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# Classification of Broad-Leaved Dock Plants Using Open Sprayer Images: A Comparative Study

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## Abstract

This paper presents a comprehensive analysis of a model developed for classifying images of broad-leaved dock plants and non-dock plants captured using open sprayers, specifically drones used in agricultural settings. The dataset, sourced from Kaggle, includes annotated images of both broad-leaved docks and non-dock areas. We introduce and evaluate a novel model, referred to as MC-OAFM, using performance metrics such as accuracy, precision, recall, and F1 score. The experimental results demonstrate that the proposed model achieves an accuracy of 98.9%, with precision, recall, and F1 score each at 98%. The performance of the MC-OAFM model is compared with existing models, highlighting its superior performance. The study underscores the efficacy of using advanced deep learning techniques for plant classification in agricultural domains.

## I. Introduction

Agricultural practices are increasingly leveraging technology to enhance crop management and yield. One such technological advancement is the use of drones, particularly open sprayers, to capture images of crops and weeds. These images can be analyzed using machine learning and computer vision techniques to improve the accuracy and efficiency of plant classification. This study focuses on classifying broad-leaved dock plants from non-dock plants using a dataset of images captured by open sprayers. We propose a model named MC-OAFM and evaluate its performance against existing classification techniques.

## II. Dataset

The dataset utilized for this research is available on Kaggle(Open Sprayer Images Dataset) and contains labelled images of dock plants and non-dock plants. It comprises images of broad-leaved dock plants and areas without broad- leaved docks. The dataset is divided into training and testing subsets, with annotations indicating the presence or absence of broad-leaved docks. This division allows for a comprehensive evaluation of the proposed model's ability to distinguish between dock and non-dock plant images. The challenge addressed in this paper is the development and evaluation of a robust classification system that can accurately identify these plant types from drone-captured images.

## III. Methodology

The classification model proposed in this paper employs the MC-OAFM (Model Classification - Optimized Adversarial Feature Matching) algorithm. The methodology involves several key steps:

1. **Data Preprocessing:** Images are resized and normalized to ensure uniformity. Data augmentation techniques such as rotation, zooming, and flipping are applied to enhance the model's robustness.
2. **Feature Extraction:** Features are extracted using pixel-based methods. This involves identifying key characteristics of the images that differentiate dock plants from non-dock plants.
3. **Model Training:** The MC-OAFM algorithm is trained using the processed images. The training process involves optimizing the model to maximize accuracy while minimizing classification errors.
4. **Evaluation Metrics:** The model's performance is evaluated using performance Metrics like accuracy, precision, recall, and F1-score. These metrics provide a comprehensive assessment of the model's effectiveness in classifying dock and non-dock plants.
   - **Accuracy** − Accuracy is one of the most basic performance metrics and measures the proportion of correctly classified instances in the dataset. It is calculated as the number of correctly classified instances divided by the total number of instances in the dataset.
   - **Precision** − Precision measures the proportion of true positive instances out of all predicted positive instances. It is calculated as the number of true positive instances divided by the sum of true positive and false positive instances.
   - **Recall** − Recall measures the proportion of true positive instances out of all actual positive instances. It is calculated as the number of true positive instances divided by the sum of true positive and false negative instances.
   - **F1 Score** − F1 score is the harmonic mean of precision and recall. It is a balanced measure that takes into account both precision and recall. It is calculated as 2 * (precision × recall) / (precision + recall).

## IV. Exploratory Data Analysis (EDA)

EDA was conducted to understand the dataset's characteristics, visualize the distribution of dock and non-dock images, and detect any anomalies. Figures 4.1 and 4.2 illustrate sample images of
dock and non-dock plants, respectively. Figures 4.3 through 4.7 show pixel-based feature extraction results, highlighting the feature differences between dock and non-dock images.

