INFORMATICS INSTITUTE OF TECHNOLOGY

In Collaboration with

ROBERT GORDON UNIVERSITY ABERDEEN

Disease and Pest detection of Crops and Agricultural community forum using image processing techniques

Group 22 literature review document by

Runisi Nikoya Samaranayake – 20221247

Damitha Udara Weerasinghe – 20210669

Seth Nimthaka Rajarathne – 20211344

Yasini Mandara Karunanayake - 20221151

Supervised by

Ms. Kalhari Walawage

Submitted in partial fulfilment of the requirements for the BEng/BSc in <Insert the nomenclature of the degree> degree at the Robert Gordon University.

October 2023

CONTENTS

INTRODUCTION

In recent years, the agricultural industry has faced a major challenge - the rising threat of diseases and pests to our crops. This menace- has grown significantly, putting food security and agricultural sustainability at risk. Our project aims to tackle this issue- by utilizing advanced image processing techniques. We envision a future- where our innovative approach re-volutionizes the detection of crop diseases and pests. Through this endeavour, we strive to safe-guard our agricultural resources and ensure- a sustainable future for everyone involved in farming.

RELEVANT WORK

DISEASE AND PESTS' DETECTION OF CROPS

There have been several researches done to identify diseases and pests of crops. With the automated leaf and pest detection. (Ngugi, Abelwahab and Abo-Zahhad, 2020) which tells about the development of efficient and accurate methods for plant disease recognition using Image Processing Technologies (IPTs) and Deep Learning Techniques.

Have used Support Vector Machines (SVM), Random Forest and Artificial Neural Networks (Domingues, Brandão and Ferreira, 2022) to automatically detect, identify, and predict pests and diseases, ultimately contributing to the goals of smart farming, precision agriculture, reduced pesticide usage, and improved crop quality and production.

Another research was conducted by (Miguel Ángel Rodríguez-García, García-Sánchez and Valencia-García, 2021) where they proposed a novel approach to the recognition of crop pests and diseases, which is based on the combination of language technologies and semantic conceptual representations. The paper then showed an accuracy of 98.8% was obtained by using a natural language processing model to automatically populate the ontology from unstructured documents, also A rule-based model to classify symptoms into crop pests and diseases and developed their own ontology model called CropPestO to represent the crop pest domain and integrate data from heterogeneous sources.

This paper (Liu and Wang, 2021) summarizes recent research in plant disease and pest detection based on deep learning, a branch of artificial intelligence that can automatically learn features from data and uses convolutional Neural networks for classifying plant diseases and pest images. The authors utilized mature network structures prevalent in computer vision, including AlexNet, GoogleLeNet, VGGNet, ResNet, Inception V4, DenseNets, MobileNet, and SqueezeNet. They highlight the challenges of small dataset sizes and propose solutions such as data amplification, transfer learning, and designing reasonable network structures.

This paper (Francisco et al., 2023) which aims to find studies on automating processes in detecting, identifying, and classifying diseases and pests in agricultural crops. The review found that Convolutional Neural Networks (CNN) models were the most commonly used, with 54.2% of the studies referring to them and other models such as SVM, k-NN, ANN, Random Forest, and others were used to train the datasets, classify the diseases and pests.

The paper (Tiwari and Richmond, 2019) uses Deep Neural Networks and Transfer Learning techniques for the identification of pests and diseases in tea leaves. They use deep learning framework(Resnet34) retrained on a dataset of tea leaf images and Convolutional Neural Network(CaffeNet) develop an Image Classification model which has achieved an overall accuracy of 98.4%.

The paper (Suresh et al., 2020) by employs a Convolutional Neural Network (CNN) for image classification and uses TensorFlow Lite (TFLite) for model deployment on mobile devices. The research problem in this paper is to develop an automatic and accurate plant disease detection system using image processing techniques.

The paper (Lathusha Sritharan, Manikavasagar Anjanan and Gamage, 2022) by uses image processing and deep learning techniques to detect and classify plant diseases and suggest pesticides and management methods. The authors have created an image recognition system based on multiple linear regression, and uses Convolutional Neural Networks (CNN) to extract features from plant leaf images and classify them, and an accuracy of 98% obtained detecting plant diseases.

