National Research Journal of Information Technology & Information Science
Volume No: 11, Issue No: 1, Year: 2024 (January-June)
PP: 47-53
ISSN No: 2350-1278 (Print)
Peer Reviewed & Refereed Journal
National Research Journal

DETECTION AND CLASSIFICATION OF COTTON LEAF DISEASES USING MACHINE LEARNING ALGORITHMS- A REVIEWS

Sonali Kamra

Research Scholar, Department of Computer Applications, Guru Kashi University, Talwandi Sabo

Vijay Laxmi

Professor, Computer Applications, Guru Kashi University, Talwandi Sabo

ABSTRACT

This review study discusses various techniques for identifying illnesses in cotton plants. Studies reveal that classifying and diagnosing diseases based just on professional observations made with the unaided eye can be expensive and time-consuming, especially in poor and rural areas. We present an image processing based fast, automated, precise, and economical approach. There are four primary steps in this solution: (a) Color Transformation: First, we implement color space transformation to the RGB leaf image, after which we build a structure for modifying its colors. (b) Image Segmentation: The K-means clustering algorithm is used to divide the images into pieces. (c) Texture Feature Calculation: For the divided afflicted regions, we calculate texture features. (d) Neural Network Classification: A neural network that has already been trained is used to examine the extracted features.

KEYWORDS: Disease detection, Cotton leaf disease, Neural Network, Machine Learning.

1. INTRODUCTION

A sizable portion of Indian workers are engaged in agriculture. A country's economy can only be strengthened by its crop output. The crop's growth determines how much it produces, and any disease that affects the crop could have an impact on the crop's overall yield. However, without the use of an outside tool, diagnosing the ailment is a difficult process for the farmers. To get to the disease's core cause and prevent agricultural production losses, it would be helpful to identify the disease that is affecting the crop's growth in its early stages. There is constant pressure on the agriculture industry to produce more and more. Every year, a large number of agricultural crops are imported and exported to other countries. Half of the world's population depends on cotton, also referred to by its scientific name Gossypium her baceum. It is one of the most frequently used items worldwide. India is the world's largest exporter and the third-largest producer of cotton. India is without a doubt the world's biggest user and producer of cotton. Cotton is widely utilized in clothes, home textiles, home décor, cotton seed oil, and money in addition to the textile and fabrics sector. One could consider cotton to be a miraculous substance that works for everyone. The need for cotton is rising along with the population, yet there is still very little supply or manufacturing. A method that either boosts crop productivity or reduces crop production loss is required to keep up with the demand-supply mismatch.

2. CULTIVATION OF COTTON CROP

Knowing the steps for the cultivation of Cotton is the first step in identifying the constraints that limit its production, growth, and yield. To prevent the plant from getting infected with various cotton diseases, special treatment is required at different stages of the plant's development. There are many forms of cotton grown in India. Good irrigation systems and field management techniques could make cotton cultivation profitable quickly. Cotton cultivation phases are shown in the figure.

ISSN No: 2350-1278 (Print)
Peer Reviewed & Refereed Journal
National Research Journal

