International Journal for Rapid Research in Engineering Technology & Applied Science
Vol IX Issue IX September 2023
ISSN Online:- (2455-4723)

Citrus Diseases Detection & Classification using DL and ML Models: A Systematic Review

Palak Singh Parihar, M.Tech.
Rajni Mishra, Assistant Prof.
Department - Computer Science Engineering
LNCT Bhopal Indore Campus, Indore
palakparihar1999@gmail.com

Abstract: Citrus fruits, including lemons, mandarins, oranges, tangerines, grapefruits, and limes, are widely cultivated around the world. Citrus manufacturing enterprises generate a substantial amount of trash annually, with fifty percent of citrus peel being lost to various plant diseases. This paper provides a survey of the various methodologies applicable to the detection and classification of citrus plant leaf diseases. The page provides a comprehensive classification of citrus leaf diseases. Initially, the difficulties of each stage, which affect the accuracy of detection and classification, are described in depth. In addition, a comprehensive literature assessment of strategies for automated disease identification and classification is offered. In order to accomplish this, several picture preprocessing, segmentation, feature extraction, feature selection, and classification techniques are investigated. Discuss the significance of feature extraction and deep learning methods as well. The survey provides a detailed assessment of studies, analyzes their merits and weaknesses, and identifies more research concerns. According to the survey results, automated detection and classification approaches for citrus plant diseases are still in their infancy. To fully automate the detection and classification processes, therefore, new technologies are required. Comparative analysis of deep learning models currently used for citrus disease detection and classification. The creation of an updated model containing new characteristics and classifiers. Improvement of the proposed model's accuracy in the identification and classification of citrus illnesses. Citrus production and export have increased gradually over the past three decades, albeit at a slower rate than rival products such as mangoes, avocados, and melons. Citrus fruit production is severely affected by illnesses in its growing stages. The diseases develop not only on foliage but also on fruits. Hence, the presence of faults degrades the quality of fruits. The citrus fruits are evaluated in two ways, based first on the color of their skin and then on their size. So, it is necessary to assess citrus illnesses in order to prevent output losses. In addition, citrus fruit must be graded to facilitate its packaging in terms of its quality, so that the correct Citrus fruit values can be generated. This research examined and assessed various machine vision-based citrus disease prediction and postharvest citrus fruit grading approaches reported between 2010 and 2022. This study discusses the present successes, limits, and recommendations for future research on citrus illnesses and fruit grading.

Key words –Citrus Disease Detection, Plant Disease Detection deep learning, Machine learning, Citrus Disease, CNN, Feature Extraction, Segmentation

I INTRODUCTION

Citrus is an important source of nutrients such as vitamin C for plants around the world. Citrus contains numerous economically significant species. Few species are cultivated commercially in India, including grapefruit, lemons, limes, sweet oranges, and mandarins. Citrus is indigenous to Southeast Asia. Several citrus species, such as mandarins, are native to the North East of India. In central India's Vidharbha region, Nagpur Santra is cultivated on a big scale. Similarly, the Brahmaputra Valley and Dibrugarh district are renowned for their production of mandarins in Assam. Khasi mandarin is a notable Nilgiri hills cultivar. In addition to mandarins, limes and lemons are also grown everywhere. India. Pests and illnesses are the two most influential influences on citrus yield. Many citrus pests and illnesses exist in nature. Several of them have a similar look, making it challenging for farmers to identify them in a timely manner. In recent years, advancements in machine learning algorithms have significantly advanced computer vision.These new network topologies have allowed researchers to achieve great precision in picture classification, object detection, and semantic segmentation [1].Thus some studies have applied the machine learning approach to determine the disease category based on an image. As a significant contributor to the agricultural economy as a whole, the citrus industry requires proper disease control in citrus groves to prevent losses. Melanoses, greasy patch, and scab are the most destructive citrus diseases [2].Ensuring fruit quality and safety, and boosting the citrus industry's competitiveness and profitability, would be technologies that easily identify these pathogens. The objective is to examine the viability of pattern classification algorithms for detecting disease lesions on citrus leaf surfaces. Based on the disease, the leaves are divided into four categories: scab, melanoses, greasy patch, and normal leaf [3].

Citrus production: Around 923.2 thousand hectares are devoted to citrus cultivation in India, with an estimated output of 8, 607,7 thousand metric tons. Agriculture entails substantial production risks, and numerous variables must be taken into account when making decisions [4]. For management strategies and development programs to be effective, it is necessary to have a thorough understanding of the variables that have the most direct impact on output. Comprehending the behavior of variables is challenging due to the complexity of relationships and the number of relevant elements.

