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PLANT SPECIES AND DISEASE DETECTION

Nayan V Bhandari[1], Prajna N[2], Likith R[3], Nishith R[4], Dr. Anitha K
[1,2,3,4]B.E Students, Department of Computer Science & Engg. Global Academy of Technology, Bangalore
[5]Associate Professor, Department of Computer Science & Engg.Global Academy of Technology, Bangalore

ABSTRACT
This survey paper examines the current state of the art in plant species and disease detection using machine learning techniques. The paper explores various approaches, including image-based, and analyses their strengths and weaknesses. Additionally, the paper investigates the challenges associated with data collection and annotation, as well as the performance metrics used to evaluate the accuracy of detection models. The paper concludes with a discussion on the potential future directions of this field, including the integration of emerging technologies such as drone-based imaging and edge computing.
KEY TERMS: *Machine Learning, Support Vector Machine, Convolutional Neural Network, Long Short-Term Memory, Principal Component Analysis*

INTRODUCTION

Plant species and disease detection are crucial tasks in agriculture and forestry management, as they help prevent crop losses, maintain high yields, and promote sustainable agriculture. Traditional methods of plant species and disease detection are often time-consuming, labour-intensive, and expensive. With the emergence of machine learning (ML) and computer vision techniques, there have been several attempts to automate this process. This paper aims to provide an overview of the current methods and research in plant species and disease detection using ML. Researchers have used ML techniques to classify plant species based on leaf shape, texture, and color. CNNs have been particularly effective in this area, enabling accurate classification of plant species from images. Some studies have also explored the use of plant phenotyping, which involves the analysis of plant traits such as leaf area, height, and volume, to distinguish between plant species. Additionally, researchers have developed automated plant species identification systems based on plant DNA analysis, enabling more accurate and reliable identification of plant species.

BACKGROUND

Plant species and disease detection is traditionally done through manual inspection and observation by experts. This process can be time-consuming, costly, and subject to human error. ML techniques have been applied to automate this process, enabling quick and accurate detection of plant species and diseases. These techniques can be applied to a range of scenarios, including large agricultural or forested areas, greenhouse production, and urban agriculture.

LITREATURE REVIEW

Name of paper	Year of Publication	Algorithm used	Accuracy achieved	Disadvantages
"Overview of PlantCLEF 2022: Image-based plant identification at global scale"	2022	Vision Transformers	Highest MA-MRR being 0.626 achieved by Mingle Xu Run 8 by South Korea	High Computation Cost
"Plant Species Identification from Leaf Images Using Deep Learning Models (CNN-LSTM Architecture)"	2021	LSTM on top of CNN	95% (almost consistently)	Prone to over-fitting
"Identification of Different Plants through Image Processing Using Different Machine Learning Algorithms"	2020	PCA layered with SVM	90%(minimum) 98%(maximum)	High energy Consumption
"Machine learning for image based species identification"	2018	Plain CNN	86%	Different algorithms can give better accuracy

Several ML techniques have been used for plant species and disease detection, which includes deep learning, support vector machines (SVMs), and convolutional neural networks (CNNs). These techniques can handle large amounts of data and can learn from complex patterns, enabling accurate and efficient detection of plant species and diseases.

According to [1] Hervé Goëau et al. (2022), the pressing need to increase our knowledge of plant species worldwide, which is essential for human civilization to be developed, including constriction, agriculture, and other areas. However, the systematic identification of plant species by human experts is a significant challenge, resulting in a burden on the acquisition of new information and understanding. To address this issue, automatic identification has been used more often in recent years and it has shown good progress, with deep learning techniques showing promise in addressing the problem of global assessment of plant biodiversity The paper outlines the PlantCLEF2022 challenge's resources and evaluations and provides an overview of the methods and systems used by the research groups involved. The analysis of the result provides insights into the effectiveness of different techniques and their potential to improve automatic identification of plant species. The paper concludes that Deep Learning techniques can address the challenge of global identification of plant biodiversity and that the PlantCLEF2022 challenge represents a significant step towards this goal.

According to [2] J. Banzi et al. (2021), a deep understanding of plant species is crucial for achieving sustainable development and preserving biodiversity. However, the conventional approach to identifying plant species through botanical terms and morphology can be complicated and be very time-consuming, which may discourage learners from acquiring species knowledge. Therefore, automating plant species identification has become an increasingly popular area of interest, especially due to the increasing accessibility of digital cameras and mobile devices, combined with sophisticated image processing and pattern recognition techniques. This paper focuses on a convolutional neural network (CNN) model for plant species identification based on simple plant leaf images. The model was trained on a dataset of various different plant species images containing 64 different element vectors of plants in a set of 100 distinct classes of plant species. Several CNN model architectures were trained, and the with an accuracy of 95.06% in correctly identifying the associated plant species, the proposed model demonstrated remarkable precision and efficacy. The significant success rate of the proposed CNN model makes it a useful tool for plant species identification and as an advisor for non-experts. Furthermore, expanding this approach could lead to the development of a comprehensive plant species identification system that operates in real-world ecosystem services. Overall, the development of automated plant species identification models using deep learning methodologies has the potential to revolutionize the way we approach biodiversity conservation and sustainable development.

