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A Review Article Classification and Recognition of Soybean Leaf Disease Detection Using Convolutional Neural Network (CNN)

Bhanu Pratap Singh, Dr. Shailja Shukla
Department of Electrical Engineering,
Jabalpur Engineering College
Jabalpur, India
bhanupratasingh224@gmail.com, shailja270@gmail.com

Abstract- Agriculture is the backbone of every economy on the planet. Crop output is one of the most important aspects influencing a country's domestic market situation. Agricultural output is also a critical component of economic development in any country. It is vital because it offers raw materials, jobs, and food to a variety of citizens. Many factors contribute to the disparity in crop production estimates across the globe. Overuse of chemical fertilizers, the presence of chemicals in water supplies, irregular rainfall distribution, varying soil fertility, and other factors are among them. Aside from these concerns, one of the most common challenges around the world is the destruction of a large portion of production due to diseases.

Keywords- Plant disease detection, Machine learning, Imaging sensors, and systemsPlant disease classification, Image processing.

I. INTRODUCTION

Agriculture is the primary source of income in almost every country on the planet. Agriculture has a significant role in the production and distribution of human nourishment. Agriculture can not only provide requirements for people's everyday lives, but it can also enhance soil fertility, maintain a healthy soil ecosystem, manage soil erosion, lessen natural disasters like mudslides and sandstorms, and improve the environment on which humans rely. Crop growth and development, on the other hand, are inextricably linked to the environment in which they grow. As the environment becomes increasingly contaminated, potentially causing crop illness Soybean is one of the world's most important crops [1].

Today, it is plagued by several diseases that concern many farmers, and the fight against crop diseases continues to be a big issue for them. To combat these diseases, a huge number of pesticides or fungicides are employed on the citrus crop, resulting in both economic loss and pollution [2].

Now, new artificial intelligence-based technology can help develop precision agriculture, improve crops, and monitor and limit chemical usage in the beds [3, 4]. Plant disease detection and categorization are critical activities for increasing plant productivity and economic growth [5, 6, and 7]. It is possible to construct tools for the control and analysis of plant diseases using computer vision, machine learning, and deep learning algorithms [2, 8, and 9].

Plants respond to biotic and abiotic stressors by undergoing biophysical and biochemical changes such as reduced biomass and chlorosis, which can be detected by visible-NIR (VNIR) remote sensing [1,2,3]. Early detection of crop diseases and their spatial pattern of incidence can be critical for environmentally and economically successful disease management in precision agriculture. Stress can generate subtle changes in biophysical and physiological features of plant canopies, which can be detected via hyperspectral remote sensing [4, 5, 6, 7, and 8].

Despite advancements in hyperspectral remote sensing for detecting plant properties including biomass, color, water content, and fluorescence, identifying the delimiting input or plant growth factors [9], which are crucial for stress differentiation, remains a difficulty. Hyperspectral remote sensing could be a valuable tool for early detection of plant diseases and potential for disease discrimination because of how canopy spectra can capture unique biochemical or metabolic changes in the plants that may not be visible to the human eye [7, 8].

II. RESEARCH MOTIVATION

To meet the growing needs of the world's population, worldwide crop production must quadruple by 2050. (Khalili et al., 2019). Plant diseases are the major source of significant economic losses in the global agriculture industry. According to recent figures, plant diseases, weeds, and insects are causing a 14 percent loss in global crop output. As a result, early disease identification is critical to preventing disease spread and reducing crop production harm (Martinelli et al., 2015). About 700 plant species are affected by Macrophominaphaseolina (Tassi) Goid, which causes rot diseases.Cotton, grains, oilseeds, legumes, jute, as well as fruits and vegetable plants, are all affected by this exceptionally hardy soil-borne fungus (Ambrosio et al., 2015; Sun et al., 2016).

M. phaseolina can adapt to a wide range of climatic environments thanks to its physiological, morphological, and pathogenic diversity (Ambrosio et al., 2015). Furthermore, the fungus's sclerotia and chlamydospore structures allow it to persist in the soil for longer periods (Katan, 2017).

