**Plant Disease Detection Using Machine Learning**

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(TASK-0)

**ABSTRACT**

Crop diseases are a noteworthy risk to sustenance

security, however their quick distinguishing proof stays

troublesome in numerous parts of the world because of the non

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KEYWORD

Diseased and Healthy leaf, Random Forest, Feature extraction, Training, Classification.

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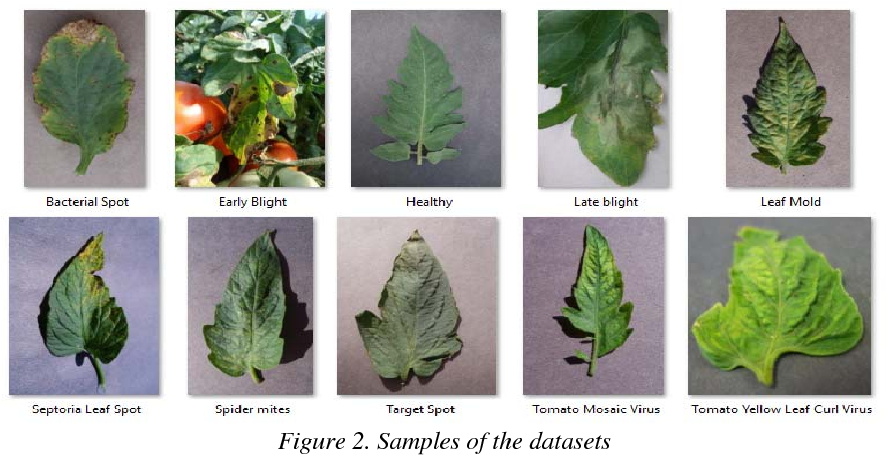
**PROBLEM STATEMENT**

One of the important sectors of Indian Economy is Agriculture. Employment to almost 50% of the countries workforce is provided by Indian agriculture sector. India is known to be the world's largest producer of pulses, rice, wheat, spices and spice products. Farmer's economic growth depends on the quality of the products that they produce, which relies on the plant's growth and the yield they get,Therefore, in field of agriculture, detection of disease in plants plays an instrumental role.

Plants are highly prone to diseases that affect the growth of the plant which in turn affects the ecology of the farmer. In order to detect a plant disease at very initial stage, use of automatic disease detection technique is advantageous.

The symptoms of plant diseases are conspicuous in different parts of a plant such as leaves, etc. Manual detection of plant disease using leaf images is a tedious job. Hence, it is required to develop computational methods which will make the process of disease detection and classification using leaf images automatic.

The global economy mainly depends on the agricultural sector. Rising incidents of plants getting affected by diseases that are discovered recently or did not exist before is an increasing concern in the agriculture sector. The environment is changing continuously which is harmful to the crops and leading farmers towards debt and suicides. Leaf images are vital in the automatic diagnosis of plant diseases, according to the majority of researchers.



**INTRODUCTION**

The agriculturist in provincial regions may think that it’s hard to differentiate the malady which may be available in their harvests. It's not moderate for them to go to agribusiness office and discover what the infection may be. Our principle objective is to distinguish the illness introduce in a plant by watching its morphology by picture handling and machine learning.

Pests and Diseases results in the destruction of crops or part of the plant resulting in decreased food production leading to food insecurity. Also, knowledge about the pest management or control and diseases are less in various less developed countries. Toxic pathogens, poor disease control, drastic climate changes are one of the key factors which arises in dwindled food production.

Various modern technologies have emerged to minimize postharvest processing, to fortify agricultural sustainability and to maximize the productivity. Various Laboratory based approaches such as polymerase chain reaction, gas chromatography, mass spectrometry, thermography and hyper spectral techniques have been employed for disease identification. However, these techniques are not cost effective and are high time consuming.

In recent times, server based and mobile based approach for disease identification has been employed for disease identification. Several factors of these technologies being high resolution camera, high performance processing and extensive built in accessories are the added advantages resulting in automatic disease recognition.

