Automation of Plant Diseases Detection through Machine learning Technologies

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Abstract:

Plants are constantly exposure to pathogens such as virus, bacteria and fungi. Plant diseases caused by pathogens lead significant crop yield loss globally. Numerous researchers have been studying how to reduce the damage of plant diseases. Plant disease has long been one of the major threats to agriculture security in India because it dramatically reduces the crop yield and compromises its quality. Pests and Diseases results in the destruction of crops or part of the plant resulting in decreased food production leading to food insecurity. Accurate and precise diagnosis of diseases has been a significant challenge. Traditionally, identification of plant diseases has relied on human annotation by visual inspection. Plant diseases affect the growth of their respective species; therefore their early identification is very important. Modern technological approaches such as machine learning and deep learning algorithm have 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. In this paper a comparative study on machine learning techniques for plant disease detection is performed. In this survey it observed that Convolutional Neural Network gives high accuracy and detects more number of diseases of multiple crops.

Keywords: Plant disease, deep learning, Support vector machine (SVM), Convolutional neural networks

Introduction

India is agrarian country because almost 55% of its population depends on the agriculture and its related activities for their livelihoods. In no other developing country, such a large number of people depend on the agriculture. India ranks second worldwide in farm outputs. As per 2018, agriculture employed more than 50% of the Indian work force and contributed 17–18% to country's GDP. Rising Indian population putting agriculture industry and farmers in pressure to be more productive. Increasing population of the world is putting more and more stress on agriculture, providing impetus for development of better crops with higher yields. However, even with better crop varieties, water and planting management, crop diseases pose a major threat to agriculturists. Plant disease has long been one of the major threats to agriculture security in India because it dramatically reduces the crop yield and compromises its quality.

Types of Plant Diseases:

Plants can be categorized by their similar features. Disease identification in plants can be done on the basis of plant type. Most plant diseases are caused by bacterial, fungal and viral, etc.

- **Bacterial Diseases**

  Bacteria spread in infected seed, propagating material and crop residues, through water splash and wind-driven rain, and on contaminated equipment and workers hands. Bacteria in plants may affect stems, leaves, roots or be carried internally without external symptoms. Bacterial disease symptoms include cankers, leaf spots, overgrowths, scabs, wilts, and others. The two main bacterial diseases in plants are citrus canker and potato scab.

- **Fungal Diseases**

  Fungi constitute the largest number of plant pathogens and are responsible for a range of serious plant diseases. Most vegetable diseases are caused by fungi. The main source of fungal disease is the infected seed, soil, crop, and weeds. In the initial stage, it appears on lower or older leaves as water-soaked, gray-green spots. Later, these spots darken and then white fungal growth spread on the undersides. Some fungal diseases occur in a wide range of vegetables. These diseases include anthracnose, botrytis rots, downy mildew, fusarium rots and powdery mildews.

- **Viral diseases**

  Viruses can be spread from plant to plant by several means. Some of these would include transmission from the parent plant to an offspring through the genetic structure of the plants. The most accessible symptoms of virus-infected plants are usually those appearing on the leaves, but some viruses may cause strike on the leaves, fruits, and roots. The viral disease is very difficult to diagnose. Leaves are seen as wrinkled, curled and growth may be stunted due to the virus.

Accurate and precise diagnosis of diseases has been a significant challenge. Traditionally, identification of plant diseases has relied on human annotation by visual inspection. Farmers spend billions of rupees are on disease management, often without adequate technical support, resulting in poor disease control, pollution and harmful results. Plant disease management faces ever-growing challenges due to: (i) increasing demands for total, safe and diverse foods to support the booming global population and its improving living standards; (ii) reducing production potential in agriculture due to competition for land in fertile areas and exhaustion of marginal arable lands; (iii) deteriorating ecology of agro-ecosystems and depletion of natural resources; and (iv) increased risk of disease epidemics resulting from agricultural intensification and monocultures.

Modern technologies have given human society the ability to produce enough food to meet the demand of more than 7 billion people of this world. To enhance the agriculture productivity, applications of new current cutting edge technologies in the field of agriculture is the need of hour. Governments should not just focus on farming processes but also they need to improvise entire farming ecosystem.

Indian agriculture is at the nascent stages of adoption of Information and Communication Technology (ICT) techniques for managing and improving farm output. ICT can prove to be beneficial for all farmers including small landholders, the most vulnerable to crop losses. One of the most prominent technology for automation of plant disease detection is Machine learning.

Literature Review:

In this paper, we perform a survey of 40 research efforts that employ deep learning techniques, applied to various agricultural and food production challenges. We examine the particular agricultural problems under study, the specific models and frameworks employed, the sources, nature and pre-processing of data used, and the overall performance achieved according to the metrics used at each work under study [11]. The proposed solution increases in efficiency of the detection, identification, and classification process will enable the tea industry in Bangladesh to become more competitive globally, by reducing the losses suffered due to diseases of the leaf, and thus increasing the overall tea production rate [2].

