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Severity Classification of Philippine Downy Mildew in Corn using Infrared Thermography and Deep Learning

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GOAL OF THE STUDY

This study uses infrared thermography and deep learning to identify and categorize the severity of Philippine Downy Mildew in maize crops. Traditional methods are often influenced by lighting and time constraints, as well as an invasive approach. This research addresses these limitations by:

- Developing a practical, non-invasive method for identifying and categorizing the disease
- Proposing Deep learning models for thermal imagery to achieve high accuracy.
- Equipping researchers and farmers with tools to protect crops and enhance practices
- Advancing disease detection in agriculture
- Highlighting the need for further development to implement these techniques in the field

Fig. 1 System Architecture

The system includes a smartphone, infrared camera, internet connection, and laptop. Smartphone data is wirelessly stored and processed online. Algorithms run on the laptop, with the Gradio app serving as the web-based GUI.

TEST SAMPLES

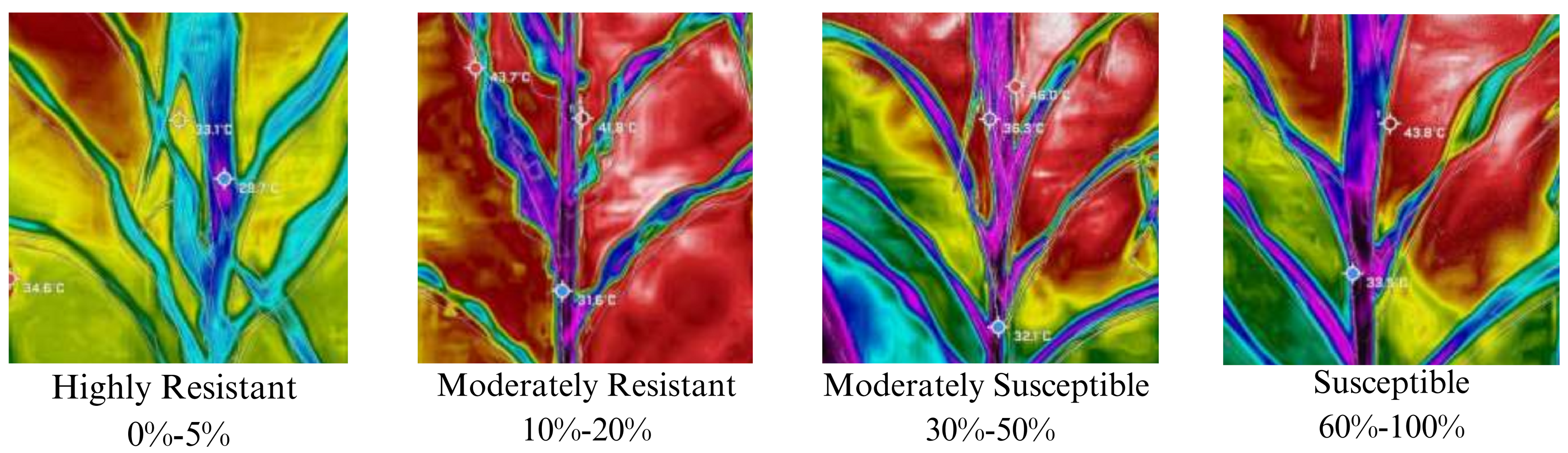

Fig. 2 Acquired Corn Plant Thermogram Samples

METHODOLOGY

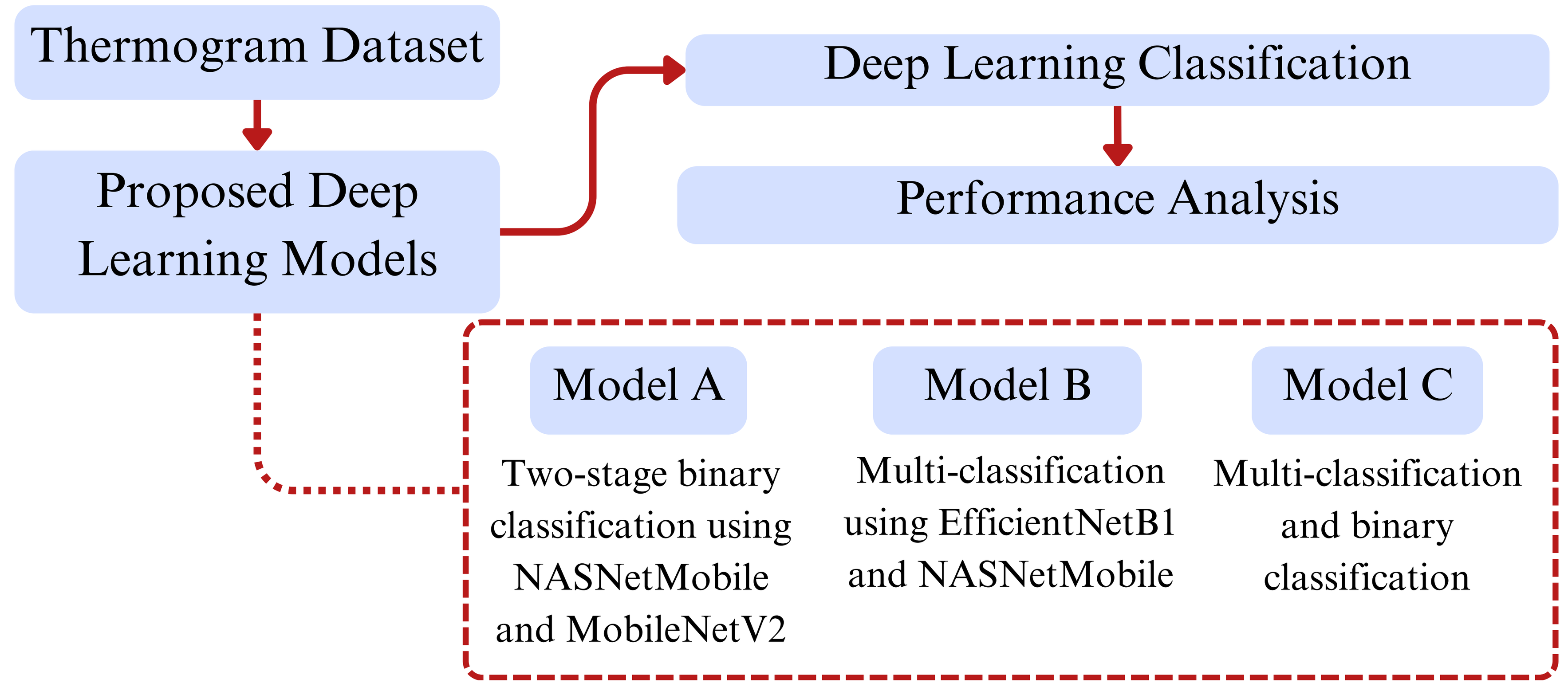

Fig. 3 System Flowchart

DEEP LEARNING MODELS

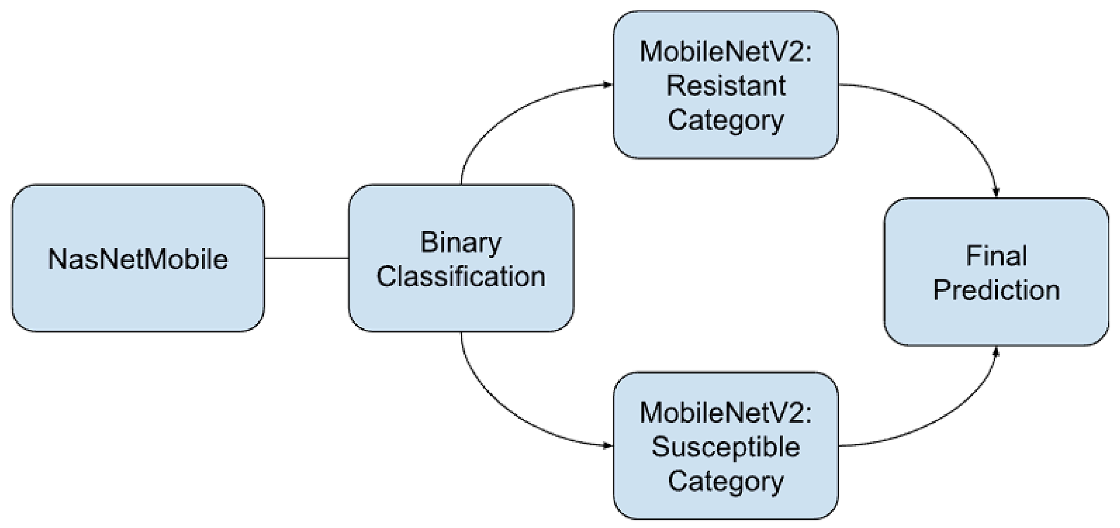

Fig. 4 Model A

- Model A: Two-stage binary classification using NASNetMobile and MobileNetV2
- Stage 1: NASNetMobile classifies the input image as Resistant or Susceptible.
- Stage 2: MobileNetV2 further classifies the prediction into the four categories

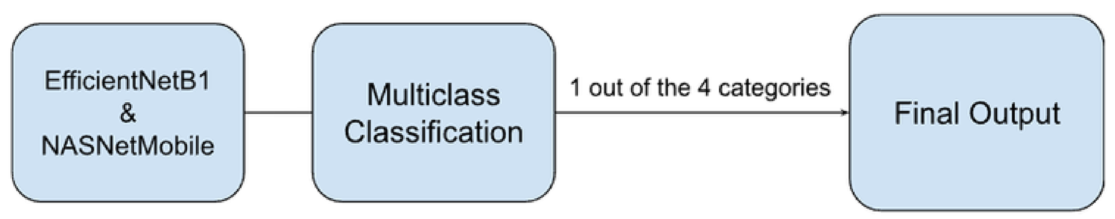

Fig. 5 Model B

- Model B: Multi-classification CNN model using both EfficientNetB1 and NASNetMobile.

