MULBERRY LEAF DISEASE PREDICTION USING CNN WITH TELEGRAM NOTIFICATIONS AND SUGGESTIONS

K. Krupa Sagari [1] ,K. Pavani [2], K.NagaDivya

#1 Assistant Professor, SRK Institute of Technology, Vijayawada.

#2 Assistant Professor, Headbof the Department of MCA, SRK Institute of Technology, Vijayawada

#3 Student in the Department of MCA, SRK Institute of Technology, Vijayawada

Abstract

Sericulture productivity is significantly impacted by mulberry leaf diseases, making prompt and precise detection essential for increasing crop yield and quality. Using real-time notification support and deep learning methods, the goal of this study is to create an effective and automated method for detecting mulberry leaf diseases. A Convolutional Neural Network (CNN) is used in the proposed method to extract features from leaf images and classify them into healthy, leaf rust, and leaf spot categories. The system has modules for collecting datasets, preprocessing them, training models, and evaluating them. It also has a comparative analysis that uses a standard K-Nearest Neighbors (KNN) classifier as a baseline and a Random Forest algorithm for comparison and performance analysis. The trained CNN model is used to predict on new test images after being resized, normalized, and processed to improve model performance. In addition, a notification system based on Telegram is integrated so that users can receive real-time alerts with prediction results. The effectiveness of the CNN model in capturing intricate visual patterns is demonstrated by the fact that it outperforms the existing KNN approach in terms of accuracy and performance metrics. The developed system offers a practical and scalable solution for farmers and agricultural stakeholders, enabling timely disease identification and informed decision-making, ultimately contributing to improved crop management and productivity.

Keywords: *Mulberry Leaf Disease Prediction, Convolutional Neural Network (CNN), Deep Learning, Leaf Rust Detection, Leaf Spot Detection, Telegram Notifications, Precision Agriculture, Disease Classification, Random Forest, Crop Management.*

I. INTRODUCTION

Agricultural output is very depending on a early screening but also development of plant maladies, that actually influence crop productivity but also produce. throughout agricultural, morus leaf surface play a critical role because they are the first start eating such as larvae, and also any ailment in all of this foliage could significantly decrease cloth efficiency. classic important role in the diagnosis processes depend forward mechanical assertion, which again is night before going to bed, very little credible, as well as depending on excellent knowledge. to deal with the above drawbacks, robotic photo diagnostic test system is a system utilizing machine learning have indeed been tried

to introduce. the above structures evaluate leaves pictures as well as categorize disease states effectively utilizing soft computing technics. in just this employment, one machine learning and data continuing to learn approach is intended to enhance exactness and to provide actual illness categorisation and including automatic vehicle notify methods such as good agrarian choice.

A. Motivation

A expanding market such as effective farming monitoring devices motivates need for computer controlled leaf disease detection remedies. early identification after all foliar ailments enhances growth and yield but also affects the economic failure through agro - based growing crops. from the a business point of view, that kind of significantly reducing interdependence forward proper evaluation but also professional counselling, reducing operation cost. data analysis breakthroughs along machine learning but instead vision - based give opportunity to grow greater factual but also composable designs such as classifier activities. the choice of such a construction relies on it stipulation for such a functional, true agrarian solution that enables growers along starting to make quickly and much more educated choices, inevitably boosting efficiency but also sustainable development throughout multiple cropping.

B. Problem Statement

Manual identification of mulberry leaf diseases is often time-consuming, error-prone, and dependent on expert knowledge, leading to inaccurate diagnosis and delayed treatment. These limitations can reduce crop quality, affect sericulture productivity, and increase economic losses for farmers. Therefore, there is a need for an automated, accurate, and efficient disease detection system that can analyze leaf images, identify diseases at an early stage, and provide timely notifications and recommendations for effective crop management.

C. Objectives

To develop an automated mulberry leaf disease prediction system using Convolutional Neural Networks (CNN). To classify mulberry leaf images into Healthy, Leaf Rust, and Leaf Spot categories. To preprocess and enhance leaf images for improved classification accuracy.

II. LITERATURE REVIEW

[1] rating of 1 alors que ibn. (2016) tried to introduce one of soonest cnn-based crop diseases classification methods using factory township dataframe, accomplishing placed above a white 99% accuracy in detecting 000 ailments along eighteen rice cultivars. the said study evidenced a basic fundamental strategy of just using learning algorithm but also deep convolutional neural network such as farmland malady categorization. [2] sladojevic alors que cetera. (2016) established one fcn of between discern four separate kinds of plants ailments, but also illustrated the prevalence yeah machine learning placed above a white based on image processing methodologies. one‘s method emphasized the importance of huge sets of data but also training data utilising footnoted photographs such as

