International Journal of Interdisciplinary Innovative Research & Development (IJIIRD)
ISSN: 2456-236X
Vol. 10 Issue 01 | 2025

Automated Cotton Crop Disease Detection Using Deep Learning Techniques

Bhagyashri More[1], Manjiri Karande[2]

[1] M.E. Student, Dept. Of. Computer Sci. and Engineering , Padmashri Dr. V.B. Kolte College of Engineering, Maharashtra, India
[2] Assist.Prof , Dept. Of. Computer Sci. and Engineering, Padmashri Dr. V.B. Kolte College of Engineering, Maharashtra, India

DOI: 10.5281/zenodo.15751581

ABSTRACT

The most recent developments in deep learning and artificial intelligence are bringing about dramatic changes in the agricultural sector. Crop maturity evaluation, disease detection, and crop yield estimation are just a few of the many applications for these potent instruments. Since cotton is a vital source of income for many nations, it is imperative that it be protected from fatal illnesses that can significantly. India has the second-largest population, and its farmers can grow a wide variety of crops. The majority of farmers grow cotton in vast quantities, but in recent decades, cotton leaf disease has become a major issue, causing crops, productivity, and financial losses. The diseases Cercospora, Bacterial Blight, Ascochyta Blight, and Target Spot all harm cotton leaves. Farmers' general observations can be costly, time-consuming, and occasionally erroneous. The Disease of Cotton Leaf For farmers, early disease detection and identification is an extremely challenging task. Both the crops and the farmers would suffer if the infection or illness on the crops is not detected by the farmers at the early stage. The primary goal of farming is to produce disease-free, healthy crops. Visually estimating the health of a cotton leaf is extremely challenging. To overcome this issue, a machine learning-based method is suggested that can evaluate a plant's leaf image and use machine learning to identify the illness and, consequently, the cotton's quality. In order to use this, the user must supply an image. With the help of image processing, we can obtain a color digital image of a damaged leaf, after which we can use CNN to forecast cotton leaf illness. CNN and neural networks. Most plant diseases are caused by fungi, bacteria, and viruses. Traditionally farmer visually checks the disease. This paper presents an approach for careful detection of diseases and timely handling to stop the crops from heavy losses. The diseases on cotton are a critical issue that creates the sharp decrease within the production of cotton. So for the study, of interest is that the leaf instead of the entire cotton. About 85%-92% of diseases occurred on the cotton leaves are like Alternaria, Cercospora, Red spot, white spot and Yellow spot on the Leaf

Keyword:- ***Convolution Neural Network ,Deep Learning ,Machine Learning etc***

INTRODUCTION

Cotton is one of the most widely cultivated crops globally and plays a vital role in the agricultural economy. However, its yield is often affected by plant diseases, which reduce both quality and productivity. Cotton diseases such as Bacterial Blight, Powdery Mildew, and Target Spot can severely impact cotton farming, causing economic losses for farmers. Traditional methods of detecting these diseases rely on manual inspection by agricultural experts, which is labor-intensive, time-consuming, and susceptible to errors. Furthermore, many small-scale farmers lack access to expert advice, leading to delayed or incorrect diagnoses. With recent advancements in artificial intelligence and deep learning, automated disease detection systems have emerged as a viable solution to address these challenges. Deep learning models, particularly Convolutional Neural Networks (CNNs), have demonstrated remarkable performance in image recognition tasks, making them well-suited for plant disease classification. CNNs are capable of extracting deep hierarchical features from images, enabling precise identification of plant diseases. By leveraging these technologies, this paper proposes a system that can automatically detect cotton plant diseases from images and provide real-time predictions to farmers. Cotton is the main fiber crops in whole world to give fundamental raw material to cotton textile industry. Cotton crop deals with numerous issues because of infections which influence it a lot and it is difficult to recognize it by naked eyes. The generally influenced part for the infection is leaf of the plant. Around 80 to 90% of diseases on the plant is on its leaves. So, in this paper we concentrate mainly on the leaf part rather than the entire plant. Many methods were proposed to identify the diseases in cotton plants using it's Leaf's. Many of the methods were failed to give more identification accuracy.