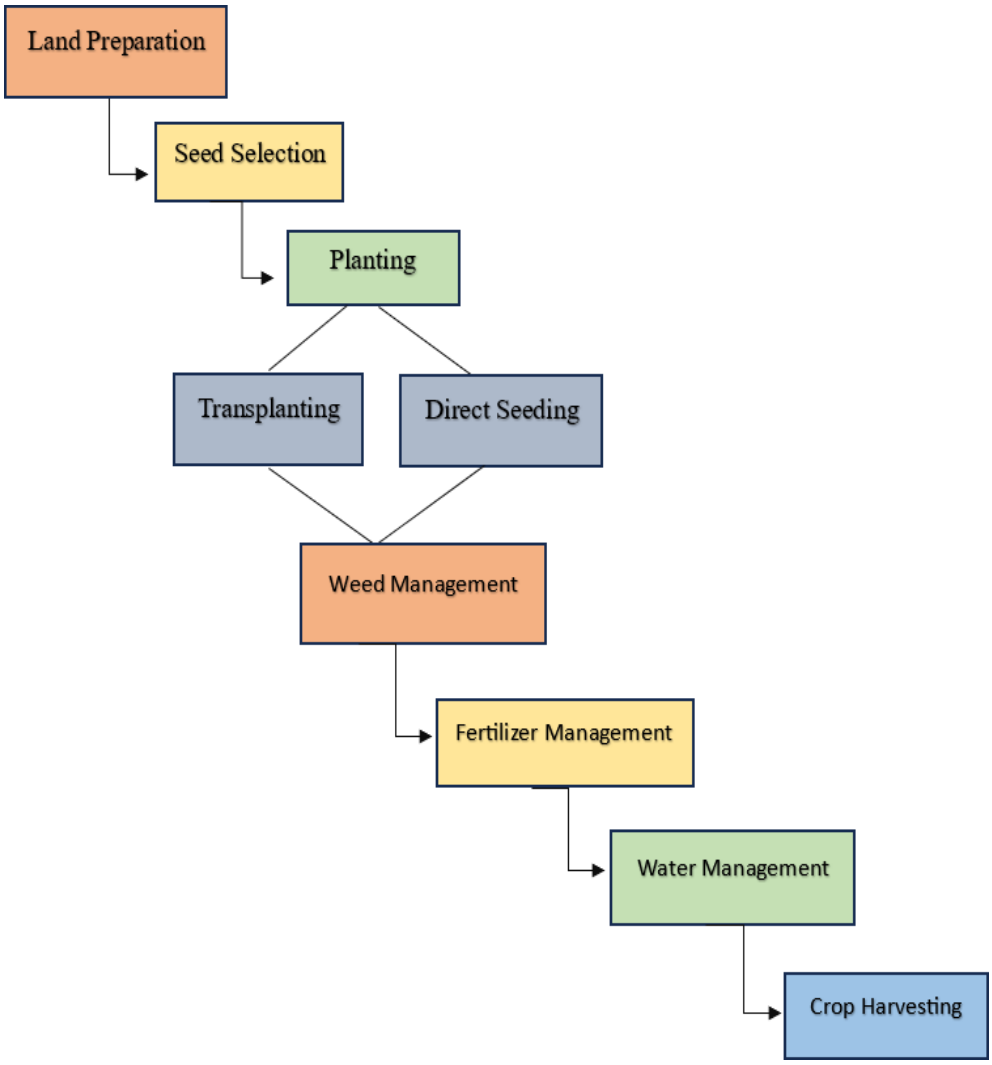

Fig. 1 Cultivation of Cotton crop

Preparation of the land is the first step in cotton cultivation. By creating furrows in the soil, cotton is grown on prepared land. The planting season for cotton begins in early February and ends in late June. A direct water irrigation system and furrows help the soil warm faster. A soil temperature of 65 degrees is the appropriate temperature for planting. Seeds will be planted in the soil by farmers. The second step in cotton cultivating a crop is to choose the seeds. Crop production is greatly influenced by seed selection. Farmers should use tractors and large farm equipment, such as a harrow, cultivator, field leveller, etc., for planting and soil preparation. The quality of the soil is improved by soil preparation for better production. Next is management of weeds, which involves methods for preventing or eliminating weed development. Different fertilizers are used in fertilizer management to avoid viruses, fungus, and pests from growing on the plant. Through water management, the right amount of water is kept at the right level for plant growth. Next comes the last phase of crop harvesting. Cotton production is influenced by numerous variables, such as soil quality, the environment, prevention of diseases, water management, fertilizer management, etc.