The paper (Pest Detection using Image Processing, 2019) proposes a method to detect pests on plant leaves using image processing and machine learning techniques such as nucleus counter to classify and count the pests. The paper claims that their method can help farmers to detect the pests early and take appropriate measures to protect the crops.

The paper by (Mohammed and Yusoff, 2023) have reviewed and compared various techniques and algorithms that have been used in previous studies, such as k-means clustering, SVM, ANN, CNN, etc, and in this paper it proves that using CNN are superior to other methods in terms of accuracy and performance. The paper aims to help researchers and farmers in improving crop production and quality by using image processing techniques.

In this research paper (Miranda, Gerardo and Tanguilig III, 2014) developed an automatic detection and extraction system for pest identification. They used image processing techniques, including background modelling to detect the presence of insect pests in captured images. The system also uses median filter to remove noise and scans the image horizontally and vertically to determine the coordinates and size of each insect.

The paper (Xin and Wang, 2021) by They have used a **DCNN-G model** based on deep learning and Google data analysis to train and test data samples of crop diseases and insect pests images. They have also used an improved network **YOLO-V4** to test the images after quality level classification. They have created a **Deep Convolutional Neural Network Model** for the classification of crop pest and insect pest image quality. They

have also created an **enhanced 3D panoramic image synthesis method** that can reduce the display distortion of three-dimensional objects in the agricultural scene.

The paper (Pooja, Das and Kanchana, 2017) uses Support Vector Machines (SVM) as the classifier to identify and label the diseases based on the extracted features. the K-Means technique is used for image segmentation. The paper uses various image processing techniques such as K-Means Clustering, Otsu's method, and boundary and spot detection algorithms to refine the injected regions of the plant leaves. The proposed methodology achieves a high recognition rate of 98.67%.

In this research (Itnal et al., 2019) proposes a methodology that uses image processing techniques to detect pests on plant leaves. The authors have applied several models such as Gaussian blur to reduce noise, and using segmentation techniques to separate the pests from the background. The paper claims that the method can help farmers to identify pests early and take preventive measures to avoid crop losses.

This paper (Mohanty, Hughes and Salathé, 2016) The paper discusses how the combination of increasing global smartphone penetration and recent advances in computer vision made possible by deep learning has paved the way for smartphone-assisted disease diagnosis. They trained a Deep Convolutional Neural Network to identify 14 crop species and 26 diseases.

The paper (Nagar and Sharma, 2021) The main approach is to use wavelet transformation and oriented FAST and rotated BRIEF (ORB) to extract features from leaf images and classify them as with or without pest. The models they have used are Dynamic Time Warping (DTW) for feature comparison and Support Vector Machine (SVM) for classification.

This paper (Li and Chao, 2021) They proposed a semi-supervised few-shot learning approach for plant diseases recognition, which uses both a few labelled samples and many unlabeled samples to train a model. They used a Convolutional Neural Network (CNN) as the base model, and applied transfer learning to transfer the knowledge from the source domain to the target domain.

The paper (Ferentinos, 2018) presents a deep learning approach for plant disease detection and diagnosis using simple leaves images of healthy and diseased plants. The paper uses Convolutional Neural Network (CNN) models, which are powerful techniques for image recognition and pattern recognition.

COMMUNITY FORUM

The paper(Sivakumar et al., 2023) proposes an Android application that can help farmers and transport service providers to pool their resources and optimize their logistics and tells by using AI systems it enables early detection of plant diseases and pest's infestations. They have used Natural Language Processing (NLP) for chatbot and machine learning model for virtual assistant.

This paper (Poonkuzhali Ramadoss et al., 2023) discusses the issues related to agriculture with peers and experts and support system for farmers to make timely decisions on agriculture. The farmers can upload images of the crops and plants which is affected by any diseases.

This paper (Jain et al., 2022) user-friendly and real-time mobile application that can provide accurate detection and suggestions for rice disease control.