Importance of Early Disease Detection Cotton

plant diseases can spread rapidly if not detected at an early stage, leading to severe economic losses. If left untreated, these diseases can reduce fiber quality and overall crop yield, significantly affecting the agricultural economy. Early detection enables timely intervention, reducing the need for excessive pesticide use and mitigating the risk of widespread crop failure. AI-based solutions enhance detection accuracy and ensure proactive measures can be taken before significant damage occurs. This technology empowers farmers with real-time insights into their crop health, allowing them to take appropriate action before the disease spreads uncontrollably.

Role of Deep Learning in Agriculture Deep learning, a subset of artificial intelligence, has revolutionized various domains, including agriculture. Convolutional Neural Networks (CNNs) are particularly effective for image classification tasks due to their ability to automatically extract relevant features from images without manual intervention. Traditional machine learning techniques require extensive feature engineering, whereas CNNs learn hierarchical patterns directly from data. This ability makes CNNs highly efficient in detecting plant diseases, even in complex scenarios where symptoms may vary due to environmental conditions. By leveraging CNNs, our system provides a scalable and reliable approach for identifying cotton plant diseases. The trained model can classify multiple disease types based on visual symptoms, providing farmers with precise and instant feedback. Furthermore, by integrating this model into a web-based application, we ensure that farmers can access disease detection tools from their smartphones or computers, making precision agriculture more widely available.

Convolutional Neural Networks (CNN). Cotton is a crucial cash crop, but its yield is significantly affected by various plant diseases, leading to economic losses for farmers. Traditional disease detection methods rely on manual inspection, which is time-consuming, error-prone, and requires expert knowledge. To address this challenge, we propose an automated system that leverages CNNs for image classification and Flask for web deployment. The CNN model is trained on a dataset of cotton leaf images and classifies diseases such as Bacterial Blight, Powdery Mildew, and Target Spot. The model is designed with multiple convolutional layers that extract intricate features from images, ensuring high classification accuracy. Image preprocessing techniques such as normalization and augmentation are applied to enhance model performance. The trained model is then integrated into a web-based platform using Flask, allowing users to upload images for real-time disease prediction. The application is designed to be user-friendly, making it accessible to farmers and agricultural researchers.

LITERATURE REVIEW

Anand et al. [4] introduced a technique for the location of leaf infections in the brinjal plants utilizing RGB pictures. About 85% of the diseases in brinjal plants happen in the leaves making it the space of interest for disease recognition. Thermal pictures catch the infrared radiations produced by the leaves and the power of every pixel depicts the temperature at that actual point. Hence thermal images have a fine potential for early recognition of infections because of the temperature varieties that are noticed.

Veni et al. [6] proposed a model which can detect healthy and unhealthy leaves. In order to classify healthy and unhealthy leaves, they used image processing techniques. For this experiment, brinjal datasets are used. RGB and Thermal cameras are used to collect brinjal leaf datasets. By considering color and temperatures as the main feature they got an accuracy of 90.9% with SVM and an accuracy of 89.1% with ANN.

Galip and Fatih [7], done various implementations for comparing different types of activation functions. Some of them are tanH, sigmoid, ReLu, soft plus on classification. Among all these ReLu got the highest accuracy i.e., 98.43%. From the results, they came to know that if the number of iterations increases, the accuracy also increases.

Robert G. de Luna et al. [12] proposed an automatic system that captures images automatically. They proposed this system for identifying the diseases in tomato leaves. They used a transfer learning model for achieving this. By implementing this they got an accuracy of 95.75%. But the previous works did for identifying diseases in tomato leaves got only 91.67% accuracy.