2. TYPES OF LEAF DISEASES AND FACTORS INFLUENCING THE DISEASES

Leaf diseases can be categorized into bacterial, viral, and fungal types. This work aims at addressing the loss to the crop due to various diseases. The less production of the crop can be attributed to various factors like the crop being infected by various contaminated diseases,

ISSN No: 2350-1278 (Print)
Peer Reviewed & Refereed Journal
National Research Journal

use of low-quality seed, unsuitable weather conditions, improper irrigation facilities etc. Out of these, the loss because of crop disease is the most vital factor affecting the yield of the crop and ranges from 20% to 100%. If we can detect the infection at an early stage, we could stop it from spreading over the whole field. It is also important to know the gravity of the infection to the crop as that would affect the total yield of the crop. Further, it is also important from the point that if the gravity of infection is low, it could be treated with pesticides and reduce the loss of crop yield, which would not be possible in case of very the gravity of infection is high. Advanced computer vision technology can come in handy to diagnose the type andgravity of the infection infecting the crop. Certain deep learning algorithms can be use in categorizing the infection or disease affecting the cotton plant. A quality corpus of disease or infection affecting the crop is required for smooth running of these models.

Below are examples of diseased and non-diseased cotton leaves. Diseases of crops are classified as follows:

1. Red Spot Disease (Lalya)
2. White Spot Disease (PandhariMashi)
3. Crumple Leaf Disease (Kokada)

(a) Normal Leaf (b) Red Spot (c) White Spot (d) Leaf Crumple

Fig. 2 Image of Cotton leaves disease detection based on machine learning. (a) Normal (b)(c)(d) Diseased.

Plant diseases can often be identified through observable symptoms, including changes in color, alterations in the shape or function of the plant. Among various leaf diseases affecting plants, the most challenging to diagnose are those caused by viruses. Agricultural experts possess the knowledge to identify plant diseases effectively, although this process is time-consuming and labour-intensive. When it comes to monitoring extensive crop fields, automating disease detection becomes crucial, aiding in the identification of diseases based on their symptoms. Utilizing image processing techniques, automatic plant disease detection contributes to efficient disease management.

3. NEED OF THE STUDY

i) Early detection allows farmers to identify diseases before they cause significant damage to the crop.

ii) Monitoring and detecting diseases contribute to understanding how changing climate conditions may impact disease prevalence.

iii) Detecting and managing diseases helps minimize economic losses associated with reduced crop yields and lower quality fibers.

4. GENERAL APPROACH FOR COTTON LEAF DISEASES DETECTION

The cotton leaf disease detection process involves a combination of image processing techniques and machine learning algorithms to automate the identification and monitoring of diseased plants, aiding farmers in timely disease management and crop protection.

ISSN No: 2350-1278 (Print)
Peer Reviewed & Refereed Journal
National Research Journal

The methodology for detecting cotton leaf diseases typically involves several key steps:

1. **Image Acquisition**: Capture images of cotton leaves using digital cameras or other imaging devices. Ensure that the images have sufficient resolution for accurate analysis.
2. **Pre-processing**: Clean and enhance the acquired images to improve their quality and facilitate subsequent analysis. This may involve tasks such as noise reduction, contrast enhancement, and image normalization.
3. **Segmentation**: Divide the pre-processed images into meaningful regions or segments, separating the cotton leaf areas from the background and other irrelevant elements.
4. **Feature Extraction**: Extract relevant features from the segmented regions, such as color, texture, shape, and other visual characteristics. These features serve as input for the disease detection algorithms.
5. **Classification**: Employ machine learning or deep learning algorithms to classify the extracted features into different categories representing healthy or diseased cotton leaves. Train the classification model using labeled data to enable it to distinguish between different disease types accurately.
6. **Detection and Diagnosis**: Use the trained classification model to detect and diagnose cotton leaf diseases based on the features extracted from the images. This step aims to identify the presence and severity of diseases in cotton plants.
7. **Validation and Testing**: Evaluate the performance of the disease detection system using separate datasets not used during training. Assess the accuracy, sensitivity, and specificity of the system to ensure reliable disease detection.
8. **Deployment and Monitoring**: Implement the developed detection system for real-time or periodic monitoring of cotton crops in the field. Continuously monitor the health status of cotton plants and take appropriate actions based on the detected diseases to prevent further spread and minimize crop damage.

Overall, the methodology for cotton leaf disease detection involves a combination of image processing, feature extraction, machine learning, and validation techniques to develop an accurate and reliable detection system for early disease identification and management in cotton crops.