According to Gaige et al. (2010), the illness is spread through contaminated plant leftovers, wind, and soil. The M. phaseolina pathogen can infect plants at any stage of growth, however, symptoms usually appear at midseason or maturity, i.e. growth stage R7, when yellowing of the leaves and yellow pods are seen. (Hartman et al., 2016).

Other signs and symptoms include the formation of "blackleg" in infected plants, which causes them to become weaker and less productive (Santos et al., 2016). Plants infected with M. phaseolina perish for a variety of causes, including vascular obstructions that impair nutrient delivery (Santos et al., 2016) or exposure to phytotoxic compounds generated by the parasite.

III. INFECTED SOYBEAN SAMPLES

On soybean, this pathogen infects various sections of the plant, including branches, leaves, pods, petioles, root, stem, and seeds (Gupta et al, 2012). However, the key symptoms of an illness appear after the flowering stage, i.e., the R7 stage, especially in low humidity and high-temperature conditions (Schoving et al., 2020). The main symptoms seen in infected plants include chlorosis of leaves, premature defoliation, and reduced vigor (Romero Luna et al., 2017), which result in lower productivity, sterility of pods, and generation of crinkled and small seeds. Infected plants have brown discoloration in the vascular tissues of the taproot that has progressed into the stem. On soybean, this pathogen infects various sections of the plant, including branches, leaves, pods, petioles, root, stem, and seeds (Gupta et al, 2012).

However, the key symptoms of an illness appear after the flowering stage, i.e., the R7 stage, especially in low humidity and high-temperature conditions (Schoving et al., 2020). The main symptoms seen in infected plants include chlorosis of leaves, premature defoliation, and reduced vigor (Romero Luna et al., 2017), which result in lower productivity, sterility of pods, and generation of crinkled and small seeds. Infected plants have brown discoloration in the vascular tissues of the taproot that has progressed into the stem.Powdery black sclerotia appear under the epidermis and root of infected plants during the seed development stage. Because the symptoms of this illness might be confused with those of other plant abiotic stresses such as dehydration or abiotic stress such as cyst nematode, detecting this disease based on morphological aerial plant parts can be difficult (Sanchez et al., 2019). KekeZhang, using multi-feature fusion, detect soybean leaf disease faster from a synthetic image.

R -CNN: For soybean quality and the agricultural economy, accurate identification of soybean leaf disease in soybean fields is critical. Even though many studies have been done on recognizing soybean leaf disease, the tasks of detecting soybean leaf disease in a complex scene are poorly performed due to a lack of data and technical problems. To address the problem of a lack of data, this paper creates a synthetic soybean leaf disease picture dataset.

Furthermore, detecting soybean leaf illness in a complex scene necessitates the detection model's ability to distinguish between multiple features, such as healthy and sick leaf features, features of leaves with various diseases, and so on.To overcome the aforesaid intractable challenge, this work proposes a multi-feature fusion Faster R-CNN (MF3 R-CNN). In the real test dataset, we get an optimal mean average precision of 83.34 percent. Furthermore, the experimental results show that the MF3 R-CNN trained solely on the synthetic dataset is superior to the state-of-the-art in identifying soybean leaf disease in complex scenarios.

IV. LITERATURE REVIEW

Aditya Karlekar, SoyNet: Soybean leaf diseases classification: According to projections, the human population would reach 9 billion by 2050, with a 60% rise in food demand. As a result, increasing and improving the quality of crop yield is a hot topic. Infectious biotic and abiotic illnesses have recently reduced prospective yields by an average of 40%, with many farmers in developing countries reporting yield losses of up to 100%. Plant disease identification and treatment are a problem for farmers all over the world.

There have been several works done for plant disease categorization as a result of advances in precision agricultural technology, albeit the results of the existing methodologies are not sufficient. Furthermore, earlier attempts have failed to accurately segment the leaf sections from the entire image, especially when the background is complicated. To solve these issues, a computer vision solution is presented. Two elements make up the proposed strategy. The first module subtracts the complicated backdrop from the entire image to isolate the leaf component. The second module introduces SoyNet, a deep learning convolution neural network (CNN) for disease recognition in soybean plants using segmented leaf images.