Peng Jiang et.al. [17] in their paper used a deep convolutional neural network for identifying diseases in apple plant leaf. This is a real-time model. For the training model, Google Net is used. This model is capable of extracting features automatically. It identifies different types of 5 diseases in plants. Santhana Hari [18], introduced a new CNN model which helps in extracting features from the images of leaves of different yields. The new CNN model introduced is Plant Disease Detection Neural Network. This model has 16 layers and 32*32 filters. They implemented this model on the dataset of 14810 images. By using this model, they achieved a higher accuracy i.e., 86%. When compared with MobileNet50 they observed that the accuracy has increased 7%

OBJECTIVES

- To develop an automated disease detection system that provides accurate results.
- To train a CNN model using a dataset of diseased and healthy cotton leaves.
- **Develop an Automated Detection System**
  To design and implement a deep learning-based system capable of automatically identifying diseases in cotton crops from leaf images.
- **Create a Robust Dataset**
  To collect and pre process a comprehensive dataset of cotton leaf images, including various disease classes and healthy leaves, ensuring high-quality data for training and testing.
- **Train a Deep Learning Model**
  To train a convolutional neural network (CNN) or other deep learning architecture to accurately classify and detect different cotton crop diseases.
- **Improve Detection Accuracy**
  To optimize the deep learning model using techniques like data augmentation, hyperparameter tuning, and transfer learning to achieve high accuracy and low false detection rates.
- **Real-time Detection and Classification**
  To enable real-time disease detection using mobile or web applications, allowing farmers to identify diseases on the field with minimal latency.
- **Evaluate Model Performance**
  To assess the model using standard metrics such as accuracy, precision, recall, F1-score, and confusion matrix for a thorough performance analysis.
- **Support Decision Making in Agriculture**
  To provide actionable insights and recommendations for disease management, contributing to improved crop yield and reduced chemical usage.

PROPOSED SYSTEM

In our proposed system we consider CNN models with image processing techniques that can provide an accurate and efficient method for cotton plant disease detection. The models can learn to recognize the unique visual features and patterns associated with different types of cotton plant diseases from large datasets of labelled images.

The system is categorized into two major divisions:

1. The training system
2. Image processing methods

In recent years, CNN models have been increasingly applied to agricultural applications, including the detection and classification of plant diseases. CNN models have shown great promise in detecting cotton plant diseases with high accuracy.

The following steps are followed as training model takes the input:

1. Convolutional Layers: The first few layers in a CNN model are convolutional layers, which apply a set of filters to the input image. Each filter is designed to detect specific features, such as edges, lines, or curves. The filters slide across the image
2. Pooling Layers: The feature maps generated by the convolutional layers are then passed through pooling layers, which reduce the spatial dimensions of the feature maps by performing operations such as max-pooling or average pooling. and generate a set of feature maps that capture presence of these features at different spatial locations in the image. amount of data that needs to be processed and improves the model's efficiency.

3. Fully Connected Layers: The feature maps generated by the pooling layers are then flattened into a vector and passed through a series of fully connected layers, which perform classification based on the extracted features. The fully connected layers are responsible for learning high-level features, such as textures, shapes, and patterns, that are specific to the cotton plant diseases.

4. Output: The final layer in the CNN model is the output layer, which produces a prediction of the disease status of the input leaf image based on the learned features.