Modern approaches such as machine learning and deep learning algorithm has been employed to increase the recognition rate and the accuracy of the results. Various researches have taken place under the field of machine learning for plant disease detection and diagnosis, such traditional machine learning approach being random forest, artificial neural network, support vector machine(SVM), fuzzy logic, K-means method, Convolutional neural networks etc.…

Random forests are as a whole, learning method for classification, regression and other tasks that operate by constructing a forest of the decision trees during the training time. Unlike decision trees, Random forets overcome the disadvantage of

over fitting of their training data set and it handles both numeric and categorical data.

**ASSESEMENT**

1. Plant health status: Plant disease detection refers to the process of identifying and diagnosing diseases or abnormalities affecting the health of plants. It involves the use of various techniques and technologies to recognize symptoms, patterns, or deviations from a healthy state in plants The health status of plants can be assessed through visual inspection, laboratory analysis, or, more recently, through advanced technologies such as machine learning and image processing.
2. Suitable climate: The process of identifying and understanding the environmental conditions that are conducive to the development and spread of plant diseases. It involves analyzing climatic factors such as temperature, humidity, rainfall, and other meteorological variables to assess their influence on the prevalence and severity of plant diseases in a specific region or crop-growing area.
3. Plant dataset: A plant disease detection dataset is a collection of labeled and annotated data specifically curated for training and evaluating machine learning models designed to recognize and diagnose diseases in plants. This dataset typically consists of images or other relevant data representing various plant species, both healthy and infected with different diseases. The dataset serves as a foundation for training algorithms to automatically identify patterns, features, or symptoms associated with specific plant diseases.
4. Type of soil: There are different types of soil can influence the growth of plants and the microorganisms present in the soil, including pathogens that may cause diseases. Analyzing the soil type is an important aspect of integrated pest management and precision agriculture, allowing for proactive measures to be taken to prevent or mitigate the impact of diseases on crops.
5. Plant architecture: The study of plant architecture involves understanding how genetic, environmental, and hormonal factors influence the development of different plant structures. Researchers and plant breeders often focus on optimizing plant architecture to enhance traits such as yield, resistance to environmental stress, and adaptation to specific growing conditions.
6. Plant Protection: Plant disease plant protection involves the implementation of strategies, measures, and practices to prevent, manage, and control diseases that affect plants. The goal of plant protection is to safeguard crops and plants from the damaging effects of pathogens (such as fungi, bacteria, viruses, and nematodes), pests, and environmental stressors. This field plays a crucial role in ensuring agricultural productivity, food security, and the overall health of plant ecosystems.

**1.MARKET NEED ASSESSMENT**

Identification of Market Demand:

* Market Size and Growth: Determine the overall size of the market for plant disease detection solutions and project its growth trajectory. Understand the market's current status and potential for expansion.
* Target Audience: Identify the specific industries, stakeholders, or user segments that would benefit from plant disease detection technologies. This may include farmers, agricultural extension services, agribusinesses, researchers, or governmental organizations.

Understanding User Requirements:

* User Needs and Preferences: Assess the specific requirements of end-users regarding plant disease detection. Consider factors such as ease of use, affordability, scalability, and integration with existing agricultural practices.
* Geographic Considerations: Recognize regional variations in agricultural practices, climate, and prevalent plant diseases. Tailor solutions to meet the unique needs of different geographic areas.

Evaluation of Existing Solutions:

* Market Landscape:Analyze the current market landscape, including competitors, available technologies, and the strengths and weaknesses of existing solutions. Identify gaps or areas where improvements are needed.
* Technology Trends:Stay abreast of emerging technologies in plant disease detection, including advancements in sensors, imaging, machine learning, and data analytics. Understand how these trends may influence user preferences.

Cost-Benefit Analysis:

* Cost of Implementation: Evaluate the costs associated with adopting and implementing plant disease detection solutions. Consider factors such as initial investment, ongoing maintenance, and potential cost savings from disease prevention.
* Return on Investment (ROI): Understand the potential economic benefits for users. Demonstrate how plant disease detection solutions can lead to increased crop yields, reduced losses, and improved overall agricultural productivity.

