**Technical Report on PlantGuard: An AI-based Plant Disease Detection System**

**1. Introduction**

PlantGuard is an innovative hardware application aimed at automating plant disease detection using Artificial Intelligence. Designed for efficient, accurate diagnosis, the system integrates three AI models running sequentially to analyze plant health, providing rapid feedback to users through a dedicated hardware interface. This report provides an overview of the system's architecture, functionality, limitations, and potential impact.

**2. System Architecture**

The PlantGuard hardware application comprises three core components:

**Input Module:**

Raspberry Pi integrated with a high-resolution camera to capture images of plants.

**Processing Module:**

The captured images are processed by three sequential AI models:

1. **Leaf Detection Mode**l: Uses YOLO ONXX to detect plant leaves from the image.

2. **Plant Classification Model**: Uses ResNet to classify the plant type.

3. **Disease Identification Model**: Uses ResNet to detect disease presence.

**Output Module:**

Results from the AI processing stage are displayed on an intuitive Screen, notifying the type of disease.

**3. Technical Implementation**

Hardware Specifications:

* Raspberry Pi 4 Model B (4GB RAM)
* USB Webcam 720P
* 16x2 LCD Screen
* 5000 mAH Powerbank

Software Framework:

* Python-based implementation leveraging ONXX and PyTorch for model deployment.
* Real-time inference pipeline optimized to minimize latency and maximize performance.

**4. Performance and Accuracy**

Preliminary testing indicates moderate accuracy levels:

Leaf Detection Accuracy: ~85%

Plant Classification Accuracy: ~78%

Disease identification accuracy: ~70%

Inference times average around 500-700 milliseconds per analysis cycle, demonstrating practical usability in field conditions.

**5. Limitations**

The current version of PlantGuard faces several limitations:

* The AI models for leaf classification and disease detection currently employ ResNet architecture, which is computationally intensive and results in only moderate accuracy.
* Accuracy is not significantly high due to limited dataset size and diversity.
* Currently using a 16-bit LCD screen, which restricts clarity and color accuracy.
* The functionality to display captured images directly on the LCD screen has not yet been implemented.

**6. Future Work**

To address current limitations and enhance performance, we’ve planned the following improvements:

* Transition from **ResNet** to a more lightweight architecture such as **MobileNet** to optimize performance and computational efficiency.
* Expansion of datasets to significantly improve model accuracy.
* Integration of a dedicated camera module in place of the webcam for improved image capture quality.
* Upgrade from the 16-bit LCD to an OLED display for clearer, brighter, and more detailed visuals.
* Implementation of image display functionality directly on the screen for enhanced user interaction.
* Development of a mobile application companion for improved accessibility and user interaction.

**7. Potential Impact and Applications**

PlantGuard can significantly impact agricultural practices by:

* Allowing early detection and treatment of plant diseases, thereby reducing crop loss.
* Enhancing productivity for small and medium-scale farms through affordable technology.
* Providing data-driven insights for agricultural experts and researchers.

**Conclusion**

PlantGuard represents a significant advancement in agricultural technology, providing a practical, affordable, and progressively accurate solution for plant disease detection. Continuous improvements in hardware efficiency and AI capabilities promise broad adoption and substantial benefits for global agriculture.