This paper (S, S and C, 2022) design and implement a conversational AI bot for smart agriculture that can assist farmers with various information and advice related to farming and crops.

This paper (Omara et al., 2023) develop a mobile application that can diagnose crop diseases and provide real-time feedback and recommendations to smallholder farmers in sub-Saharan Africa. Uses Convolutional Neural Network (CNN) model trained on cassava leaf images to classify five types of diseases and pests.

In this paper (Lacasta et al., 2018) creates an ontology and a recommendation system for agricultural crop protection, using heterogeneous and unstructured data sources and facilitates the identification of pests and the selection of suitable treatments for different crops and regions.

The paper(V Rajeshram et al., 2023) they proposed in this paper is to develop a deep learning technique for leaf diseases prediction, pest detection and pesticides recommendation using plant leaf images. They have used Deep neural networks for pesticide recommendation and pre-processing of leaf images.

COMPARISON TABLE OF RELEVANT WORK

Research	Author	Year	Dataset	Model used	Metric
DISEASE AND PESTS' DETECTION					
Recent advances in image processing techniques for automated leaf pest and disease recognition - A review	Lawrence C. Ngugi a, Moataz Abelwahab a, Mohammed Abo-Zahhad	2021	300 potato leaves drawn from the Plant Village dataset	SVM,	Over 98.5%
Machine Learning for Detection and Prediction of Crop Diseases and Pests: A Comprehensive Survey	Tiago Domingues, Tomás Brandão and João C. Ferreira	2022	Plant Village, Plant Doc, IP102, Flavia and MalayaKew Leaf.	SVM, Random Forest, ANN	Does not specifically mention the accuracy
Plant diseases and pests' detection based on deep learning: a review	Jun Liu and Xuewei Wang*	2021	1)Northern Leaf Blight (NLB) dataset for Maize 2) IP102: Insect Pest Recognition Database: 75,000 images belonging to 102 categories database of eight common tomato pest images.	CNN	does not report a single accuracy metric

Algorithms and Models for Automatic Detection and Classification of Diseases and Pests in Agricultural Crops: A Systematic Review	Mauro Francisco, Fernando Ribeiro, José Metrôlho and Rogério Dionísio	2023	Not mentioned but mentions the common datasets such as Plant village, PlantDoc Middlebury dataset, Xie1 and Xie2 dataset, Coffee Leaf dataset, PlantPathology, CIFAR-10 dataset	Not specified but CNN commonly used	Accuracy for tomato crops - 90.3% to 99.89% 88.96% to 98% for citrus crops, and 89% to 97% for potato crops.
Knowledge-Based System for Crop Pests and Diseases Recognition	Miguel Ángel Rodríguez-García, Francisco García-Sánchez, and Rafael Valencia-García	2021	The dataset for preliminary validation contains 212 symptoms, linked to 75 pests and diseases in three crops: almond tree, olive tree, and grape vine.	A natural language processing model and a rule-based model	98.8%
The development of methodology and techniques for crop disease identification	N. S. Tiwari, J. W. Richmond	2019	Dataset containing 500 images	Deep learning (Resnet34) and CNN(CaffeNet)	The model trained on the original data set achieved accuracy - 98.4%. modifying the original dataset – 98.3%
Plant Disease Detection using Image Processing	Mr.V Suresh, D Gopinath, M Hemavarthini, K Jayanthan, Mohana Krishnan	2020	A dataset of 54,305 images of diseased and healthy plant leaves collected under controlled conditions Plant Village dataset.	CNN	93%