Citrus Diseases: Citrus fruits, including lemons, mandarins, oranges, tangerines, grapefruits, and limes, are widely cultivated around the world. Citrus manufacturing enterprises generate a substantial amount of trash annually, with fifty percent of citrus peel being lost to various plant diseases. [6]Currently, citrus exports to international markets are significantly hampered by fruit illnesses. Citrus diseases negatively impact citrus fruit yield and quality.

Taxonomy of Citrus Diseases: In the agriculture industry, plant diseases are primarily responsible for the decline in productivity that results in economic losses at the national level. Grapefruit is an important global source of nutrients such as vitamin C. Unfortunately; citrus diseases severely impacted citrus fruit supply and quality. Many citrus lesions, including anthracnose, citrus scab, black spot, melanoses, and canker greening, afflict citrus plants such as lemons, oranges, grapefruits, and limes [7-8]. Included below are brief descriptions of several citrus illnesses.

Anthracnose-Anthracnose is a disease of citrus plants caused by a fungus (Colletotrichumgloeosporioides) and characterized by twig blight of mature tips, leaf spots, and fruit stains, spots, or rots. It can spread rapidly during wet seasons.

Canker-It is a highly serious citrus disease, primarily affecting limes. Sickness manifests itself on leaves, twigs, and fruits. It shows as yellow dots on leaves. Which progressively increase in size, grow rough and brownish, and become elevated on both sides of the leaf? These specks have a yellow halo surrounding them. The sores on the fruit's peel grow tough and corky. Kagji limes and grapefruits are extremely vulnerable.

Citrus Scab-Acne scabs on citrus leaf and fruit are composed of fungal and organism tissue. The color of a scab lesion is dirty grey and yellow-brown. Tiny, dark brown, rough, uneven, elevated lesions appear, predominantly on the undersides of the leaves. Fruits and branches are also infected.

Citrus black spot-Citrus black spot is caused by the fungus Guignardiacitricarpa. This ascomycete fungus affects citrus plants in subtropical climates, reducing both the quantity and quality of the fruit. Symptoms consist of both fruit and leaf lesions, with the latter being crucial for inter-tree dispersal.

Melanose-Melanose is caused by Phomopsis citric fungus. On leaves, branches, and fruits, it appears as dark circular depressions with yellow edges. Subsequently, the dots grow rough and elevated, and their light brown and yellow edges vanish. The surfaces of leaves and fruits develop a sandpaper-like roughness.

Greening:-It is caused by bacteria and shows as many, rigid, erect branches and buds. The leaves shrink and become speckled. Early defoliation and branch dieback are observed.

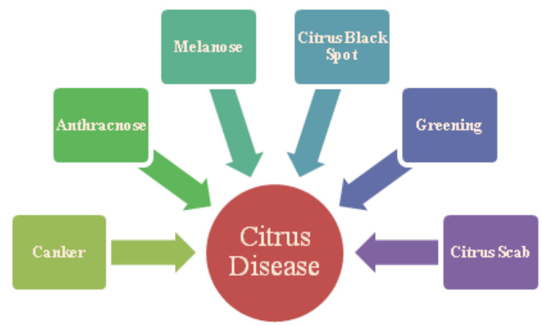

Figure 1 different types of citrus disease

1.1 Major Challenges in Disease Detection and Fruit Grading of Citrus based on Machine Vision-Machine vision, which integrates cameras, processing gear, and software algorithms, allows for the automation of regular visual inspection tasks. With machine vision, these include location, identification, verification, measurement, and flaw detection. The fundamental purpose of machine vision in this crop is to detect defects (diseases), classify diseases and citrus fruit kinds, and evaluate fruit quality and size. (1) Optical consistency; (2) separation of the disease from the background; (3) the presence of irrelevant features; and (4) the absence of big datasets are significant challenges in citrus disease identification and diagnosis. [9]

1.2 Machine vision mainly relies on preprocessing to improve the optical consistency of the incoming images.

International Journal for Rapid Research in Engineering Technology & Applied Science
Vol IX Issue IX September 2023
ISSN Online:- (2455-4723)

Included in the preparatory procedures is image enhancement, color space conversion, image resizing, and image filtering. Many challenges, including lighting, brightness, and contrast issues, can therefore be eliminated. These factors have a direct effect on the accuracy of disease classification. For the identification of plant diseases, numerous preprocessing techniques are utilized. They include image enhancement, scaling, image correction, and the elimination of shadows. Segmentation is the second primary process for separating the disease's fragments. Color change, substantial diversity in colors, changing lighting circumstances, variations in the size of the sick portion, the volume of fruits, and estimation of disease area and fruit size are some of the most typical obstacles for segmenting diseased parts in an image [10-11].

