Aqua Growth

An intelligent machine learning-based hydroponic system for predicting plant growth, recommending nutrient mixes, and optimizing environmental parameters

CO/PO & SDG Mapping

COs: CO1: Apply ML to real-world problems
CO2: Design intelligent systems
CO3: Analyze and optimize performance

POs: PO1: Engineering knowledge
PO2: Problem analysis
PO3: Solution design
PO5: Use of modern tools
PO7: Environmental sustainability

SDGs: SDG 2 (Zero Hunger), SDG 6 (Clean Water), SDG 12 (Responsible Consumption), SDG 13 (Climate Action)

Outcome of the Project : Research Paper

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Project Abstract

Overview

Aqua Growth is an intelligent hydroponic monitoring and recommendation system that integrates machine learning models with environmental data to optimize plant growth in soilless farming. The system predicts plant development, suggests nutrient mixes, selects the best hydroponic system, and tunes growth conditions such as pH, light, and temperature.

Key Objectives

•**Predict Plant Growth:** Forecast growth rate using environmental and nutrient data .

•**Recommend Nutrient Mixes:** Suggest ideal NPK and micronutrient levels for each crop.

•**Optimize Conditions:** Adjust parameters like pH, EC, light, and temperature.

•**System Suggestion:** Choose the most suitable hydroponic method based on plant needs.

•**Enable Sustainability:** Improve yield while minimizing resource usage.

Approach

•Developed and trained ML models (Linear Regression, Decision Tree, Random Forest, XGBoost).

•Preprocessed and analyzed a multidimensional dataset with 750 entries.

•Designed a Streamlit-based web interface for user interaction and real-time recommendations.

•Evaluated models using metrics like R^2, RMSE, and MAE.

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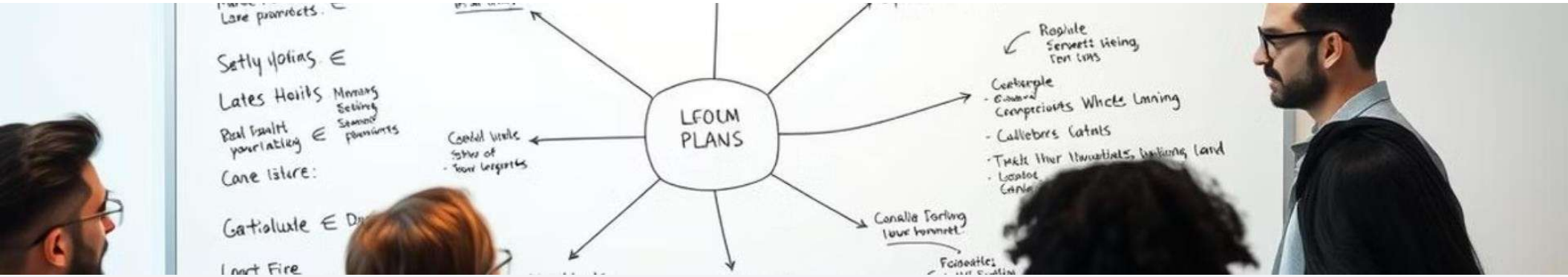


Project Goals and Objectives

1 Plant Growth Prediction

Accurately forecast growth rates using environmental and nutrient data..

2 Nutrient Mix Recommendation

Suggest precise NPK and environmental values..

3 Optimization of Growth Conditions

. Fine-tune pH, temperature, light, EC, etc., for maximum yield.

4 Hydroponic System Selection

Recommend suitable systems based on real-time parameters.