Plant Diseases Detection Using Image Processing and Suggest Pesticides and Managements	Lathusha Sritharan; Manikavasagar Anjanan; Anjalie Gamage	2022	Images were collected from farming field and kaggle data set. The data set has more than twenty thousand images.	CNN	98%
Pest Detection using Image Processing	Shilpa Itnal, Mathena Akhila, Syed Sha Noorulla Khadri, Vanukuri Meher Sreemaiee	2019	Not specified	machine learning techniques such as nucleus counter	accuracy not clearly defined
Detection and classification of plant leaf diseases using image processing methods: review	Lele Mohammed, Yusliza Yusoff	2023	Not specified	Not mentioned as compared various techniques and algorithms that have been used in previous studies	All the techniques used in previous studies has achieved accuracy over 80%
Pest Detection and Extraction Using Image Processing Techniques	Johnny L. Miranda, Bobby D. Gerardo, and Bartolome T. Tanguilig III	2014	Images were collected but not specified	image processing techniques – background modelling.	Not mentioned
Image Recognition of Crop Diseases and Insect Pests Based on Deep Learning	Mingyuan Xin and Yong Wang	2021	train 640 data samples, and then using 5000 test samples for testing	DCNN-G model and YOLO-V4	95%
Identification of Plant Leaf Diseases Using Image Processing Techniques	Pooja V, Rahul Das, and Kanchana V	2017	For which a training set of 227 images and a testing set of 121 images is constructed. The training and test set	SVM	92.4%

			consists of a combination of 5 diseases and pests		
Pest Detection using Image Processing	Shilpa Itnal, Mathena Akhila, Syed Sha Noorulla Khadri, Vanukuri Meher Sreemaiee	2019	Images were acquired but dataset not mentioned	Gaussian blur	Not mentioned
Using deep learning for image-based plant disease detection	Sharada P. Mohanty, David P. Hughes, and Marcel Salathé	2016	Using a public dataset of 54,306 images of diseased and healthy plant leaves	CNN	99.35%
Pest Detection on Leaf using Image Processing	Harshita Nagar, R.S. Sharma	2021	A total of 47 images were present in the final dataset in which 15 images were of leaf and 32 were of pests.	DTW, SVM	Precision score – 0.96
Semi-supervised few-shot learning approach for plant diseases recognition	Yang Li1 and Xuewei Chao	2021	Plant Village Dataset	CNN	Not mentioned average improvement by the single semi-supervised method is **2.8%**, and iterative semi-supervised method is **4.6%**.

Deep learning models for plant disease detection and diagnosis	Konstantinos P. Ferentinos	2018	87,848 images, containing 25 different plants in a set of 58 distinct classes including healthy plants.	CNN architectures: AlexNet, AlexNetOWTBn, GoogLeNet, Overfeat, and VGG.	99.53%
COMMUNITY FORUM					
Farmer's Friend: Conversational AI BoT for Smart Agriculture	Venkata Reddy P S, Nandini Prasad K S, Puttamadappa C	2022	SASI IOT system, Conversational AI	NLP	96.1%
Artificial Intelligence based Agricultural Chatbot and Virtual Assistant for Delivery of Harvested Crops	Dr. S. A. Sivakumar, Dr. B. Maruthi Shankar, Ms. B. Anuradha, Mr. K. A. Karan, Mr. A. Karthik, Mr. R. Karthik, Dr. Jambi Ratna Raja Kumar7	2023	-	NLP for chatbot and Machine learning model for virtual assitant	-

E - Xpert Bot - Guidance and Pest Detection for Smart Agriculture using AI	Poonkuzhali Ramadoss, Vasanth Ananth, Navaneetha M, Oviya U	2023	-	Google dialogflow	-
Automatic Rice Disease Detection and Assistance Framework Using Deep Learning and a Chatbot	Siddhi Jain, Rahul Sahni, Tuneer Khargonkar , Himanshu Gupta, Om Prakash Verma, Tarun Kumar Sharma, Tushar Bhardwaj, Saurabh Agarwal, and Hyunsung Kim	2022	The dataset consists of 762 images	1. CNN - **VGG 16** 2. **VGG 19** 3. **MobileNet** 4. **LeNet5** 5. **ResNet 50** These are to identify the diseases.	91%
A field-based recommender system for crop disease detection using machine learning	Jonathan Omara, Estefania Talavera, Daniel Otim, Dan Turcza , Emmanuel Ofumbi and Godliver Owomugisha	2023	AgroQA dataset	(CNN) model trained on cassava leaf images to classify five types of diseases and pests.	Not mentioned
Agricultural recommendation system for crop protection	Javier Lacasta, F. Javier Lopez-Pellicer, Borja Espejo-García, Javier Nogueras-	2018	Not mentioned	OWL, Spring Batch, Apache Jena	Not mentioned