All of the experiments are carried out using the 16-category "Image Database of Plant Disease Symptoms." The proposed model has a 98.14 percent identification accuracy, as well as good precision, recall, and f1-score. The suggested method is compared to three hand-crafted features based on state-of-the-art methodologies, as well as six widely used deep learning CNN models, including VGG19, GoogleLeNet, Dense121, XceptionNet, LeNet, and ResNet50. According to the findings, the proposed strategy outperforms nine state-of-the-art methods/ models.

BingXue, developing a multiplex RT-PCR technique to detect soybean mosaic virus, bean common mosaic virus, and cucumber mosaic virus in soybean field samples: Soybean is sensitive to viral illnesses, which are frequently found in combination with other infections. Individual simplex RT-PCR approaches for detecting numerous viruses are more time-consuming and difficult than the related multiplex RT-PCR procedures. To evaluate a multiplex RT-PCR technique developed for the simultaneous detection of these viruses, researchers employed leaf samples infected with soybean mosaic virus (SMV), bean common mosaic virus (BCMV), and cucumber mosaic virus (CMV) from southern China as test materials.

The annealing temperature, extension duration, number of cycles, and primer type and concentration were all tuned.Multiplex RT-PCR yielded specific fragment sizes of 550 bp for SMV, 288 bp for BCMV, and 99 bp for HIV (CMV). Infected soybean samples were collected from farmers' fields in Sichuan Province, China, to test the assay. The multiplex RT-PCR assay exhibited high sensitivity, was quick and easy to perform, and could be used in the field to diagnose soybeans infected with different combinations of these viruses.

Wei-zhenLiang, Color image analysis was used to estimate the area, edge, and defoliation of soybean leaves: Soybeans are an enormously significant crop in the United States, as they represent the country's primary source of animal protein feed and vegetable oil. The purpose of this study is to find methods for estimating the % defoliation of the soybean canopy and leaves using RGB photos captured in the field. To process sets of photos and calculate leaf area (number of pixels) corresponding to two classes (leaf and background) with eight different color groups, the Mahalanobis distance classification method was employed.

The Canny edge detection algorithm was found to be an effective way for recognizing leaf edges, with the threshold t2 = 20 being the best value for predicting soybean leaf edge. Using Mahalanobis distance classification, the segmentation findings for soybean leaves revealed a 96 percent accuracy. Based on individual photographs of trifoliate leaves acquired from the field, two statistical regression models (polynomial and logistic regression) for soybean defoliation were created. Both models used leaf area and edge to estimate soybean defoliation, but a logistic equation has the potential to provide a better understanding and more accurate estimations of defoliation with fluctuations, particularly at low defoliation levels.Estimated and observed defoliation of trifoliate leaves had R2 and root means square error (RMSE) of 0.90 and 6.16 percent, respectively. Validation of soybean canopy defoliation and trifoliate leaves defoliation revealed a fair association (R2 = 0.96 and RMSE = 1.85 percent). This method could lead to the use of remotely sensed imaging to estimate soybean defoliation and prompt intervention with integrated pest management tactics.

BinLi, Prediction, and monitoring of leaf water content in soybean plants using terahertz time-domain spectroscopy: Leaf water content (LWC) is one of the physiological parameters most commonly used for describing crop growth status and productivity. Thus, rapid and non-destructive methods for the prediction of LWC are important. Here, a rapid and accurate LWC monitoring method using terahertz time-domain spectroscopy (THz-TDS) was tested on soybean.

A high-precision mathematical model was developed to predict LWC based on THz-TDS results. Next, the model was used to study the effect of various levels of water - stress, different growth media, and leaf treatment with exogenous ABA. The correlation coefficient and root mean square error of the prediction set were 0.9153 and 0.0526, respectively, according to reliable results. Under various moisture treatments, LWC steadily reduced over time, and even more slowly under normal water supply than under water stress. Underwater shortages, LWC's trend were determined by the growth medium's water-holding capacity.

Heng-Antin, Quantitative PCR was used to accurately quantify and detect Septoriaglycines in soybean. In the United States, Septoria brown spot, caused by Septoriaglycines, is a common foliar disease of soybeans. The pathogen in soybeans can be accurately identified and quantified, which can provide useful information for disease control. We present the development and validation of a quantitative PCR (qPCR) approach for accurately detecting and quantifying Septoriaglycines in this paper.