SYSTEM DESIGN

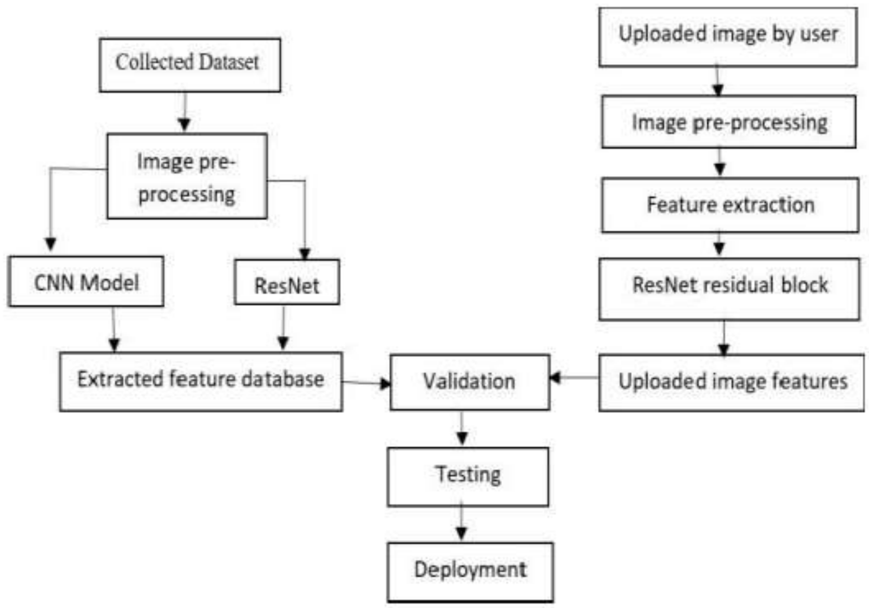


Fig 1 Proposed System Workflow

SYSTEM ARCHITECTURE

The system follows a three-tier architecture:

• **Frontend:** Developed using HTML, CSS, and JavaScript to provide a user-friendly interface for image uploads.

• **Backend:** Built using Flask to handle image processing and communicate with the trained CNN model.

• **Machine Learning Model:** A CNN-based classifier trained to detect and classify cotton plant diseases from images.

CNN ARCHITECTURE

Convolutional Neural Networks (CNN) are a type of multi-layer neural network that is meant to discern visual patterns from pixel images. In CNN, 'convolution' is referred to as the mathematical function. It's a type of linear operation in which you can multiply two functions to create a third function that expresses how one function's shape can be changed by the other. In simple terms, two images that are represented in the form of two matrices, are multiplied to provide an output that is used to extract information from the image. CNN is similar to other neural networks, but because they use a sequence of convolutional layers, they add a layer of complexity to the equation. CNN cannot function without convolutional layers.

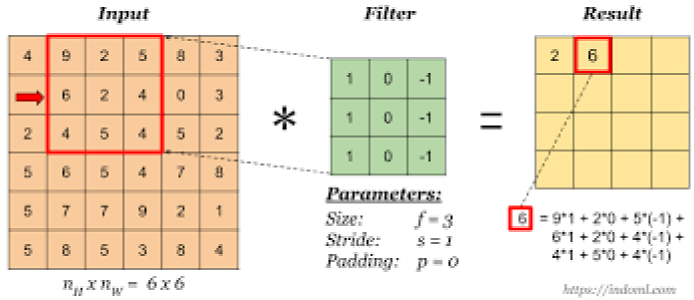
It stands for *Convolution Neural Network*, and it is the best algorithm when it comes to working with images, basically it takes two major mathematical processes that differentiate it with other Neural Network techniques.

1. Convolution Opration
2. Pooling Opration

1. **Convolution Opration**: Convolution is a specialized kind of linear operation. Convolution between two functions in mathematics produces a third function expressing how the shape of one function is modified by the other.

Convolution Kernels

A kernel is a small 2D matrix whose contents are based upon the operations to be performed. A kernel maps on the input image by simple matrix multiplication and addition, the output obtained is of lower dimensions and therefore easier to work with.



In this figure we found that our input matrix is of 6x6 and filter is of size 3x3 with *stride* = 1 and *padding* = 0, ***** represents convolution operation between Input matrix and the filter. This filter is basically used to detect the vertical edge in the image i.e. resultant matrix is basically used to reduce the image width and only take those part which is important.

