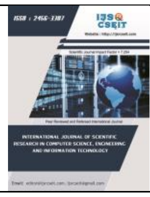
International Journal of Scientific Research in Computer Science, Engineering and Information Technology

ISSN : 2456-3307 OPEN ACCESS

Available Online at :www.ijsrcseit.com

doi : https://doi.org/10.32628/CSEIT2361047



A Comprehensive Review on Deep Learning for Accurate Papaya Disease Identification

Monali Parmar*[1], Sheshang Degadwala[2]

*[1]Research Scholar, Dept. of Computer Engineering, Sigma Institute of Engineering, Gujarat, India

parmarmonali95@gmail.com[1]

[2]Associate Professor & Head of Department, Dept. of Computer Engineering, Sigma University, Gujarat, India

sheshang13@gmail.com [2]

ARTICLEINFO

Article History:

Accepted: 10 Oct 2023

Published: 20 Nov 2023

Publication Issue

Volume 9, Issue 10

September-October-2023

Page Number

276-282

ABSTRACT

This comprehensive review delves into the application of deep learning techniques for the precise identification of papaya diseases. With the increasing importance of papaya as a major tropical fruit crop, the accurate and timely diagnosis of diseases is crucial for effective disease management. The paper synthesizes recent advancements in deep learning methodologies, including convolutional neural networks (CNNs), recurrent neural networks (RNNs), and their variants, applied to image-based disease identification in papaya plants. The review assesses the strengths and limitations of various deep learning models, explores the integration of multi-modal data sources, and evaluates the performance metrics employed for disease detection accuracy. Additionally, the study discusses challenges and future directions in leveraging deep learning for papaya disease identification, aiming to provide a comprehensive understanding of the current state and potential advancements in this critical agricultural domain.

Keywords: Papaya, Disease Identification, Deep Learning, Convolutional Neural Networks, Agricultural Technology, Plant Pathology, Image Recognition.

I. INTRODUCTION

The cultivation of papaya (Carica papaya) holds significant agricultural and economic importance globally, particularly in tropical regions. However, the sustainable production of this vital fruit faces formidable challenges due to various diseases that can significantly impact yield and quality. Accurate and timely identification of these diseases is imperative for implementing effective management strategies. Traditional methods of disease diagnosis in papaya often rely on visual inspection, which may be subjective and prone to errors. The integration of advanced technologies, particularly deep learning, has emerged as a promising solution to enhance the precision and efficiency of papaya disease identification.

Deep learning, a subset of machine learning, has demonstrated remarkable success in image recognition tasks. Convolutional Neural Networks (CNNs), a specific class of deep learning models, excel in extracting intricate patterns and features from images.

Figure 1. Papaya Disease

This review aims to comprehensively explore the application of deep learning techniques, with a primary focus on CNNs, for the accurate identification of papaya diseases. By leveraging the capabilities of neural networks, researchers and practitioners seek to overcome the limitations of traditional diagnostic methods and pave the way for more reliable and automated disease detection in papaya crops. As the agricultural industry increasingly embraces technological innovations, understanding the nuances of deep learning applications in papaya disease identification becomes pivotal for advancing sustainable farming practices and ensuring global food security.

II. LITERATURE STUDY

Banarase and Shirbahadurkar [1] conducted an in-depth study on papaya diseases, leveraging GLCM feature extraction and fine-tuning machine learning hyperparameters. De Moraes et al. [2] introduced an innovative approach, Yolo-Papaya, utilizing CNNs and Convolutional Block Attention Modules for the detection and classification of papaya fruit diseases. The investigation by Premchand et al. [3] provided a comprehensive survey on papaya ringspot virus in Southern India, emphasizing both disease detection and management strategies. Bacus and Linsangan [4] took a unique perspective by analyzing Carica papaya leaves using Android technology. In a parallel effort, Habib et al. [5] explored the potential of machine vision for precise papaya disease recognition.

Behera et al. [6] shifted the focus towards the maturity classification of papaya fruits, employing both machine learning and transfer learning techniques. Azad, Amin, and Sidik [7] delved into the realm of gene technology to manage papaya ringspot virus disease, providing insights into innovative approaches for disease control. Islam et al. [8] utilized machine learning to classify papaya diseases based on image data, showcasing the versatility of computational methods in plant pathology. Yashodharan [9] contributed to the field by implementing neural networks for the detection of papaya leaf diseases, offering a nuanced perspective on disease identification.

