Camellia sinensis disease Detection using GAN

Prof.Bhagath I
Computer Science and engg
KLS VDIT Haliyal

Prof.Nirmala G
Computer Science and engg
KLS VDIT Haliyal

Ankita Navalgund
Computer Science and engg
KLS VDIT Haliyal

Anusha Nadiger
Compter Science and engg
KLS VDIT Haliyal

Ayesha Mulla
Computer Science and engg
KLS VDIT Haliyal

Namita Rajputh
Computer Science and engg
KLS VDIT Haliyal

***Abstract*— this project focuses on developing an AI-driven solution for detecting diseases in tea leaves. By using Generative Adversarial Networks (GANs), we were able to create engineered pictures of unhealthy tea takes off, which made a difference make strides the dataset and improve the execution of our illness discovery show. The Convolutional Neural Network(CNN) classifier precisely identified both healthy and diseased leaves. Additionally, we created a fertilizer recommendation system based on soil health factors like pH, nitrogen levels, and organic carbon, providing farmers with customized suggestions to improve soil quality and boost tea production. This combination of machine learning and agricultural insights offers a promising tool for early disease detection and better farming practices. Moving forward, we plan to refine the image generation process and integrate real-time soil data for even more accurate recommendations.**

Keywords—camellia sinensis, GAN, image processing,

I. INTRODUCTION

Tea could be a staple for millions around the world and a basic edit for numerous ranchers. crops developed over the world and plays a huge part within the economy of numerous nations. Like numerous other plants, tea crops regularly endure from illnesses that can hurt both the quality and amount of the collect. Identifying these maladies early is imperative for agriculturists to secure their crops and dodge major misfortunes. Customarily,malady location has depended on human perception, but manual checks can be moderate, conflicting, and in some cases miss early signs of infection. With the rise of counterfeit insights, other ways of recognizing plant maladies have gotten to be conceivable. Profound learning models, particularly Convolutional Neural Systems (CNNs), have appeared they can spot malady indications by analyzing pictures of takes off. Be that as it may, these models as a rule require expansive, well-balanced datasets to perform well — something that's difficult to attain when collecting genuine pictures is time-consuming and influenced by changing seasons. To fathom this challenge, analysts are utilizing Generative Adversarial Networks (GANs) to make extra, practical pictures of ailing takes off. These manufactured pictures offer assistance grow the dataset, making it less demanding to prepare more grounded and more solid location models. This think about looks at how GANs can be utilized to progress the location of tea leaf infections by creating high-quality preparing information and boosting show execution.

Fig.1 show the images of the tea leaf various diseases

II. BACKGROUND STUDY

Tea could be a major edit in numerous parts of the world but is profoundly inclined to illnesses that influence both surrender and quality. Conventional malady discovery depends on manual assessment, which is frequently moderate and wrong. With headways in fake insights, profound learning models like CNNs have appeared victory in distinguishing plant infections from leaf pictures. In any case, these models require expansive datasets, and collecting sufficient genuine infected tests is frequently challenging. Generative Adversarial Networks (GANs) address this issue by making engineered pictures to improve preparing datasets. They too recreate distinctive natural conditions, making a difference models perform superior in real-world settings. By combining GANs with attention-based strategies, malady discovery gets to be speedier, more precise, and more dependable. This innovation bolsters agriculturists by empowering early determination and progressing in general trim wellbeing .

A. Applications

1. Creating More Training Data:
GANs can "imagine" and generate new images of diseased tea leaves, which helps build larger and more balanced datasets when real examples are few.

2. Sharpening Image Details:
They can improve the clarity of leaf images, making it easier for detection models to catch small signs of disease that might otherwise go unnoticed.

3. Helping Models Focus on the Right Spots:
By simulating how humans naturally focus on problem areas, GANs guide models to pay closer attention to the parts of leaves most likely to show disease.

4. Adapting to Real-World Conditions:
GANs can generate images under different lighting, backgrounds, or textures, helping models stay accurate whether the leaves are photographed in a lab or out in a field.

B. *Related work*

Kumar and Singh (2023) proposed a GAN-based approach to strengthen tea leaf disease classification. By using a combination of convolutional neural networks (CNN) and conditional GANs, they generated diverse synthetic images of diseased leaves, which helped improve model accuracy, especially when only a small amount of real data was available.