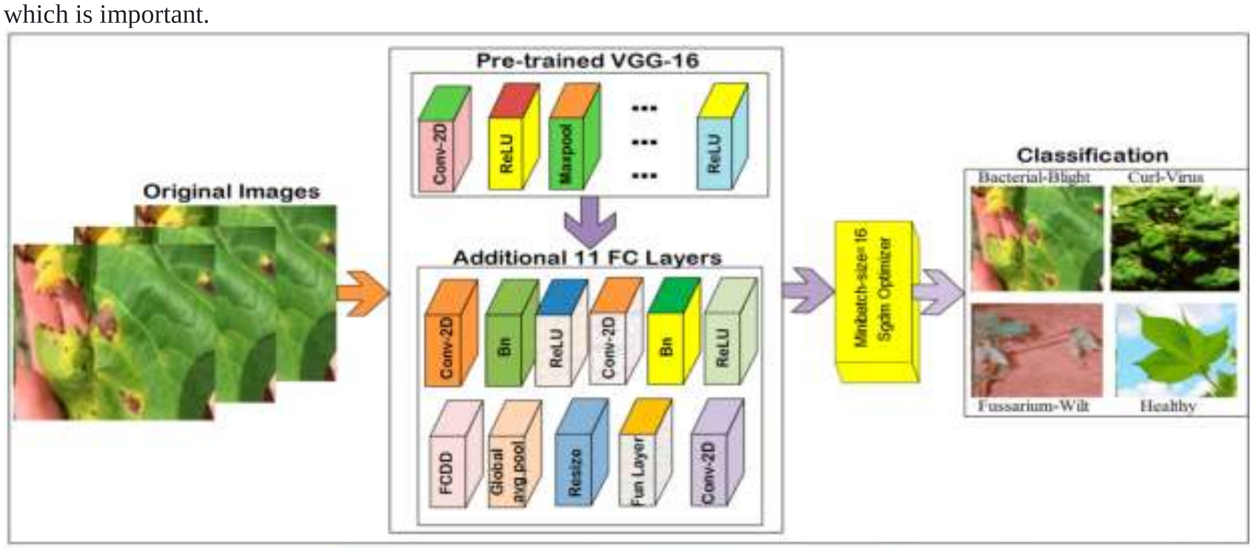


Fig 2 CNN Architecture

2. Average pooling: Average pooling is also doing a similar operation but instead of taking the maximum value from the window it calculates the average of the window and then gives the result. Basically today's in general we are using max-pooling as the pooling layer operation because it gives better accuracy and also it's a little faster than the average pooling operation

With these two operations in CNN we can able to compute 2D inputs such as images very easily.

Steps involved in this architecture

- In the first step an image is passed to Conv layer 1 which is used to do convolution operation
- Then pooling layer is created to reduced parameters
- Layer 3 and 4 are similar like 1 and 2
- In layer 5 which termed as hidden in this image also called flatten on fully connected layer are just a dense layer converted from the last conv layer after this layer only we apply **sigmoid or softmax** activation function to get the output.

