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**PlantShield: AI-Driven Disease Diagnosis and**

**Smart Sensor-Based Irrigation System**

Literature Data Research and Technology Review: Capstone Project (Second Assignment)

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Literature Review

## Introduction

The importance of this project is the development of a machine learning-based plant disease detection system and a smart irrigation solution for sustainable agriculture, which is paramount for food security and environmental conservation. Since climate change and diseases are affecting agriculture more, it is necessary to use water effectively and handle diseases better and on time. A literature review of the material available will highlight successful methods and gaps for devising an optimized solution for plant health and resource conservation.

## Organization

The literature review is organized around themes, focusing on the two aspects of the project: machine learning in the detection of plant diseases, and smart irrigation systems based on the IoT (Internet of Things).

## Summary and Synthesis

### Research 1:

**Title:** Using Deep Learning for Image-Based Plant Disease Detection

**Key Findings:**

* Verified the applicability of deep convolutional neural networks (CNNs) in identifying plant diseases from leaf images.
* Achieved an accuracy of 99.35% in classifying 14 crop species and 26 diseases.

**Methodology:**

* Utilized a public dataset with over 54,000 labeled images.
* Implemented CNNs for feature extraction and classification.

**Contribution to the Field:**

* Demonstrated the effectiveness of deep learning for plant disease diagnosis.

**Link:** <https://www.frontiersin.org/journals/plant-science/articles/10.3389/fpls.2016.01419/full>

### Research 2:

**Title:** Smart Water Management Platform: IoT-Based Precision Irrigation System

**Key Findings:**

* Developed an IoT-based platform for precision irrigation.
* Ensured optimized water use to promote productive and sustainable agricultural practices.

**Methodology:**

* Combined sensors for soil moisture, air temperature, and humidity with control systems.
* Utilized data-driven decision-making for irrigation scheduling.

**Contribution to the Field:**

* Addressed the need for efficient water use in agriculture through IoT technologies.

**Link:** https://www.mdpi.com/1424-8220/19/2/276

## Conclusion:

The literature reviewed signifies how the concepts of deep learning as well as IoT-based systems might transform agricultural practices. By using these technologies together in one system, which finds diseases, suggests the best treatment for those diseases, and controls irrigation based on current data, the proposed project solves the problems noted in the research. This helps improve precision agriculture and sustainable farming. This system will provide accessible, effective tools for plant health monitoring and water management, directly supporting SDGs 2 and 12.

## Proper Citations:

All referenced papers have been cited with direct links for transparency and acknowledgment.

Data Research

## Introduction

Data is crucial in the development of effective solutions for detecting plant diseases and smart watering systems. The project aims to develop robust models and systems that will meet the overall objectives of increasing agricultural productivity and sustainability through the analysis of relevant datasets.

## Organization

The data research findings are organized to describe the primary dataset used for plant disease detection and the real-time sensor data employed for smart watering.

## Data Description

### Plant Disease Dataset:

* **Source:** Publicly available dataset from Kaggle.
* **Format:** Image files, categorized into directories based on plant type and disease.
* **Size:** Approximately 70,295 images across 38 categories, with around 1,900 images per category.
* **Preprocessing:** Images will undergo resizing, normalization, and augmentation to enhance the deep learning model's performance.
* **Relevance:** This dataset forms the backbone of the disease detection system, enabling the training of a CNN to accurately classify plant diseases.
* **Dataset Link:** <https://www.kaggle.com/datasets/vipoooool/new-plant-diseases-dataset/data>

### Sensor Data for Smart Watering:

* **Source:** Real-time data collected using IoT sensors.
* **Format:** Numerical values representing soil moisture, air temperature, and humidity.
* **Predefined Thresholds:** Based on research literature on optimal plant water requirements.
* **Relevance:** This data guides the rule-based irrigation system programmed into Arduino, ensuring efficient water usage.

## Data Analysis and Insights

* **Key Insights from Plant Disease Dataset:** Preprocessing early on shows the requirement for uniform image size and well-balanced class distribution to avoid model bias. Flipping and rotation can augment the diversity of the dataset by considerable amounts.
* **Key Insights from Sensor Data:** Preliminary analysis shows a clear relationship between soil moisture levels and optimal irrigation times, following the threshold-based rule implementation.

## Conclusion

The data research indicates that the selected dataset and sensor inputs are suitable for achieving the goals of the project. Sensitive preprocessing and analysis will enhance the performance of the system, which will help the end-users by providing them with accurate disease diagnostics and effective water management.

Technology Review

## Introduction

This technology review provides an overview of the tools, software, and hardware required for the plant disease detection system and smart watering feature. This review shows how these technologies relate to the project's goals and help make the system efficient, accurate, and easy to use.

## Technology Overview

### Software and Tools for Development

1. **Python:**  This is used to create a machine learning model that finds plant diseases from leaf pictures.
2. **Django:** Acts as the backend framework to integrate the ML model into the system for processing user inputs and serving predictions.
3. **React:** Provides the front-end framework to build an intuitive interface for farmers and gardeners to interact with the system.
4. **Arduino IDE:** Used for programming the Arduino to manage the smart watering feature based on sensor readings.
5. **MS Word:** Essential for documenting project planning, progress, documentation, findings, and implementation details.
6. **PowerPoint:** Used to make final project presentations to show the project during its development and final demonstrations.
7. **Photoshop:** Optionally employed for designing the project’s logo and creating mockups of the app and website interfaces.

### Integration of Machine Learning

To integrate the ML model with Django, libraries such as Flask or TensorFlow Serving can be used. This would ensure the trained model could communicate smoothly with the backend of the application and thus provide the results of disease detection accordingly.

### User Requirements Post-Implementation

1. **Mobile Devices or Laptops:**  Users will require a mobile device or a laptop having a camera that can take pictures of diseased plants and utilize the application or website.
2. **Arduino and Sensors:** To really use the smart watering feature well, users need to have an Arduino board and at least one set of sensors - like soil moisture, air temperature, and humidity sensors.

### Hardware Tools

1. **Arduino:** It is the heart of the smart watering system that takes the inputs from sensors and commands the watering system to turn on or off based on the coding instructions.
2. **Sensors:** Includes soil moisture, air temperature, and humidity sensors to collect data for precise irrigation.

## Relevance to the Project

* The software tools allow for disease detection with ease and are user-friendly.
* Hardware parts enable the smart watering system to be implemented, thereby solving problems in farming, such as overwatering and crop loss.

## Comparison and Evaluation

* **Software:** Python is ideal for Machine learning, Django ensures scalability and React provides a highly interactive user experience.
* **Hardware:** Arduino is cost-effective and widely supported, while the sensors are accurate and compatible with IoT systems.
* **Hosting Services (Optional):** Cloud platforms like AWS or Google Cloud can host the app, offering scalability and security.

## Use Cases and Examples

* **Machine Learning:** Studies like "Using Deep Learning for Image-Based Plant Disease Detection" validate the use of CNNs for plant disease diagnosis.
* **IoT in Agriculture:** Research on IoT-based precision irrigation demonstrates how sensor data improves farming practices.

## Identified Gaps and Research Opportunities

* The selected technologies are working perfectly, but there could be issues with real-time connection between the sensors and the app when the network is slow.
* This could be addressed by using edge computing. Customizing settings for different plant types in the smart watering system could make it more flexible.

## Conclusion

The mix of software and hardware tools provides a comprehensive solution for finding plant diseases and managing water usage. These technologies help achieve the goals of the project while supporting larger and more enduring methods of farming. With both advanced machine learning techniques and Internet of Things systems, the project has a high chance of changing modern farming.