**Fig 4.1 Dock images**

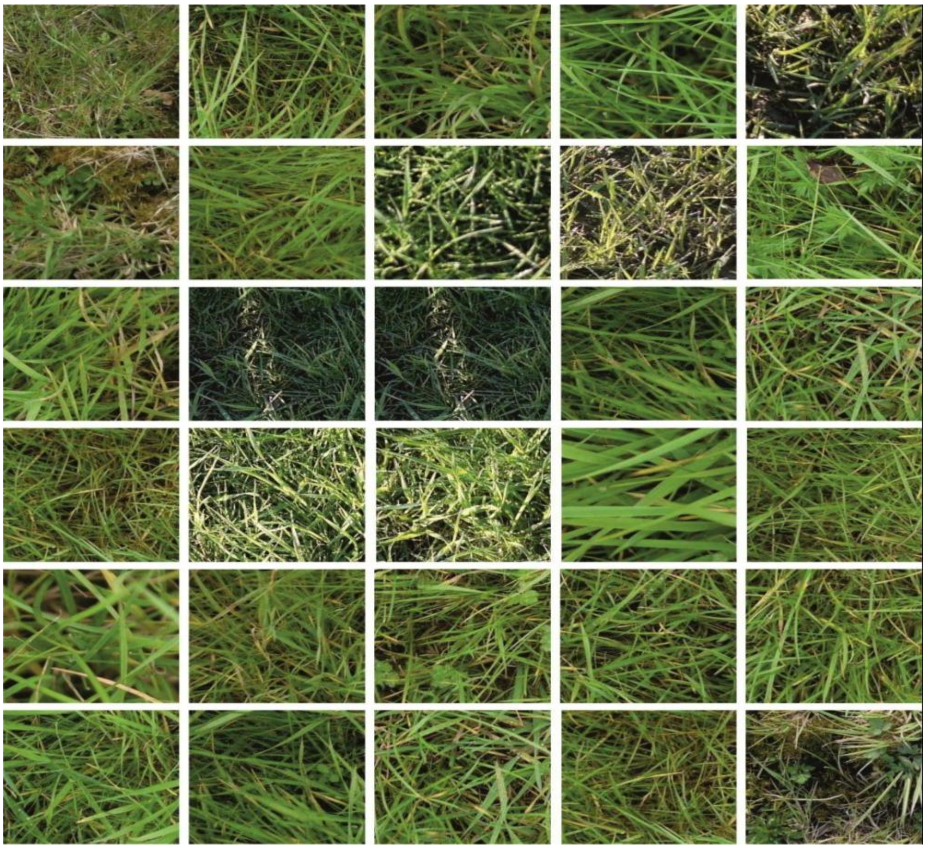

**Fig 4.2 Non-dock images**

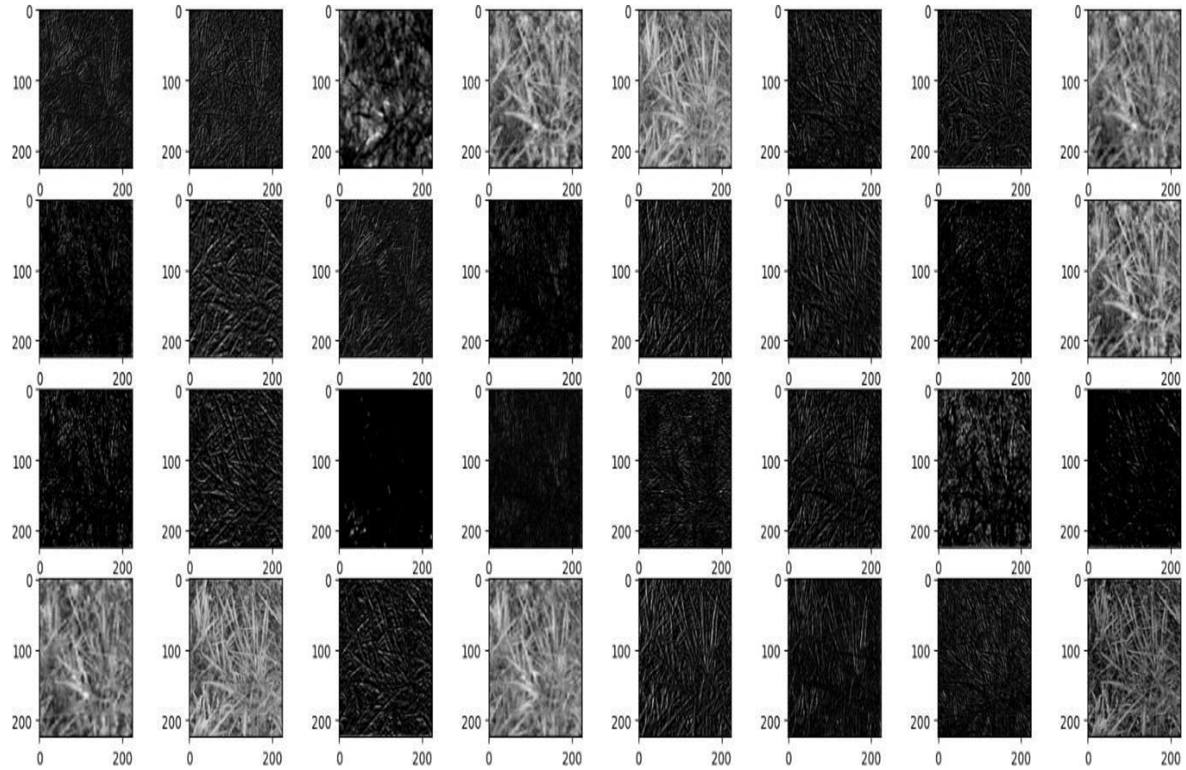

Fig 4.3 Pixel Based Feature Extraction in Block 2