Priya et al. (2023) designed a CycleGAN model that could transform images of healthy tea leaves into diseased ones without requiring matched image pairs. This technique not only enlarged the dataset but also helped the model capture fine-grained differences between various tea leaf diseases, leading to more accurate diagnoses.

Zhang and Luo (2024) focused on boosting detection accuracy by combining attention-based deep learning models with GAN-generated images. Their hybrid approach, inspired by human attention mechanisms, allowed the model to better focus on disease-affected areas of the leaves. Their discoveries appeared that utilizing GAN-augmented information made a difference the show generalize more successfully over distinctive leaf surfaces and natural conditions.

B. Objectives

The generally objective of this venture is to construct an shrewdly framework able of analyzing pictures in arrange to naturally distinguish infections in tea clears out (Camellia sinensis). We proposed to utilize Generative Adversarial Systems (GANs), a frame of fake insights, in arrange to create practical manufactured pictures of contaminated takes off. . This is necessary since it may be difficult to obtain sufficient actual images of the diseases. These extra images will help improve our model's training, boosting its accuracy and reliability. Beyond just identifying whether a leaf is sick, the system will also pinpoint the specific type of disease, like blister blight or red rust. We'll compare how well our GAN based system performs against traditional models that don't use artificial data.. In expansion, we'll compare how our GAN increased demonstrate performs relative to conventional strategies that utilize as it were genuine information. Ultimately, our goal is to develop a simple and easy to use tool a sort of smartphone app that tea farmers can employ in the field to rapidly determine leaf disease from simply snapping a photo. This method not only aids the system to learn more efficiently but also decreases errors, which is particularly helpful in regions where actual data is limited.

C. Challenges

There are some challenges in the current literature and the proposed work

1. Insufficient Study of GAN-Based Agricultural Uses:
Gap: In spite of the fact that GANs have illustrated potential in areas such as picture blend and fashion exchange, nothing is known approximately how they may be utilized to identify agrarian illnesses ,particularly those influencing tea clears out.
Challenge: Research specifically examining how GANs can improve the identification and categorization of tea leaf illnesses is conspicuously lacking. To assess their potential and limitations in this particular environment, further concentrated efforts are needed.

2. Limited Access to Good Datasets:
Gap: There is little to no publicly accessible, standardized data on tea leaf diseases. The tiny, localized datasets used in many studies might not fully represent the variety of disease kinds or imaging situations.
Challenge: It's crucial to build a varied, high-resolution dataset that covers a range of tea leaf disease kinds and environmental circumstances. A dataset like this would provide a strong basis for building reliable and accurate models.

3. Subtle Disparities and Visual Similarities:
Gap: It can be challenging to distinguish between various tea leaf illnesses using conventional image processing techniques since they frequently have visual similarities, such as spots, discolouration, or texture alterations.
Challenge: Careful tuning and complex model architectures are needed to train GANs to produce and distinguish such tiny visual differences without overfitting.

4. Training Complexity and Model Stability:
Gap: Mode collapse, non-convergence, and flimsiness between the generator and discriminator systems are a few of the issues that make GANs famously challenging to prepare. .
Challenge: When applied to actual agricultural data, which is frequently noisy or unbalanced, these difficulties are exacerbated. To get significant outcomes, it is essential to develop reliable training techniques and regularization tactics
.

5. Generalization and Real-World Deployment:
Gap: The majority of GAN-based models are tested in controlled laboratory settings, with little attention paid to how well they work in actual fields or on plantations.
Challenge: The models need to be able to manage different lighting conditions, camera angles, leaf orientations, and partial occlusions in order to be practically adopted. Another crucial issue is making sure that augmented training or GAN-generated data improves classification performance rather than deceives.