	Iso, F. Javier Zarazaga-Soria				
Leaf Diseases Prediction Pest Detection and Pesticides Recommendation using Deep Learning Techniques	Rajeshram V, Karthikeyan S, Prathab S, Rithish B	2023	Plant Village Dataset	DNN	100%

SUMMARY

Our core objective is to develop an advanced system for the accurate and timely identification of diseases and posts in agricultural crops. Central to our approach is the utilization of cutting-edge technologies, including Convolutional Neural Networks (CNNs) and computer vision, to create a powerful AI model. This model will be capable of analysing images of crops and pinpointing the presence of diseases or posts with remarkable precision. we plan to establish an agricultural community forum where farmers, researchers, and experts can collaborate and share their insights. This forum will serve as a platform for knowledge exchange, enabling farmers to access valuable information, receive timely advice, and contribute their observations to further improve our disease and posts detection system. Our overarching goal is to provide a comprehensive and accessible tool that empowers farmers to make informed decisions and safeguard their crops effectively.

REFERENCES

1. Ngugi, L.C., Abelwahab, M. and Abo-Zahhad, M. (2020). Recent advances in image processing techniques for automated leaf pest and disease recognition – A review. *Information Processing in Agriculture*.
doi:https://doi.org/10.1016/j.inpa.2020.04.004.

2. Domingues, T., Brandão, T. and Ferreira, J.C. (2022) 'Machine Learning for Detection and Prediction of Crop Diseases and Pests: A Comprehensive Survey', Agriculture, 12(9), pp. 1350-1376. doi: https://www.mdpi.com/2077-0472/12/9/1350

3. Liu, J. and Wang, X. (2021). Plant diseases and pests' detection based on deep learning: a review. Plant Methods, 17(1).
doi:https://doi.org/10.1186/s13007-021-00722-9.

4. Francisco, M., Ribeiro, F., Metrôlho, J. and Dionísio, R. (2023). Algorithms and Models for Automatic Detection and Classification of Diseases and Pests in Agricultural Crops: A Systematic Review. *Applied Sciences*, [online] 13(8), p.4720.
doi:https://doi.org/10.3390/app13084720

5. Miguel Ángel Rodríguez-García, García-SánchezF. and Valencia-García, R. (2021). Knowledge-Based System for Crop Pests and Diseases Recognition. *Electronics*, 10(8), pp.905–905.
doi: https://doi.org/10.3390/electronics10080905

6. Tiwari, N. and Richmond, J. (2019). The development of methodology and techniques for crop disease identification.
doi: https://doi.org/10.1101/702621

7. Suresh, V., Krishnan, M., Hemavarthini, M., Jayanthan, K. and Gopinath, D. (2020). Plant Disease Detection using Image Processing. *International Journal of Engineering Research & Technology*, [online] 9(3). doi: https://doi.org/10.17577/IJERTV9IS030114

8. Lathusha Sritharan, Manikavasagar Anjanan and Gamage, A. (2022). Plant Diseases Detection Using Image Processing and Suggest Pesticides and Managements. *2022 IEEE 7th International conference for Convergence in Technology (I2CT)*. doi:https://doi.org/10.1109/i2ct54291.2022.9825082

9. Itnal S., Akhila M., Khadri S.S.N. and Sreemaiee, V.M. (2019) 'Pest Detection using Image Processing', International Journal of Innovative Technology and Exploring Engineering, 9(2), pp. 1496-1498. Available at: IJITEE.