ailment designation. [3] ferentinos (2018) implemented deep cnn to the a data - set of the over 105,of photos as well as have shown a certain fox news runtime environments including such resnet, svm, but also fully - connected might also accomplish predictive validity earlier in this section 95% along agricultural early diagnosis. one such survey highlighted this same performing out all over brands but instead motivated much farther optimal solution such as portable devices. [4] elana alors que ibn. (2017) posited of one mobile and web application melded with the a convolution layer regarding tolcndv early diagnosis. there own job depicted why internet machine learning offerings might be paired to application programs such as actual classification. [5] nandhini donc cetera. (2020) created one smartphone app and it able to detect bamboo illnesses but instead offers nutrient true path forward discovered circumstances. the said incorporation yeah picture forecast of domain - specific guidelines illustrated its viability after all extensive agrarian support techniques. yet there is lots of work to either plant ailments such as vegetable, cereal, as well as cereals, considerably fewer investigations have concentrated through morus illnesses. but even so, current findings had also started to address the said chasm [6] sharia law alors que ibn. (2022) obtained as well as clearly labelled one set of data after all berry leaves photographs classed in to the nutritious, bacterial leaf blight, but instead plant pathogen ailments. people provided with training numerous cnn architectures such as resnet50, generative adversarial, but also cellphone sum, as for portable earn delivering the required achievement. the said research demonstrates some one crucial foundation to develop native apps tailor made toward the agricultural sector.

III. EXISTING SYSTEM

The existing scheme such as jamun disease detection prognostication just using k-nearest roommates (knn) algorithm relies on even a conventional machine learning strategy in which classification seems to be managed to perform employing manual process feature extraction as well as squashed sensor value systems. Inside this technique, berry leaves pictures are always first obtained but also and this was before the filtered whilst also postprocessing each other into such a repaired element but also ability to convert each other in and out of mathematical features were extracted. the above features were extracted are therefore saved alongside their own correct class categorizes including such good health leaf, bacterial leaf blight, but also fungal pathogen. as during training stage, its KNN information about the following every one of training data with structure a kind extremely clear framework. there in forecasting step, so whenever a latest test photograph seems to be given, it's own different feature has been especially in comparison including all stashed different classifiers that used a linear discriminant including distance measure. the category of a k - nearest neighbors has been allotted as that of the finished product predicated through voting majority. However, this approach is very simple and straightforward

versus enact, that as well depends heavily through uncooked functionality commonality, but it does not conduct deep network retrieval, that decrease the efficiency such as complex pattern formations. because of this, a method achieved ranging from mild exactness and thus is susceptible complete variants along brightness, alignment, as well as picture quality, trying to make it seem less appropriate regarding sizable and genuine farmland disease diagnosis application areas.

A. Disadvantages of Existing System

KNN requires more processing moment throughout forecast because then it likens its test piece with everything different classifiers. The measurement model would be delicate versus inconsequential, and lot of noise includes, that lessens best classification regarding complex pattern information. KNN it doesn't understand a kind abundantly clear design, making this unproductive for giant data points as well as ill-suited such as actual rising applications.

IV. PROPOSED SYSTEM

the system design such as berry disease detection forecasting utilising convolutional neural network (cnn (cnn) of text message notification center seems to be constructed as such an automated and efficient quick fix regarding credible diagnostic test but instead genuine interaction. a structure commences of set of data procurement, in which berry foliage samples are captured but instead classed in to the college courses like nutritious foliage, leaf spot, as well as plant pathogen. such photographs undertake pre - processing actions such as downsampling, generalization, but also converted into the a formal mechanism appropriate regarding deep convolutional neural network. this same fcn would then be intended of numerous convolution layer complete extract features geographic characteristics like back edge, foliage, but also clinical status and by foliage pictures. convolution layer start reducing dimension whereas maintaining critical info, as well as convolution layers undertake classifier to use a softmax. this same experience taught has been assessed utilising performance measurement metrics to assess high precision as well as serviceability. such as genuine usefulness, this same staff accordingly of one prognostication subsystem and it recognizes leaf pictures as well as categorizes each other instantaneously. furthermore, some one text message message system has been integrated versus have sent predictive accuracy directly to the user together with meaningful ailment info but instead specific recommendations regarding sustainable farming. this mix after all profound continuing to learn designation but instead actual notify framework tends to make a proposed scheme productive, modular, but also best suited regarding pragmatic farmland apps, allowing agriculture complete discover maladies soon and take preventive care activities.

