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Case Study

A diversified study on pesticide spraying equipment for vineyards using drones

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Some researcher groups in the Department of Mechanics and Aerospace Engineering (DIMEAS) Politecnico di Torino have an interesting experience with the applications of automatic systems in the agriculture fields [1-6].

A part of a wide study, carried out in the PRIN Project 2017 "New technical and operative solutions for the use of drones in Agriculture 4.0" (Research projects of significant national interest), on pesticide spraying systems for vineyards using drones is here presented.

During this research, the authors collected the real dimensions of a vineyard and then realised a vine scale model (scale 1:1) in a software environment. Using this model it was then possible to test different positions of a drone on the vineyard or their rows. Drawing in scale 1:1 the cone jets of some spraying commercial nozzles, the comprehension of the area covered by the sprayers during the drone flight was also possible.

To study the components of the spraying circuit some simulation models were realised, considering all of the parts of the circuit: the tank, the pump, the nozzles, the pipelines, etc... This analysis was useful to understand the best structure of the spraying circuit to reduce the weight and the dimensions of these parts then collocated under a drone (maximum payload equal to 100 N).

In this way, some commercial components were selected and bought and an experimental circuit was realised. It can test a single nozzle or more than one, studying both the behaviour of the single nozzle and the functioning of the whole spraying circuit. The types of nozzles tested are full cone, space cone, and fan jet. The nozzles spray a mixture of blue colour and water on a specific and useful photographic paper and the images were then elaborated using special software. This allows us to know important information such as the VMD (Volume Median Diameter) of the droplets, the coverage area, and the density of the droplets.

The experimental tests using a circuit with three nozzles (one with a full cone jet and the two lateral with fan jets) were carried out on a vineyard simulator, realising through three photographic papers one disposed on the top of the crop, in a horizontal position, and the others in the vertical position, along the height of the crop. Using these experimental results and the parameters above mentioned and calculated, the real distribution of the droplets in the vineyards was analysed. In this step of the study, the authors did not use water-sensitive papers as they wanted to investigate the whole area sprayed from the nozzles, analysing immediately in all of its parts the coverage area and the density of the droplets. The results obtained are good and useful for the study [7,8].

Then, as some leaves' characteristics such as the roughness, can influence the behaviour of the pesticide treatments, authors studied some leaves of different vine species (Muscat, Chardonnay, Cortese, Dolcetto, Nebbiolo, Ruche') both with specific images elaboration software and with some experimental tests. The study aimed to understand the diameter of the water droplets that can cause the slip of the droplet from the vine leaf. The results obtained were interesting and coherent with the literature [9], as in this application the diameter of the droplet must be more than 100 μm to avoid the wind drift effect and less than 300 μm to avoid the slip phenomenon from the leaf surface.

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To investigate also the effects of the rotors and the advancement of the drone on the jets sprayed from the nozzles [10,11], a specific little wind tunnel (designed on a proper scale) and some simulations using commercial software were carried out. The study was interesting and gave important information on these effects, also suggesting the best positioning of the nozzles under the drone.

In the following Figures 1, the Figure 1a shows a detail of the vine model and the drone, Figure 1b shows an example of the experimental circuit with three nozzles and the vineyard simulator, the Figure 1c shows an example of a vine leaf analysis with the image elaboration software.

All of the results obtained are coherent from similar to the literature and will be useful for further future research in this field.

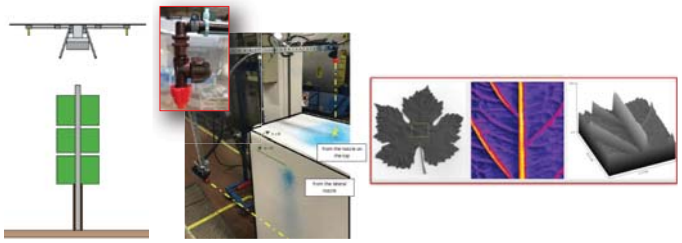

Figure 1: a) the vine model and the drone, b) the circuit with three nozzles, c) an example of the vine leaf analysis.

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