**2. BUSINESS NEED ASSESSMENT**

A plant disease detection business needs assessment involves evaluating the commercial viability, market potential, and strategic requirements for developing and offering solutions in the plant disease detection domain. This assessment is essential for understanding the business landscape, identifying opportunities, and addressing challenges associated with providing plant disease detection technologies or services.

Market Analysis:

* Market Size and Growth: Determine the overall size and growth potential of the market for plant disease detection solutions. Analyze market trends and dynamics to understand the demand for such technologies.
* Target Market Segments: Identify specific industries, geographic regions, or user segments within the agricultural sector that represent the primary target market for plant disease detection solutions.

Competitive Landscape:

* Competitor Analysis: Evaluate existing and potential competitors in the plant disease detection space. Assess their strengths, weaknesses, market share, and technological capabilities.
* Unique Selling Proposition: Define a compelling USP that distinguishes the plant disease detection solution from competitors. Highlight features or benefits that address specific needs in the market.

Customer Needs and Preferences:

* User Requirements: Identify and prioritize the needs and preferences of potential customers. Consider factors such as ease of use, affordability, scalability, and integration with existing agricultural practices.
* User Feedback: Gather feedback from potential users or stakeholders to refine and optimize the plant disease detection solution based on real-world needs.

Revenue Model:

* Monetization Strategies: Define the revenue model for the plant disease detection business. Consider pricing structures, subscription models, licensing fees, or other monetization strategies that align with market expectations.
* Value-added Services: Explore opportunities to provide additional services or features that complement the core plant disease detection offering, potentially increasing the overall value proposition.

Technology and Innovation:

* Technology Trends: Stay abreast of emerging technologies in plant disease detection, such as advancements in sensors, imaging, machine learning, and data analytics. Ensure that the technology used remains competitive and relevant.
* Innovation Roadmap: Develop a roadmap for continuous innovation to keep the plant disease detection solution at the forefront of technological advancements.

Business Sustainability:

* Environmental and Social Impact: Consider the environmental and social impact of the plant disease detection solution. Highlight sustainability practices and contributions to responsible agriculture.
* Long-term Viability: Assess the long-term sustainability and scalability of the business model. Consider factors such as market evolution, evolving customer needs, and potential expansion into new markets.

**TARGET SPECIFICATION**

1.Accuracy and Reliability:

The accuracy and reliability of a plant disease detection system are crucial for its effectiveness in agricultural applications. High sensitivity ensures that the system correctly identifies the presence of diseases in plants, minimizing false negatives. Simultaneously, high specificity reduces false positives, ensuring that the system accurately distinguishes healthy plants from those affected by diseases.

2.Real-time or Rapid Detection:

Timely detection is essential for effective disease management. A plant disease detection system should offer real-time or rapid detection capabilities, allowing farmers to quickly assess the health status of their crops. Real-time detection enables immediate intervention measures, helping to prevent the further spread of diseases and mitigate potential crop losses.

3.User-Friendly Interface:

The user interface of a plant disease detection system plays a pivotal role in its adoption and usability. An intuitive and user-friendly interface ensures that farmers, agronomists, or end-users can easily operate the system without extensive technical training. Clear visualizations, straightforward navigation, and easily interpretable results contribute to the accessibility of the system, making it a practical tool for individuals with varying levels of technical expertise.

4.Machine Learning Integration:

Integration of machine learning algorithms enhances the system's analytical capabilities and adaptability. By leveraging machine learning, the system can learn and recognize patterns indicative of specific diseases, improving its accuracy over time. Machine learning integration contributes to the system's scalability and long-term relevance.

5.Cost-Effectiveness:

Cost-effectiveness is a critical consideration to ensure widespread adoption of a plant disease detection system. The affordability of components, ease of maintenance, and minimal operational costs make the system accessible to a broader range of farmers, including those in resource-constrained environments.

