dynamic segmentation routines. The main algorithm was implemented onboard a mid-size tractor and synchronizes crop images grabbed from the camera with the instantaneous position of the vehicle to generate real-time maps of the spatial variability of vegetation, with the purpose of their comparison with other crop maps of interest, such as terrain variation maps automatically generated by the vehicle, or manually generated

maps of soil resistance, yield, or alcohol potential of the future wine. A friendly graphic user interface helps operators illiterate in information technology control the perception and localization systems simultaneously from the tractor's cabin.

The results of this investigation indicate that reducing the complexity of precision farming applications is instrumental for its success as long as data are optimally managed after acquisition and processing. The novel crop maps defined in this work allowed the establishment of correlations between key crop parameters with statistical significance, resulting in the objective quantification of spatial variability for vegetation, yield, soil resistance, and several chemical properties of grape's juice. The fact that all the models proposed may be further completed with the addition of new data gathered from upcoming seasons is quite attractive to producers, who are endowed with a tool specifically adapted to their field and gaining in precision with time. This approach is affordable to medium-size vineyards because there is no need for purchasing airborne imagery, neither especially adapted vehicles, what in the end lets operators generate their own crop maps while performing other tasks with the vehicle, as global positioning accounts for the right localization of the field measurements at any time.