



Ai and Vision Reality – 2,000 words

AI-Based Crop Disease Detection and Management: Challenges and Ethical Considerations'

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Abstract - Summative paragraph

Table of Contents

ABSTRACT.....	2
1. INTRODUCTION.....	4
1.1 DEFINITION OF TERMS.....	5
2. LITERATURE REVIEW -	5
2.1 HISTORICAL METHODS IN CROP DISEASE DETECTION.....	6
2.2 EMERGENCE OF AI IN AGRICULTURE	7
2.3 RECENT ADVANCES IN AI-DRIVEN CROP DISEASE DETECTION.....	7
3. METHODOLOGY	9
3.1 LITERATURE SELECTION CRITERIA	9
3.2 DATA ANALYSIS METHODS	9
4. REFLECTIONS/DISCUSSIONS.....	10
4.1 CHALLENGES, ETHICAL DILEMMAS AND CONSIDERATIONS IN AI-BASED CROP DISEASE DETECTION	10
4.2 GAPS IN CURRENT RESEARCH	11
5. CONCLUSION	12
6. REFERENCES.....	12

1. Introduction

The integration of Artificial Intelligence (AI) in agriculture has been gaining significant attention especially in the sector of crop disease detection, Agriculture being one the biggest industry in the world is the main backbone for many countries and, due to the growing population, there is a constant demand for food. To satisfy the pressing need. It is of importance to improve agricultural potency and protect crops. Crop diseases can decrease productivity of agricultural production by 10% to 95% ensuing notable decrease in the quality and quantity (Orchi, et al., 2021). AI emerging technologies offer effective solutions to enhance agricultural productivity by enabling early and accurate identification of crop diseases.

For instance, AI driven techniques have demonstrated effectiveness in combating agricultural disease like early blight in potatoes, highlighting the potential algorithms and image analysis. However, a thorough evaluation uncovers uncertainties surrounding the potential of AI solutions in various agricultural environments. (Haasan, et al., 2021).

Furthermore, as agriculture progressively embraces AI technology, it is crucial it evaluate the wider consequences for sustainability and farming practices. This integration in traditional agricultural methods aim to reduce waste, enhance sustainability, and enhance farmers to make informed decisions (Vasiliki, et al., 2023).

To maintain global food security and sustainability, it is imperative that AI based crop detection and management be investigated. Therefore, this paper aims to critically examine the use of AI in crop disease detection, and management by scrutinizing current literature and technological developments.

1.1 Definition of terms

- i. Artificial Intelligence – AI
- ii. Emerging technologies
- iii. Machine Learning – ML
- iv. Internet of things - IOT

2. Literature review

2.1 Introduction

Crop diseases are caused by insects, pests, bacteria, fungi, and viruses, which are found and can spread in all parts of the plant. Historical methods and recent methods of crop disease detection are being reviewed to understand the transition and technological improvements over the years.

2.2 Historical Methods in Crop Disease Detection

For ages, crop diseases have been identified through the following methods.

- I. Visual observation: This longstanding traditional method of crop disease detection is obtained by solely relying on the naked eye inspection and accumulated knowledge and experience using the naked eyes (Singh, 2020). Expert farmers in this sector rely on the plant height, color, leaf shape, leaf density on the branches, changes in the root system to make diagnosis. Through this tentative diagnosis of the primary pathogenesis of a nematode, fungus, bacterium are made (Khakimov, et al., 2022). This outdated method of relying on the eyes, limits the accuracy and reliability of diagnosis, as it may overlook underlying complexities and variations in disease pathology, emphasizing the requirement for more advanced diagnostic approaches (Singh, 2020).
- II. Microscopy; As times improved, plants wounded are taken to laboratories to undergo microscopic observation, in anticipation of an accurate diagnosis. With the aid of stereomicroscope analysts can zoom in on specific plant components to identify certain disease symptoms (Khakimov, et al., 2022). Since 1999, farmers and quadrative inspectors can take very specialized using this method (Mahlein, 2016).

These time-consuming methods require skilled personals with advanced abilities in diagnosis and illness identification, making the susceptible to human prejudice (Mahlein, 2016).

2.3 Emergence of AI in Agriculture

Introduction of AI technologies: The advent of AI in recent years has led to significant advancement in agriculture, providing novel answers to long standing objectives. It has revolutionized traditional agricultural procedures and increased efficiency.

By emulation human cognitive functions, Ai holds the potential to revolutionize traditional farming practices and enhance overall efficient and productivity. (Dharmaraj & Vijayanand, 2018).

Applications of AI in Agriculture: AI integration is revolutionizing agriculture and promises transformative advancements in soil analysis, insect control, crop monitoring, yield predictions, water management, disease control, weed management and crop forecasting.