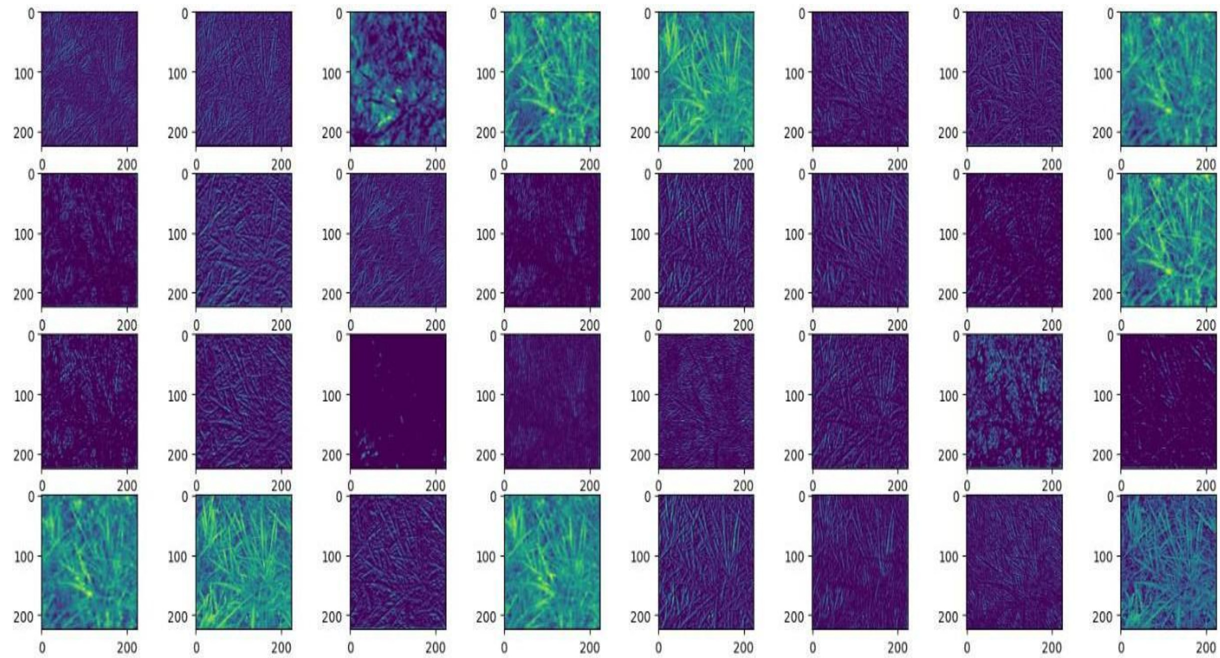

Fig 4.4 Saturation of Pixel Based Feature Extraction in Block 2

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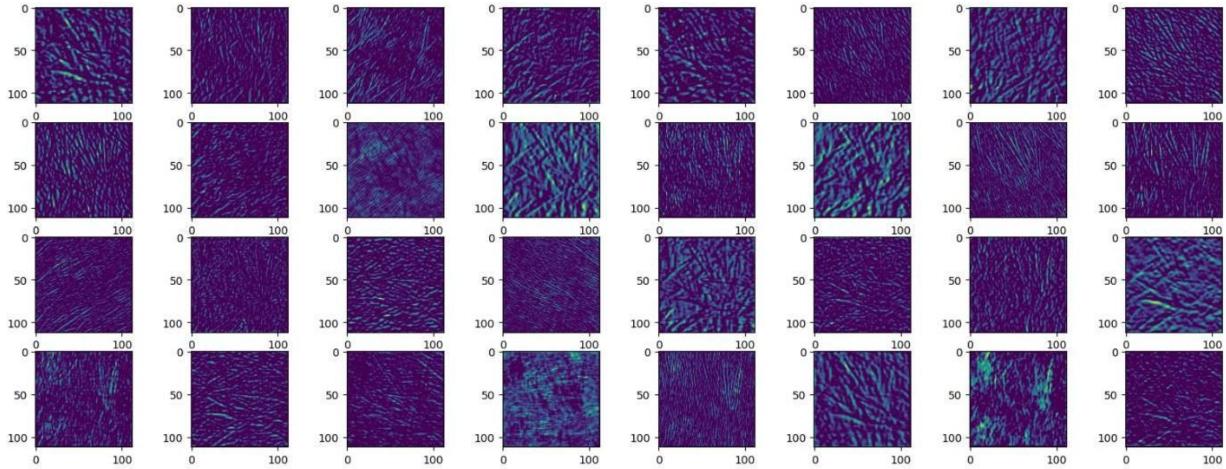

