LEAF DISEASE DETECTION AND RECOMMENDATION OF PESTICIDES USING DEEP LEARNING APPROACH

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Chapter 8

CHAPTER 8

SUMMARY OF FINDINGS

8.1 INTRODUCTION

This chapter presents the summary of results obtained by the four proposed works on leaf disease and pest classification with pesticide recommendation models. Performance metrics serve as crucial elements of quality analysis in deep-learning methods, allows to assess the models' efficiency. Performance indicators like as precision, recall, f-measure, and accuracy are used to assess the efficacy of various models on n-dimensional datasets. Mathematical formulations of the evaluation metrics, dataset details and experimental setup are discussed in Chapter 3.

8.2 COMPARISON OF THE LEAF DISEASE DETECTION

PVD image categorization for different types of leaf diseases, Table 8.1. summarize the current model of Improved AlexNet (Wang 2022) with the present models of PDATFGAN and PDATFEGAN.

Table 8.1 Results of PDATFGAN and PDATFEGAN Models

Models	Precision	Recall	F-measure	Accuracy (%)
Improved AlexNet	0.8434	0.8501	0.8468	84.86%
FCOS	0.8697	0.8722	0.8710	87.13%
CRN	0.8861	0.8904	0.8883	88.97%
PlantDiseaseNet	0.9083	0.9096	0.9090	90.85%
DATFGAN-ShuffleNetV2	0.9135	0.9140	0.9142	91.38%
DATFGAN-DenseNet121	0.9249	0.9252	0.9251	92.54%
DATFGAN-MobileNetV2	0.9264	0.9266	0.9265	92.69%
PDATFGAN-ShuffleNetV2	0.9148	0.9151	0.9150	91.52%
PDATFGAN-DenseNet121	0.9270	0.9273	0.9272	92.74%
PDATFGAN-MobileNetV2	0.9283	0.9287	0.9285	92.87%
PDATFEGAN-ShuffleNetV2	0.9232	0.9137	0.9184	92.36%
PDATFEGAN-DenseNet121	0.9321	0.9331	0.9326	93.26%
PDATFEGAN-MobileNetV2	0.9351	0.9362	0.9356	93.58%