The polymorphic areas on the -tubulin, calmodulin, and actin genes of S. glycines were used to build three sets of primers and tests.Both traditional PCR and qPCR assays using the actin gene (Ac) were specific to S. glycines. On the qPCR, the test designed with the -tubulin (Bt) gene was solely specific to S. glycines. The Ac and Bt tests had qPCR reaction efficiency of 95% and 98 percent, respectively. Both the Ac and Bt assays have a sensitivity

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of 10 pg of S. glycinesgDNA. The Bt assay was tested on field samples with various necrotic regions. Necrosis symptoms ranging from 0% to 30% were significant and were linked with S. glycinesgDNA (r = 0.87). In detached leaf assays, S. glycinesg DNA was identified as early as one day after inoculation.

We expect that the assays reported here could be used for disease diagnosis and to better characterize the infection process of S. glycines.

Puneet Singh (Puneet Singh) Early identification and classification of soybean seeds infected with a seed-borne fungal disease (Colletotrichumtruncatum) using an intelligent laser biospeckle system: The development of quick and non-destructive approaches for the early identification of seed-borne fungal pathogens is necessary since they might be a crucial step in the adoption of successful disease control measures. Existing seed-borne disease detection methods are insensitive to early phases of pathogen development (i.e., when seeds are asymptomatic), as well as being costly, time-consuming, complex, requiring mycological expertise, and requiring destructive testing operations.

K.Suganya Devi, H2K – A robust and optimum approach for detection and classification of groundnut leaf diseases: Leaf disease attack is one of the most important causes contributing to low yield and groundnut plant destruction. It consists of multiple phases, including image acquisition, image pre-processing with a binary mask, HSV segmentation to segment disease-affected parts, and feature recognition and extraction utilizing H2K (Harris, HOG, and K-Nearest Neighbor) based groundnut leaf disease classification.

Existing research has focused on leaf diseases that can affect any crop, but this publication is the first of its type to present a robust and optimum approach for detecting and classifying all-important leaf diseases in the groundnut crop. As a result, the H2K technique aids in crop production and maximizes yield. The suggested approach H2K performs well on sample photos and detects and classifies five important groundnut leaf diseases, including late spot, which is difficult to manage if caught early. The H2K is compared to the existing Multiclass SVM, and the findings reveal that the H2K is resilient and optimal in classifying groundnut leaf diseases, with enhanced accuracy of 97.67%.

M.Yogeshwari, Automatic feature extraction and detection of plant leaf disease using GLCM features and convolutional neural network agricultural productivity is crucial in defining a country's economy. Plant leaf disease detection is critical because it has a significant impact on agricultural productivity. If proper detection is not carried out, the quality and quantity of the agricultural yield may be severely harmed. We present a unique technique for detecting plant leaf diseases using deep convolutional neural networks in this study (DCNN). The plant leaf images are first preprocessed utilizing filtering and enhancement techniques in the suggested framework. For noise removal, we use the 2D Adaptive Anisotropic Diffusion Filter (2D AADF) in our research. The Adaptive Mean Adjustment (AMA) approach is improved using these de-noised photos.

N.B.Quoc, Development of sugarcane white leaf disease detection techniques using loop-mediated isothermal amplification: Sugarcane white leaf disease (SWLD) is caused by Sugarcane white leaf (SCWL) phytoplasma from group 16SrXI, which causes major yield losses in the sugar sector. Although diagnostic tests such as microscopy, serology-based approaches, dot blot DNA hybridization, and PCR have been established, they are labor-intensive, expensive, and time-consuming and can only be performed in well-equipped laboratories. As a result, the goal of this study was to create a loop-mediated isothermal amplification (LAMP) assay for SCWL as an alternate method for detecting the sugarcane white leaf (SCWL) phytoplasma in less than 30 minutes.