Deep learning is quickly becoming the standard technique for image classification. The main problem facing the automatic identification of plant diseases using this strategy is the lack of image databases capable of representing the wide variety of conditions and symptom characteristics found in practice. Data augmentation techniques decrease the impact of this problem, but those cannot reproduce most of the practical diversity. This paper explores the use of individual lesions and spots for the task, rather than considering the entire leaf. Since each region has its own characteristics, the variability of the data is increased without the need for additional images. This also allows the identification of multiple diseases affecting the same leaf. On the other hand, suitable symptom segmentation still needs to be done manually, preventing full automation. The accuracies obtained using this approach were, in average, 12% higher than those achieved using the original images. Additionally, no crop had accuracies below 75%, even when as many as 10 diseases were considered. Although the database does not cover the entire range of practical possibilities, these results indicate that, as long as enough data is available, deep learning techniques are effective for plant disease detection and recognition [9]. Many studies shows that quality of agricultural products may be reduced from many causes. One of the most important factors contributing to low yield is disease attack. The plant disease such as fungi, bacteria and viruses. The leaf disease completely destroys the quality of the leaf. Common ground nut disease is cercospora. It is one of the type of disease in early stage of ground nut leaf. The upgraded processing pattern comprises of four leading steps [6].

Convolutional neural network has a huge partake and is still a dominating tool in the field of computer vision. In this study, we introduce a model with depthwise separable convolution architecture for plant disease detection based on images of leaves. We present two versions of depthwise separable convolution comprising two varieties of building blocks. Training and testing of the models were performed on a subset of publicly available PlantVillage dataset of 82,161 images containing 55 distinct classes of healthy and diseased plants. These depthwise separable convolutions achieved less accuracy and high gain in convergence speed. Several models were trained and tested, of which Reduced MobileNet achieved a classification accuracy of 98.34% with 29 times fewer parameters compared to VGG and 6 times lesser than that of MobileNet. However, MobileNet outperformed existing models with 36.03% accuracy when testing the model on a set of images taken under conditions different from those of the images used for training [17].

In the era of technology burst and usage of software as an alternative for the manual involvement for decision making, every field is trying to find its own comfort and cost cutting solutions in replacing software methods for best possible expert opinion. SVM, is initially proposed for binary classification technique, with simple manipulation can be used for a multiple class case. This project tries to attempt for improvement in classifying the leaf diseases [1]. This work is inspired by Kaggle competition which was part of the Fine-Grained Visual Categorization workshop at CVPR 2019 (Conference on Computer Vision and Pattern Recognition) we participated in. It aimed at detecting cassava diseases using 5 fine-grained cassava leaf disease categories with 10,000, labeled images collected during a regular survey in Uganda. Traditionally, this detection is done mostly through physical inspection and supervision of cassava plants in the garden by farmers or agricultural extension workers from NAADS (National Agricultural Advisory Services) and then reported to NARO (National Agricultural Advisory Services) for further analysis [16]. This paper explores the use of individual lesions and spots for the task, rather than considering the entire leaf. Since each region has its own characteristics, the variability of the data is increased without the need for additional images. This also allows the identification of multiple diseases affecting the same leaf. On the other hand, suitable symptom segmentation still needs to be done manually, preventing full automation. The accuracies obtained using this approach

were, in average, 12% higher than those achieved using the original images [9]. Basic ingredients of the First Green Revolution (GR 1.0) were: High Yield Varieties (HYV) of crops with superior genetics; use of chemicals - pesticides and fertilizers; and multiple cropping system supported by the use of modern farm machinery and proper irrigation system. During the period there was also expansion of farming areas. GR 1.0 resulted in increase in production and changed the thinking of the farmers [14]. The studies of the plant diseases mean the studies of visually observable patterns seen on the plant. Health monitoring and disease detection on plant is very critical for sustainable agriculture. It is very difficult to monitor the plant diseases manually. In this paper, we have implemented the methods for the detection of Pomegranate plant diseases using the images of the leaves [8]. Experimental results show that, SVM can segment disease spot images on the condition of low shot learning while retaining the edge information well, improved C-DCGAN can generate augmented images with the same data distribution as real disease spot images, the VGG16 deep learning model trained with augmented disease spot images can identify tea leaf's diseases accurately, and the average identification accuracy of the proposed method reaches 90%, far exceeding classical low shot learning methods[13]. We propose and evaluate a framework for detection of plant leaf/stem diseases. Studies show that relying on pure naked-eye observation of experts to detect such diseases can be prohibitively expensive, especially in developing countries. Providing fast, automatic, cheap and accurate image-processing-based solutions for that task can be of great realistic significance [4]. We present a new learning architecture: the Decision Directed Acyclic Graph (DDAG), which is used to combine many two-class classifiers into a multiclass classifier. For an N-class problem, the DDAG contains N(N+1)/2 classifiers, one for each pair of classes. We present a VC analysis of the case when the node classifiers are hyperplanes; the resulting bound on the test error depends on N and on the margin achieved at the nodes, but not on the dimension of the space [15]. Experiments are performed by separately utilizing color features, texture features, and their combinations to train three models based on support vector machine classifier. Results are generated using thousands of images collected from Plant Village dataset. Acceptable average accuracy values are reported for all the considered combinations which are also found to be better than existing ones [3]. Tomato is the most popular crop in the world and in every kitchen, it

is found in different forms irrespective of the cuisine. After potato and sweet potato, it is the crop which is cultivated worldwide. India ranked 2 in the production of tomato. However, the quality and quantity of tomato crop goes down due to the various kinds of diseases. So, to detect the disease a deep learning-based approach is discussed in the article [12].