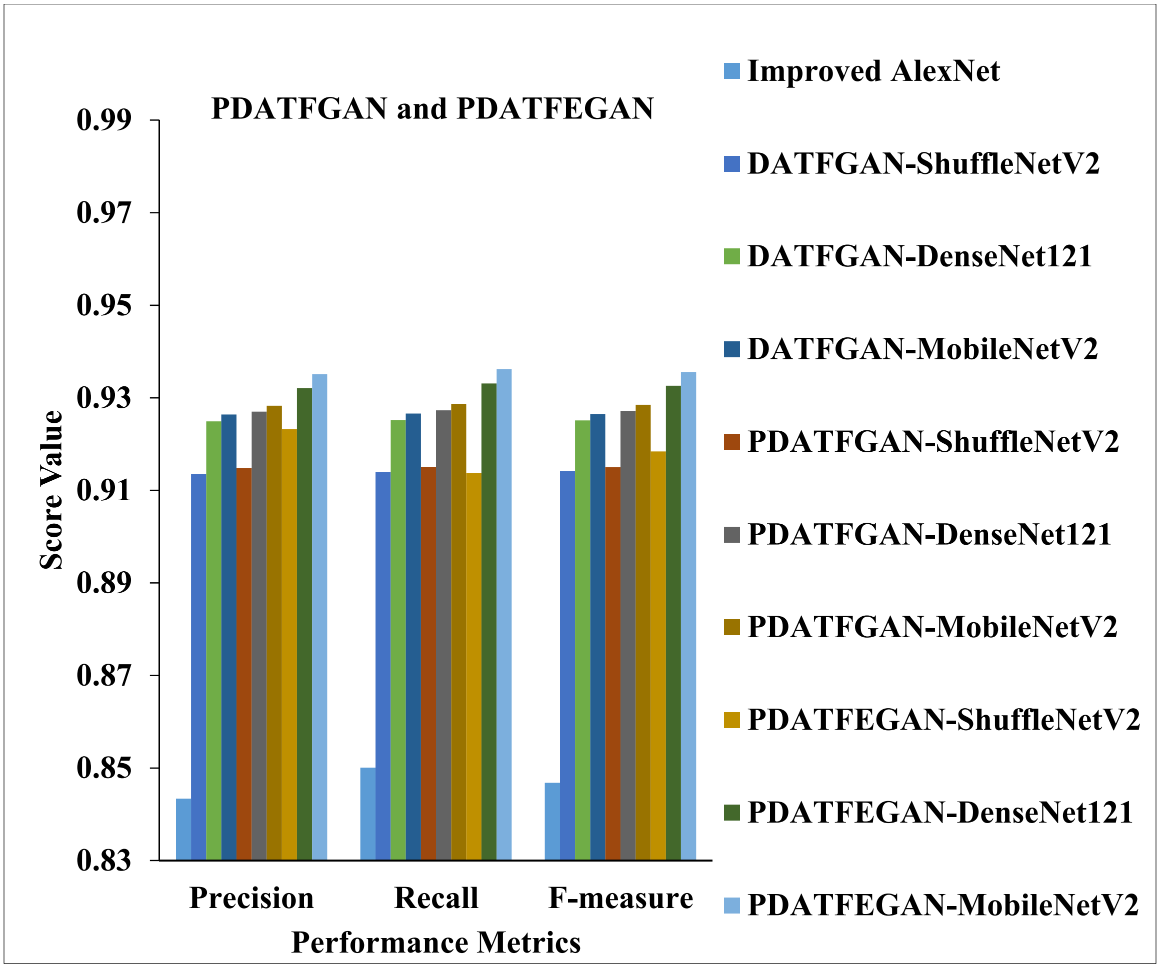

Fig. 8.1 Performance Analysis of PDAFTGAN and PDATFEGAN Models

Figure 8.1 displays a comparison of the proposed PDATFGAN and PDATFEGAN models to the state-of-the-art leaf disease detection methods applied to the plant village datasets. When compared to other deep-learning models, the PDATFEGAN model was shown to be the most effective when it came to classifying leaf diseases in agriculture. PDATFEGAN has better average precision (3.22 %), recall (0.96 %), and f-measure (0.76 %) than any other proposed or existing model.