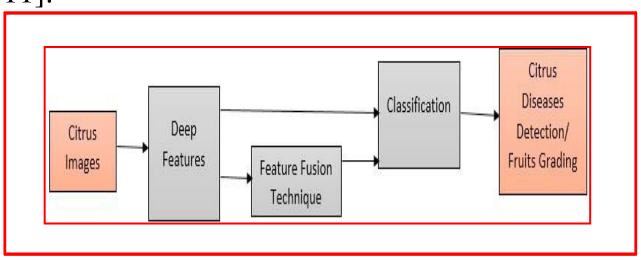

Figure 3. Framework based on Deep Learning.

II RELATED WORK

1.3 Citrus Disease Detection Using Machine Vision The typical approach for detecting citrus diseases is time-consuming and requires a thorough understanding of the problem, making it a hot topic among researchers. With machine vision, it is possible to detect citrus diseases. Greening illness and know & mandarin citrus were found for the first time in 2017 [12] by H. Ali et al. Using an algorithm based on the color difference of E, the sick area was isolated. Textural characteristics and a color histogram were used to classify diseases. They used fine KNN, Cubic SVM, Boosted tree, and Bag of trees to achieve 99.9% precision. A method has been devised for diagnosing diseases such as Black Spot and Citrus Scab. Preprocessing, segmentation, feature extraction, and classification are all components of their research. K-means clustering is used for segmentation, whilst SVM and KNN are used for classification, according to Pandey et al. Muhammad Sharif et al. [13] created a hybrid illness detection and classification strategy few years ago. Some of the ailments include black patches, canker, greening, and melanoses.

1.4 Multiclass SVM (M-SVM) is loaded with the appropriate features to categorize citrus illnesses. The proposed classification approach was 95.8% accurate. Six CNN architectures, including AlexNet, GoogLeNet, Inception v3, ResNet-50, ResNet-101, and SqueezeNet, were tested to identify Grapevine yellow (GY). Comparing accuracy and training expenses, they determined that the ResNet-50 model was the most effective. 2018 [14] paper by Konstantinos P. Ferentinos et al. describes a method for identifying Huanglongbing disease.

1.5 GoogLeNet and VGG architectures were also utilized. VGG had the highest success rate, at 99.53 percent. "According to Mrunalini R. Badnakhe et al., 2018 [29], the Gummosis disease can be identified and predicted throughout time in citrus. "Huanglongbing (HLB), melanoses, oleocellosis (oil spot), wind scar, Leafminer, and dust mites had their spectral signatures found by [15] using support vector regression (SVR) and multilinear regression (MLR) approaches. The study includes an ant colony optimization (ACO) algorithm and variable selection concepts. For the first time, scientists have identified an effective method for identifying citrus huanglongbing (HLB) disease. Many AI tools, including decision trees, SVMs, k-nearest neighbors, and direct discriminant examinations, can be used to identify groups of unwell individuals.

1.6 The results indicated that critical hyper spectral reflectance can be used to effectively categorize objects. While the SVM's three-way classification accuracy was 90.8%, its two-way classification accuracy was 96%. (Healthy versus asymptotic HLB leaves). Diseases can be utilized to identify citrus fruits and leaves, according to [16]. Diseases include Blackspot, Canker, Scab, and Melanoses. The Toys for Tots Program Using a CNN model proposed by [17], citrus variegated chlorosis, sooty form, leprosy, halo scourge, citrus mosaic, and scab were recognized. 62% of the time, citrus fruit diseases can be accurately recognized. Victor Patel and his coworkers have created a technique for identifying citrus illnesses. CNN's model was utilized. These disorders are known scientifically as Huanglongbing, or "citrus greening." Using two CNNs, psyllids were recognized, and debris fell from the tree with 80% and 95% accuracy and precision, respectively. Utpal Barman et al. 2020 suggested techniques for distinguishing citrus leaf diseases.

