PARSHWANATH CHARITABLE TRUST'S
A.P. SHAH INSTITUTE OF TECHNOLOGY
Department of Computer Science and Engineering
Data Science

AgroSense: ML-Powered Solutions for Sustainable Agriculture

Group No. 07

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Project Guide

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Contents

Abstract

This project applies machine learning to improve agricultural efficiency and support sustainable farming. It focuses on four core functionalities: weed detection using image processing to identify the weed and crops; soil moisture prediction for optimized irrigation and water conservation; water footprint calculation to monitor and manage the water usage involved in agriculture process; and plant disease detection. By combining technology with precision agriculture, the system empowers farmers to make smarter decisions, improve crop yields, and reduce environmental impact.

Introduction

Agrosense uses technology to help farmers with common farming challenges. It can detect weeds (unwanted plants) in an agriculture field. It also tracks soil moisture and climate humidity (using sensors). If the moisture level is low water pump gets started automatically which help farmers and reduce their work. Additionally, it analyzes the water footprint of the entire agriculture process. This system aims to improve farming, save resources, and make agriculture more sustainable. System also detects whether the plant is healthy or diseased.

Objectives

AGROSENSE project integrates technologies like image processing, machine learning, and IoT to address key farming challenges. Its main features include:

1. **Weed Detection:** To develop an automated system to accurately identify and classify weeds in agricultural fields using image recognition and machine learning techniques.
2. **Soil Moisture Monitoring:** To develop a predictive model using sensor data and optimize irrigation by accurately forecasting soil moisture levels and climate humidity to reducing water waste.
3. **Water Footprint:** To quantify and monitor the water usage (water footprint) of crops throughout their growth cycle, enabling the reduction of water consumption and environmental impact.
4. **Plant Disease Detection:** Identifying whether the plant is diseased or in healthy condition. Also specifying the disease.

Literature Review

Sr.no	Title	Author(s)	Year	Methodology	Drawback
1	Weeds Detection and Classification using Convolutional Long-Short-Term Memory	Sheeraz Arif, Rajesh Kumar, Shazia Abbasi, Khalid Mohammadani, Kapeel Dev	2021	In the research work, Convolutional Neural Network (CNN) and long short-term memory (LSTM) models are proposed for the classification of weed plants. The proposed model is divided into three main stages. Initially, CNN is employed to capture the features, then features are input to LSTM,and lastly, these output features are fed into fully connected layers	High computational cost: Due to heavy datasets, it requires high-end computation. This can be a challenge for resource-constrained environments.
2	A Comprehensive Review of Weed Detection through Advanced Image Processing and Deep Learning	Prof. Sowmya., Dr. Sandeep Bhat	2024	In classic image processing, characteristics like color, texture, and form are extracted from photos and used with conventional machine learning methods like Support Vector Machine (SVM) or random forest to identify weeds.	One drawback is that it can be difficult to obtain high-quality data. Another drawback is that deep learning models can be computationally expensive to train. Finally, deep learning models can be difficult to interpret, which can make it difficult to understand why they make certain predictions.

Literature Review

Sr.no	Title	Author(s)	Year	Methodology	Drawback
3	Water Footprint Assessment: Evolvement of a New Research Field	Arjen Y. Hoekstra	2020	The methodology has developed over time to include spatial and temporal assessments, virtual water trade analysis, and sustainability evaluations. The full WFA method includes four steps: defining the scope, accounting, sustainability assessment, and response formulation.	The paper identifies several challenges and criticisms of the WFA methodology. One of the key limitations is its inability to account for the opportunity costs of water use or properly integrate water scarcity into the footprint metrics.
4	Prediction of Temperature and Humidity Using IoT and Machine Learning Algorithm	Vamseekrishna Allam K L University R. Nishitha T. Anil Kumar K. Hanuman	2021	In this paper analyze and predict the temperature and humidity using IoT and linear regression algorithm in machine learning. In ancient days, people use to check the climate conditions by seeing clouds or through storm warnings they have noticed the weather conditions for many purposes like harvesting and involves many household activities.	The project mentions a drawback related to the use of linear regression for predicting temperature and humidity. While the difference between actual and predicted values is relatively low, suggesting high accuracy, the prediction might not always account for more complex, non-linear relationships in the data.