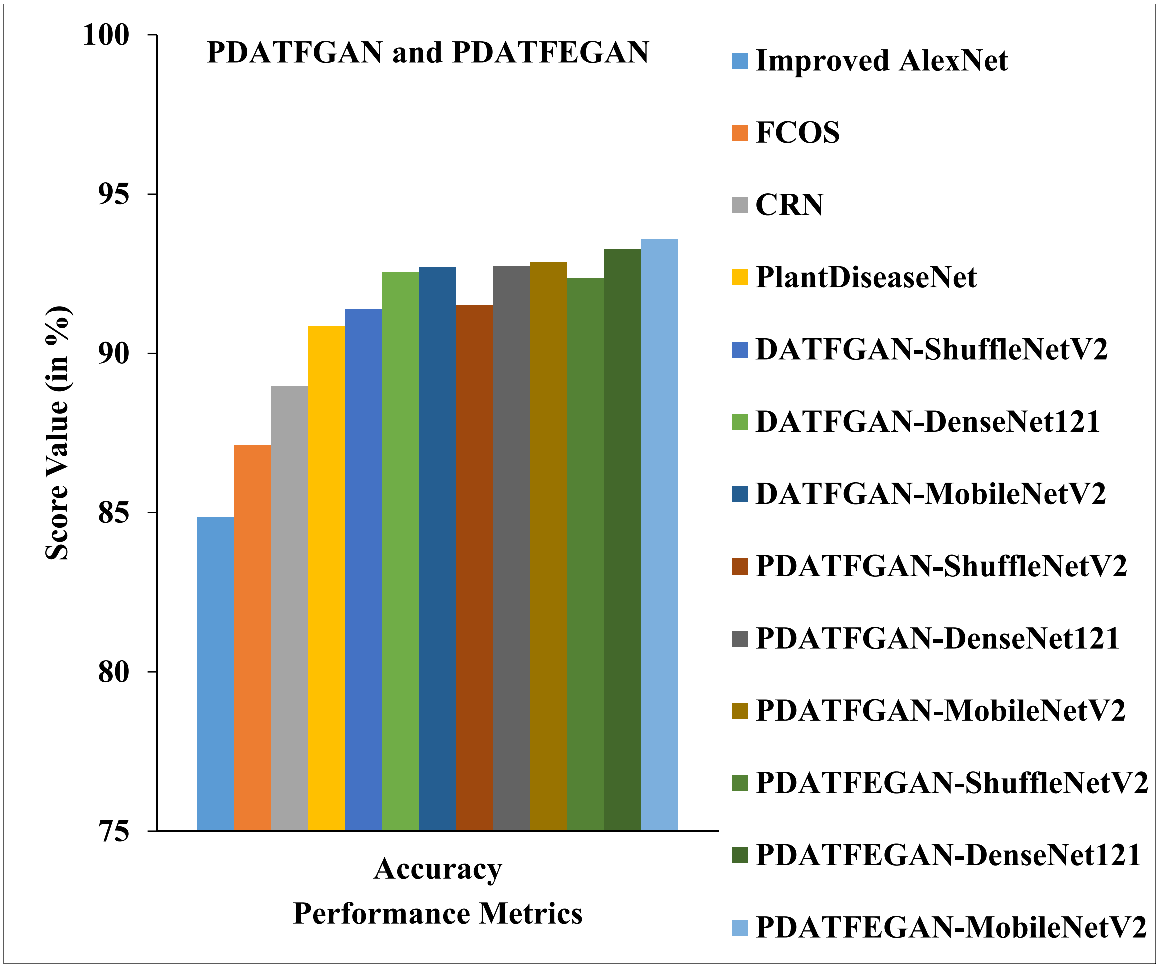

Fig. 8.2 Accuracy Analysis of PDATFGAN and PDATFEGAN Models

The accuracy values achieved by the proposed four models on the multi-dimensional dataset against current the use of DL models for pest and disease categorization on leaves, as well as pesticide advice, as seen in Fig. 8.2. It is noticed that the PDATFEGAN model can increase the classification accuracy contrasted with the other proposed and current models. On average, the accuracy of PDATFEGAN model is boosted by 3.22% compared to all other models.

8.3 COMPARISON OF THE PEST DETECTION AND PESTICIDES RECOMMENDATION

Insect identification and advice on pesticide use based on PVD images of a variety of leaf diseases, Table 8.2. summarize the current models are CRN (Yang et al. 2021), PlantDiseaseNet (Turkoglu et al. 2022) and FCOS (Xie et al. 2023) with the present models of PDATFEGAN-MFL-DCNN and PDATFEGAN-MFL-DCNN-RSF.

Table 8.2 Results of PDATFEGAN-MFL-DCNN and PDATFEGAN-MFL-DCNN-RSF Models

Models	Precision	Recall	F-measure	Accuracy (%)
FCOS	0.8697	0.8722	0.8710	87.13%
CRN	0.8861	0.8904	0.8883	88.97%
PlantDiseaseNet	0.9083	0.9096	0.9090	90.85%
PDATFEGAN-MFL-DCNN	0.9706	0.9638	0.9672	97.29%
PDATFEGAN-MFL-DCNN-RSF	0.9871	0.9769	0.9820	98.93%

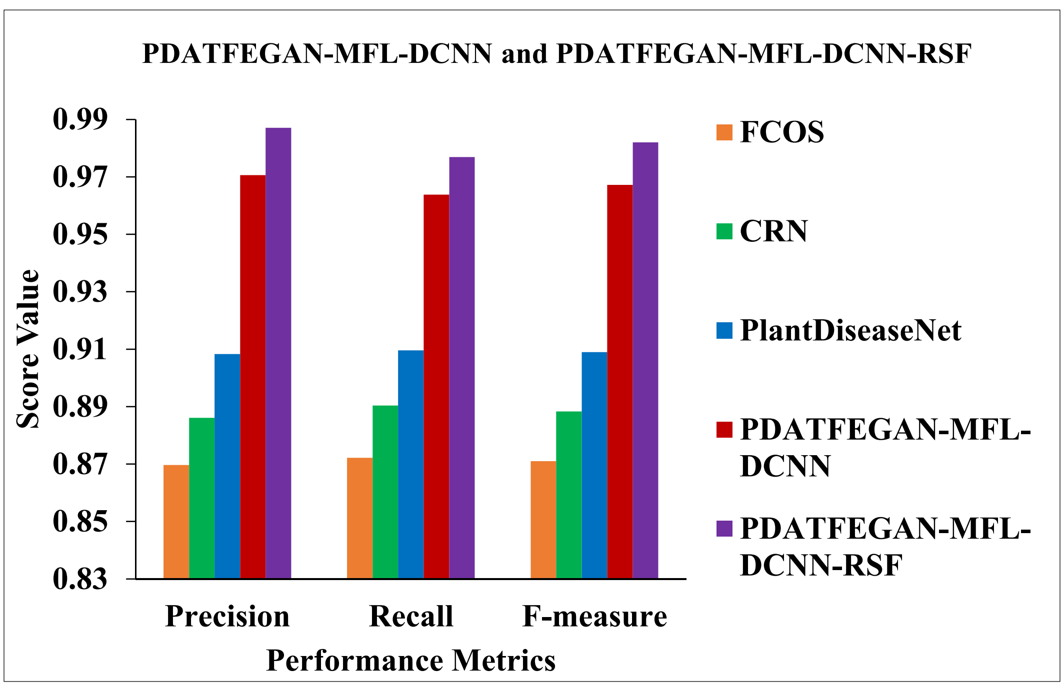

Fig. 8.3 Performance Analysis of PDATFEGAN-MFL-DCNN and PDATFEGAN-MFL-DCNN-RSF Models