RESULT ANALYSIS

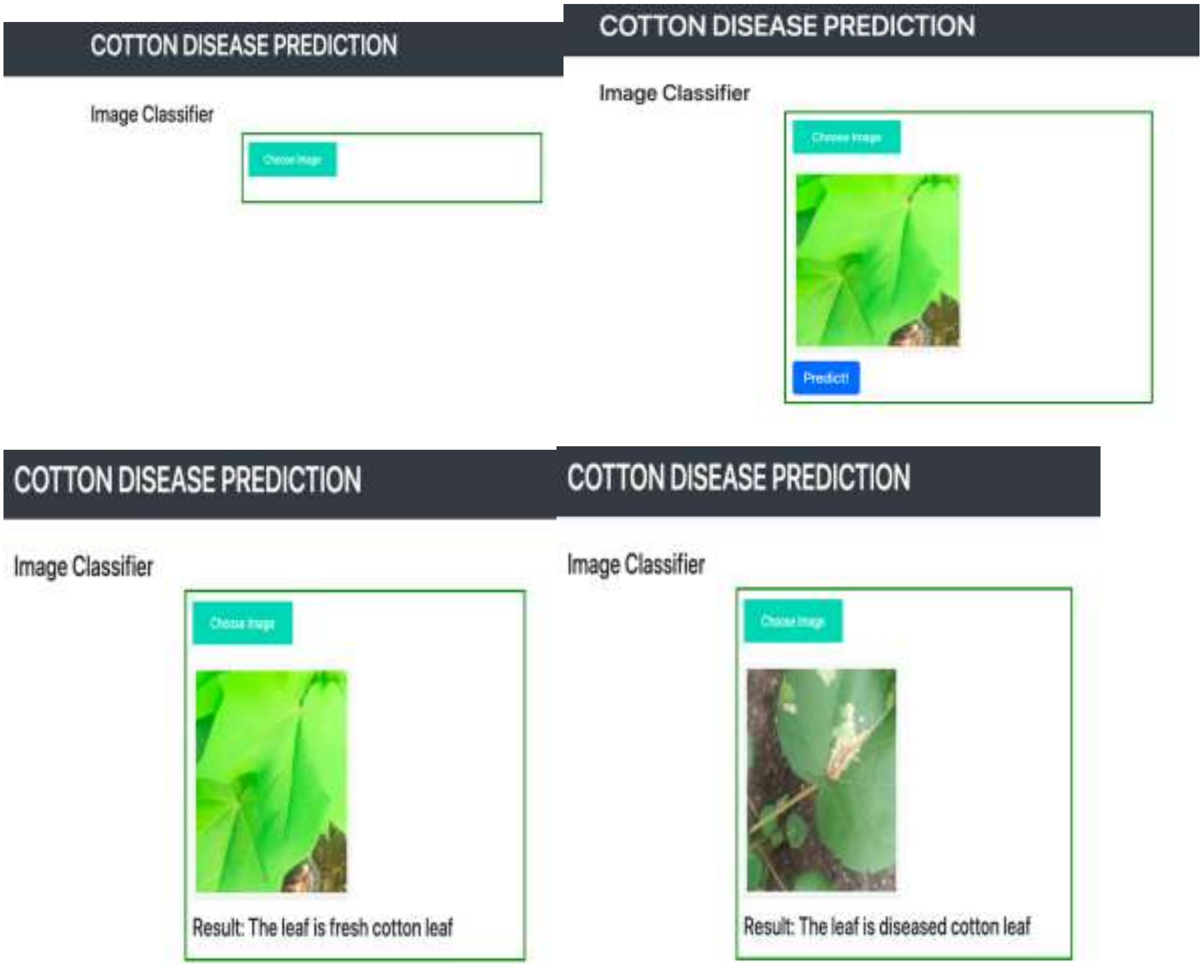


Fig.3.a: Classification of fresh Leaf 3.b: Classification of diseased Leaf

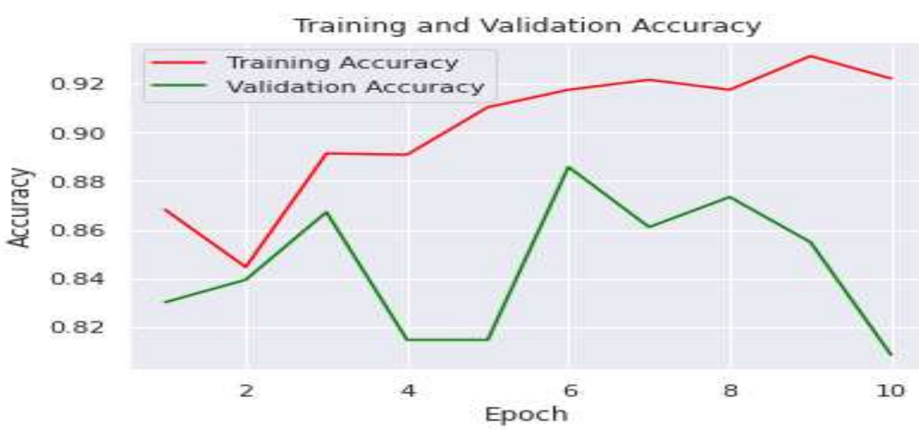


Fig 4 Graphical Analysis

4. CONCLUSIONS

The uploaded input images from the user are processed by the system and produced output with detected disease. The use of image processing techniques, CNN, models for cotton plant disease detection has potential to improve the efficiency and accuracy of disease diagnosis in cotton crop. By automating the detection process and providing reliable and accurate results, this technology can help farmers and researchers to quickly identify and respond to diseases, preventing further spread and reducing crop losses. The goal of this application is to develop a system which recognizes crop diseases and displays user the results as detected disease, pesticides recommended and cost of pesticides recommended, and for that user have to upload an image then, Image processing starts with the digitized color image of the diseased leaf.