Literature Review

Sr.no	Title	Author(s)	Year	Methodology	Drawback
5	Crop Health Monitoring System	Kirti Tyagi, Aabha Karmarkar, Simran Kaur, Dr. Sukanya Kulkarni	2020	Temperature, moisture values will be compared with theirrespective thresholds which are different according to theplant. If the threshold is crossed, the farmer will get an alert on mobile phone	The crop health monitoring system has two key limitations: it focuses only on detecting diseases in plant leaves, missing potential issues in other parts like the stem and roots, and it relies on conventional energy sources.
6	AI-enabled Crop Health Monitoring and Nutrient Management in Smart Agriculture	Suman Kumar Swarnkar; Leelkanth Dewangan; Omprakash Dewangan; Tamanna Manishkumar Prajapati; Fazle Rabbi	2024	In this research paper, we explore the integration of AI technologies in smart agriculture to enhance crop health monitoring and nutrient management. By leveraging AI algorithms and techniques, we aim to improve the efficiency and sustainability of farming practices.	Limitations are high initial cost, data availability and quality, environmental and climate variability

Research Gap(Limitations of existing systems)

1. **Data Scarcity and Quality**: High-quality, labeled datasets of different weed species in various growth stages and environmental conditions are often lacking, limiting model accuracy.
2. **Generalization Across Environments:** Models trained in specific conditions may not perform well across diverse regions, climates, or crop types, leading to reduced adaptability.
3. **Weed-Crop Similarity:** Some weeds closely resemble crops, making it challenging for machine learning models to differentiate between them accurately.
4. **Environmental Variability:** Changing lighting, shadows, soil conditions, and weather can degrade model performance, requiring robust models or preprocessing steps.
5. **Scalability Issues**: Current systems may struggle to scale efficiently to larger, complex fields while maintaining accuracy and speed.

Problem Definition

Agriculture faces several challenges that productivity and sustainability, such as inefficient weed management, delayed plant disease detection, and improper water usage. Traditional methods often rely on manual labor and excessive chemical inputs, which can harm crops and the environment. Additionally, farmers lack real-time data on soil moisture and climate conditions, making it difficult to optimize farming practices.

This project aims to address these issues by developing a Smart Agriculture System that leverages technologies like machine learning, IoT, and image processing to automate weed detection, identify plant infections early, calculate water footprint, and monitor soil moisture, ultimately improving resource efficiency and promoting sustainable farming.

Scope

1. Using historical data and environmental conditions (such as soil quality, and weather patterns), machine learning models can predict where and when weeds are likely to grow.

1. Machine learning models, especially using image data from drones, robots, or cameras mounted on farm equipment, can distinguish between crops and weeds in real time.

1. Detecting unwanted plants early allows for targeted herbicide application, reducing chemical use and cost.

1. The Optimizing water usage by accurately predicting and monitoring crop water requirements, leading to sustainable agriculture and resource management.

Technological Stack

Algorithms :

- Weed detection: Image processing, R-CNN(Region based Convolution Neural Network) algorithm
- Water footprint: Mass balance analysis algorithm
- Plant Disease Detection: Deep Learning, CNN (Convolution Neural Network)

Language and Libraries :

- Python (libraries – TensorFlow, Pytorch, OpenCV, and deep learning models)
- Python (Flask): for building the backend.
- Html, CSS : for building frontend.