The comparison of the proposed PDATFEGAN-MFL-DCNN and PDATFEGAN-MFL-DCNN-RSF distinct models on the multi-dimensional datasets against current leaf disease and pest classification models with pesticide recommendation in terms of precision, recall and f-measure as shown in Fig 8.3. It is observed that the PDATFEGAN-MFL-DCNN-RSF model outperformed all other deep-learning models on the multi-dimensional datasets for efficiently categorizing related pests, as well as recommending appropriate pesticides in agriculture. The PDATFEGAN-MFL-DCNN-RSF model outperforms all other suggested and present models by an average of 7.94%, 6.8%, and 7.36% with regard to precision, recall, and f-measure, respectively.

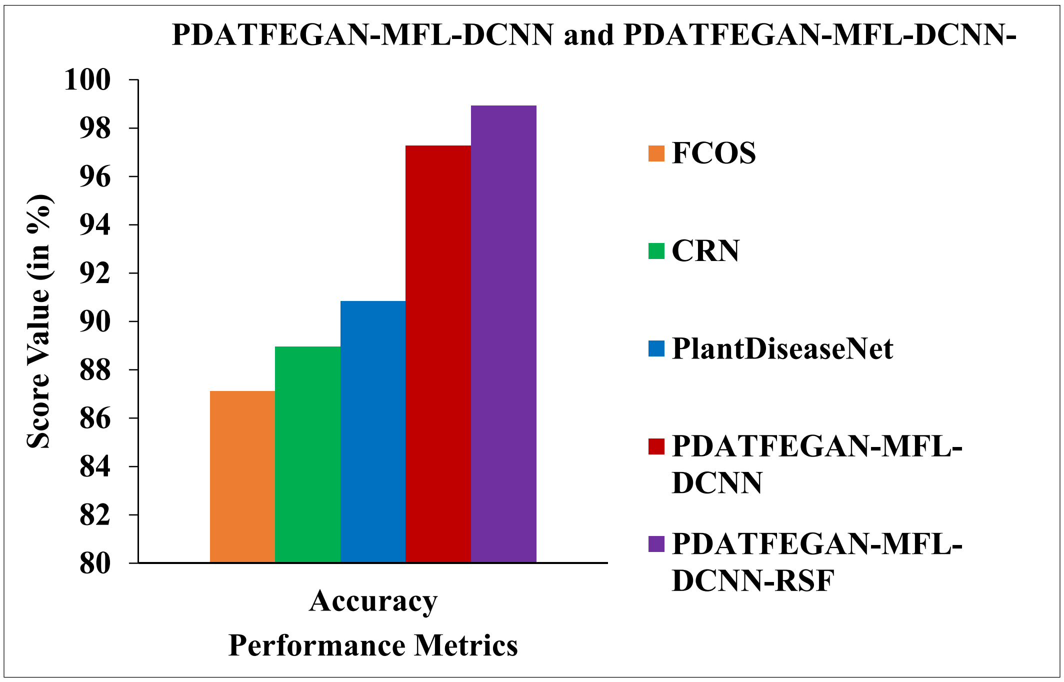

Fig. 8.4 Accuracy Analysis of PDATFEGAN-MFL-DCNN and PDATFEGAN-MFL-DCNN-RSF Models

The proposed PDATFEGAN-MFL-DCNN and PDATFEGAN-MFL-DCNN-RSF models for pest and disease classification in leaves and pesticide recommendation are shown to outperform state-of-the-art DL models on the multi-dimensional dataset (Fig. 8.4). In comparison to other suggested and existing models, the PDATFEGAN-MFL-DCNN-RSF model is shown to improve classification accuracy. The PDATFEGAN-MFL-DCNN-RSF model improves accuracy by 8.03% on average compared to all other models.

The comparative research shows that when compared to other models applied to multi-dimensional datasets, the gives the highest accuracy when identifying leaf diseases and pests and making predictions about the most effective pesticides to apply. Instead than relying just on low-resolution photos of leaves and pests, as do current models, the suggested PDATFEGAN-MFL-DCNN-RSF model employs a wide range of parameters for pesticide prescription. Existing models are also increasingly complicated and time-consuming to train, especially as data volumes rise. Results show that the PDATFEGAN-MFL-DCNN-RSF model is the most successful at detecting leaf diseases and pests and providing guidance on where to apply pesticides.

