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Crop classification and weed detection in rainfed maize crops using UAV and PlanetScope imagery

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Abstract:

The invasion of weeds in crop fields producing maize, wheat and rice is a major issue especially for smallholder farms (Sims et al., 2018). Maize production is essential to rural livelihoods in Africa and the presence of weeds in these fields is a potential threat to food security throughout the continent (Cairns et al., 2021). The Sustainable Development Goals (SDGs) identified food security as a major focus point for investigating smallholder crops in developing countries such as South Africa. The main aim of this study was to evaluate the impact of spectral-temporal characteristics on the classification of maize in a weed-infested field. We used unmanned aerial vehicle (UAV) imagery, PlanetScope satellite data and two machine learning algorithms i.e. random forest (RF) and support vector machine (SVM) to map a maize field in Bronkhorstspruit, South Africa. Machine learning for crops provides valuable insights into various aspects of agriculture, and when integrated with cartography, it enhances our understanding of crop distribution, health, productivity, and land use patterns, facilitating better decision-making and sustainable agricultural practices. Moreover, machine learning models aid in distinguishing weeds with the utility of UAV imagery in an automated manner. The use of UAV data is of importance for weed mapping because other commonly used remote sensing platforms such as Sentinel and Landsat-8 are not optimal in precision agriculture applications due to their low temporal and spatial resolutions, as opposed to the high spatial resolution of UAVs (Nhamo et al., 2020). Sampling positions for three classes, including maize, weeds and soil were identified to split the data into 80% training and 20% validation data. The classification accuracy assessment and Stratified K fold cross-validation were used to compare the performance of the machine learning algorithms. The study was conducted from January 2022 to May 2022 during the mid to late stages of the maize growing season. Our results demonstrate the importance of UAV image data and machine learning algorithms to accurately detect weeds in maize crops in medium-sized smallholder farming. There was a significant improvement in the accuracy of crop classification with the use of UAV data in different classification experiments. The study's findings indicated that the accuracies produced by PlanetScope satellite data were less favourable for both RF and SVM models, with overall accuracy lower than the UAV data. A crop map showing maize-weed classification was produced for each month during the mid-to late maize growing season. The developed maps are useful for weed control and enable site-specific treatments based on the extent of the weed coverage which is necessary for precision agriculture applications.

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