10. Mohammed L. and Yusoff, Y. (2023). DETECTION AND CLASSIFICATION OF PLANT LEAF DISEASES USING DIGTAL IMAGE PROCESSING METHODS: A REVIEW. *ASEAN Engineering Journal*, 13(1), pp.1–9. doi:https://doi.org/10.11113/aej.v13.17460

11. Miranda, J.L., Gerardo, B.D. and Tanguilig III, B.T. (2014). Pest Detection and Extraction Using Image Processing Techniques. *International Journal of Computer and Communication Engineering*, 3(3), pp.189–192. doi:https://doi.org/10.7763/ijcce.2014.v3.317

12. Xin, M. and Wang, Y. (2021). Image Recognition of Crop Diseases and Insect Pests Based on Deep Learning. *Wireless Communications and Mobile Computing*, 2021, pp.1–15. doi:https://doi.org/10.1155/2021/5511676

13. Pooja, V., Das, R. and Kanchana, V. (2017). *Identification of plant leaf diseases using image processing techniques*. [online] IEEE Xplore. doi:https://doi.org/10.1109/TIAR.2017.8273700.

14. Mohanty, S.P., Hughes, D.P. and Salathé, M. (2016). Using Deep Learning for Image-Based Plant Disease Detection. *Frontiers in Plant Science*, 7. doi:https://doi.org/10.3389/fpls.2016.01419

15. Nagar H. and Sharma R.S. (2021). Pest Detection on Leaf using Image Processing. *2021 International Conference on Computer Communication and Informatics (ICCCI). IEEE, pp.1-5.* doi:https://doi.org/10.1109/ICCCI50826.2021.9402606

16. Li, Y. and Chao, X. (2021). Semi-supervised few-shot learning approach for plant diseases recognition. Plant Methods, 17(1).

doi:https://doi.org/10.1186/s13007-021-00770-1.

17. Ferentinos K.P. (2018). Deep learning models for plant disease detection and diagnosis. *Computers and Electronics in Aggriculture, 145, pp.311–318.*
doi:https://doi.org/10.1016/j.compag.2018.01.009.

18. Sivakumar, S.A., Shankar, B.M., Anuradha, B., Karan, K.A., Karthik, A., Karthik, R. and Kumar, J.R.R. (2023). Artificial Intelligence based Agricultural Chatbot and Virtual Assistant for Delivery of Harvested Crops. *International Journal of Intelligent Systems and Applications in Engineering*, [online] 11(8s), pp.576–583. Available at: https://ijisae.org/index.php/IJISAE/article/view/3200 [Accessed 11 Oct. 2023].

19. Poonkuzhali Ramadoss, V. G. Ritesh Ananth, M Navaneetha and U Oviya (2023). E -Xpert Bot - Guidance and Pest Detection for Smart Agriculture using AI. doi:https://doi.org/10.1109/csnt57126.2023.10134588.

20. Jain, S., Sahni, R., Tuneer Khargonkar, Gupta, H., Om Prakash Verma, Tarun Kumar Sharma, Bhardwaj, T., Agarwal, S. and Kim, H. (2022). Automatic Rice Disease Detection and Assistance Framework Using Deep Learning and a Chatbot. *Electronics*, 11(14), pp.2110–2110. doi:https://doi.org/10.3390/electronics11142110.

21. S V.R.P., S N.P.K. and C P. (2022). Farmer's Friend: Conversational AI BoT for Smart Agriculture. *Journal of Positive School Psychology*, [online] 6(2), pp.2541–2549. Available at: https://journalppw.com/index.php/jpsp/article/view/1833 [Accessed 5 Oct. 2023].

22. Omara, J., Talavera, E., Otim, D., Turcza, D., Ofumbi, E. and Godliver Owomugisha (2023). A field-based recommender system for crop disease detection using machine learning. *Frontiers in artificial intelligence*, 6. doi:https://doi.org/10.3389/frai.2023.1010804.

23. Lacasta, J., Lopez-Pellicer, F.J., Espejo-García, B., Nogueras-Iso, J. and Zarazaga-Soria, F.J. (2018). Agricultural recommendation system for crop protection. *Computers and Electronics in Agriculture*, 152, pp.82–89. doi:https://doi.org/10.1016/j.compag.2018.06.049.

24. V Rajeshram, B Rithish, Karthikeyan, S. and S Prathab (2023). Leaf Diseases Prediction Pest Detection and Pesticides Recommendation using Deep Learning Techniques. doi:https://doi.org/10.1109/icscds56580.2023.10104652.