Fig 4.5 Pixel Based Feature Extraction in Block 5

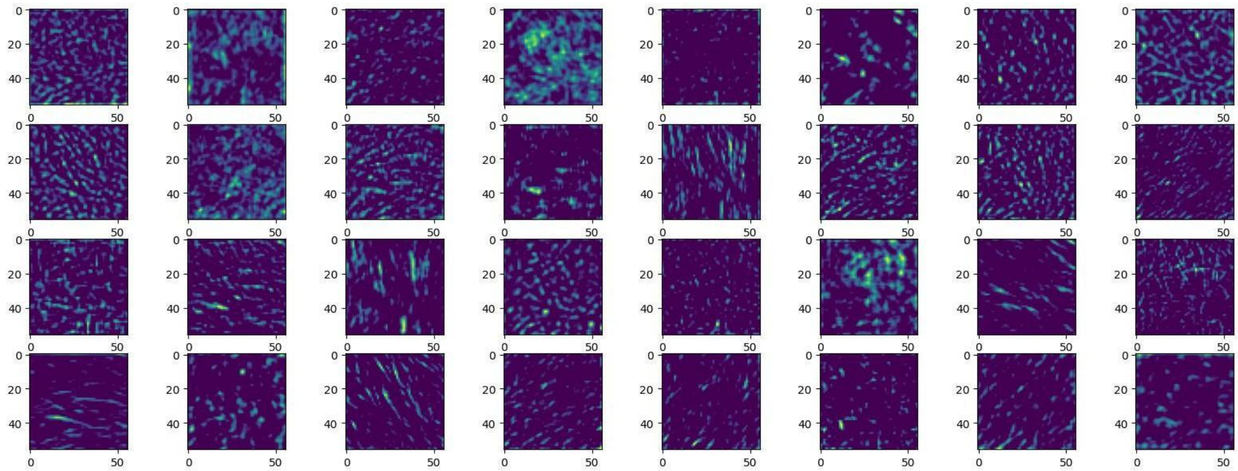

Fig 4.6 Pixel Based Feature Extraction in Block 9

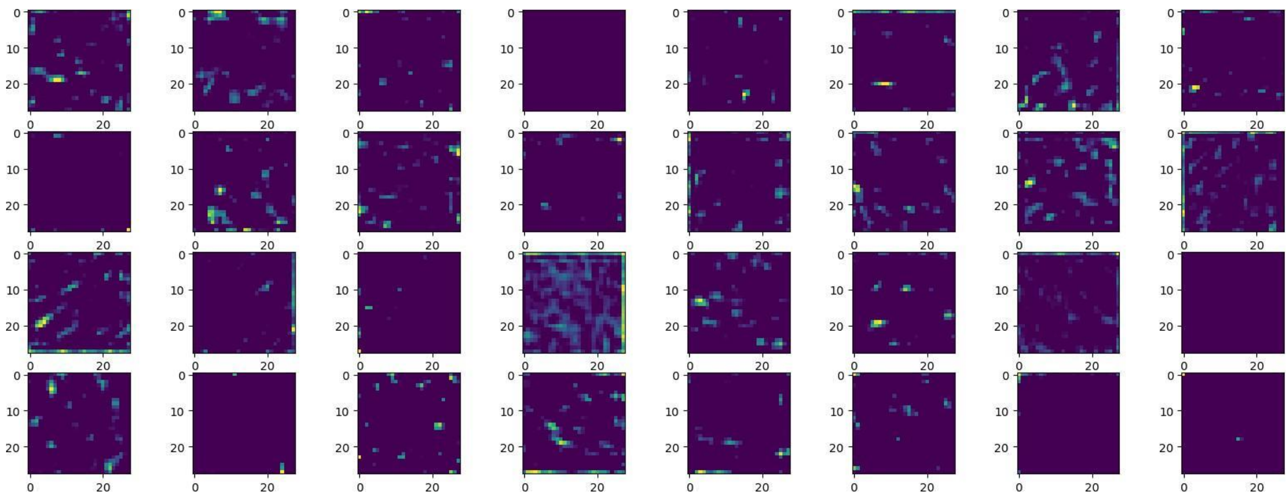

Fig 4.7 Pixel Based Feature Extraction in Block 13

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## V. Experimental Analysis

The MC-OAFM model was tested on the dataset, and its performance metrics were evaluated. The results are summarized in Table 4.1, with graphical representations in Figures 4.8 and 4.9. The MC-OAFM model achieved a high performance with an accuracy of 98.9%, precision, recall, and F1 score all at 98%. The confusion matrix in Figure 4.11 provides further insight into the model's classification performance.

**Table 4.1 Performance Analysis of Proposed Model**

| Methods | Accuracy | Precision | Recall | F1-score |
|---|---|---|---|---|
| Proposed model | 98.9 | 98 | 98 | 98 |