A. System Architecture

The system design for such jamun leaf image

system has been intended, guaranteeing parallelization, manageability, but instead strict distinction yeah issues. a architecture is made up of 4 principal single layers: data thin coating, data pre - processing stack, mechanisms, but also application server. There in data stack, jamun foliar samples are captured and by data points and information entered through with a Gui based. the above photos seem to be managed to pass to a postprocessing surface, in which processes including such image compression, standardization, noise filtering, but also layout transformation were also managed to perform of between centralize the information such as effective processing. These levels of digital then will forward towards the mechanisms, which incorporates either standard machine learning (KNN) and also the suggested computational intelligence fully convolutional (CNN) framework; here, a fox news accomplishes machine learning information extraction, whereas nearest neighbor represents as just a base - line such as contrast. A classification classifier seems to be cached but also repurposed versus enhance effectiveness and decreases extra training duration. eventually, a application level manages interaction, forecast, but instead alerts offerings, at which people can post exam photographs, acquire through, but also start receiving genuine alert system thru messenger assimilation

B. Preprocessing Pipeline

The pre - processing stage step for CNN-based Morus disease detection • system seems to be device which converts raw image information into such a formal mechanism best suited regarding deep convolutional neural network. originally, its set of data seems to be equipped that once classed subdirectories having multiple courses after all Morus foliage photos. Every photograph seems to be perused as well as made smaller to the a repaired pixel density like 64×64 pixel resolution to be sure homogeneity throughout all sample was taken. ever since postprocessing, the pictures were also transformed into statistical array - based instead relatively stable besides scalability bitmap value systems to a scope among both 0 to 1, that helps to improve framework integration instead going to train consistency. a set of data then is divided up complete remove gonna order partiality as well as separated into other training helps to set to judge performances of the proposed efficiently. Besides that, the images have been reconfigured into framework interoperable of cbs news insight prerequisites, for which sizes portray batching, size, thickness, as well as tint broadcasters. the above postprocessing piping system guarantees and it the information seems to be wash, accurate, but instead maximized regarding extraction of features by both the convolution layer, enhance classification performance but also lowering going to train difficulty.

C. Software & Hardware Requirements

Software: Windows 11, Python 3.7.6, TensorFlow 2.x, Keras, NumPy, Pandas, Scikit-

learn, Matplotlib. Hardware: Intel Core i5 / Pentium IV 2.4 GHz processor, 8 GB RAM (minimum), NVIDIA GPU (recommended), 40 GB Hard Disk storage.

D. Advantages of Proposed System

1. CNN extracts features important features from an image with involves physical attribute selection. 2. Its levels of service precision through classifier work activities as a result of the deep network teaching building. 3. CNN is extremely efficacious through acknowledging layers through agrarian photos, making something that best suited regarding true early diagnosis processes.

V. RESULTS AND DISCUSSIONS

The results achieved first from organization brings proof that perhaps the fully convolutional (CNN) performance results than just the classical k-nearest relatives (KNN) classification model through categorizing Morus foliage maladies. a can automatically identify powerful image trends that once foliage pictures, that helps to improve it's own ability to differentiate among both nutritious leaf surface, fungal pathogens, but also plant pathogen to increased precision. Compared, a nearest neighbor method relies immediately forward undercooked bitmap virtues, that also confines it's own performance classification work activities. its measurement methods like exactness, pinpoint accuracy, recollect, but instead order to meet the growing make clear that now the deep CNN might provide extra stable and accurate forecasts. this same original dataset both demonstrates smaller numbers classification errors inside the proposed technique, verifying it's own efficacy. Furthermore, the mixing yeah genuine forecasting to text message notification center improves the sensible usefulness of a framework whilst also supplying immediate results of between subscribers. summary, a debate affirms a certain profound having to learn fox news is so much more best suited such as jamun leaf diseases compared to conventional machine learning, because it helps improve either of those exactness as well as true utilization.

A. Classification Performance

Class	**Precision (%)**	**Recall (%)**	**F1-Score (%)**
Healthy Leaf	96.20	97.10	96.65
Leaf Rust	95.70	95.20	95.45
Leaf Spot	95.84	95.40	95.62
Average	**95.91**	**95.90**	**95.91**

The CNN model demonstrated excellent classification performance across all mulberry leaf categories. The Healthy Leaf class achieved the highest recognition rate with a precision of 96.20%, recall of 97.10%, and F1-score of 96.65%. The Leaf Rust class attained a precision of 95.70%, recall of 95.20%, and F1-score of 95.45%, indicating effective disease identification. Similarly, the Leaf Spot class achieved a precision of 95.84%, recall of 95.40%,

and F1-score of 95.62%. The overall average precision, recall, and F1-score of approximately 95.91% confirm the robustness and reliability of the proposed CNN model for accurate mulberry leaf disease classification.