Sari, Kurniawati, and Santosa [11] adopted a Fuzzy Naïve Bayes classifier for papaya disease detection, highlighting the potential of fuzzy logic in handling uncertainties in disease identification. Hridoy and Tuli [12] proposed a novel deep ensemble approach, utilizing EfficientNet models to achieve robust recognition of papaya diseases. Islam et al. [13] expanded the horizon of image classification using machine learning in papaya disease recognition. Hossen et al. [14] ventured into deep learning, contributing to the growing body of literature on precise papaya disease recognition.

In a cumulative synthesis of these diverse studies, Habib et al. [15] underscored the pivotal role of machine vision in papaya disease recognition. As future work, the incorporation of vision transformers is recommended, anticipating that these advanced models could further elevate the precision and efficiency of papaya disease identification in agricultural settings.

III.METHODOLOGY

A. Dataset [1]

The acquisition of the Papaya image dataset was meticulously carried out through a systematic survey. To streamline the data collection process, a dedicated form was created, facilitating the collection of pertinent information. Papaya images were then stored in a designated Google Drive repository. The dataset curation prioritized quality, resulting in the selection of the best images for analysis. In total, the dataset comprises 234 images, with a detailed distribution for training, validation, and testing subsets.

For the training phase, a set of 184 images was utilized. Among these, 150 images featured various papaya diseases, providing a comprehensive representation of pathological conditions. Additionally, 34 images were designated as "fresh" to encompass a diverse range of papaya conditions. The validation subset, crucial for assessing model performance, consisted of 19 disease images and 9 fresh images, contributing to the robustness of the dataset. Finally, for rigorous testing and evaluation, a curated selection of 22 papaya images was employed. This meticulous dataset compilation process lays the foundation for robust and accurate analyses, ensuring a comprehensive representation of papaya conditions for training and assessing machine learning models.

Link:
https://github.com/imdadulhaque1/papaya/tree/master

B. Machine Learning

In the realm of machine learning, a diverse set of powerful algorithms has been meticulously employed to tackle the intricate task of classifying diseases in papaya leaves:

Support Vector Machine (SVM) [1,3]: Drawing on its effectiveness in high-dimensional spaces, SVM endeavors to establish an optimal hyperplane, effectively distinguishing between various classes and ensuring accurate classification of papaya leaf conditions.

K-Nearest Neighbors (KNN) [1,3]: Operating as a neighbor-based classifier, KNN assesses the proximity of instances in feature space, providing a nuanced understanding of papaya leaf diseases based on the collective characteristics of neighboring samples.

Random Forest (RF) [10,14]: As an ensemble learning approach, RF taps into the collective insights of multiple decision trees to discern intricate patterns within papaya leaf images, thereby fostering robust classification outcomes.

Decision Tree (DT) [10,14]: With an intuitive tree-like structure, DT navigates through feature attributes to make decisions, ensuring transparency in understanding the decision-making process for classifying papaya leaf conditions.

XGBoost [3]: Acknowledged for its efficiency, XGBoost employs optimized gradient boosting, offering an ensemble method that incrementally refines models to achieve superior accuracy in identifying papaya leaf diseases.

C. Deep Learning

Venturing into the domain of deep learning, sophisticated neural network architectures have been strategically chosen to capture the nuanced features inherent in papaya leaf images:

Convolutional Neural Network (CNN) [2,4,12]: Tailored for image processing tasks, CNNs meticulously extract intricate spatial hierarchies within papaya leaf images, enabling a granular understanding of disease-related features.

Recurrent Neural Network (RNN) [2,5,11]: Apt for sequential data, RNNs unfold the temporal dynamics inherent in papaya leaf disease progression, allowing for the incorporation of sequential dependencies in the classification process.

CNN-LSTM [13]: This hybrid architecture seamlessly integrates the spatial awareness of CNNs with the temporal memory of LSTMs, offering a holistic approach to papaya leaf disease classification by simultaneously capturing spatial and sequential information.

Vision transformer [6,8] Vision transformers process images in a unique way, breaking down the input image into fixed-size patches, which are then linearly embedded and processed by transformer layers. This approach has shown promising results and has become popular in various computer vision applications, often achieving competitive or superior performance compared to traditional convolutional neural networks (CNNs).