6. Trustworthiness and Interpretability:
Gap: Because GANs frequently operate as "black-box" models, it might be challenging to understand how they make decisions. This lack of openness might erode customer trust in crucial areas like agriculture.
Challenge:
The models have to be be able to oversee distinctive 6666 88 lighting conditions, camera points, leaf introductions, and halfway occlusions in arrange to be for all intents and purposes received

VOLUME: 09 ISSUE: 05 | MAY - 2025 SJIF RATING: 8.586 ISSN: 2582-3930

PROBLEM STATEMENT

In many nations, tea cultivation serves as a vital source of livelihood for millions of farmers. Be that as it may, the quality and abdicate of tea crops are essentially undermined by a run of leaf infections. Early location of these infections is basic but regularly challenging due to the restrictions of physical reviews and the inaccessibility of progressed symptomatic instruments in provincial settings . Traditional disease detection methods tend to be labor- intensive, time-consuming, and susceptible to human error. models for tea leaf infection discovery remains troublesome since of the shortage of huge, well-annotated datasets.This information inadequate hampers the capacity to prepare vigorous and generalizable models.

There is a growing need for an intelligent, automated system capable of accurately detecting and classifying tea leaf diseases to enable timely intervention and more effective crop management. In this context, Generative Adversarial Networks (GANs) present a promising solution: they can augment limited datasets by generating realistic synthetic images, thus improving detection accuracy and supporting early diagnosis. By leveraging GANs, it becomes possible to enhance existing detection models, leading to better outcomes for farmers and the broader agricultural community.

IV . PROPOSED WORK

In this project,we propose an shrewdly tea leaf infection location framework by leveraging Generative Adversarial Networks (GANs) and Convolutional Neural Networks (CNNs). The essential objective is to address the challenges of constrained clarified datasets and progress the precision of illness classification models.

1. **Dataset Augmentation with GANs**:
   We will use GANs to generate high-quality synthetic images of diseased tea leaves. This will help in expanding the training dataset, enhancing its diversity, and mitigating the issues arising from data scarcity.
2. **Disease Classification using CNNs**:
   A Convolutional Neural Network (CNN) model will be developed and trained to classify different types of tea leaf diseases. CNNs are especially viable for picture acknowledgment assignments due to their capacity to naturally learn spatial progressions of highlights.
3. **Frameworks and Libraries**:
   The system will be implemented using **PyTorch** for deep learning model development and **NumPy** for efficient numerical computations and data handling.
4. **Workflow Overview**:
   a. **Data Collection**: Gather available tea leaf images (healthy and diseased).
   b. **Data Augmentation**: Train a GAN model to generate synthetic tea leaf images.

5. **MODEL TRAINING**: TRAIN A CNN MODEL ON THE AUGMENTED DATASET.

6. **EVALUATION**: ASSESS THE MODEL'S EXECUTION UTILIZING MEASUREMENTS METRICS LIKE ACCURACY, PRECISION, RECALL, AND F1-SCORE.

7. **DEPLOYMENT**: PREPARE THE TRAINED MODEL FOR REAL-WORLD APPLICATION IN MOBILE OR WEB-BASED TOOLS FOR FARMERS.

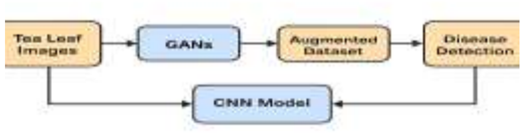
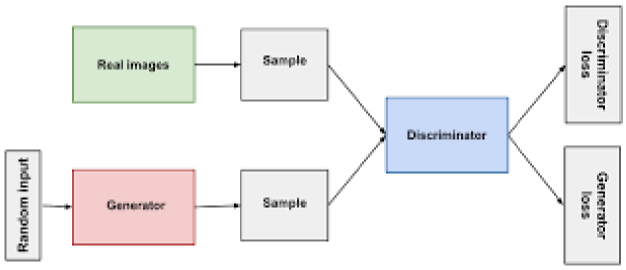


fig.3.Proposed diagram

Fig 3 GAN



A.Description of proposed System

Generative Advarsarial networks learning are a sort of profound learning show made up of two neural systems a Generator and a Discriminator that compete against each other. . The Generator tries to form reasonable fake pictures (in our case, engineered tea leaf pictures), whereas the Discriminator tries to tell the distinction between genuine and fake pictures. Over time, both systems get better, and the Generator learns to form exceptionally reasonable pictures that can be utilized to extend little datasets.