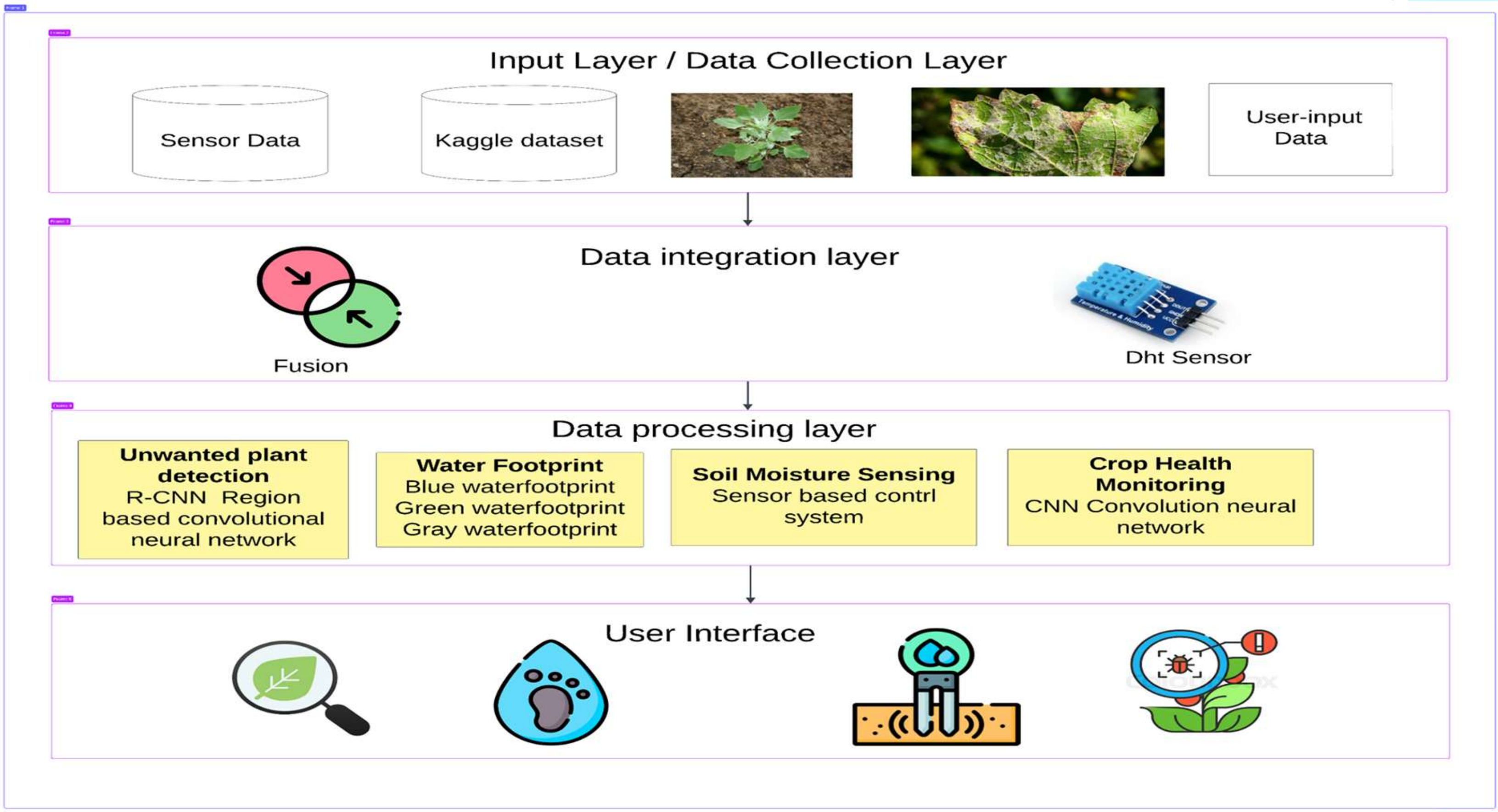
Data Collection :

- Data is collected from Open source platform : Kaggle dataset (Dataset name: Plant Village data). This dataset includes diseased and healthy plant leaf images and corresponding labels.

Hardware :