The 16SrXI SCWL phytoplasma was detected using three LAMP primer sets, including a global 16S rRNA-based phytoplasma assay and two 16SrXI group-specific assays. Plant cytochrome oxidase (cox) LAMP primers were used as controls, which amplified a housekeeping gene in plants. Using a commercially available master mix and a real-time fluorometer, LAMP tests enabled the detection of the SCWL phytoplasma in 30 minutes at 63 °C via the observation of an amplification plot on screen. In comparison to established approaches that are labor-intensive and prone to cross-contamination during implementation, the results obtained in this study demonstrated the potential usefulness of the LAMP-based assay with 16SrXI SCWL primers for in-field detection of SCWL.

Jiangsheng Gui, Using hyperspectral imaging technologies, a system of grading soybean mosaic disease has been developed: Soybean is a crop with a long history of cultivation and a significant role in agricultural production. Soybean mosaic virus disease (SMV) has resulted in a rapid drop in soybean yields, resulting in significant losses for the soybean business, where early detection is critical. This study suggests a novel approach for grading the severity of early SMV, separating it into categories 0, 1, and 2.

This paper offers a combined convolutional neural network and support vector machine (CNN-SVM) strategy for the early detection of SMV in a small number of soybean experimental samples.Experimental results showed that the accuracy of the training set of the CNN-SVM model reached 96.67%, and the accuracy rate of the test set reached 94.17%. The experiment proved the feasibility of using the proposed CNN-SVM model to classify early SMV under the new classification method and provided a new direction for early SMV detection based on hyperspectral images.

Mariana Juliana, A novel proposal for detecting several soybean diseases automatically: This paper proposes a method for automatically detecting soybean diseases based on the color, texture, and local characteristics of spots on affected leaves using a combination of digital image processing techniques including color moments, local binary patterns (LBP), and a bag of visual words (BoVW) model. After data collection and implementation of the described methodologies, the retrieved features are pooled and used as input to the support vector machine (SVM) for disease classification.

The images used in the development and validation of the proposed identification system came from Digipathos, a database provided by the Brazilian Agricultural Research Agency (Embrapa) that contains 354 images related to eight common soybean diseases: bacterial blight, soybean rust, copper phytotoxicity, soybean mosaic, target spot, downy mildew, powdery mildew, and Septoria brown spot. Performance analyses are reported individually for the techniques employed in various phases of data processing and for the overall system, which is made up of these approaches and the SVM classifier. The proposed approach has a success rate of 75.8%, which is around 17% higher than the findings of other systems in the literature.

HenanSun, MEAN-SSD: Using improved light-weight convolutional neural networks, a unique real-time detector for apple leaf diseases has been developed: Apple leaf diseases such as Alternaria blotch, Brown spot, Mosaic, Grey spot, and Rust have a significant impact on apple output and quality. Even though various CNN approaches for apple leaf diseases have been developed, there are still no apple leaf disease detection models that can be used on mobile devices, limiting their use in real production.

This research presents a lightweight CNN model for real-time detection of apple leaf diseases on mobile devices. First, using data augmentation and data annotation technologies, a dataset of apple leaf illnesses named AppleDisease5 is created, which is made up of simple and complicated background photos. Then, by reconstructing the typical 33% convolution, a fundamental module called MEAN block (Mobile End AppleNet block) is developed to boost detection speed and reduce model size. Meanwhile, the Apple-Inception module is created by using GoogLeNet's Inception module and replacing all 33 convolution kernels in Inception with MEAN blocks.

Olive Spot Disease Detection and Classification Using Analysis of Leaf Image Textures, Aditya Sinha, Aditya Sinha, Aditya Sinha, Aditya Sinha, Aditya Sinha, Aditya Sinha, Ad The olive tree is a highly beneficial fruit tree with a long history of cultivation dating back over 6000 years. Due to climate change and the spread of illnesses, the production of olive oil is currently under threat. In this work, image processing techniques are used to analyzeand classify olive disease. The signs of Neofabrea leaf spot disease and Peacock leaf spot disease were correlated with some texture parameters using image texture analysis of olive plant leaves. Neofabrea leaf spot disease appears as distinct, conspicuously circular patches that are very similar to peacock leaf spot disease.

V. CONCLUSIONS

We presented a review paper on a simple and noise-tolerant approach for extracting crop disease zones based on saliency detection. In our tests, we directly extracted the disease and skipped the background segmentation stage, reducing the experiment's complexity and difficulty.

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