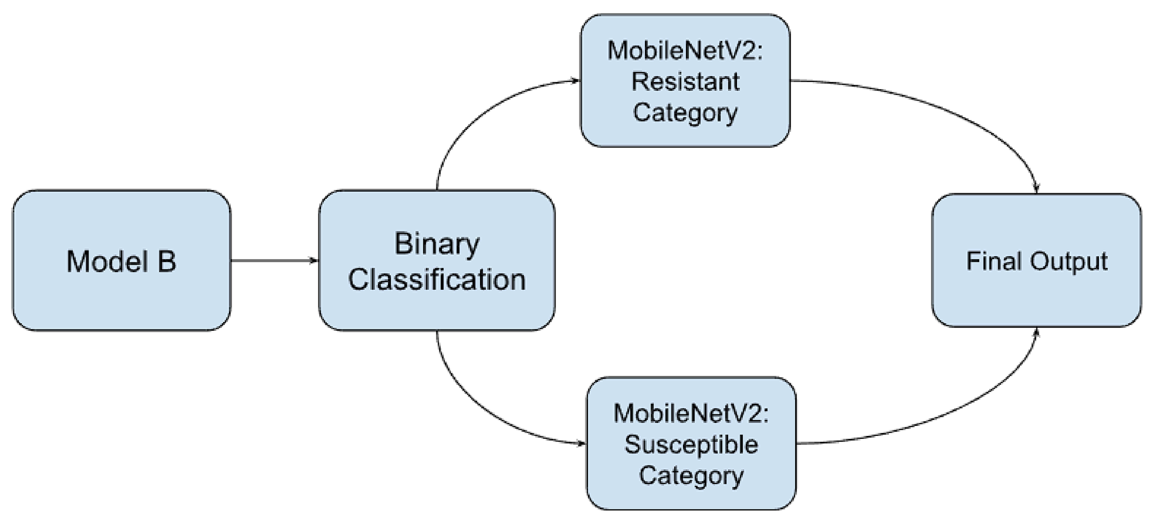

Fig. 6 Model C

- Model C: integrates Model B for Stage 1 multi-classification and Model A for Stage 2 binary classification. The average confidence score from Stage 1 is used in Stage 2 to predict the class of the input image.

RESULTS

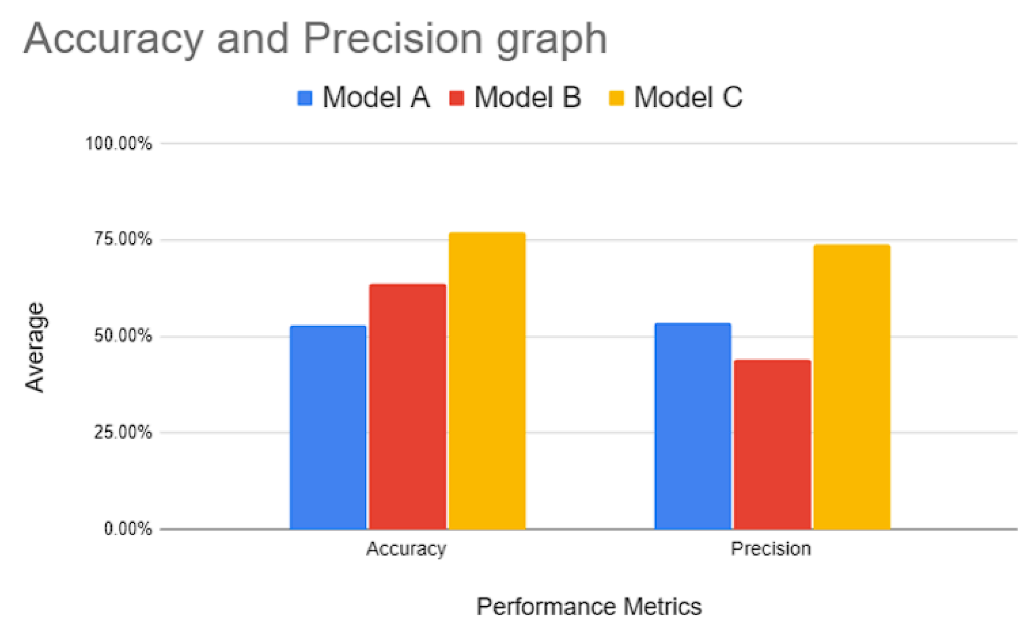

Fig. 7 Comparison of Training Accuracy of Models A, B, and C

- Model A achieved an overall accuracy of 53.03%
- Model B obtained an overall accuracy of 63.64%
- Model C obtained an overall accuracy of 76.92%

CONCLUSION

This study demonstrated the use of infrared thermography combined with deep learning techniques for detecting and classifying the severity of Philippine Downy Mildew in maize crops. The application of transfer learning and ensemble learning contributed to the enhanced performance of the models.

Based on the test results, it was observed that Model C exhibited the best performance in the actual field. Model C also demonstrated higher confidence in its predictions. However, despite the promising results, the limited datasets of Philippine Downy Mildew in corn pose a challenge to learning ability of the system.

This work underscores the potential of further advancement in machine learning approach for non-invasive plant disease severity rating and highlights the need for on-going development to fully be implemented in field conditions.