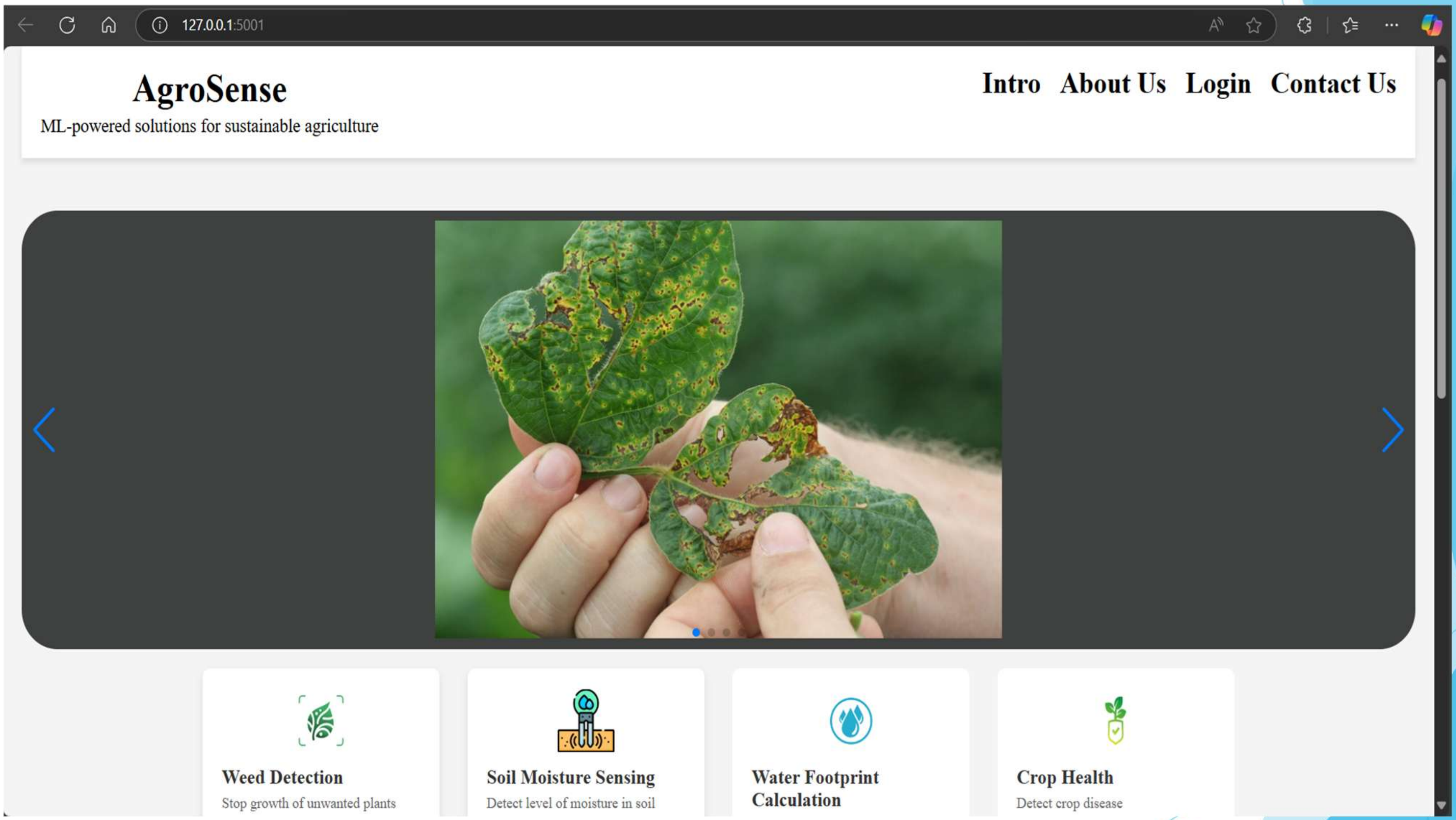
Soil Moisture Sensing : DHT Sensor (Arduino Uno)

