SELEZIONE PUBBLICA, PER TITOLI ED ESAMI, PER IL RECLUTAMENTO DI N. 1 UNITÀ DI TECNOLOGO DI SECONDO LIVELLO CON RAPPORTO DI LAVORO SUBORDINATO A TEMPO DETERMINATO DELLA DURATA DI 18 MESI, PRESSO L'UNIVERSITÀ DEGLI STUDI DI MILANO - DIPARTIMENTO DI SCIENZE E POLITICHE AMBIENTALI, PER L'ATTUAZIONE DEL PROGRAMMA DI RICERCA NATIONAL RESEARCH CENTRE FOR AGRICULTURAL TECHNOLOGIES TEMATICA TECNOLOGIE DELL'AGRICOLTURA - AGRITECH (CUP G43C22001330005) NELL'AMBITO DEL PIANO NAZIONALE DI RIPRESA E RESILIENZA (PNRR) - CODICE 22342

La Commissione giudicatrice della selezione, nominata con Determina Direttoriale n. 14947 del 28/09/2023, modificata con Determina Direttoriale n. 17106 del 31/10/2023 e composta da:

Prof. Luca Bechini	Presidente
Prof.ssa Fulvia Tambone	Componente
Prof.ssa Sara Savoldelli	Componente
Dott. Tommaso Brambilla	Segretario

comunica i quesiti relativi alla prova orale:

Quesito 1

Prospettive applicative dei modelli dei sistemi colturali a supporto della gestione agronomica.

Quesito 2

Con riferimento a un ambito di sua scelta, il candidato descriva lo stato di avanzamento e le prospettive di utilizzo e di sviluppo delle app per il supporto alle decisioni in agricoltura.

Milano, 8 novembre 2023

La Commissione

Prof. Luca Bechini - Presidente

Prof.ssa Fulvia Tambone - Componente

Prof.ssa Sara Savoldelli - Componente

Dott. Tommaso Brambilla - Segretario

Computers and Electronics in Agriculture 157 (2019) 339–350

Contents lists available at ScienceDirect

Computers and Electronics in Agriculture

journal homepage: www.elsevier.com/locate/compag

Original papers

Development and evaluation of a low-cost and smart technology for precision weed management utilizing artificial intelligence

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ARTICLE INFO

Keywords:
Weed detection
Artificial intelligence
Machine learning
Smart agriculture
Precision agriculture
Neural networks
Deep learning

ABSTRACT

Most conventional sprayers apply agrochemicals uniformly, despite the fact that distribution of weeds is typically patchy, resulting in wastage of valuable compounds, increased costs, crop damage risk, pest resistance to chemicals, environmental pollution and contamination of products. To reduce these negative impacts, a smart sprayer was designed and developed utilizing machine vision and artificial intelligence to distinguish target weeds from non-target objects (e.g. vegetable crops) and precisely spray on the desired target/location. Two different experimental scenarios were designed to simulate a vegetable field and to evaluate the smart sprayer's performance. The first scenario contained artificial weeds (targets) and artificial plants (non-targets). The second and most challenging scenario contained real plants; portulaca weeds as targets, and sedge weeds and pepper plants as non-targets. Two different embedded graphics processing unit (GPU) were evaluated as the smart sprayer processing unit (for image processing and target detection). The more powerful GPU (NVIDIA GTX 1070 Ti) achieved an overall precision of 71% and recall of 78% (for plant detection and target spraying accuracy) on the most challenging scenario with real plants, and 91% accuracy and recall for the first scenario with artificial plants. The less powerful GPU (NVIDIA Jetson TX2) achieved an overall precision and recall of 90% and 89% respectively on the first scenario with artificial plants, and 59% and 44% respectively on the second scenario with real plants. Finally, an RTK GPS was connected to the smart sprayer and an algorithm was developed to automatically generate weed maps and visualize the collected data (after every application). This smart technology integrates a state of the art (AI-based) weed detection system, a novel fast and precision spraying system, and a weed mapping system. It can significantly reduce the quantity of agrochemicals required, especially compared with traditional broadcast sprayers that usually treat the entire field, resulting in unnecessary application to areas that do not require treatment. It could also reduce costs, risk of crop damage and excess herbicide residue, as well as potentially reduce environmental impact.

1. Introduction

Farmers use mainly agrochemicals for plant disease, pest and weed control, and they follow conventional crop protection strategies (utilizing a vast amount of chemicals) despite the negative impacts on the environment and human health. For example, more than 90% of the acreage of crops in United States are being sprayed by herbicides (Gianessi and Reigner, 2007). The use of herbicides has eliminated the need of manual labor to pull weeds out of fields. The use of herbicides has resulted in reduction of production costs and increase of crop yields in the United States. The United States farmers dedicate around 65% of their total expenditure towards herbicides for weed control, and it is estimated that around $26 billion is spent on herbicides each year in the United States (Gianessi and Reigner, 2006). Pests reduce global potential crop yield up to 40%; that could be twice as large if no agrochemicals are used (Deutsch et al., 2018; Oerke, 2006). Global pesticide use was assessed to be 3.5 billion kg/year, with an estimated cost of $45 billion in 2015 (Pretty and Bharucha, 2015).

Apart from the advantages of using agrochemicals for pest and weed control, there are also disadvantages mainly due to limitations of the conventional spraying technologies. Minimizing the negative impacts of agrochemicals (and spraying technologies) is a major global societal challenge; 72% of citizens state that agrochemical residues is one of the most important food-related concern (European Food Safety Authority -EFSA, 2013). EFSA announced that 98.9% of food products contain agrochemical residues (with 1.5% of them in excess of the legal limits). Additionally, plants resistance to agrochemicals (e.g. herbicides) is posing a great threat to crop production in many countries (Jeanmart

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https://doi.org/10.1016/j.compag.2018.12.048
Received 5 November 2018; Received in revised form 19 December 2018; Accepted 23 December 2018
Available online 11 January 2019

Precision Agric (2011) 12:666–681
DOI 10.1007/s11119-010-9210-5

Variable nitrogen rate determination from plant spectral reflectance in soft red winter wheat

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Published online: 3 December 2010

Abstract Variable rate nitrogen (N) application based on in-season remote sensing can potentially improve wheat (*Triticum aestivum* L.) N management and N use efficiency (NUE). The goal of this study was to evaluate the potential of improving in-season soft red winter wheat (SRWW) variable rate N recommendations based on crop canopy reflectance. Small-plot N rate response calibration studies guided development of the Virginia Wheat Algorithm (VWA) for grain yield prediction and variable rate N fertilizer rate determination for SRWW. Large plot, replicated validation studies conducted for 15 site-years included an N-rich strip installed at growth stage (GS) 25 and various treatments at GS 30; four or five fixed-rate treatments applied to evaluate site N response, a variable rate based on the VWA applied using a GreenSeeker® RT 200 system and a "standard" fixed rate based on GS 30 wheat tissue N concentration. All sites responded positively to GS 30 N application. When data from one site were excluded, rates were 8 and 3 kg ha^{-1} below the economically optimal N rate (EONR) for the VWA and standard methods, respectively. Based on these data, the GreenSeeker® RT 200 system employing the VWA was equivalent to the current standard method and offers real-time rate prescriptions with less labor and less delay than the current tissue N concentration sufficiency standard.

Keywords Nitrogen · Variable rate · Remote sensing · Wheat (*Triticum aestivum* L.)

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