TIJER || ISSN 2349-9249 || © March 2024, Volume 11, Issue 3 || www.tijer.org

VGG19-Powered Plant Nutrient Imbalance Detection System

[1]B. Nageswara Rao, [2]K. Purandheswari, [3]S. Sumathi, [4]R. Rajesh, [5]P. Haneesh

[1]Associate Professor, [2]Student, [3]Student, [4]Student, [5]Student

[1]Computer Science and Engineering

[1]Lendi Institute of Engineering and Technology, Vizianagaram, India

Abstract - Nutrient deficiency in plants poses significant challenges to agricultural productivity and food security, especially in regions where agriculture is predominant. Early detection is crucial for optimizing crop yields and ensuring sustainable practices. This study proposes a novel approach leveraging machine learning and VGG19, a deep learning architecture. We compile a dataset of plant images showing nutrient deficiency symptoms, covering macronutrients and micronutrients. Advanced machine learning, including convolutional neural networks (CNNs), is used for accurate prediction. Fine-tuning VGG19 enhances its ability to discern deficiency features. Through validation, our framework proves effective in improving crop resilience. Integrating VGG19 enables real-time assessments via a user-friendly interface. This study highlights deep learning's potential, particularly VGG19, in swiftly detecting plant nutrient deficiencies, thus promoting sustainable agriculture and food security.

Index Terms - Nutrient Deficiency, Agriculture, Deep Learning, VGG19 Architecture, Crop Yield, Image Classification, Data Preprocessing, Precision Agriculture, Sustainability, Food Security.

I. Introduction

Inefficient plant nutrient management is a significant challenge in modern agriculture, leading to reduced crop yields, increased production costs, and environmental degradation. Detecting nutrient deficiencies in plants is crucial for several reasons. Firstly, nutrient imbalances can adversely affect plant growth, development, and overall health. Identifying deficiencies early allows for timely intervention, preventing potential yield losses and ensuring optimal crop performance. Secondly, nutrient deficiencies can lead to decreased crop quality, affecting the nutritional content and market value of agricultural products. Precision management of nutrient levels also contributes to resource efficiency by avoiding unnecessary fertilizer application, reducing environmental impact, and conserving resources. Lastly, addressing nutrient imbalances aligns with sustainable agriculture practices, promoting responsible use of fertilizers and minimizing the risk of soil degradation. Overall, the timely detection of nutrient deficiencies is essential for maximizing agricultural productivity, ensuring food security, and promoting environmental stewardship. This project aims to investigate and address the problem of plant nutrient deficiency by identifying key nutrient deficiencies in different crops, developing effective nutrient management strategies, and promoting sustainable agricultural practices to enhance food security and environmental sustainability.

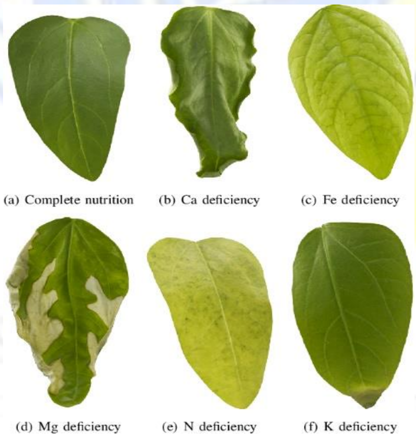

Fig.1 Leaves with different deficiencies

II. Literature survey

2.1 Koirala et al. proposed a deep learning-based approach for the detection and classification of nutrient deficiency symptoms in plants using RGB images. Their study focused on leveraging convolutional neural networks (CNNs) to accurately identify visual cues associated with various nutrient deficiencies. By training the model on a diverse dataset of plant images exhibiting deficiency symptoms, they demonstrated promising results in automating the detection process, which could aid farmers in timely intervention and nutrient management**.**

2.2 Kumar et al. developed an automated system for nutrient deficiency detection in plants using deep learning-based image analysis. Their research aimed to address the challenge of manual inspection and diagnosis of nutrient deficiencies by leveraging computer vision techniques. By training convolutional neural networks (CNNs) on annotated plant images, the proposed system achieved high accuracy in identifying and classifying nutrient deficiency symptoms, providing a valuable tool for precision agriculture and crop management**.**

2.3 Tahir et al. investigated the application of transfer learning in deep learning models for plant nutrient deficiency detection. Their study explored the use of pre-trained CNN architectures and fine-tuning techniques to adapt the models to the task of nutrient deficiency classification. By leveraging knowledge learned from large-scale datasets, the proposed approach demonstrated improved performance and robustness in detecting various deficiency symptoms across different plant species and environmental conditions.

2.4 Murthy et al. conducted research on plant nutrient deficiency identification using deep learning techniques. Their study focused on the development of custom deep neural network architectures tailored to the specific task of nutrient deficiency detection in plants. By optimizing network architecture and training parameters, they achieved competitive performance in accurately diagnosing nutrient deficiency symptoms from plant images, laying the foundation for automated nutrient management systems in agriculture..