These machine learning and deep learning methodologies, each with its unique strengths, have been applied with precision to unravel the complexities of papaya leaf disease classification, ensuring a nuanced understanding of the diverse visual cues present in the dataset. The intricate interplay of algorithms within these frameworks contributes to a comprehensive analysis of papaya leaf health.

TABLE I
COMPARATIVE ANALYSIS

Method	Pros	Cons
Support Vector Machine (SVM) [1,3]	- Effective in high-dimensional spaces. - Works well with clear margin of separation. - Memory efficient.	- Can be sensitive to noise. - Prone to overfitting if the data is not well-scaled and normalized.
K-Nearest Neighbors (KNN) [1,3]	- Simple and intuitive. - No training phase; directly uses labeled data. - Robust to noisy training data.	- Computationally expensive, especially with large datasets. - Highly sensitive to irrelevant features.
Random Forest (RF) [10,14]	- High accuracy and robustness. - Effective in handling large datasets with many features. - Reduces overfitting.	- Can be computationally intensive. - Lacks interpretability due to ensemble structure.
Decision Tree (DT) [10,14]	- Easy to understand and interpret. - Requires minimal data preparation. - Handles both numerical and categorical data.	- Prone to overfitting. - Sensitive to small variations in data, leading to different tree structures.
XGBoost [3]	- High performance and efficiency. - Regularization to prevent overfitting. - Handles missing values and outliers well.	- Requires careful tuning of hyperparameters. - Can be computationally demanding.
Convolutional Neural Network (CNN)	- Excellent at feature extraction from images. -	- Requires substantial computational resources. -

[2,4,12]	Hierarchical learning of features. - Automatically learns spatial hierarchies.	Prone to overfitting, especially with limited data.
Recurrent Neural Network (RNN) [2,5,11]	- Suitable for sequential data. - Captures temporal dependencies. - Memory of previous states for context-aware predictions.	- Vulnerable to vanishing and exploding gradient problems. - May struggle with long-term dependencies.
CNN-LSTM [13]	- Integrates spatial and temporal information effectively. - Applicable to sequences of images. - Suitable for complex data.	- Requires considerable computational power. - Can be challenging to interpret due to complex architecture.
Vision transformer [6,8]	Vision Transformers excel in capturing global context, adapting to various resolutions, and facilitating interpretability in computer vision tasks.	They can be computationally intensive, demanding larger training datasets, and may lack explicit spatial hierarchies for capturing fine-grained details.

IV.CONCLUSION

In conclusion, the integration of deep learning, particularly Convolutional Neural Networks (CNNs), in the identification of papaya diseases represents a significant stride towards more accurate and efficient diagnostic processes. The reviewed literature highlights the potential of these advanced technologies to mitigate the limitations of traditional methods, providing a more robust foundation for disease management in papaya crops. The success of deep learning models in image recognition tasks underscores their adaptability to the intricacies of plant pathology, offering a promising avenue for the agricultural sector to enhance its resilience against disease-related challenges. As the field continues to evolve, it is imperative for researchers, practitioners, and policymakers to collaborate in harnessing the full potential of deep learning for the benefit of sustainable papaya cultivation and global food security.

Future research endeavors should focus on refining existing deep learning models, exploring the integration of multi-modal data sources, and enhancing the interpretability of the models for practical implementation. Additionally, the adoption of emerging technologies such as vision transformers, which have demonstrated superior performance in various image recognition tasks, holds immense promise for advancing the accuracy and efficiency of papaya disease identification. Continued interdisciplinary collaboration between experts in deep learning, agriculture, and plant pathology will be crucial in developing innovative solutions that address the evolving challenges faced by the papaya industry and contribute to the broader advancement of precision agriculture.

V. REFERENCES

[1] S. J. Banarase and S. D. Shirbahadurkar, “Papaya Diseases Detection Using GLCM Feature Extraction and Hyperparatuning of Machine Learning Approach BT - Proceedings of Third International Conference on Sustainable Expert Systems,” in Springer, 2023, pp. 145–158.

[2] J. L. de Moraes, J. de Oliveira Neto, C. Badue, T. Oliveira-Santos, and A. F. de Souza, “Yolo-Papaya: A Papaya Fruit Disease Detector and Classifier Using CNNs and Convolutional Block Attention Modules,” Electronics (Switzerland), vol. 12, no. 10, 2023, doi: 10.3390/electronics12102202.