Proposed System Architecture

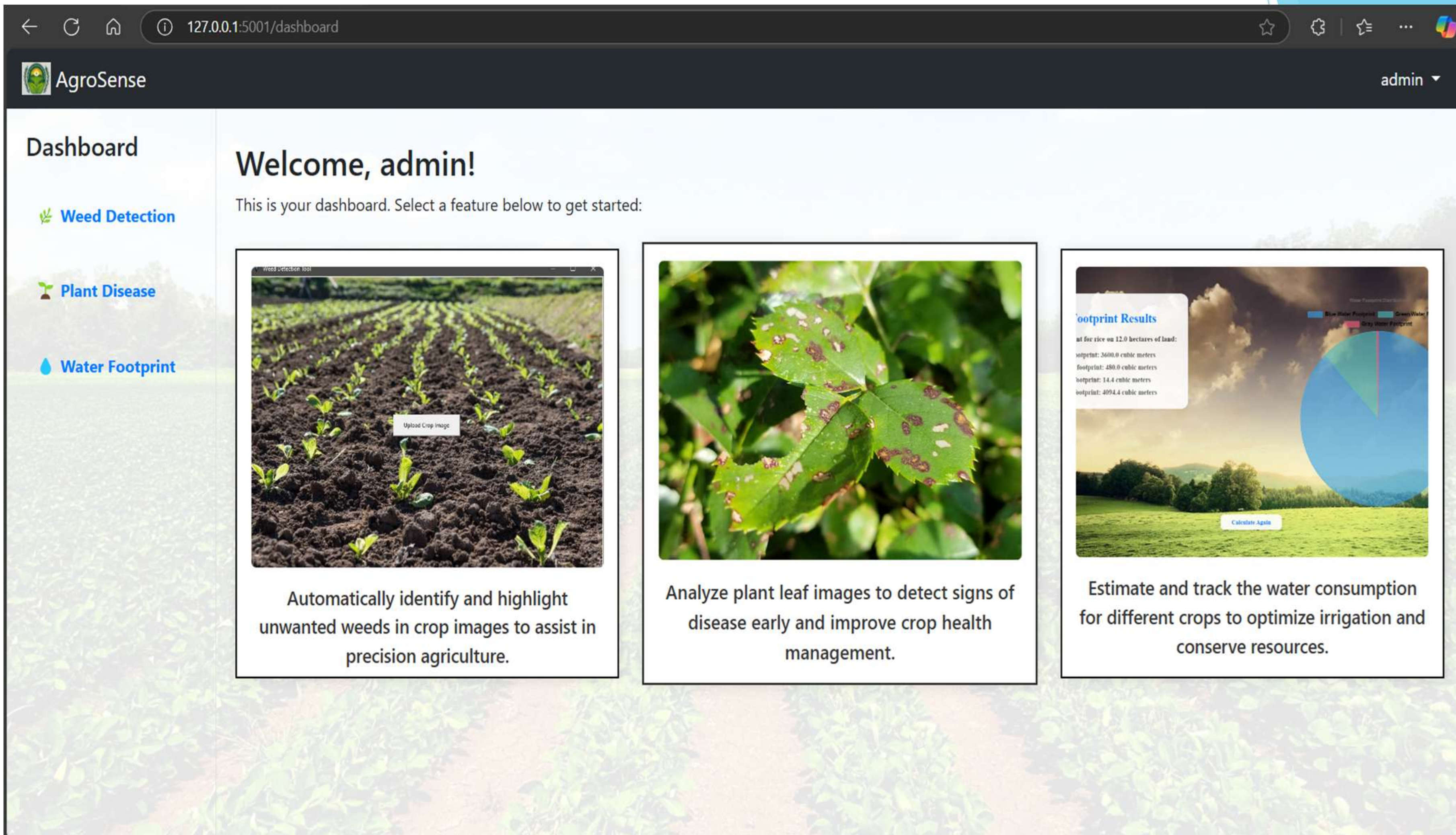


Proposed System Architecture consists of Input Layer, Data Integration Layer, Data Processing layer and User Interface.