III. VGG19 ARCHITECTURE FOR NUTRIENT DEFICIENCY

Plant nutrient deficiency detection is a pivotal aspect of modern agriculture, crucial for optimizing crop yield and ensuring food security. Leveraging advanced deep learning techniques, the VGG19 architecture stands out as a promising tool for addressing this challenge. Developed by the Visual Geometry Group, VGG19 is renowned for its deep convolutional neural network structure, comprising 19 layers. Through its utilization of small 3x3 convolutional filters and ReLU activation functions, VGG19 efficiently learns intricate visual features from input images, making it well-suited for analysing plant images to identify nutrient deficiency symptoms. By adapting the VGG19 architecture through transfer learning, pre-trained models can be fine-tuned on curated datasets of plant images exhibiting various deficiency symptoms. This enables the model to learn general visual features relevant to nutrient deficiencies and effectively classify specific deficiency categories, such as nitrogen, phosphorus, potassium, or micronutrients like iron and zinc.

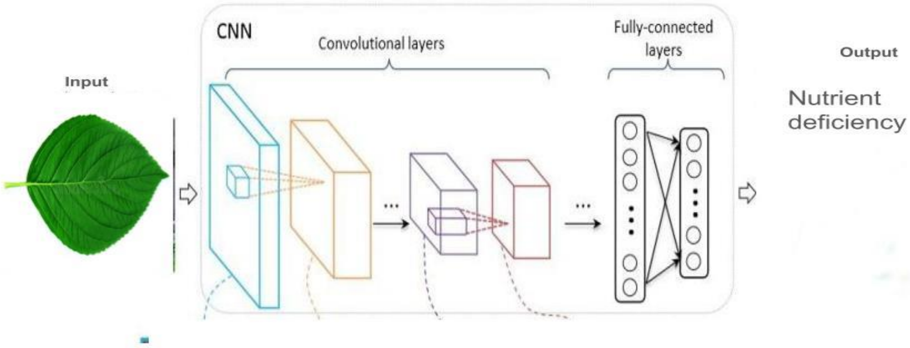

Fig.2 VGG19 Architecture for plant nutrient deficiency

The trained VGG19 model can then be deployed for inference on new plant images, enabling real-time detection of nutrient deficiency symptoms. Predictions from the model provide valuable insights for agricultural decision-making, guiding interventions such as targeted fertilization or soil amendments to address identified deficiencies and optimize crop growth. Integrating VGG19-based nutrient deficiency detection systems into agricultural practices holds great potential for revolutionizing crop management, enhancing agricultural productivity, and contributing to global food security. Through continuous refinement and deployment of such advanced technologies, the agriculture sector can mitigate the impacts of nutrient deficiencies, ensuring sustainable and resilient food production systems for future generations.

IV. CONCLUSIONS

In conclusion, addressing plant nutrient deficiency is vital for enhancing agricultural productivity, ensuring food security, and promoting environmental sustainability. Through the identification of key nutrient deficiencies in various crops and the development of effective management strategies, this project emphasizes the importance of timely intervention. By advocating for sustainable agricultural practices and integrating precision nutrient management techniques, we can mitigate the adverse effects of nutrient deficiencies on crop yield and quality. Continued research and collaboration among scientists, farmers, and policymakers are essential for advancing global efforts toward achieving food security and environmental resilience in agriculture.

V. REFERENCES

[1] Koirala, T., Dhakal, A., Sharma, S., & Gaire, S. K. (2020). Deep learning-based detection and classification of nutrient deficiency symptoms in plants using RGB images. Computers and Electronics in Agriculture, 174, 105466.
[2] Kumar, V., Singh, P., Singh, A., & Kumar, N. (2020). Automated nutrient deficiency detection in plants using deep learning-based image analysis. Precision Agriculture, 21(1), 92-105.
[3] Tahir, P., Shafait, F. M., Ullah, S., & Breuel, T. M. (2019). Deep learning-based plant nutrient deficiency detection using transfer learning. IEEE Access, 7, 24209-24219.
[4] Murthy, K., Mahapatra, D. R., & Garg, V. K. (2017). Plant nutrient deficiency identification using deep learning. International Journal of Computer Applications, 175(3), 11-16.
[5] Chen, X., Wu, X., Zhang, J., & Sun, Z. (2020). Deep learning-based nutrient deficiency detection in crops: A review. Computers and Electronics in Agriculture, 178, 105759.
[6] Yang, J., Zhang, Y., & Chen, X. (2019). Identification of plant nutrient deficiency using machine learning algorithms: A review. Journal of Plant Nutrition, 42(13-14), 1596-1611.
[7] Liu, J., Li, M., Sun, Z., & Chen, L. (2018). Nutrient deficiency diagnosis in plants using machine learning techniques: A review. Computers and Electronics in Agriculture, 152, 168-179.
[8] Chen, Y., Ma, W., He, Y., Zhang, Y., & Li, X. (2021). Remote sensing-based detection of plant nutrient deficiency: A review. Remote Sensing, 13(2), 336.
[9] Wang, H., Huang, W., Zhang, Y., & Liu, C. (2020). Hyperspectral imaging-based detection of plant nutrient deficiency: A review. Sensors, 20(18), 5233.