Robotics automate fruit harvesting for apples and litchi while smart technologies like cloud services and internet of things (IOT) improve supply chain management. Blockchain technology facilitate prompt payments and effective business dealings (Bal, 2023)

2.4 Recent Advances in AI-driven Crop Disease Detection

AI-driven crop disease detection has advanced significantly in recent years, changing agricultural practices, and providing effective means of identifying and managing diseases. The following are the AI technologies used in crop disease detection.

I. Machine Learning Algorithms

- a. Support vector machines (SVM): A supervised learning algorithm used in crop disease detection, trained on labeled data sets of crop images. Despite their high accuracy and robustness in identifying complicated patterns in crop images, SVMs may have limitations in handling large scale datasets. (Sharada , et al., 2016).
- b. Convolutional neural networks (CNNs) deep learning algorithms inspired by the human visual system, are used in crop disease detection by training on large datasets of crop images to learn

discriminative features demonstrating remarkable accuracy and scalability (Sharada , et al., 2016).

II. Image processing techniques

- a. Image segmentation: This is a technique that entails the division of images into separate segments for enhances analysis. The algorithms are used to separate crop photographs based on pixel intensity, color texture or other attributes into sections. This enables precise localization and identification of diseases symptoms thus facilitating greater accuracy (Fuentes, 2017).
- b. Feature extraction: This entails finding and extracting pertinent aspects from crop photos that are suggestive of disease symptoms (Fuentes, 2017).

The process of segmenting a picture involves breaking it up into meaningful portions, and feature extraction is the process of finding and extracting pertinent properties from these segmented areas. In image analysis jobs, picture segmentation is usually the first stage, followed by feature extraction to retrieve important data for further processing and decision making (Fuentes, 2017).

3. Methodology

3.1 Introduction

AI-Based Crop Disease Detection and Management have made a significant progress in the agricultural sector, but the implementation remains limited due to ethical concerns and obstacles. Data quality, ethical dilemmas, challenges and technology limitations are some of the issues that hinder the integration of this system and addressing them is crucial for sustainable agricultural practices. The methodology chapter will go through the literature selection criteria, analysis methods and limitations.

3.2 Literature Selection Criteria and Data Analysis Methods

This literature utilized resources focused on peer reviewed articles, research reports from 2010-2024. Credible academic resources such as google scholar, Kaggle, ResearchGate where the main resources used where accessed by filtering using terms such as 'ethical considerations in AI based crop disease detection' and 'Crop disease detection'. Mind mapping and Lists were carefully used to select and filter papers aligning with the aim and goals of the literature. The approach aimed to explore the complexities of Ai driven methods, addressing moral dilemmas.

An analytical approach was implemented to narrow down, critically analyze and extract data from approved papers. This method used themes like data quality, bias, interpretability, and transparency to analyze data.

3.3 Limitations

4. Reflections/Discussions

In reference to the group activity that lead to the innovation of a crop/human fault detector, combining of 'computer vision & AI for autonomous vehicle', AI based crop disease detection' and 'AI in healthcare fields, that uses sensors to detect specific entities like humans and crops, autonomously navigating its surroundings and generating outcomes, this shows how diverse and applicable AI crop disease detection can be.

It is paramount to evaluate this to understand the possibilities of benefits and drawbacks. AI-based agricultural disease detection has significant effects on farmers and rural communities. These technologies have the potential to increase food security, lower economic losses, and boost agricultural output.

4.1 Challenges, Ethical Dilemmas and Considerations in AI-based Crop Disease Detection

Ai based crop disease detection has several challenges, such as interpretability of the models, scalability and data quality and bias (Soltani, 2020). Furthermore, verifying the interpretability of models is vital in comprehending the logic underlying AI generated results, thus augmenting confidence and approval among interested parties (Soltani, 2020). Also, strong infrastructure and resources to handle varied agricultural landscaped and technological adoption levels are needed to achieve scalability in Ai systems for crop disease detection.

Data privacy, algorithm bias, and equal access to technology are the main ethical conundrums to be considered for AI based crop disease detection (Dwivedi, 2024). The formulation of ethical frameworks is required as issues regarding accountability and transparency in decision making processes arise (Manoj Ram Tammina, 2024). Thoroughly addressing these concerns is crucial for the proper application of AI in crop disease detection.

4.2 Gaps in current research

Current research gaps indicate differences in ML approaches used for remote pest surveillance. Despite attempts being made to combine ML with proximate digital photographs, an in depth understanding of the subject matter is hindered by the variation of species and circumstances (Barbedo, 2020).

Moreover, disease outbreaks are a serious concern in places like Morocco where agriculture is a major economic factor. Possible solutions are provided by automated disease identification methods while issues including the requirement for reliable detection algorithms and data harmonization still exist (Houda Orchi, 2021)

5. Conclusion