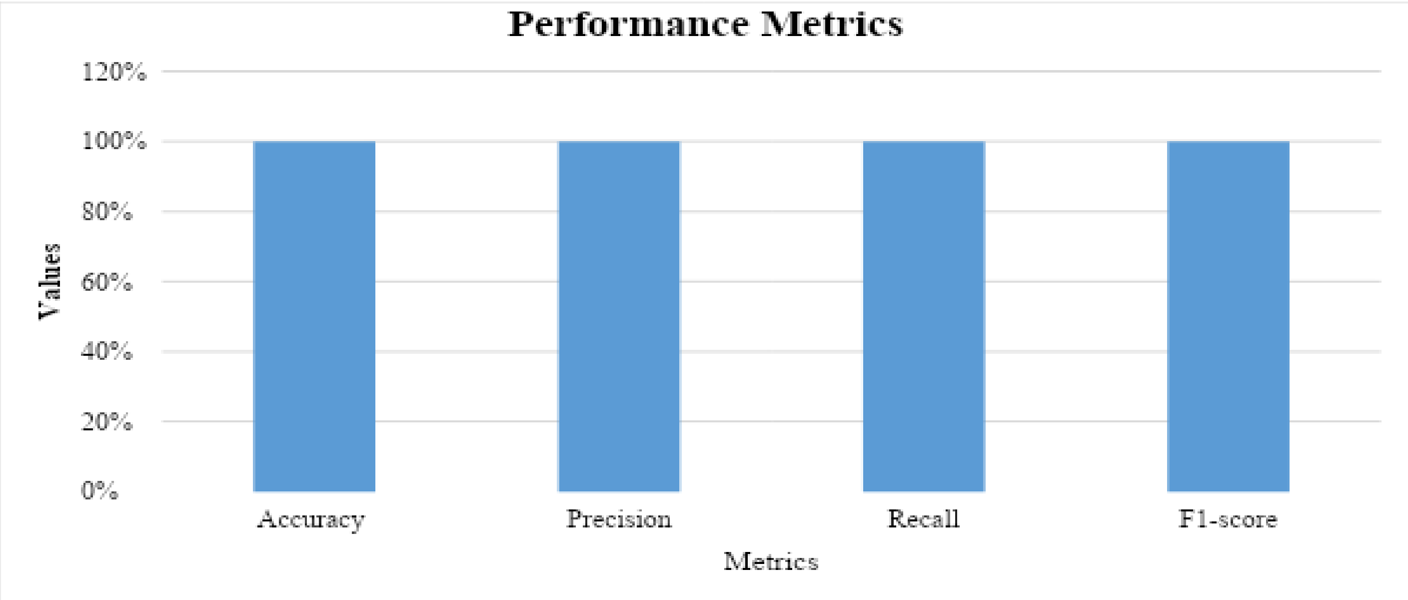


**Fig 4.8 Graphical Representation of Performance Analysis of Proposed Model**

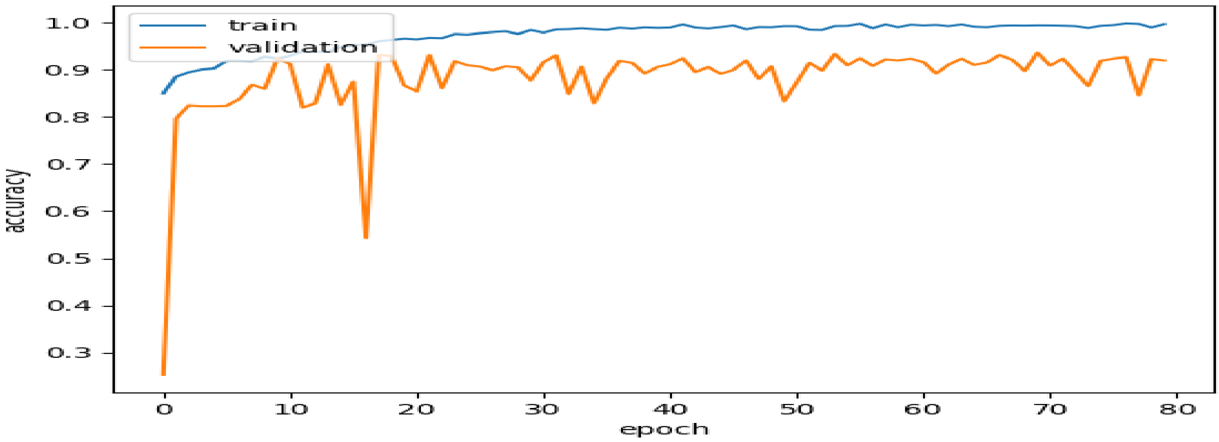


**Fig 4.9 Accuracy Correlation of Proposed Model**

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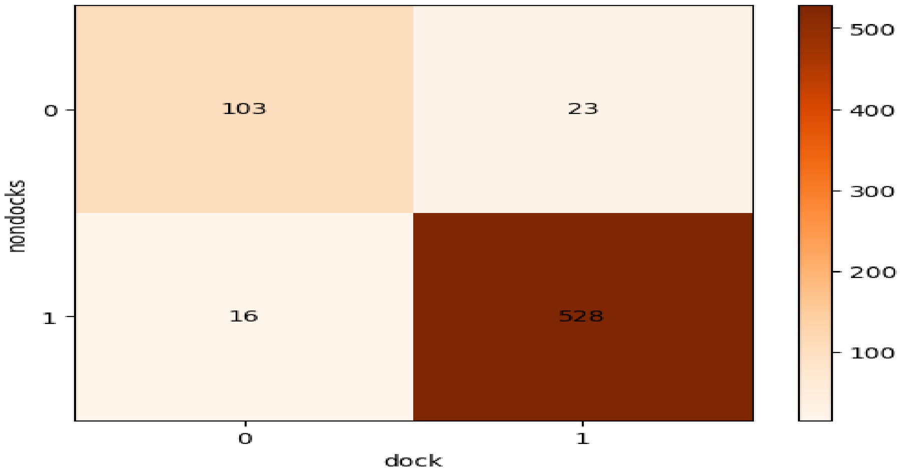


*Fig 4.11 Confusion Matrix*

## VI. Comparative Analysis

The performance of the MC-OAFM model was compared with several existing models, including DenseNet-121, DenseNet-201, ResNet, and others. Table 4.2 and Figures 4.12, 4.13, and 4.14 illustrate the comparative results. The MC-OAFM model outperformed most existing models, showcasing an accuracy of 98%, which is higher than many conventional techniques.