**EXTERNAL SEARCH IN PLANT DISEASE**

Plant diseases can be a big problem for farmers because they can harm crops and reduce the amount of food that can be grown. When people want to learn about plant diseases, they often check out special journals that have research about how to deal with these problems. These journals, like "Plant Disease" and "Phytopathology," share information on how to find, prevent, and manage plant diseases. This helps farmers to know what to do to protect their plants and make sure they grow healthy and strong.

Government organizations like the United States Department of Agriculture (USDA) and the Food and Agriculture Organization (FAO) also share important information about plant diseases. They look at what's happening with plant diseases all around the world and provide guidance on how to handle them. This helps farmers and scientists understand the bigger picture and work together to find solutions.

Companies that focus on agricultural technology and researchers in market research firms also contribute to our understanding of plant diseases. They come up with new ideas and technologies to detect and manage plant diseases. Some of these ideas include using artificial intelligence to quickly find and deal with plant diseases. Overall, there are many places to look for information on plant diseases, and by combining insights from different sources, we can find better ways to protect our plants and ensure a healthy food supply

**APPLICABLE PATENTS**

* <https://www.researchgate.net/publication/375876522_Identification_of_Various_Diseases_in_Plant_Leaves_Using_Image_Processing_and_CNN_Approach>

Traditional machine learning vision-based plant leaf disease and identification approaches often use conventional algorithms for image processing or manually created features and classifiers

* <https://www.frontiersin.org/articles/10.3389/fpls.2016.01419/full>

Crop diseases are a major threat to food security, but their rapid identification remains difficult in many parts of the world due to the lack of the necessary infrastructure.

* <https://www.researchgate.net/publication/340705523_ToLeD_Tomato_Leaf_Disease_Detection_using_Convolution_Neural_Network>
* n the research article, we have proposed a novel method to identify the disease in tomato crop after analyzing
* the images of leaves. The work will solve farmers problems of plant’s disease identiﬁcation without running after
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* The identiﬁcation of tomato plant disease may start from, to diagnose the portion having infection in plant then
* to note the diﬀerences such as brown or black patches and holes on the plant and then to look for the insects also.
* Tomatoes and similar vegetables like potatoes or brinjal must not be planted on same farm for more than one time in
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**APPLICABLE REGULATIONS**

* Quarantine Regulations:
* Research and Monitoring:
* Disease Monitoring Programs:
* Seed Certification:
* Plant Variety Protection:
* Import/Export Restrictions:
* Sanitary and Phytosanitary Measures:

**BUSINESS OPPORTUNITY**

* Development of Disease-Resistant Crop Varieties:
* Precision Agriculture Technologies
* Digital Platforms for Disease Monitoring and Advisory:
* Diagnostic Kits and Services:
* Integrated Pest Management (IPM) Consultancy:
* Remote Sensing and Satellite Imaging Services:
* Smart Farming Solutions:
* Training and Education Services:
* Collaborative Research and Development:

**CONCEPT GENERATION**

Concept is that we are creating a model which is detect plant disease and predict the disease using machine learning technique or algorithm for better growth of plants.

**CONCEPT DEVELOPMENT**

Initial stage is to analyzed the plant(beginner stage) or data then identifying the problem(disease), according the issues then apply machine learning technique basically our concept is to classify disease and fix it by using machine learning and deep learning techniques.

**FINAL PROTOTYPE IN PLANT DISEASE**

Machine learning gives PCs the ability to learn without being unequivocally customized, fundamentally the same as working of a human being. The machine is learning from past encounters (which are taken care of in information)concerning a few classes of errands if the presentation of assignment improves with more insight. Learning can be classified as

* Supervised
* Unsupervised
* Semi-Supervised
* Reinforcement

Supervised Learning

Supervised Learning alludes to named dataset, comprising of both input and output boundary, for preparing the models. While preparing a model proportion of preparing and testing information is kept 80:20. Supervised Learning is additionally sorted as Classification and Regression.This discrete worth might be a parallel worth or multi-classed. While relapse is a supervised learning model which produce persistent worth, reach. Point of the relapse is to anticipate a worth closer to output esteem.

