Chapter 9
Precision Farming With Automated Weed Detection Using Machine Learning

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ABSTRACT

An artificial intelligence-based weed detection system is a computerized system designed to automatically identify and classify different types of weeds in agricultural fields. The system utilizes advanced computer vision techniques and machine learning algorithms to accurately detect and differentiate weeds from crops or other elements in the field. The weed detection system typically consists of hardware components such as cameras or drones that capture high-resolution images or videos of the agricultural area. These images are then analyzed by the artificial intelligence algorithms which have been trained on large datasets of weed images to recognize and distinguish various weed species. This paper explores the application of AI in weed detection and offers a promising solution for automating weed detection in crops. Furthermore, the work addresses the potential benefits of using automated weed detection systems such as reduced labor costs decreased herbicide usage, and improved environmental sustainability.

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INTRODUCTION

Overview: Weeds are a significant factor that can negatively impact crop yields. Site-specific weed control is becoming a highly effective approach, especially when integrated with machine learning and image processing techniques. With the global population rapidly increasing and projected to surpass nine billion soon, agricultural production must increase by approximately 70% to meet future demands (Toğaçar, Mesut et al., 2022). However, during this period, the agricultural sector faced several problems, like shrinking arable surfaces and the need for intensified production. Water scarcity and climate change will also have an impact on output. Precision or technological agriculture presents viable answers to these problems (Jawed M. K et al., 2022).

Weeds impact crop productivity and quality because they spread swiftly and uncontrollably (S. Abouzahir, M. Sadik, and E. Sabir et al., 2022). For essential resources including nutrients, sunlight, water, and space, they compete with crops (X. Jin, J. Che, and Y. Chen et al., 2021). Farmers must thus invest time and resources in weed management. Numerous issues plague crop protection and yield enhancement methods, including cost, time, and labor intensiveness. Additionally, these practices may be harmful to people's health, plants, animals, and the environment (Hameed, S. et al., 2018; Amin et al., 2019).

Automated weed control methods offer both economic and environmental benefits. By using machines to remove weeds, labor costs can be reduced, and selective spraying can decrease herbicide use (M.J.. et al., 2003). Accurate weed detection and identification are crucial for developing autonomous weed management systems (X. Li, R. Zeng, and H. Liao, et al., 2016).

According to S. I. Moazzam et al. (2021), there are four primary steps in a conventional weed identification system: image capture, preliminary processing, feature extraction, weed detection, and classification. These procedures have been enhanced by several contemporary technologies. The classification and identification of weeds are the two most important aspects of this approach.

When it comes to picture classification, identifying objects, and recognition, deep learning is an essential portion of neural networks (ML) that outperforms conventional ML techniques in various ways. Differentiating between crops and weeds can be challenging with ML techniques due to their similar appearances. However, deep learning methods are more proficient at extracting features from images, making them more effective in addressing these challenges.

Weeds, or unwanted plants, impede crop growth by taking up space with vital resources like sunlight, water, and nutrients. Crop productivity is lowered as a result. Farmers may find it labor- and time-intensive to manually identify and remove weeds (Ying, B.; Xu, Y.; Zhang, S.; Shi, Y.; Liu, L. et al., 2021). But detecting weeds