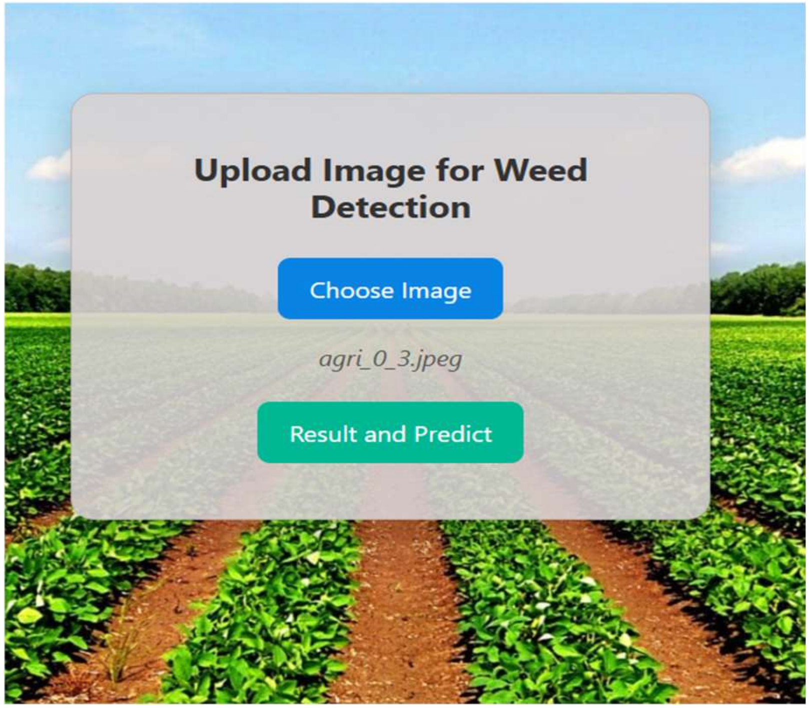
Implementation Status



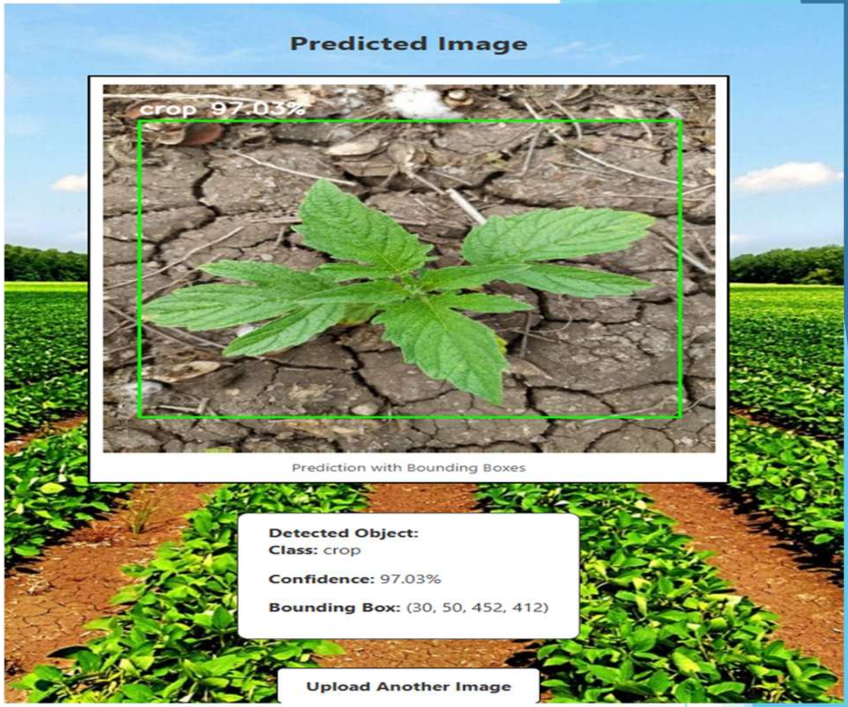
Home Page


127.0.0.1:5001/dashboard
AgroSense
admin
Dashboard
Weed Detection
Plant Disease
Water Footprint
Welcome, admin!
This is your dashboard. Select a feature below to get started:
Automatically identify and highlight unwanted weeds in crop images to assist in precision agriculture.
Analyze plant leaf images to detect signs of disease early and improve crop health management.
Estimate and track the water consumption for different crops to optimize irrigation and conserve resources.