5.1 MACHINE LEARNING METHODS

Machine Learning methods can be effectively utilized to diagnose leaf diseases in plants, including cotton. Some commonly used machine learning techniques for disease diagnosis in plant leaves include:

5.1.1 Supervised Learning Algorithms:

a. Support Vector Machines (SVM): SVMs are effective for classification tasks and can be used to classify leaf images into healthy or diseased categories.

b. Random Forest: Random Forests are like a team of decision trees working together to make better guesses. They're good at dealing with lots of information and can still make good predictions even if there's some extra noise in the data.

c. Convolutional Neural Networks (CNNs): CNNs are particularly well-suited for image classification tasks. They can automatically learn relevant features from raw image data and have achieved state-of-the-art performance in various plant disease recognition tasks.

ISSN No: 2350-1278 (Print)
Peer Reviewed & Refereed Journal
National Research Journal

5.1.2 Unsupervised Learning Algorithms:

a. K-Means Clustering: K-Means clustering can be used to group similar leaf images together, potentially identifying clusters of leaves with similar disease symptoms.

b. Hierarchical Clustering: Hierarchical clustering methods organize leaf images into a hierarchical structure based on similarity, which can provide insights into the relationships between different disease types.

5.1.3 Deep Learning Techniques:

a, Recurrent Neural Networks (RNNs): RNNs are useful for sequential data analysis and can be applied to time-series data collected from plant monitoring systems to detect disease progression over time.

b. Long Short-Term Memory (LSTM) Networks: LSTM networks are a special kind of neural network that can understand and remember long patterns in data that happens over time. They're great for looking at how plants grow and stay healthy because they can spot patterns in their growth over long periods.

5.1.4 Ensemble Learning Methods:

a, Boosting Algorithms (e.g., AdaBoost, Gradient Boosting): Boosting methods combine multiple weak classifiers to create a strong classifier, which can improve the overall accuracy of disease diagnosis.

b. Voting Classifiers: Voting classifiers combine predictions from multiple individual classifiers to make a final decision, leveraging the diversity of different models to achieve better performance.

These machine learning methods can be trained on labeled datasets containing images of healthy and diseased plant leaves to learn patterns and features indicative of specific diseases. After they learn from lots of examples, these models can check new pictures of leaves all by themselves and tell if there's a disease. This helps catch plant problems early and figure out how to fix them.

5. DATASET

We get the leaf image input from the database (Kaggle, github, Mendeley, roboflow), and it is pre-processed by resizing the image , after reducing the size of the leaf image, extracting the interest region from the natural background**.**

6. CONCLUSION

This paper examines and condenses image processing methods utilized in identifying cotton plant diseases. These methods are employed to examine both healthy and diseased cotton plant leaves. Some challenges associated with these techniques include the impact of background data on resulting images, tailoring the technique for specific plant leaf diseases, and automating the process for continuous monitoring of cotton plant leaf diseases in real-world field conditions. The review indicates that while this disease detection technique demonstrates promise in detecting cotton plant leaf diseases, it also has limitations. Hence, there is scope for enhancement in current research efforts.

REFERENCES:

Ahmad Ali Shahid, Aleena Khalid, Syed Muhammad NaumanGillani, WajeehaBatoolChaudhary, Muhammad AzmatUllah Khan, "A Novel approach to study the relationship between Cotton Leaf Curl Virus (CLCuV) and Beta Satellites." (2018) International Journal of Biotechnology and Bioengineering, 3(6), 230-235.

ISSN No: 2350-1278 (Print)
Peer Reviewed & Refereed Journal
National Research Journal

Amy Lowe, Nicola Harrison, Andrew P French, "Hyperspectral image analysis techniques for the detection and classification of the early onset of plant disease and stress." (2017) BioMed Central, Plant Methods, Vol. 13.

AsmitaSarangdharAdhao, Vijaya Rahul Pawar, "Automatic Cotton Leaf Disease Diagnosis and Controlling Using Raspberry Pi and IoT." (2018) Intelligent Communication and Computational Technologies, Springer, Singapore.