1.7 Citrus leaf diseases were discovered and categorized using MobileNet and Self-Structured (CNN) classifiers of CNN models. MobileNet CNN fared the best with a 98% preparation accuracy. The project's design will incorporate images taken with a mobile phone. Zongshuai [18] developed techniques for diagnosing agricultural diseases. MobileNetV2 was utilized to arrange the study and evaluate the speed, model complexity, and precision of various network models in comparison to MobileNetV2. These methods lowered the system's complexity, and it is now time to calculate it. Citrus huanglongbing was discovered by YubinLan and colleagues in 2020 [16].

1.8 SVM, k-nearest neighbor (kNN), logistic regression (LR), naive Bayes, and ensemble learning models were compared to sound and HLB-contaminated samples following boundary advancement. All models were shown to have the most precise and comprehensible PCA characteristics when paired with CN (computerized numbers) esteem. Utpal Barman et al. LR and ANN are used to forecast citrus leaf chlorophyll content. ANN was more accurate than LR in forecasting citrus chlorophyll levels in this instance. [17] were able to identify plant pathogens using a novel approach. Orange fruit exhibits the citrus greening disease, according to researchers. CNN models GoogLeNet, VGG16 (16 layers), and InceptionV3 were utilized (48 layers). The VGG16 performed better on tests. YiannisAmpatzidis et al. 2020[18] discovered that employing small Unmanned Aerial Vehicles (UAVs) equipped with a variety of sensors makes surveying simpler, faster, and less expensive. To process, analyze, and visualize data gathered from unmanned aerial vehicles (UAVs) and other platforms, the Agroview cloud-based artificial intelligence (AI) tool was developed (e.g., small planes, satellites, and ground platforms)

1.9 Using this user-friendly and interactive tool to: I locate plants (and plant gaps) and plant inventory (measure plant height/canopy size); and (ii) generate maps displaying the health of plants in a specific area (c). Using this Agroview application, the phenotypic characteristics of citrus trees can be analyzed (as a case study). This emerging technique detected citrus trees with a mean absolute percentage error (MAPE) of 2.3% in a commercial orchard of 175 977 trees. Vijai Singh et al. et al. evaluated the identification of plant diseases in 2020 [19]. Citrus diseases include canker, oily patch, insect damage, melanoses, wind scar, and scab. Using PCR and spectral information divergence, diseases can be discovered. Using these procedures, the results are accurate 95,2 percent of the time.A approach developed by David Argüeso and colleagues in 2020 [20] can identify citrus greening disease.

VI CONCLUSION

This paper looks at almost all papers published between 2010 and 2022 that deal with citrus diseases and how to grade fruit. This survey gives information about the signs of citrus diseases. Also, the techniques that the researcher used to understand citrus diseases and grade the fruit are looked at. These include image processing, machine learning, and deep learning. The pros and cons of the current state of the art are shown in a table. This paper also gives a brief overview of techniques for pre-processing, segmentation, feature extraction, and classification. Most of the time, a hybrid approach is suggested for automatically predicting citrus diseases and grading them. Deep learning and machine learning are both parts of the hybrid approach. Researchers in this field might also be very interested in an attempt to make such a system. In this survey, different ways of using image processing to find out what kind of disease is affecting a plant are talked about. This survey has four main steps, such as preprocessing, segmentation, feature extraction, and classification. The comparison is made for each step based on how it is done, how well it works, and what its pros and cons are. From the results of the survey, we can say that preprocessing techniques help improve the accuracy of segmentation. Also, we think that Kmeans is the most popular method for dividing up plants that have been infected. Also, the texture features are the most important for showing disease in an image, and both SVM and NN use these features. So, they need to work on making a system that works quickly, accurately, and automatically to find diseases on citrus leaves that haven't been affected. This paper does a comparison of the different kinds of Convolutional Neural Network and Deep Learning models used to find and classify different rice plant diseases. It does this by looking at research from the last five years that was published in an internationally indexed journal. This article also goes into detail about the different kinds of data sources. After this study, we found that most researchers were able to find citrus diseases more accurately when they used the Convolutional Neural Network model of Deep Learning. The goal of this research is to look at all of the different Deep Learning models and find the best one for getting better accuracy and precision.

