PARSHWANATH CHARITABLE TRUST'S

A.P. SHAH INSTITUTE OF TECHNOLOGY

Department of Computer Science and Engineering

Data Science

Title of your Project

AgroSense: ML-Powered Solutions for Sustainable Agriculture

Group No. 07

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Project Guide

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Abstract

Weed detection using machine learning. This project uses machine learning to make farming more efficient and environmentally friendly. It focuses on four important tasks to help farmers manage their crops better. First, the system can automatically detect weeds, or unwanted plants, in fields using image processing, allowing farmers to remove weeds without damaging their crops. Second, it predicts soil moisture levels, helps farmers with irrigation management, and gives predictive soil moisture, which saves water and reduces waste. Third, the system calculates the water footprint, or the amount of water used to grow each crop, so that farmers can manage their water resources more efficiently. Finally, it monitors the health of crops in real-time, spotting issues like plant stress or nutrient deficiencies early, so farmers can fix problems before they affect the harvest. This project combines technology and agriculture to improve crop yields, reduce water use, and promote sustainable farming practices.

Introduction

The Smart Agriculture System 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.

Objectives

The Smart Agriculture System project integrates modern 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 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.

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 recent 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	AGRIGRAS: Precision Farming for Unwanted Plant Detection Control	Sameer Bobde , Mayur Jagtap, Rushikesh Dawane, Om Karve, Prof . Pranjali kuche	2020	The proposed algorithm has the advantage of detecting weeds present between the plants in the crop lines. It also detects effectively as crop plants even those that are outside the crop lines, which is an objective difficult to achieve with other methods using computational vision.	Limitations high computational cost and difficulty in obtaining high-quality data. Image processing algorithms for weed detection also have drawbacks such as accuracy issues, lighting sensitivity, crop variability, and computational cost.
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	we analyze and predict the temperature and humidity usingIoT and linear regression algorithm in machine learning. In ancient days, people use tocheck the climate conditions by seeing clouds or through storm warnings or by usinganimals they have noticed the weather conditions for many purposes like harvestingand 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

Literature Review

Sr.no	Title	Author(s)	Year	Methodology	Drawback
7	Water Footprint Assessment: Evolvement of a New Research Field	Arjen Y. Hoekstra	2017	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.

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 hinder 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.
2. 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.
3. Detecting unwanted plants early allows for targeted herbicide application, reducing chemical use and cost.
4. 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 and computer vision algorithm
- Soil moisture monitoring: Gradient Boosting Machine(GBM)
- Water footprint: Mass balance analysis algorithm
- Crop health monitoring: Machine Learning (SVM, Random Forest, Decision Tree)

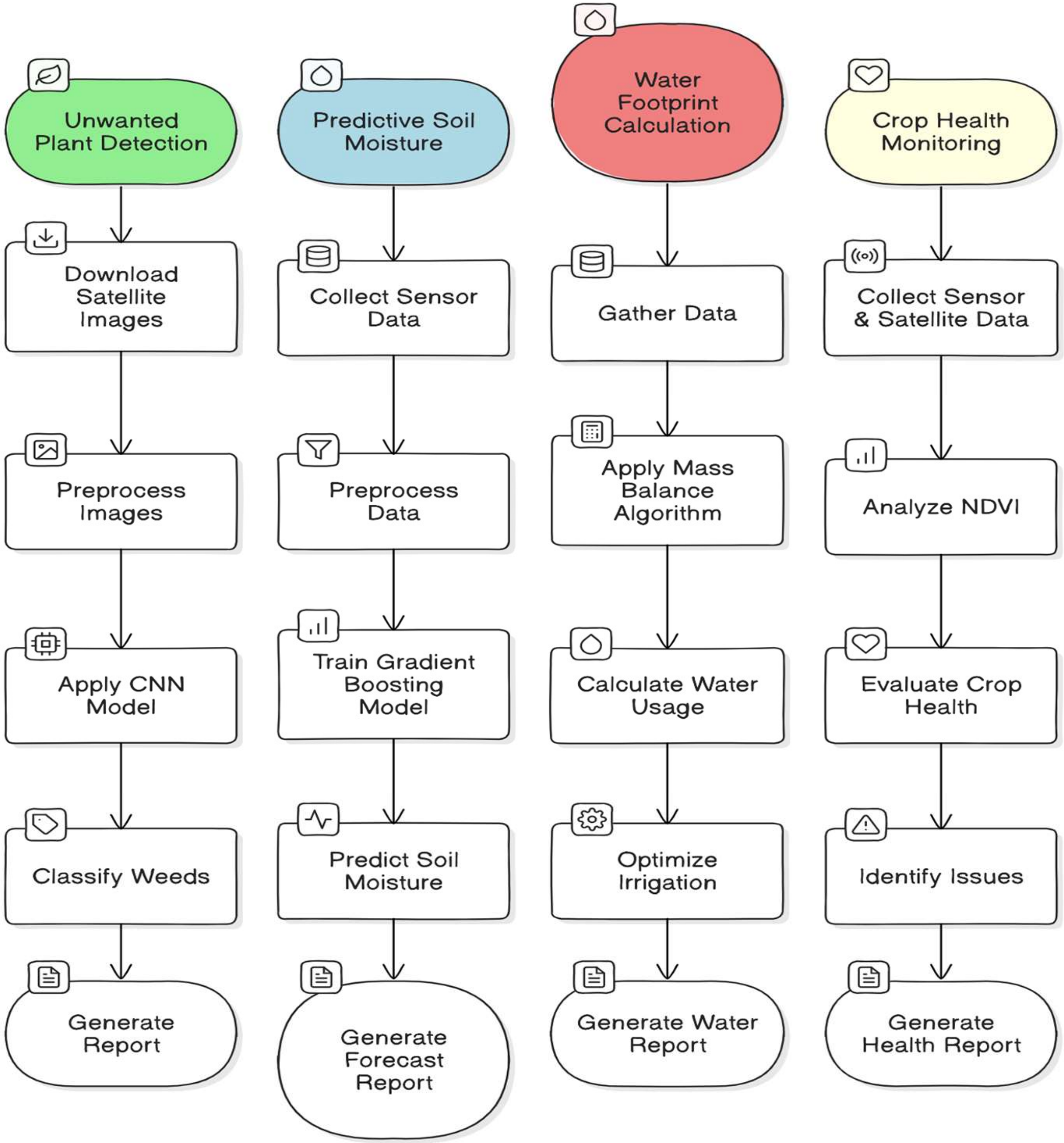
Language :

- Python (libraries – TensorFlow, Pytorch, OpenCV, and deep learning models)
- Python (Flask, Django): for building the backend.
- JavaScript (React, Angular): for building frontend.

Data Handling and Management:

- NoSQL (MongoDB) : for dealing with large, unstructured datasets like image annotations or data collected through sensors.

Proposed system architecture/Working



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Thank You...!!