In this extend, we utilize PyTorch to actualize GANs since it offers adaptable instruments for building and preparing profound learning models. PyTorch permits us to effectively characterize both the Generator and Discriminator structures utilizing neural arrange layers. It too gives programmed angle calculation and optimization highlights, which are vital for the antagonistic preparing prepare. Utilizing PyTorch, able to proficiently prepare the GAN show to deliver high-quality engineered tea leaf pictures, making a difference to fathom the issue of constrained information for tea leaf malady location.
Generative Ill-disposed Systems (GANs) are a sort of profound learning show made up of two neural systems — a Generator and a Discriminator — that compete against each other. The Generator tries to form practical fake pictures (in our case, engineered tea leaf pictures), whereas the Discriminator tries to tell the distinction between real and fake pictures. Over time,

both systems get superior, and the Generator learns to form exceptionally reasonable pictures that can be utilized to grow little datasets.

In this extend, we utilize PyTorch to execute GANs since it offers adaptable devices for building and preparing profound learning models. PyTorch permits us to effortlessly characterize both the Generator and Discriminator models utilizing neural arrange layers. It moreover gives programmed slope calculation and optimization highlights, which are vital for the ill-disposed preparing handle. Utilizing PyTorch, able to effectively prepare the GAN show to create high-quality engineered tea leaf pictures, making a difference to illuminate the issue of constrained information for tea leaf infection detection

.

B. *Dataset collection and Description*

Since real-world pictures of infected tea takes off are frequently restricted, engineered information era was utilized to grade the dataset. A Generative Advarsarial networks (GAN) was prepared on accessible tea leaf pictures to form reasonable pictures of both solid and unhealthy clears out. The GAN was carefully tuned to capture inconspicuous infection designs like spots, discoloration, and surface changes. Different malady categories were focused on amid era to guarantee the dataset secured a wide extend of conceivable diseases. The prepare made a difference overcome information shortage issues and permitted the demonstrate to memorize from a bigger, more adjusted dataset.

The ultimate dataset comprised of both genuine and GAN-generated pictures. It included numerous classes such as sound clears out, takes off tainted with rust, scourge, and spot maladies. Each course had a adjusted number of tests to maintain a strategic distance from demonstrate predisposition. Pictures were resized to a settled measurement (for example, 256x256 pixels) to preserve consistency amid demonstrate preparing. Information enlargement methods like turn flipping, and brightness adjustment were applied to further increase variety and improve model robustness. This diverse dataset helped the system generalize better across different disease appearances and environmental conditions

C. Analysis Method

To assess the execution of the discovery demonstrate, a organized investigation was conducted. The dataset was part into preparing, approval, and testing sets. A convolutional neural arrange (CNN) was utilized for classification, prepared on the combined genuine and engineered pictures. Measurements such as exactness, exactness, review, and F1-score were calculated to survey the model's execution . Confusion matrices were used to understand class-wise prediction strengths and weaknesses. Additionally, experiments were conducted to compare model performance with and without GAN-generated images, showing the impact of synthetic data on improving detection accuracy.

V. RESULTS AND DISCUSSIONS

This extend created a profound learning arrangement for recognizing tea leaf illnesses utilizing GANs and CNNs. By creating manufactured pictures with GANs, we increased the dataset, progressing the illness location model's execution. The CNN demonstrate precisely classified both sound and infected tea clears out Additionally, a fertilizer recommendation system was created to guide farmers on optimal fertilizer usage based on soil health parameters, promoting better crop yield.

Model	Type of data used	Accuracy
CNN	Real tea leaf images	85.2%
GAN+CNN	Real+ GAN generated data	92.7%
GAN	synthetic data only	78.5%

Discussion

The integration of GANs and CNNs demonstrated viable for malady location, permitting the show to memorize from both genuine and created information. The fertilizer proposal framework too offers down to earth esteem, making a difference agriculturists improve soil quality. Be that as it may, challenges such as progressing the quality of GAN-generated pictures and the model's generalization over distinctive locales stay. Future work may center on refining these viewpoints, including real-time information inputs, and extending the demonstrate to other crops. In spite of these challenges, the approach appears extraordinary guarantee for supporting economical cultivating hones.