**Table 4.2 Comparison of Proposed Model with Existing Model**

| Model | Accuracy | F1 score |
|---|---|---|
| Desnet-121 | 0.98 | 0.97 |
| Desnet-201 | 0.97 | 0.97 |
| Proposed Model | 0.98 | 98 |

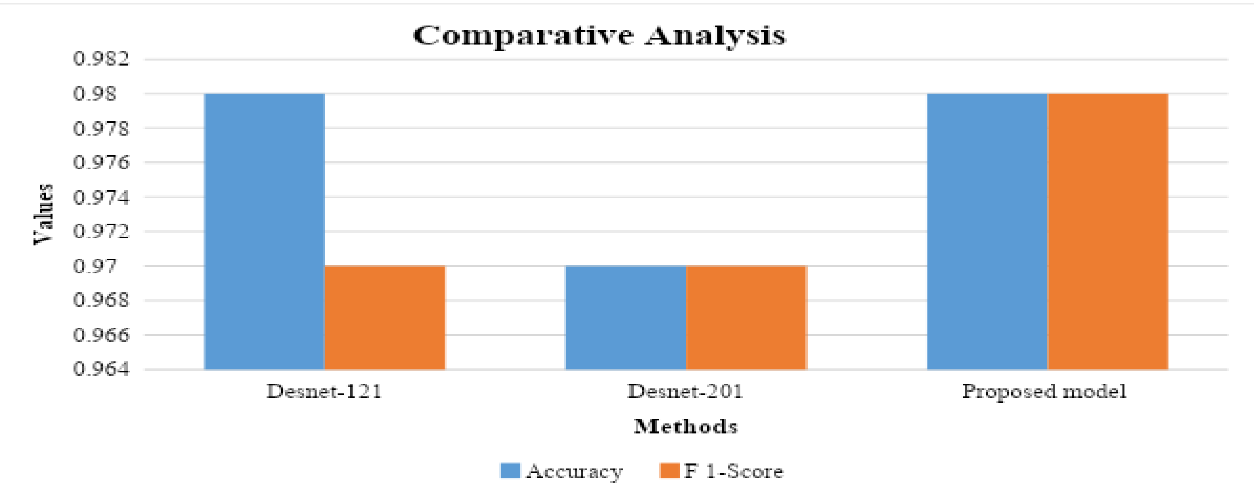


**Fig 4.12 Graphical Representation of Comparison of Existing and Proposed Model [84]**

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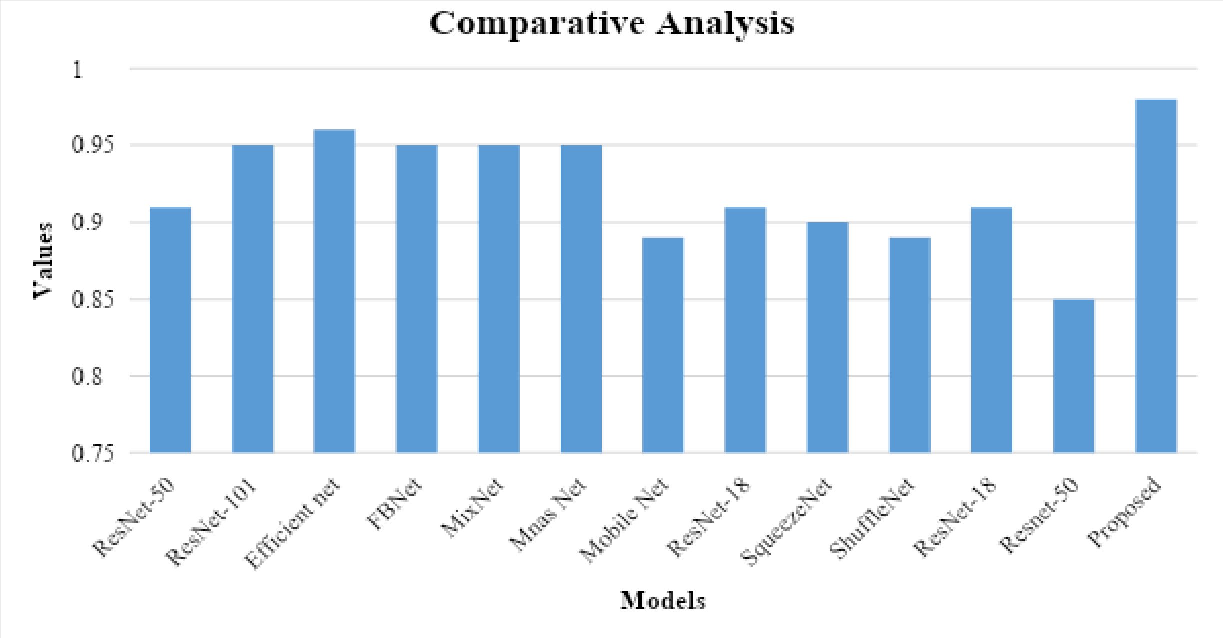


