📘 Project Report: Smart Agriculture – Plant Disease and Weed Detection

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1. Abstract

This project presents an AI-powered web application designed for precision agriculture, capable of detecting plant diseases and identifying invasive weed species from images. Using deep learning techniques and datasets like PlantVillage and DeepWeeds, the system delivers real-time classification of plant health and weed categories, thereby assisting farmers, agronomists, and agritech researchers in decision-making and field management.

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2. Scope

- Early detection of crop diseases from leaf images using classification models.
- Identification of weed species from real-world field imagery to reduce manual monitoring.
- Real-time image upload and prediction interface using Streamlit.
- Built as part of the **Kapil ItShub Agritech Hackathon** to demonstrate practical solutions in AI for agriculture.

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3. Dataset

Plant Disease Dataset:

- **Source**: PlantVillage dataset (public benchmark)
- **Classes**: 38 disease/healthy categories across crops like tomato, potato, grape, corn, etc.
- **Preprocessing**: Resized to 224×224, normalized to [0,1] scale

Weed Dataset:

- **Source**: DeepWeeds, custom-labeled images (Roboflow), field-collected data
- **Classes**: 9 categories including *Snake Weed*, *Chinee Apple*, *Parthenium*, *Rubber Vine*
- **Format**: Images organized into class folders with `.h5` model trained using Keras

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4. Methods

- **Framework**: TensorFlow/Keras for model training, Streamlit for deployment
- **Architecture**:
    - **Plant Disease Detection**: Transfer learning using MobileNetV2
    - **Weed Detection**: Custom CNN or MobileNet variant trained on annotated field data
- **Preprocessing**:
    - Image resizing (224x224)
    - Data augmentation (flip, rotation, zoom)
    - One-hot encoded labels

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5. Output

- Web interface with two detection modules:
    - **Plant Disease Detection** → Predicts disease class + shows top-3 probabilities
    - **Weed Detection** → Identifies weed species + shows prediction confidence
- Dynamic evaluation option with confusion matrix and classification report (for disease model)

6. Evaluation

Metrics Used:

- Accuracy
- Precision
- Recall
- F1-score
- Confusion Matrix

Weed Detection:

- Accuracy: ~84%
- Macro F1 Score: ~0.79
- Top-1 accuracy: High for well-separated species like *Snake weed* and *Parthenium*

Disease Detection:

- Accuracy: >90% (on validation set)
- Robust generalization across similar leaf types due to transfer learning

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7. Conclusion

This project demonstrates the practical integration of computer vision and machine learning in agriculture. By detecting plant diseases and weed species automatically from images, the tool supports smarter farming and efficient crop monitoring. It reduces dependence on expert labor while enabling data-driven intervention planning.

8. Future Scope

- Integrate with drone or smartphone-based field capture apps
- Add object detection to locate weed clusters in an image
- Expand dataset using multispectral imagery for more precise classification
- Create a mobile-friendly PWA version for offline use
- Support segmentation masks for affected leaf areas

Annexure

A. Model Architecture Summary:

- **Plant Disease Model**: MobileNetV2, input size (224, 224, 3), output: 38-class softmax
- **Weed Detection Model**: Custom CNN / MobileNet variant, trained on 9 classes with early stopping and Adam optimizer

B. Tools & Libraries:

- Python 3.10
- TensorFlow 2.14, Keras
- Streamlit
- PIL, Seaborn, Matplotlib
- scikit-learn

C. Folder Structure:

```
├── app.py                                    # Streamlit web app

├── plant_disease_model.h5                    # Plant disease
detection model

├── weed_detection_model.h5                   # Weed classification
model

├── Round1_Plant_Disease_Detection_Abisheka_Gajapathi.ipynb   # Round
1 notebook

├── Round2_Plant_Disease_Detection_Abisheka_Gajapathi.ipynb   # Round
2 notebook

├── Weed_Detection/                           # Cloned repo:
https://github.com/Abisheka06/Weed_Detection

|   ├── Chinee apple/

|   ├── Snake weed/

|   ├── Parthenium/

|   ├── Lantana/

|   └── ...

├── PlantVillage-Dataset/                     # Cloned repo:
https://github.com/Abisheka06/PlantVillage-Dataset

|   ├── Tomato___Early_blight/

|   ├── Corn___Healthy/

|   ├── Grape___Black_rot/

|   └── ...

└── Smart_Agriculture_Project_Report.pdf      # Final project report
```

D. Hardware:

- Trained using Google Colab (GPU)
- Web app tested locally on Intel i5, 8GB RAM

References

1. Mohanty, S.P., Hughes, D.P., Salathé, M. (2016). Using Deep Learning for Image-Based Plant Disease Detection. *arXiv preprint arXiv:1604.03169*.
2. Olsen, A., et al. (2019). DeepWeeds: A Multiclass Weed Species Image Dataset for Deep Learning. *Scientific Reports*.
3. PlantVillage Dataset
4. DeepWeeds Dataset
5. TensorFlow Documentation – https://www.tensorflow.org
6. Streamlit Documentation – https://docs.streamlit.io
7. Roboflow Annotated Datasets – https://roboflow.com
8. OpenAI ChatGPT (assistance in content structuring and coding)