Bhogade, G., Mawal, R., Patil, A., & Desai, S. R. (2017). "Leaf Disease Identification using Image Processing." International Journal of Engineering Science, 11489.

Bhong, V. S., &Pawar, B. V. (2016)."Study and Analysis of Cotton Leaf Disease Detection Using Image Processing."International Journal of Advanced Research in Science, Engineering and Technology, 3(2).

Brahimi, M., Arsenovic, M., Laraba, S., Sladojevic, S., Boukhalfa, K., Moussaoui, A. (2018). "Deep learning for plant diseases: Detection and saliency map visualization." In Human and Machine Learning. Springer, pp. 93–117.

Brahimi, M., Boukhalfa, K., Moussaoui, A. (2017). "Deep learning for tomato diseases: Classification and symptoms visualization." Applied Artificial Intelligence, 31, 299–315.

DeChant, C., Wiesner-Hanks, T., Chen, S., Stewart, E.L., Yosinski, J., Gore, M.A., Nelson, R.J., Lipson, H. (2017). "Automated identification of northern leaf blight- infected maize plants from field imagery using deep learning." Phytopathology, 107, 1426–1432.

Fujita, E., Kawasaki, Y., Uga, H., Kagiwada, S., Iyatomi, H. (2016). "Basic investigation on a robust and practical plant diagnostic system."In 2016 15th IEEE International Conference on Machine Learning and Applications (ICMLA), IEEE, pp. 989–992.

Howard, A.G., Zhu, M., Chen, B., Kalenichenko, D., Wang, W., Weyand, T., Andreetto, M., Adam, H. (2017). "Mobilenets: Efficient convolutional neural networks for mobile vision applications." arXiv preprint arXiv:1704.04861.

Huang, G., Liu, Z., Van Der Maaten, L., Weinberger, K.Q. (2017). "Densely connected convolutional networks."In Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 4700–4708.

Jia, Y., Shelhamer, E., Donahue, J., Karayev, S., Long, J., Girshick, R., Guadarrama, S., Darrell, T. (2014). "Caffe: Convolutional architecture for fast feature embedding." In Proceedings of the 22nd ACM international conference on Multimedia, ACM, pp. 675–678.

Karmokar, B. C., Ullah, M. S., Siddiquee, M. K., &Alam, K. M. R. (2015)."Tea leaf diseases recognition using neural network ensemble."International Journal of Computer Applications, 114(17).

Kawasaki, Y., Uga, H., Kagiwada, S., Iyatomi, H. (2015)."Basic study of automated diagnosis of viral plant diseases using convolutional neural networks."In International Symposium on Visual Computing, Springer, pp. 638–645.

Khairnar, K., &Dagade, R. (2014)."Disease Detection and Diagnosis on Plant using Image Processing – A Review."International Journal of Computer Applications, 108(13).

Krizhevsky, A., Sutskever, I., Hinton, G.E. (2012). "Imagenet classification with deep convolutional neural networks."In Advances in neural information processing systems, pp. 1097–1105.

Kruse, O. M. O., Prats-Montalbán, J. M., Indahl, U. G., Kvaal, K., Ferrer, A., &Futsaether, C. M. (2014). "Pixel classification methods for identifying and quantifying leaf surface injury from digital images." Computers and Electronics in Agriculture, 108, 155-1

Lamba, S., Saini, P., Kukreja, V. and Sharma, B., 2021, April.Role of Mathematics in Machine Learning.In *Proceedings of the International Conference on Innovative Computing & Communication (ICICC)*.

Lamba, S., Saini, P., Kukreja, V. and Sharma, B., 2023, . Machine learning based multi-classification model for rice leaf diseases.

Luo, J., Geng, S., Xiu, C., Song, D., & Dong, T. (2015). "A curvelet-SC recognition method for maize disease."Journal of Electrical and Computer Engineering, 2015, 25.

Mohanty, S.P., Hughes, D.P., Salathe, M. (2016). "Using deep learning for image- based plant disease detection." Frontiers in plant science, 7, 1419.