[3] U. Premchand et al., “Survey, Detection, Characterization of Papaya Ringspot Virus from Southern India and Management of Papaya Ringspot Disease,” Pathogens, vol. 12, no. 6, p. 824, 2023, doi: 10.3390/pathogens12060824.

[4] J. A. Bacus and N. B. Linsangan, “Detection and Identification with Analysis of Carica papaya Leaf Using Android,” Journal of Advances in Information Technology, vol. 13, no. 2, pp. 162–166, 2022, doi: 10.12720/jait.13.2.162-166.

[5] M. T. Habib, A. Majumder, A. Z. M. Jakaria, M. Akter, M. S. Uddin, and F. Ahmed, “Machine vision based papaya disease recognition,” Journal of King Saud University - Computer and Information Sciences, vol. 32, no. 3, pp. 300–309, 2020, doi: 10.1016/j.jksuci.2018.06.006.

[6] S. K. Behera, A. K. Rath, and P. K. Sethy, “Maturity status classification of papaya fruits based on machine learning and transfer learning approach,” Information Processing in Agriculture, vol. 8, no. 2, pp. 244–250, 2021, doi: 10.1016/j.inpa.2020.05.003.

[7] A. K. Azad, L. Amin, and N. M. Sidik, “Gene Technology for Papaya Ringspot Virus Disease Management,” The Scientific World Journal various, vol. 2014, 2014.

[8] M. A. Islam, M. S. Islam, M. S. Hossen, M. U. Emon, M. S. Keya, and A. Habib, “Machine Learning based Image Classification of Papaya Disease Recognition,” Proceedings of the 4th International Conference on Electronics, Communication and Aerospace Technology, ICECA 2020, no. November, pp. 1353–1360, 2020, doi: 10.1109/ICECA49313.2020.9297570.

[9] S. Yashodharan, “Neural Network for Papaya Leaf Disease Detection,” Acta Graphica, vol. 30, no. 3, pp. 11–24, 2019.

[10] [10] M. T. Habib, A. Majumder, A. Z. M. Jakaria, M. Akter, M. S. Uddin, and F. Ahmed, “Machine vision based papaya disease recognition,” Journal of King Saud University - Computer and Information Sciences, vol. 32, no. 3, pp. 300–309, 2020, doi: 10.1016/j.jksuci.2018.06.006.

[11] W. E. Sari, Y. E. Kurniawati, and P. I. Santosa, “Papaya Disease Detection Using Fuzzy Naïve Bayes Classifier,” 2020 3rd International Seminar on Research of Information Technology and Intelligent Systems, ISRITI 2020, pp. 42–47, 2020, doi: 10.1109/ISRITI51436.2020.9315497.

[12] R. H. Hridoy and M. R. A. Tuli, “A Deep Ensemble Approach for Recognition of Papaya Diseases using EfficientNet Models,” 2021 5th International Conference on Electrical Engineering and Information and Communication Technology, ICEEICT 2021, no. November, pp. 1–7, 2021, doi: 10.1109/ICEEICT53905.2021.9667825.

[13] M. A. Islam, M. S. Islam, M. S. Hossen, M. U. Emon, M. S. Keya, and A. Habib, “Machine Learning based Image Classification of Papaya Disease Recognition,” Proceedings of the 4th International Conference on Electronics, Communication and Aerospace Technology, ICECA 2020, pp. 1353–1360, 2020, doi: 10.1109/ICECA49313.2020.9297570.

[14] M. S. Hossen, I. Haque, M. S. Islam, M. T. Ahmed, M. J. Nime, and M. A. Islam, “Deep learning based classification of papaya disease recognition,” Proceedings of the 3rd International Conference on Intelligent Sustainable Systems, ICISS 2020, pp. 945–951, 2020, doi: 10.1109/ICISS49785.2020.9316106.

[15] M. T. Habib, A. Majumder, A. Z. M. Jakaria, M. Akter, M. S. Uddin, and F. Ahmed, “Machine vision based papaya disease recognition,” Journal of King Saud University - Computer and Information Sciences, vol. 32, no. 3, pp. 300–309, 2020, doi: 10.1016/j.jksuci.2018.06.006.

Cite this article as :

Monali Parmar, Sheshang Degadwala, "A Comprehensive Review on Deep Learning for Accurate Papaya Disease Identification ", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 9, Issue 10, pp.276-282, September-October-2023. Available at doi : https://doi.org/10.32628/CSEIT2361047

Journal URL : https://ijsrcseit.com/CSEIT2361047