**Fig 4.13 Graphical Representation of Comparison of Existing and Proposed Model**

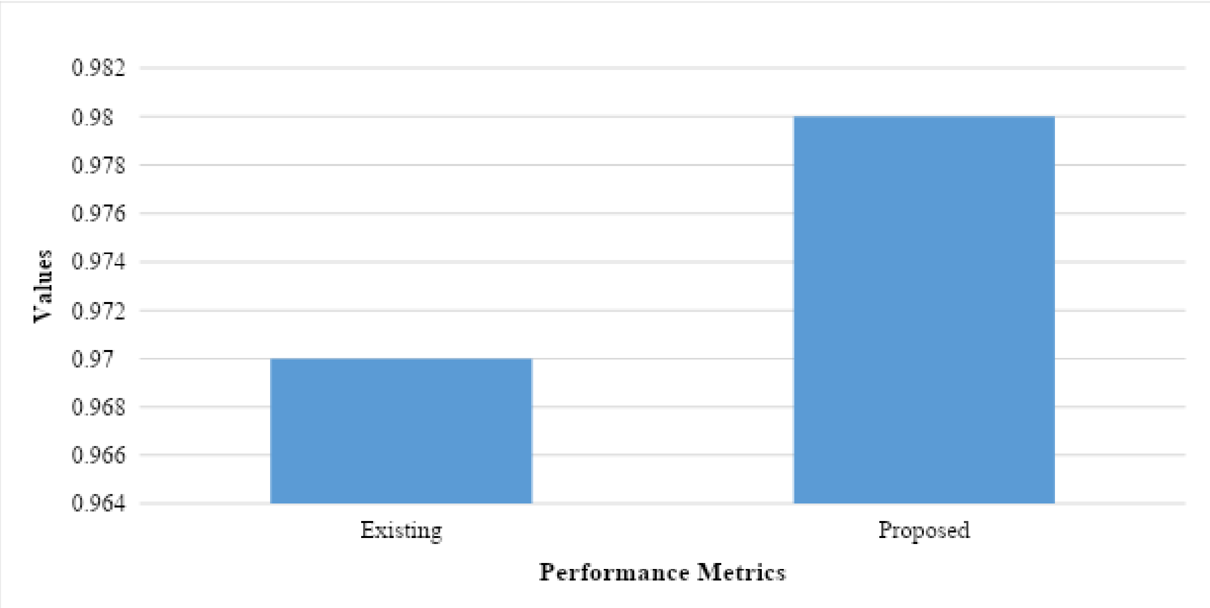


**Fig 4.14 Graphical Representation of Comparison of Existing and Proposed Model**

## VII. Results and Discussion

The MC-OAFM model demonstrated superior performance in classifying broad-leaved dock plants compared to existing models. The high accuracy, precision, recall, and F1 score indicate that the model is effective in distinguishing between dock and non-dock plant images. The comparative analysis confirms that the MC-OAFM model performs better than several state-of-the-art models, making it a promising solution for plant classification in agricultural applications.

The performance of the MC-OAFM model is evaluated using several metrics:

- **Accuracy:** The model achieved an accuracy of 98.9%. This indicates that the model correctly classified 98.9% of the images.
- **Precision:** With a precision of 98%, the model shows a high rate of correctly identified dock plants among the positive predictions.
- **Recall:** The recall of 98% signifies that the model successfully identified 98% of the actual dock plants.
- **F1-Score:** The F1-score of 98% reflects the balance between precision and recall, indicating a well-rounded performance of the model.

The confusion matrix further illustrates the model's performance. It shows that the model accurately classified 103 images as non-dock plants and 528 images as dock plants, with minimal misclassification.

## VII. Conclusion

This study introduces the MC-OAFM model for classifying broad-leaved dock plants using images captured by open sprayers. The model achieves high performance metrics, including 98.9% accuracy and 98% precision, recall, and F1 score. The comparative analysis further highlights its superiority over existing models. The results suggest that the MC-OAFM model is an effective tool for plant classification, offering potential benefits for agricultural management and crop productivity enhancement.

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