[3] Ibaphyrnaishisha Kharir et al. (2020) focuses on using digital image processing techniques and ML algorithms to identify and classify different plant species based on the features of their leaves. This research aims to develop a robust and efficient method for plant identification that can provide accurate results in less time. The research paper provides an overview of various image processing methods that can be used to identify distinct sections or areas of the plant leaves for classification. The study focuses

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on the characteristics of the leaves, such as their colour, texture, which are essential for plant identification. The SVM algorithm is the main method used in this study for plant identification and classification. SVM is a powerful machine learning algorithm that can handle large and complex datasets and can provide accurate results even with noisy data. The proposed work asserts a significant level of accuracy in identifying plant species via the use of the SVM algorithm. The experimental results of the proposed research work show that the identification of plant species based on their leaf features using image processing and ML algorithms is an efficient and reliable method. This method can be used to classify different plant species accurately, making plant identification more accessible and safer for researchers, farmers, and plant enthusiasts.

According to [4] Jana Wäldchen et al. (2018) the importance of accurate species identification in biological research and the growing need for effective approaches to fulfill the need. The advent of smart mobile devices, digital cameras, and the conversion of natural history collections into digital format has led to a vast increase in image data representing living organisms that are openly available. The authors propose that this, combined with modern machine learning methods, presents a significant opportunity for automated species identification. The paper primarily centers on the use of neural networks as a technology that has facilitated significant advancements in automated species identification within the last couple of years. The authors offer a concise summary of machine learning frameworks suitable for the task of species identification and assess various deep learning methods for identifying species through image analysis. They also introduce publicly available applications. The objective of this article is to offer perspectives into the latest developments in automated species identification and to serve as a launchpad for researchers who seek to utilize new machine learning methods in their biological investigations. The authors contend that although modern machine learning techniques are gradually being adopted in the realm of species identification, there will be a surge in the application of these methods to the issue in the coming years. The authors anticipate that in the near future, AI systems will serve as alternative tools for taxonomic identification.

CHALLENGES FACED DURING RESEARCH

While ML techniques show promise for identifying plant species automatically, there are several difficulties that need to be addressed in research. One challenge is the quality of the data used to train the algorithms. The data must be of high quality and represent a diverse range of species, which can be challenging to obtain. Additionally, there may be variations in the quality and resolution of images, which can impact the accuracy of the algorithms. nother challenge is the need for experts to annotate the images, which can be time-consuming and costly. Without proper annotations, the algorithms may not learn the necessary features to accurately identify the species. Furthermore, there may be difficulties in generalizing the algorithms to new environments or species that were not included in the original training data. This can limit the practicality of the algorithms in real-world scenarios. Finally, there is also the challenge of interpreting the results of the algorithms, particularly when they make incorrect identifications. It is important to understand the limitations and potential biases of the algorithms and to use them in conjunction with expert knowledge for more accurate species identification. Overall, while machine learning techniques offer significant potential for automated species identification, researchers must address these challenges to improve the accuracy and applicability of these algorithms.

OBJECTIVES

- Collect diverse and high-quality data for training the algorithms.
- Classify images into various different classes and pre-process them.
- Train it on an Algorithm that over come the issues faced by the other algorithms mentioned in the above survey papers.

METHODOLOGY

We intend to use the following approach for detecting and classifying plant diseases - collecting and pre-processing a diverse dataset of plant images, training a VGG16 model, tuning hyperparameters, evaluating performance using k-fold cross-validation, analysing results, comparing with existing methods, and interpreting the implications for agriculture. The approach aims to ensure accurate and reliable plant species and disease detection, which is crucial for preventing and minimizing crop losses and ensuring global food security. The results of the proposed work can have significant implications for the field of agriculture by providing a reliable and efficient way to detect and classify plant diseases, which can help farmers take timely action and minimize the impact of diseases on their crops.

CONCLUSION

The use of ML techniques for plant species and disease detection has enabled quick and accurate identification of plant species and diseases, which makes it easy for farmers and researchers to manage crops and prevent losses. This survey paper has provided an overview of the current methods and research in plant species and disease detection using ML. Future research in this area may focus on improving the accuracy of disease detection, developing automated systems for plant species and disease detection, and applying these techniques to real-world scenarios. Moreover, ML techniques can also help in identifying the environmental and biological factors that can affect plant growth and health, such as soil quality, temperature, and humidity. This information can be used to improve agronomic practices, resulting in better harvests and reduced environmental impact. However, there are still some difficulties associated with the use of Machine Learning techniques for plant species and disease detection. One of the main challenges is the availability of large and diverse datasets for training ML models. Additionally, the use of different imaging techniques can also lead to variations in image quality, which can affect the accuracy of disease detection. Another obstacle to overcome is the lack of interpretive power in ML models, which can make it challenging to comprehend how the model arrived at its decision. In conclusion, the use of ML techniques for plant species and disease detection is a rapidly growing field with numerous applications in agriculture and plant science. ML techniques have shown great potential in accurately and quickly identifying plant species and diseases, leading to improved crop management practices and reduced economic losses. As this technology continues to advance, it is important to tackle the difficulties associated with it and further explore its potential in real-world scenarios.

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