8.4 SUMMARY

Precision, recall, f-measure, and accuracy are used to evaluate four different suggested models in this chapter. Pest categorization on leaves and recommended pesticides are compared using state-of-the-art models. The results are best on the PDATFEGAN-MFL-DCNN-RSF model, in which analysis is performed using multi-dimensional datasets such as PVD, soil, weather attributes, pests and pesticide datasets. This means that the high-resolution leaf images along with the soil and weather factors are valuable to precisely classify the different classes of leaf diseases and related pests with maximum accuracy. Also, it is used to predict proper pesticides for leaf disease and pest control. Thus, by combining optimized adversarial learning, multi-dimensional feature learning and intuitionistic fuzzy rough set decision support, the PDATFEGAN-MFL-DCNN-RSF model may achieve more accurate, robust and generalize to assist cultivators or agriculturalists in controlling leaf diseases and pests with the use of the right insecticides.

Chapter 9

CHAPTER 9

CONCLUSION AND FUTURE WORK

9.1 CONCLUSION

Within the scope of this research, a robust DL model was created to correctly categorize leaf diseases and associated pests, and to advise on the most effective insecticides for managing crop yields. The first phase of the research developed the PDATFGAN model to create high-resolution leaf images by learning a coordinate manifold. This model comprised the PGAN, in which the generator was trained to generate high-resolution leaf image patches at each resultant spatial location by constraining each pixel's position and orientation. Those generated image patches were merged to obtain whole leaf images, which were then fed to the ShuffleNetV2, DenseNet121 and MobileNetV2 models for classifying them into healthy and different kinds of leaf diseases.

The second phase of the research work developed the PDATFEGAN model to fine-tune the generator for high-resolution leaf image generation. This model adopted PEGAN to formulate the adversarial learning procedure as an evolutionary problem. First, the PEGAN considered various adversarial objective functions by applying different mutation processes to minimize loss between the generated and actual image distributions. To find the best discriminator, the quality of images produced by the improved progeny was evaluated. Based on the image quality, weakly-performing offspring were excluded and the well-performing offspring were kept for consecutive training of PEGAN. So, high-resolution leaf images were generated by the optimal generator. Those images were classified by the ShuffleNetV2, DenseNet121 and MobileNetV2 models for leaf disease classification.

The third phase of the research work proposed a unified leaf disease and pest classification model to enhance crop yield. Multivariate information was taken into account in this model, including leaf images, soil characteristics, meteorological parameters, and pest information. The MFL-DCNN was trained on these datasets, and then the softmax classifier was utilized to effectively identify leaf diseases and pests.

The fourth phase of the research work proposed a hybrid use of the MFL-DCNN model in a recommendation system for pesticides based on the RSF framework. This model introduced RSF to create the rules by considering the multi-dimensional datasets, showing how leaf diseases, pests, soil, and climate are all interconnected. The developed rules may be used for the prediction and recommendation of suitable pesticides for leaf diseases and associated pests categorised by the MFL-DCNN model. Finally, the proposed models on the multi-dimensional datasets such as PVD, soil, pest, weather and pesticide datasets were implemented using Python 3.7 to measure their performance. Compared to state-of-the-art models and various variations of suggested models for simultaneous classification of leaf diseases and pests together with the pesticide recommendation, the experimental findings demonstrated that the PDATFEGAN with MFL-DCNN-RSF model achieved 98.93% accuracy.

The suggested approach may be utilized by farmers and government agencies to categorize images of leaves. The proposed model may encourage responsible decisions for the control and eradication of leaf diseases and pests by predicting the most effective pesticide for a specific crop in a given geographic region with different soil and climatic conditions. Besides, this model can guarantee that healthy plants have been cultivated by reducing the chances of over or inappropriate usage of pesticides.

9.2 FUTURE WORK

This proposed research can involve the following future enhancements:

- In the future, the proposed models can be extended using leaf images from other multiple species (Some examples are apple, corn, grape, etc.) and diseases (scab, black rot, rust, etc.) to enhance their generalizability
- Future study will investigate the influence of several pre-trained DCNN models on classification accuracy, including GoogLeNet, Xception, InceptionResNet, and EfficientNet.
- The usefulness of the suggested models may be analysed by extending them to categorise illnesses affecting other sections of plants, such as roots, stems, fruits, etc.

- The presented models may be used in the future to perform remote monitoring of leaf diseases utilizing mobile and online apps in conjunction with cloud services.
- Future work can be considered various stages of leaf diseases to provide proper solutions at each stage.