Methodology:

In this study a survey is performed on various research papers on applications of Machine learning techniques for plant disease identification. In this study, based on the findings of the previous studies, we provide a deeper evaluation of the Machine learning methods for identifying plant disease. In this survey we did a study on various research papers that presented the use of Machine learning in plant disease detection, and analyses them in terms of the dataset used, models employed, and overall performance achieved. In addition, some research gaps are identified from which to obtain greater transparency for detecting diseases in plants, even before their symptoms appear clearly. According to this study ICT can prove to be beneficial for all farmers including small landholders, the most vulnerable to crop losses. One of the most prominent technologies for automation of plant disease detection is Machine learning. Deep learning is a class of machine learning algorithms that uses multiple layers to progressively extract higher-level features from the raw input. Deep learning is a subset of machine learning where artificial neural networks, algorithms inspired by the human brain, learn from large amounts of data. Similarly to how we learn from experience, the deep learning algorithm would perform a task repeatedly in multiple layers, each time tweaking it a little to improve the outcome. Deep learning techniques techniques can enable the vulnerable farmers, especially small stakeholders, to take appropriate preventive / mitigative actions in case of crop diseases, adverse weather or even soil health.

Fig 1: Image disease identification process

Plant diseases affect the growth of their respective species; therefore their early identification is very important. Deep learning models stand for a new learning paradigm in artificial intelligence (AI) and machine learning. Deep learning can be used in a variety of problems including pattern recognition, classification, clustering, dimensionality reduction, computer vision, natural language processing (NLP), regression, predictive analysis, etc.

The use of machine and Deep learning in Agriculture has seen a huge revolution in the last decades. Neural networks have been introduced in different scientific applications and proved their high efficiency with minimum costs. It is used mostly in the field of plants disease identification. In this process crop leaf images are pre-processed and pass to machine learning algorithm for disease identification.

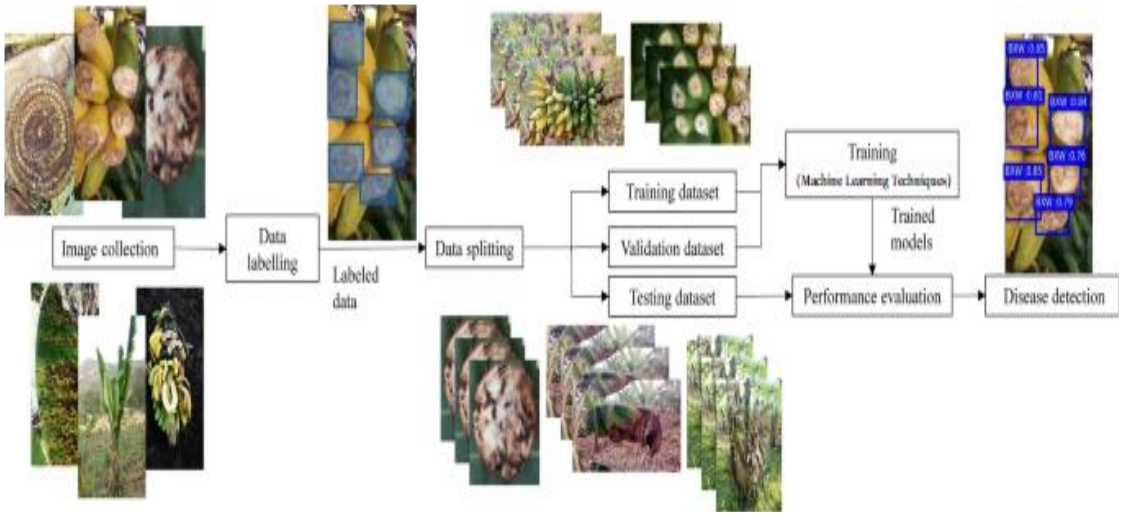

Fig 2: Plant Disease Detction

Conclusion:

This paper makes a review on the existing machine learning techniques and also suggests the best technique which can be implemented by farmers to recognize the disease faster and which proves to be economical to them. Using Machine learning in plant disease detection made it possible to produce higher prediction accuracies as well as broadened the scope of detected diseases and plant species considered. This article presents a survey of research papers that presented the use of Machine learning techniques in plant disease detection, and analyses them in terms of the dataset used, models employed, and overall performance achieved.

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