Examples of supervised learning models are Linear Regression, Nearest Neighbour, Gaussian Naïve Bayes, Decision Trees, Support Vector Machine (SVM) and Random Forest.

Unsupervised Learning

In unsupervised Learning, targets are not given to display to be prepared so just input boundaries are there and no output boundary is given to the model. Bunching and Association are two kinds of unsupervised Learning. Clustering is applied to information orchestrated as gatherings made by different examples distinguished by the model of machine. While a standard-based method to sort out relations among boundaries of a vast informational collection, is called Association.

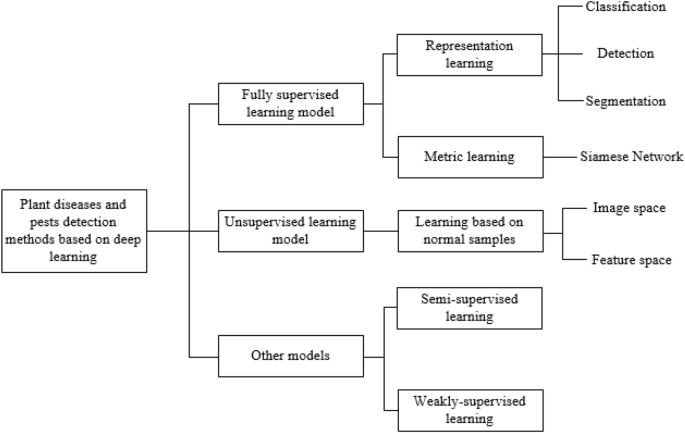
Examples of unsupervised learning models are K-Means Clustering, BIRCH – Balanced Iterative Reducing and Clustering using Hierarchies.

Semi-supervised Learning

Working of Semi-supervised Learning lies in the vicinity above talked about procedures. This sort of Learning is utilized while dealing with information, some of which is named, and some part is Electronic copy available at: <https://ssrn.com/abstract=3729753> unlabelled. The unsupervised strategy is utilized to compute marks, and afterwards, these determined qualities are taken care of to supervised learning strategies. In image datasets where a large portion of the images are not named, this procedure is more well known.

Reinforcement Learning

Execution of the model continues improving with criticism to learn examples and conduct. Each time information is taken care of, it is found out and added to information which is preparing information. Thus, more it learns the better it get prepared and subsequently experienced. Algorithm for reinforcement learning is Temporal Difference, Q-Learning and Deep Adversarial Networks.



To calculate histogram the image first must be converted to HSV (hue, saturation and value), so we are converting RGB image to an HSV image as shown the figure5. Finally, the main aim of our project is to detect whether it is diseased or healthy leaf with the help of a Random forest classifier which is as depicted

|  |  |
| --- | --- |
| **Various Machine learning**  **models** | **Accuracy(percent)** |
| Logistic regression | 65.33 |
| Support vector machine | 40.33 |
| k- nearest neighbor | 66.76 |
| CART | 64.66 |
| Random Forests | 70.14 |
| Naïve Bayes | 57.61 |



**CONCLUSION**

The objective of this algorithm is to recognize abnormalities that occur on plants in their greenhouses or natural environment. The image captured is usually taken with a plain background to eliminate occlusion. The algorithm was contrasted with other machine learning models for accuracy. Using Random forest classifier, the model was trained using 160 images of papaya leaves. The model could classify with approximate 70 percent accuracy. The accuracy can be increased when trained with vast number of images and by using other local features together with the global features such as SIFT (Scale Invariant Feature Transform), SURF (Speed Up Robust Features) and DENSE along with BOVW (Bag Of Visual Word) The graph and table below gives the comparison of machine learning algorithms.

Applications of machine learning and deep learning in the field of agriculture are picking up energy. Strategies of image preparing are utilized for precise discovery and grouping of harvest disease and the exact location and order of the plant disease‟s significant for the productive development of the crop. Several industrially available items are turning out to be well-known step by step to distinguish plant diseases and recognize recuperation arrangements and help farmers in improving their yield profitability and like these benefits.

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* <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3729753>