5 FUTURE ENHANCEMENT

Future Enhancement implementing AI-driven solutions in agriculture fosters sustainable farming by reducing the need for excessive pesticide usage, minimizing environmental impact, and optimizing resource allocation. The integration of this technology ensures that even small-scale farmers with limited access to agricultural experts can benefit from precision farming techniques. Ultimately, this research contributes to the broader vision of leveraging artificial intelligence for smarter and more efficient agricultural practices.

6. REFERENCES

[1] S. Kumar, K. M. V. V. Prasad, A. Srilekha, T. Suman, B. Pranav Rao, and J. Naga Vamshi Krishna, “Leaf disease detection and classification based on machine learning,” in Proceedings of the 2020 International Conference on Smart Technologies in Computing, Electrical and Electronics (IC- STCEE), October 2020.

[2] V. Kiranmai, D. Ghai and S. Kumar, “A review on classification of land use/land cover change assessment based on normalized difference vegetation index”, Journal of Critical Reviews, vol. 7, no. 14, pp. 2416–2431, 2020.

[3] Das, A., Mallick, C. Dutta, S. Deep Learning-Based Automated Feature Engineering for Rice Leaf Disease Prediction: Computational Intelligence in Pattern Recognition, 133–141, Springer AISC Series, 2020.

[4] Y. Dong, F. Xu, L. Liu et al., “Monitoring and forecasting for disease and pest in crop based on web-GIS system,” in the proceedings of the 8th International Conference on Agro Geoinformatics Istanbul, Turkey, September 2019.

[5] S. Sun, C. Li, A. H. Paterson, P. W. Chee, and J.S. Robertson, “Image processing algorithms for infield single cotton boll counting and yield prediction,” Computers and Electronics in Agriculture, vol. 166, Article ID 104976, 2019.

[6] M. J. Brewer and J. P. Glover, “Boll injury caused by leaf footed bug in late-season cotton,” Crop Protection, Vol. 119, pp. 214– 218, 2019.

[7] N. Shah and S. Jain, “Detection of disease in cotton leaf using artificial neural network,” in Proceedings of the 2019 Amity International Conference on Artificial Intelligence (AI-CAI), Dubai, UAE, February 2019.

[8] K. Prashar, R. Talwar, and C. Kant, “CNN based on overlapping pooling method and multi-layered learning with SVM and KNN for American cotton leaf diseases recognition,” in the Proceedings of the International Conference on Automation, Computational and Technology Management (ICACTM), London, UK, April 2019.

[9] C. H. Usha Kumari, S. Jeevan Prasad, G. Mounika, “Leaf disease detection: feature extraction with Kmeans clustering and classification with ANN,” in Proceedings of the International Conference on Computing Methodologies and Communications (ICCMC) (2019), Erode, India, March 2019.

[10] S. Bhanumathi, M. Vineeth and N. Rohit. Crop Yield Prediction and Efficient use of Fertilizers [IEEE] 2019.

[11] C. H. Usha Kumari, S. Jeevan Prasad, and G. Mounika, “Leaf disease detection: feature extraction with K-means clustering and classification with ANN,” in Proceedings of the 8ird International Conference on Computing Methodologies and Communications (ICCMC 2019), Erode, India, March, 2019.

[12] Nikhil Shah, Sarika Jain, "Detection of disease in Cotton leaf using Artificial Neural Network", IEEE 2019. International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 10 Issue: 03 | Mar 2023 www.irjet.net p-ISSN: 2395-0072

[13] Crop Yield Prediction and Efficient use of Fertilizers [IEEE] S. Bhanumathi, M. Vineeth and N. Rohit. 2019

[14] A. Jenifa, R. Ramalakshmi, V. Ramachandran, "Classification of cotton leaf Disease using Multisupport Vector Machine", IEEE 2019

[15] Tejonidhi M.R, Nanjesh B.R, Jagadeesh Gujanuru Math, Ashwin GeetD'sa "Plant Disease Analysis Using Histogram Matching Based onBhattacharya's Distance Calculation" International Conference on Electrical, Electronics and Optimization Techniques (ICEEOT)-20164 Vector Machine", IEEE 2019.