B. Comparative Analysis

Model	Accuracy (%)	Precision (%)	Recall (%)	F1
KNN	82.00	82.28	81.39	81.46
RFC	92.00	91.99	91.86	91.86
CNN	95.92	95.91	95.90	95.91

The performance comparison of the three models shows that the proposed CNN model significantly outperforms both the existing KNN classifier and the Random Forest algorithm in mulberry leaf disease prediction. The KNN classifier achieved an accuracy of 82.00%, precision of 82.28%, recall of 81.39%, F1-score of 81.46%, sensitivity of 95.59%, and specificity of 77.81%, indicating moderate classification performance. The Random Forest model improved the results considerably, achieving 92.00% accuracy, 91.99% precision, 91.86% recall, 91.86% F1-score, 95.62% sensitivity, and 96.95% specificity, demonstrating better disease detection capability. However, the proposed CNN model achieved the highest performance with 95.92% accuracy, 95.91% precision, 95.90% recall, 95.91% F1-score, 97.76% sensitivity, and 99.19% specificity. These results indicate that the CNN model is more effective in extracting complex features from mulberry leaf images, accurately identifying diseased and healthy leaves, and minimizing misclassification. Therefore, the CNN-based approach provides a more reliable and efficient solution for automated mulberry leaf disease detection and real-time agricultural decision support.

C. Test Cases

Test Case ID	Test Scenario	Input	Expected Output	Status
TC01	Healthy Leaf Detection	Healthy mulberry leaf image	Predicts **Healthy** and sends Telegram notification	Pass
TC02	Leaf Rust Detection	Leaf rust affected leaf image	Predicts **Leaf Rust** with treatment suggestion	Pass
TC03	Leaf Spot Detection	Leaf spot affected leaf image	Predicts **Leaf Spot** with treatment suggestion	Pass
TC04	Invalid File Upload	Non-image file (PDF/TXT)	Displays invalid file format message	Pass
TC05	Telegram Noti Ver	Successful prediction result	Sends real-time prediction user	Pass

The mulberry leaf disease prediction system was validated using five important test cases covering disease detection, input validation, and notification functionality. The system correctly identified healthy leaves, leaf rust, and leaf spot diseases from uploaded images and provided corresponding treatment suggestions. It also successfully handled invalid file uploads by displaying appropriate error messages.

D. Discussion

The experimental results demonstrate that the proposed CNN-based mulberry leaf disease prediction system is highly effective in accurately classifying mulberry leaf images into Healthy, Leaf Rust, and Leaf Spot categories. The CNN model achieved an accuracy of 95.92%, outperforming the traditional KNN classifier and Random Forest algorithm across all evaluation metrics, including precision, recall, F1-score, sensitivity, and specificity. The superior performance of the CNN model can be attributed to its ability to automatically learn and extract complex visual features from leaf images, resulting in more accurate disease identification. The integration of Telegram notifications further enhances the practical usefulness of the system by providing real-time prediction alerts and disease management suggestions to users. The conducted test cases confirmed the reliability of the system in handling different disease classes, validating input files, and delivering notifications successfully. Overall, the proposed approach offers a scalable, efficient, and user-friendly solution for early mulberry leaf disease detection, supporting farmers and agricultural experts in improving crop health, reducing yield losses, and enhancing sericulture productivity.

VI. CONCLUSION

Using image-based classification methods, the developed system successfully demonstrates an effective method for detecting mulberry leaf diseases. When compared to more conventional machine learning approaches like K-Nearest Neighbors (KNN), the incorporation of a Convolutional Neural Network (CNN) provides a robust feature learning capability, which enhances the precision with which diseases can be identified. With dependable performance, the system efficiently divides leaf images into healthy, rusty, and spot categories. The standardization of the input data that is made possible by the inclusion of preprocessing methods enhances model learning. Additionally, the system's usability is improved by the instantaneous results provided to users by the real-time prediction feature and Telegram notification. The overall implementation demonstrates that deep learning-based strategies can assist farmers in making timely decisions regarding crop management and are highly effective for agricultural disease detection tasks

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Author Details

Ms.K. Krupa Sagari is working as an Assistant Professor in the Department of MCA at SRK Institute of Technology, Vijayawada. She has completed her MCA and M.Sc. (Mathematics). She has 6 years of teaching experience at SRK Institute of Technology, Enikepadu, Vijayawada, NTR District. Her areas of interest include Artificial Intelligence, Machine Learning, and Cybersecurity.

Ms.K. Pavani Working as Assistant & Head of Department of MCA ,in SRK Institute of technology in Vijayawada. She done with MCA ,M. Tech in Computer Science .She has 10 years of Teaching experience in SRK Institute of

technology, Enikepadu, Vijayawada,NTR District. Her area of interest includes AI ML, etc

Ms.K.NagaDivya is an MCA Student in the Department of Computer Application at SRK Institute Of Technology, Enikepadu, Vijayawada, NTR District. She has Completed Degree in B.Sc.(Mathematics, Statistics ,Computer science) from SDM Siddhartha Mahila Kalasala. Her area of interest are DBMS and Machine Learning with Python.