REFERENCE

1. Ullagaddi, S.B., Viswanadha Raju, S., 2017. An Enhanced Feature Extraction Technique for Diagnosis of Pathological Problems in Mango Crop.
2. Abdullah, Noor Ezan, Hashim, Hadzli, Yusof, YuslindaWati Mohammad, Osman, FairulNazmie, Kusim, Aida Sulinda, Adam, MohdSyukhry, 2012. A characterization of watermelon leaf diseases using Fuzzy Logic. In: 2012 IEEE Symposium on Business, Engineering and Industrial Applications (ISBEIA). IEEE, pp. 1 –6.
3. Rishi, Nikita, Gill, Jagbir Singh, 2014. An Overview on Detection and Classification of

Plant Diseases in Image Processing.
4. Akintoye, Kayode A., Shafry, M. Rahim M., Abdullah, Abdul Hanan, 2017. A novel approach for finger vein pattern enhancement using Gabor and canny edge detector. Int. J. Comput. Appl. 157 (2).
5. Gurjar, Ajay A., Gulhane, Viraj A., 2012. Disease detection on cotton leaves by eigenfeature regularization and extraction technique. Int. J. Electron., Commun. Soft Comput. Sci. Eng. (IJECSCSE) 1 (1), 1.
6. Gutte, Vitthal S., Gitte, Maharudra A., 2016. A survey on recognition of plant disease with help of algorithm. Int. J. Eng. Sci. 7100.
7. Haidar, Abudulhamid, Dong, Haiwei, Mavridis, Nikolaos, 2012. Image-based date fruit classification. In: 2012 4th International Congress on Ultra Modern Telecommunications and Control Systems and Workshops (ICUMT), 3–5 Oct 2012, pp. 357–363.
8. Ayane, Swapnil S., Khan, M.A., Agrawal, S.M., 2013. Identification of nitrogen deficiency in cotton plant by using image processing. Int. J. Pure Appl. Res. Eng. Technol. 112 –118 ISSN.
9. Al Bashish, Dheeb, Braik, Malik, Bani-Ahmad, Sulieman, 2011. Detection and classification of leaf diseases using K-means-based segmentation and Neural Networks. Inform. Technol. J. 10 (2), 267 – 275
10. Al-Hiary, H., Bani-Ahmad, S., Reyalat, M., Braik, M., ALRahamneh, Z., 2013. Fast and accurate detection and classification of plant diseases. Mach. Learn. 14, 5.
11. Al Ohali, Yousef, 2011. Computer vision based date fruit grading system: design and implementation. J. King Saud Univ. Comput. Inform. Sci. 23, 29 –36. Amara, Jihe
12. Bouaziz, Bassem, Algergawy, Alsayed, 2017. A deep learning-based approach for banana leaf diseases classification. In: BTW (Workshops), pp. 79 –88.
13. Anami, Basvaraj S., Pujari, J.D., Yakkundimath, Rajesh, 2011. Identification and classification of normal and affected agriculture/horticulture produce based on combined color and texture feature extraction. Int. J. Comput. Appl. Eng. Sci. 1 (3), 356 –360
14. Arivazhagan, S., NewlinShebiah, R., Ananthi, S., Vishnu Varthini, S., 2013. Detection of unhealthy region of plant leaves and classification of plant leaf diseases using texture features. Agric. Eng. Int.: CIGR J. 15 (1), 211 –217.
15. Ayane, Swapnil S., Khan, M.A., Agrawal, S.M., 2013. Identification of nitrogen deficiency in cotton plant by using image processing. Int. J. Pure Appl. Res. Eng. Technol. 112 –118 ISSN.
16. Babu, M.S. Prasad, Srinivasa Rao, B., 2007. Leaves recognition using back propagation neural network-advice for pest and disease control on crops. IndiaKisan. Net: Expert Advissory Syst. Badnakhe.
17. Xie, C.Q. Brahimi, Mohammed, Boukhalfa, Kamel, Moussaoui, Abdelouahab, 2017. Deep learningfor tomato diseases: classification and symptoms visualization. Appl. Artif. Intell. 31(4), 299 –315.
18. Chang, Wen-Teish, Chen, Yu-Chung, Jao, Chia-Ling, 2007. Antifungal activity and enhancement of plant growth by Bacillus cereus grown on shellfish chitin wastes.Bioresour. Technol. 98 (6), 1224 – 1230.
19. M.R., Deshmukh, P.R., 2012. Infected leaf analysis and comparsion by Otsu Threshold and K-means Clustering, 2(3).
20. Kamal KC, Zhendong Yin ⁎, Mingyang Wu, Zhilu Wu Depthwise separable convolution architectures for plant disease classification g/10.1016/.compag.2019.104948 School of Electronics and Information Engineering, Harbin Institute of Technology, China 0168-1699