Moriones, E., Navas-Castillo, J. (2000)."Tomato yellow leaf curl virus, an emerging virus complex causing

ISSN No: 2350-1278 (Print)
Peer Reviewed & Refereed Journal
National Research Journal

epidemics worldwide."Virus research, 71, 123–134.

Mr.Chandrakant, DeelipKokane, Prof.N.L.Bhale,2017, To Detect and Identify Cotton leaf disease based on pattern recognition technique.

Navas-Castillo, J., Sanchez-Campos, S., Díaz, J.A., Saez-Alonso, E., Moriones, E. (1999). "Tomato yellow leaf curl virus-is causes a novel disease of common bean and severe epidemics in tomato in Spain." Plant Disease, 83, 29–32.

P. Ravathi, M. Hemalatha, 2012 Classification of Cotton Leaf Spot Diseases Using Image Processing Edge Detection Techniques.

Patil, S. P., &Zambre, R. S. (2014)."Classification of cotton leaf spot disease using support vector machine."International Journal of Engineering Research, 3(4), 1511- 1514.

Patil, Sonal P., and Rupali S. Zambre."Classification of cotton leaf spot disease using support vector machine." (2014) International Journal of Engineering Research, 3(4), 1511-1514.

Pico, B., Díez, M.J., Nuez, F. (1996)."Viral diseases causing the greatest economic losses to the tomato crop."ScientiaHorticulturae, 67, 151–196.

R Manavalan, July 2022,Towards an intelligent approach for cotton diseases detection.

Rangarajan, A.K., Purushothaman, R., Ramesh, A. (2018). "Tomato crop disease classification using pre-trained deep learning algorithm." Procedia computer science, 133, 1040–1047.

ShrutiGodara, N. Saini, S.M. Paul Khurana, and Kajal Kumar Biswas. "Lack of resistance in cotton against cotton leaf curlbegomovirus disease complex and occurrence of natural virus sequence variants." (2015) Indian Phytopath, 68(3), 326- 333.

Simonyan, K., Zisserman, A. (2014). "Very deep convolutional networks for large- scale image recognition." arXiv preprint arXiv:1409.1556.

Sukhvirkaur, ShreelekhaPandey&ShivaniGoel(2018). "Plant disease identification and classification through leaf images: A survey 26, 507–530.

Szegedy, C., Ioffe, S., Vanhoucke, V., Alemi, A.A. (2017). "Inception-v4, inception- resnet and the impact of residual connections on learning."In Thirty-First AAAI Conference on Artificial Intelligence.

Szegedy, C., Vanhoucke, V., Ioffe, S., Shlens, J., Wojna, Z. (2016). "Rethinking the inception architecture for computer vision."In Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 2818–2826.

Tan, W., Zhao, C., Wu, H. (2016). "Intelligent alerting for fruit-melon lesion image based on momentum deep learning." Multimedia Tools and Applications, 75, 16741– 16761.

Too, E.C., Yujian, L., Njuki, S., Yingchun, L. (2018). "A comparative study of fine- tuning deep learning models for plant disease identification." Computers and Electronics in Agriculture.

Wang, J., Chen, L., Zhang, J., Yuan, Y., Li, M., Zeng, W. (2018). "CNN transfer learning for automatic image-based classification of crop disease." In Chinese Conference on Image and Graphics Technologies, Springer, pp. 319–329.

Yamamoto, K., Togami, T., Yamaguchi, N. (2017). "Super-resolution of plant disease images for the acceleration of image-based phenotyping and vigor diagnosis in agriculture." Sensors, 17, 2557.

Zhou, R., Kaneko, S. I., Tanaka, F., Kayamori, M., & Shimizu, M. (2014)."Disease detection of Cercospora Leaf Spot in sugar beet by robust template matching." Computers and Electronics in Agriculture, 108, 58-70.

Zubair, M., Zaidi, S.S.-E.-A., Shakir, S., Amin, I., Mansoor, S. "An Insight into Cotton Leaf Curl Multan Betasatellite, the Most Important Component of Cotton Leaf Curl Disease Complex." (2017) Viruses, 9, 280.