Automating Crop Damage Assessments with Unmanned Aerial Systems and Machine Learning

Eduard Puig[1], Felipe Gonzalez[2], Grant Hamilton[3], Paul Grundy[4]

[1]Australian Research Centre for Aerospace Automation, QUT, 2 George St, Brisbane QLD 4000, eduard.puiggarcia@qut.edu.au
[2]Australian Research Centre for Aerospace Automation, Science and Engineering Faculty, QUT, 2 George St, Brisbane QLD 4000, felipe.gonzalez@qut.edu.au
[3]Science and Engineering Faculty, Queensland University of Technology, 2 George St, Brisbane QLD 4000, g.hamilton@qut.edu.au
[4] Queensland Department of Agriculture and Fisheries, 203 Tor Street, Toowoomba QLD 4350, paul.grundy@daf.qld.gov.au

Keywords: Unmanned Aerial Systems (UAS), machine learning, remote sensing

Abstract:
Agricultural pests are responsible for millions of dollars in crop losses and management costs every year. In order to implement optimal site-specific treatments and reduce control costs, new methods to accurately monitor and assess pest damage need to be investigated. In this paper we explore the combination of unmanned aerial vehicles (UAV), remote sensing and machine learning techniques as a promising methodology to address this challenge. The deployment of UAVs as a sensor platform is a rapidly growing field of study for biosecurity and precision agriculture applications. In this experiment, a data collection campaign is performed over a sorghum crop severely damaged by white grubs (Coleoptera: Scarabaeidae). The larvae of these scarab beetles feed on the roots of plants, which in turn impairs root exploration of the soil profile. In the field, crop health status could be classified according to three levels: bare soil where plants were decimated, transition zones of reduced plant density and healthy canopy areas. In this study, we describe the UAV platform deployed to collect high-resolution RGB imagery as well as the image processing pipeline implemented to create an orthoimage. An unsupervised machine learning approach is formulated in order to create a meaningful partition of the image into each of the crop levels. The aim of this approach is to simplify the image analysis step by minimizing user input requirements and avoiding the manual data labelling necessary in supervised learning approaches. The implemented algorithm is based on the K-means clustering algorithm. In order to control high-frequency components present in the feature space, a neighbourhood-oriented parameter is introduced by applying Gaussian convolution kernels prior to K-means clustering. The results show the algorithm delivers consistent decision boundaries that classify the field into three clusters, one for each crop health level as shown in Figure 1. The methodology presented in this paper represents a venue for further research towards automated crop damage assessments and biosecurity surveillance.

Keywords:
Unmanned aerial vehicles (UAV), machine learning, k-means, remote sensing, biosecurity

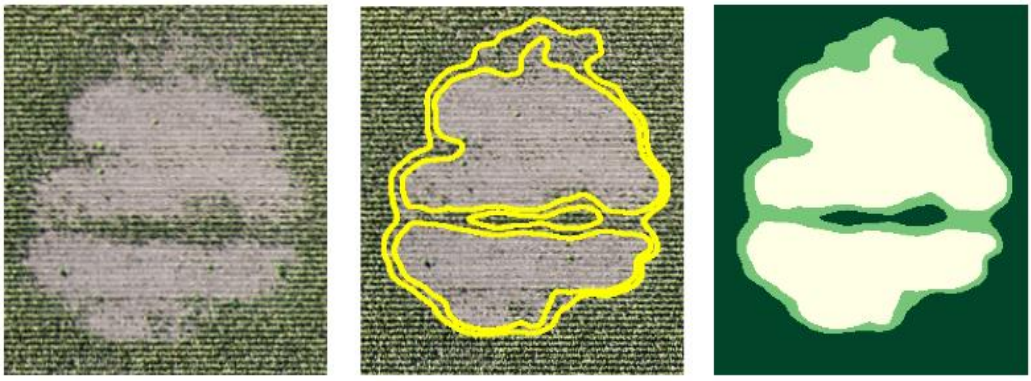

Figure 1. Original image caption, together with decision boundary and membership diagrams that automatically classify the crop damaged field into three health levels.

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