Alignment with UN Sustainable Development Goals (SDGs)

SDG 2: Zero Hunger

Increased food security through high-yield systems

SDG 6: Clean Water

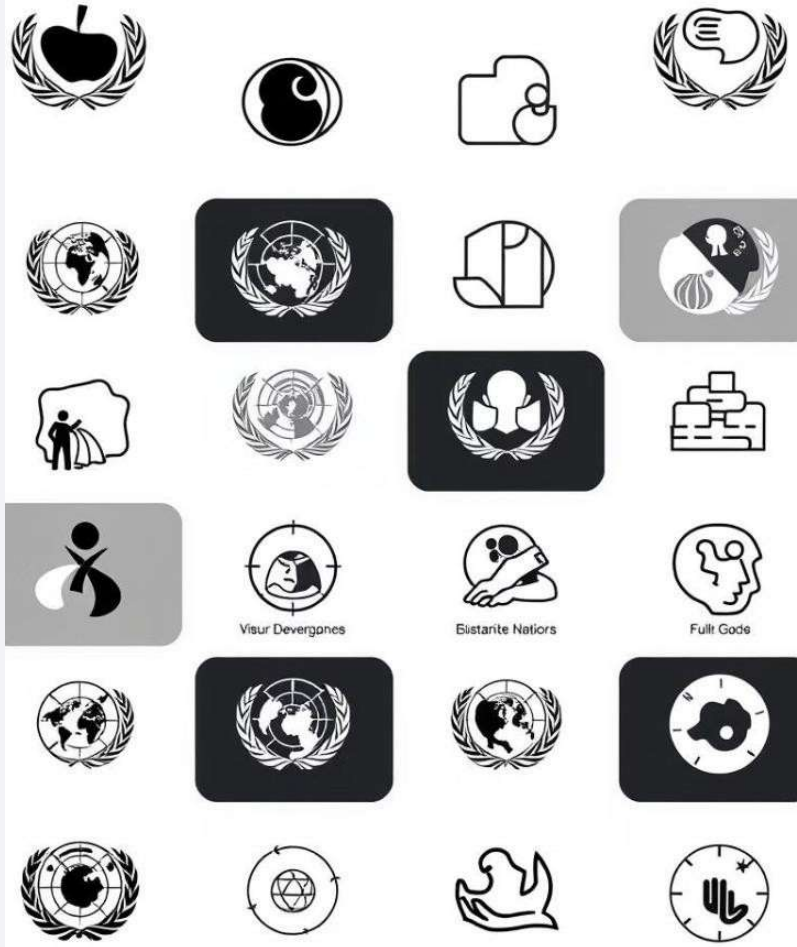
Water-saving hydroponic systems.

SDG 12 : Responsible Consumption and Production

Minimizes water, nutrient, and energy waste via data-driven optimization.

SDG 17: Partnerships for the Goals

Sustainable food production with low carbon footprint.



Methodology and Approach

1

Data Collection

Collected a dataset of 750 samples covering plant growth metrics, environmental factors (temperature, pH, EC, humidity), and system types (NFT, Drip, Ebb & Flow).

2

Data Preprocessing

Handled missing values, standardized features, encoded categorical data, and split the dataset into training (80%) and testing (20%).

3

Model Development

Implemented and trained machine learning models: Linear Regression, Decision Tree, Random Forest, and XGBoost for prediction and recommendation.

4

System Implementation

Developed a user-friendly web dashboard using Streamlit, allowing users to input conditions and receive real-time growth predictions and system recommendations.

Expected Outcomes and Impact

Improved Plant Growth Prediction

Accurate forecasting of growth rates with ML models

Optimized Resource Usage

Reduces water and nutrient waste through data-driven recommendations.

System Recommendations

Suggests the most suitable hydroponic system (NFT, Drip, or Ebb & Flow) based on real-time conditions.

Empowered Sustainable Farming

Promotes high-yield, low-resource farming practices, supporting precision agriculture and environmental sustainability.

Key Project Deliverables

Web-Based Dashboard	A Streamlit-based web app providing real-time predictions, system recommendations, and nutrient suggestions.
Trained ML Models	Well-optimized machine learning models (Random Forest, XGBoost) for growth forecasting and system selection.
Sustainable Development Integration	Supports UN SDGs (2, 7, 12, 13) by enabling resource-efficient, low-waste, high-yield urban farming using smart, soilless systems.

Next Steps and Conclusion

1 **Integrate IoT Sensors**

Enable real-time data collection for live monitoring and dynamic recommendations..

2 **Expand Dataset**

Include more plant types and failure cases to improve model accuracy and generalization..

3 **Enhance the Dashboard**

Add mobile app support, visual analytics, and user customization features.