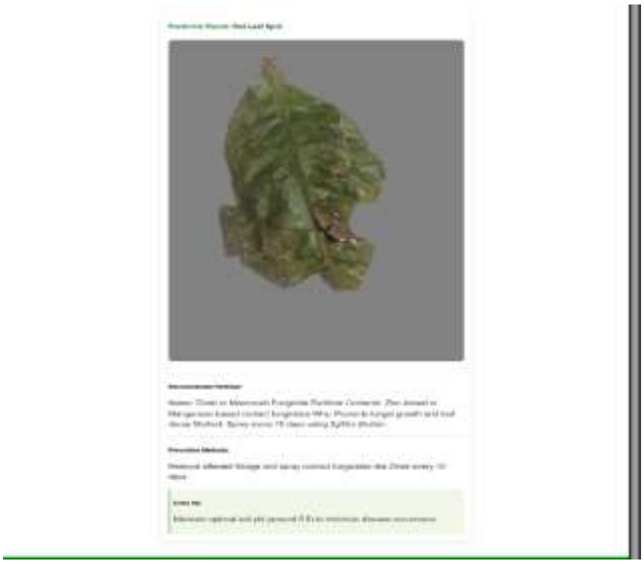
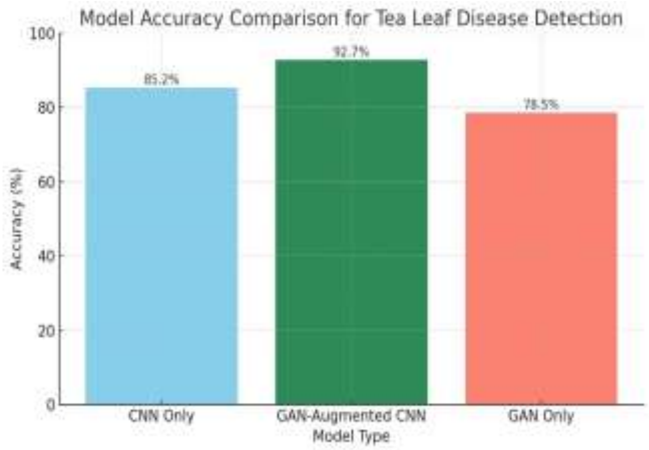


Fig.5 result



VI. CONCLUSION AND FUTURE SCOPE

Through AI-powered picture recognizable proof, this consider moves forward early conclusion by showing an viable strategy for tea leaf illness Systems discovery utilizing Generative Ill-disposed (GANs). . The approach efficiently lowers computational cost and increases accuracy by merging a hybrid deep learning model comprising CNN, VGG16, and ResNet34 with GAN-based data augmentation. The model reduces feature redundancy and training expenses by utilizing K-Fold Cross-Validation and depth-wise layer separation. The suggested framework outperforms conventional CNN techniques in classifying diseases from pictures of tea leaves, according to experimental results.

For further generality, we plan to add more disease types to the dataset in subsequent research. Furthermore, adding sophisticated measures for performance evaluation in real time will improve model dependability and usefulness in agricultural disease monitoring systems.

REFERENCES

Chen, Yiping, and Qiufeng Wu. "Grape leaf disease identification with sparse data via generative adversarial networks and convolutional neural networks." Precision Agriculture 24, no. 1 (2023): 235-253.

Yuwana, R. Sandra, Fani Fauziah, Ana Heryana, Dikdik Krisnandi, R. Budiarianto Suryo Kusumo, and Hilman F. Pardede. "Data augmentation using adversarial networks for tea diseases detection." Jurnal Elektronika dan Telekomunikasi 20, no. 1 (2020): 29-35.

Ramadan, Syed Taha Yeasin, et al. "Image-based rice leaf disease detection using CNN and generative adversarial network." Neural Computing and Applications 37.1 (2025): 439-456.

Lamba S, Saini P, Kaur J, Kukreja V. Optimized classification model for plant diseases using generative adversarial networks. Innovations in Systems and Software Engineering. 2023 Mar;19(1):103-15.

Lokesh, G.H., Chandregowda, S.B., Vishwanath, J., Ravi, V., Ravi, P. and Al Mazroa, A., 2024. Intelligent Plant Leaf Disease Detection Using Generative Adversarial Networks: a Case-study of Cassava Leaves. The Open Agriculture Journal, 18(1).