Dashboard



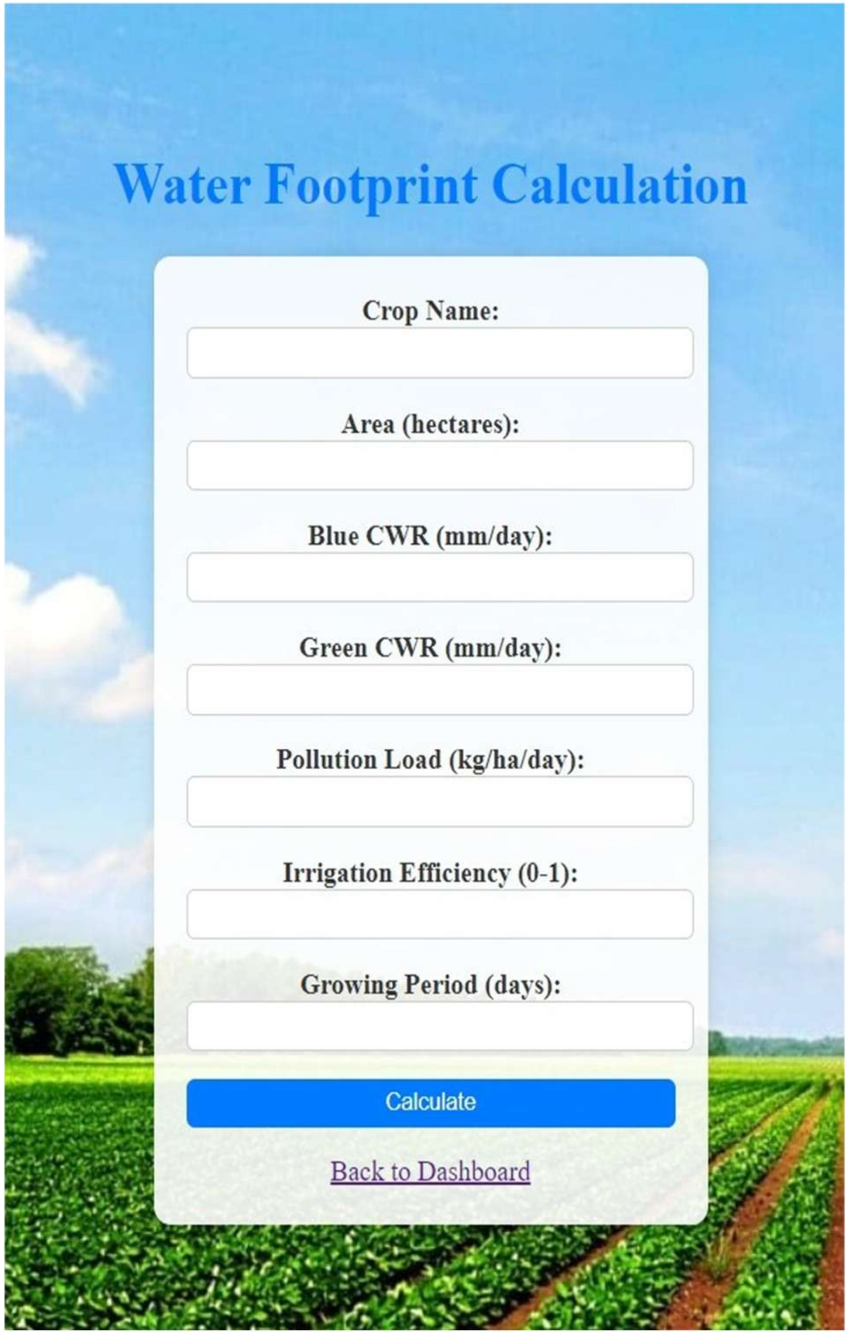
User Input for crop



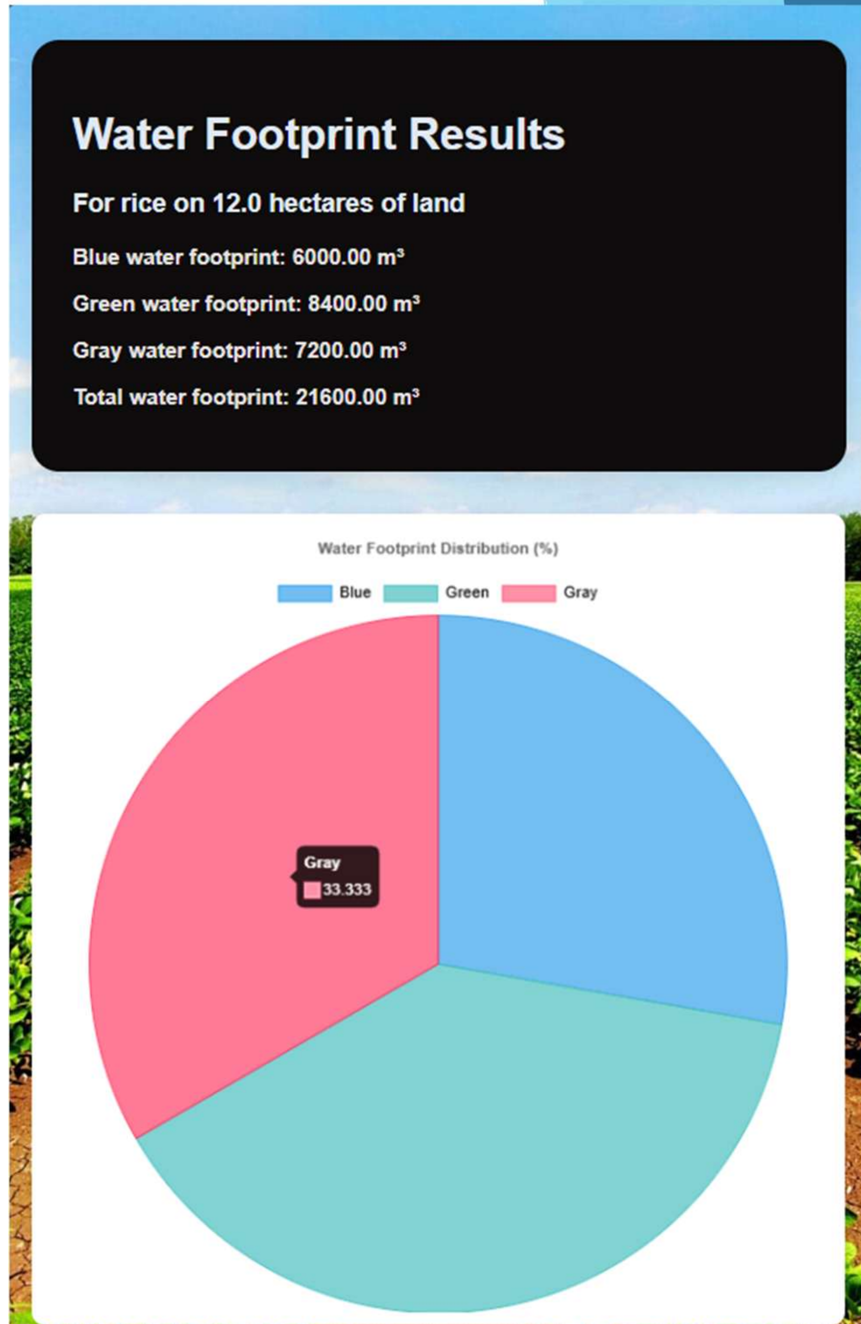
crop and weed detection result

User Input for plant

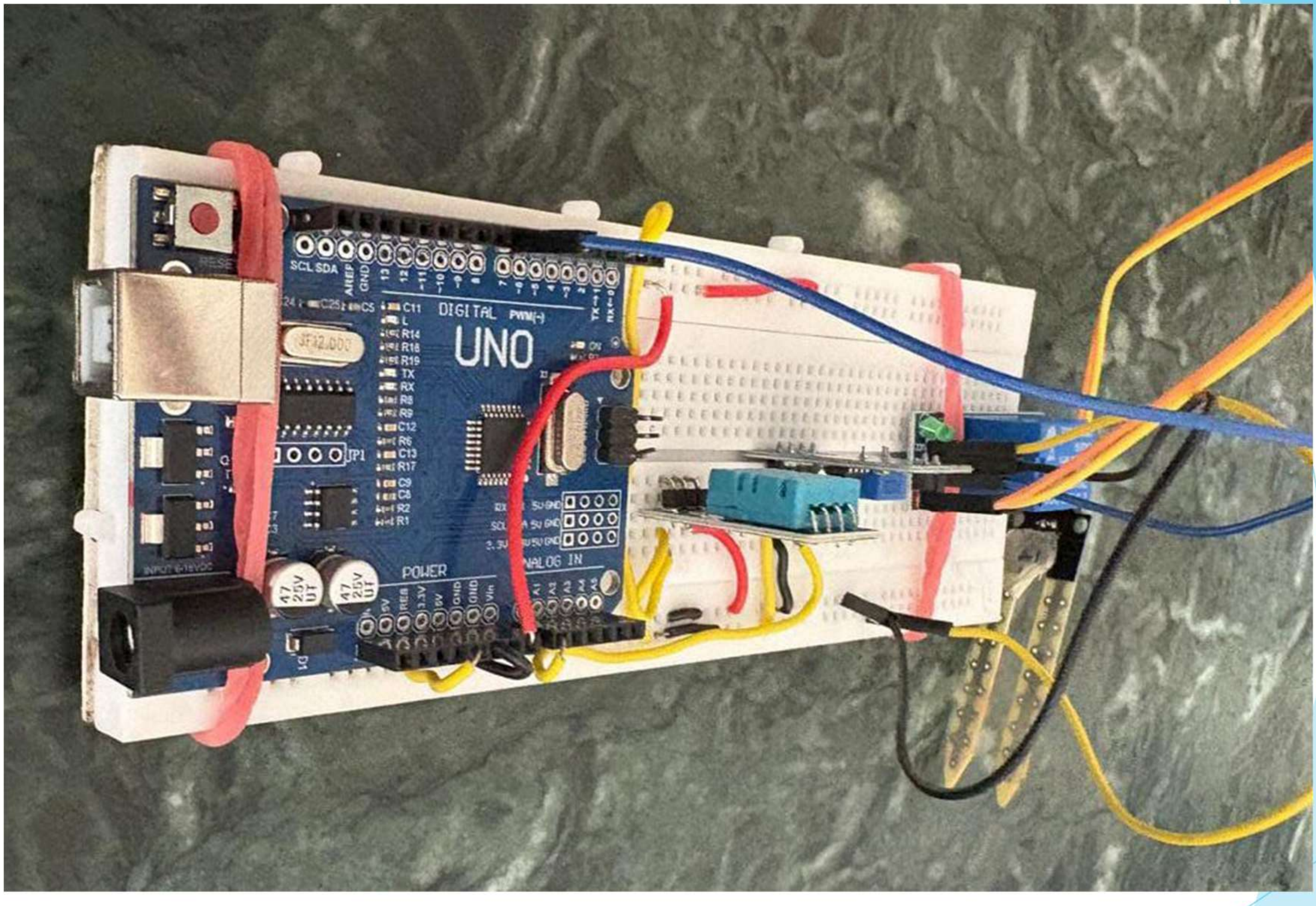
Plant Disease Detection



Water Footprint Input



Result



Hardware Component for Soil Moisture Sensor

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Thank You...!!