# *Giuseppe Pellizzi Prize 2018*

## [F] PhD Extended Abstract Form

CONTRIBUTIONS ON ADVANCED AUTOMATION FOR SELECTIVE PROTECTION TREATMENTS ON SPECIALTY CROPS

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**Extended Abstract**

### 1. Chapter 1: Introduction

Food security and food safety are the main global objectives of today's agriculture. Within this framework, the recent growing sensibility of both policy makers and consumers for food safety themes appear to be a hopeful sign for the introduction of new strategies and technological systems for the agricultural sector. A particularly challenging issue for current crops management is the control of plant's diseases while avoiding environmental pollution. Precision pest management techniques –an emerging subset of precision agriculture suite- aim at facing this challenge by means of: i) sensing technologies for the early detection and localization of diseased areas in the canopy, and ii) variable rate technologies for the selective application of crop protection treatments on target areas

### 2. Chapter 2 : Methodology development

Two innovative methodologies for hyperspectral crop's disease detection are presented. The measurements were acquired by means of a hyperspectral camera mounted onto a robotic manipulator which allowed to compose the subsequent hyperspectral scans (1 spatial dimension x 1 spectral dimension) into a hypercube (2D spatial x 1D spectral) of the imaged plant. The first disease detection method is based on the combinatorial selection of the most significant wavelengths from the hypercube data by applying linear discriminant analysis, and the classification power of the optimal selected combination is then evaluated by applying a principal component analysis. The second method is based on a new spatial filter approach, acting along the different channels of the hypercube. The two methods of detection are applied by discussing two case studies of diseases, both on cucumber plants. A first set of experiments was conducted on plants artificially inoculated with powdery mildew. A second and more extensive set of experiments was conducted on plants infected by the cucumber green mottle mosaic virus (CGMMV), which is nowadays considered one of the most dangerous diseases for the Cucurbitaceae family. The application of the two methodologies was successful in identifying the major symptoms of the diseases considered, and specifically the spatial filtering approach enable to detect the subtle morphological modifications in the plant tissue at rather early stage of CGMMV infection.

### 3. Chapter 3 : Technical-economic analysis

Due to the high cost and complexity of the technologies adopted in the disease detection and of precision spraying equipment, the second part of the thesis applies the classical methods of mechanization cost-analysis to investigate what are the economic thresholds, which may enable the introduction of new precision pest management technologies. To this aim, the analysis is focused on vineyard and apple orchard that represent a favourable case for introducing these kind of innovations, due to the high protection treatments costs typical for these specialty crops. Starting from the results obtained in research on precision spraying in speciality crops, the technical-economic analysis considers on three different technological levels of precision spraying equipment, associated with increasing levels of reduction of the distributed amount of pesticide. This reduction is assumed to be linked to the improved accuracy in targeting the application without affecting the biological efficiency of the treatment, and hence generating a net cost benefit for the farmer. To gain insights into evaluating this benefit is of primary interest, since the profitability of precision spraying technologies will be a major driver for their adoption in speciality crops. Therefore, this study aims at: a) assessing the total costs associated to spraying equipment at the different technological levels considered; b) evaluating weather more advanced equipment can be

profitable compared to current conventional sprayers. Furthermore, this analysis was extended to a high-precision, robotic spraying platform, here considered as a perspective scenario for precision spraying technologies. For this specific case, the study aimed at assessing the maximum allowed cost for such a robotic platform, which could generate positive net benefits for the farmer thanks to the envisaged pesticide reduction.

**Final remarks concerning the competition benchmarks and strength points**

The presented thesis work focus on *Automation and Electronic* topic for the first part and on *Mechanization* for the second part. In the first part the thesis presents two innovative methodologies for the selection of wavelengths of interest in automatic disease detection through hyperspectral cameras. The first method is a combinatorial selection of the most significant wavelengths from the hyperspectral data, the second one is based on the design of a spatial filter, acting along the different channels of the hypercube. In the second part of the thesis the economic sustainability of the adoption of automation in the agricultural sector was estimated. In detail three different scenarios at increasing levels of automation are compared with a reference scenario. The convenience in the adoption of new technologies was explored for different field extensions.