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International Water Resources Association
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XIX WORLD WATER CONGRESS
International Water Resources Association (IWRA)
Marrakech, Morocco| 1-5 December 2025

Kingdom of Morocco
Ministry of Equipment and Water

Smart Agriculture System: Integrating AI and Embedded

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Presentation date

Introduction

- Agricultural challenges: irrigation, disease detection, pest control
- Technology as a key enabler for modern farming

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Problem Statement

- Inefficient water usage
- Delayed detection of plant diseases
- High dependency on manual labor

Importance of AI & Embedded Systems

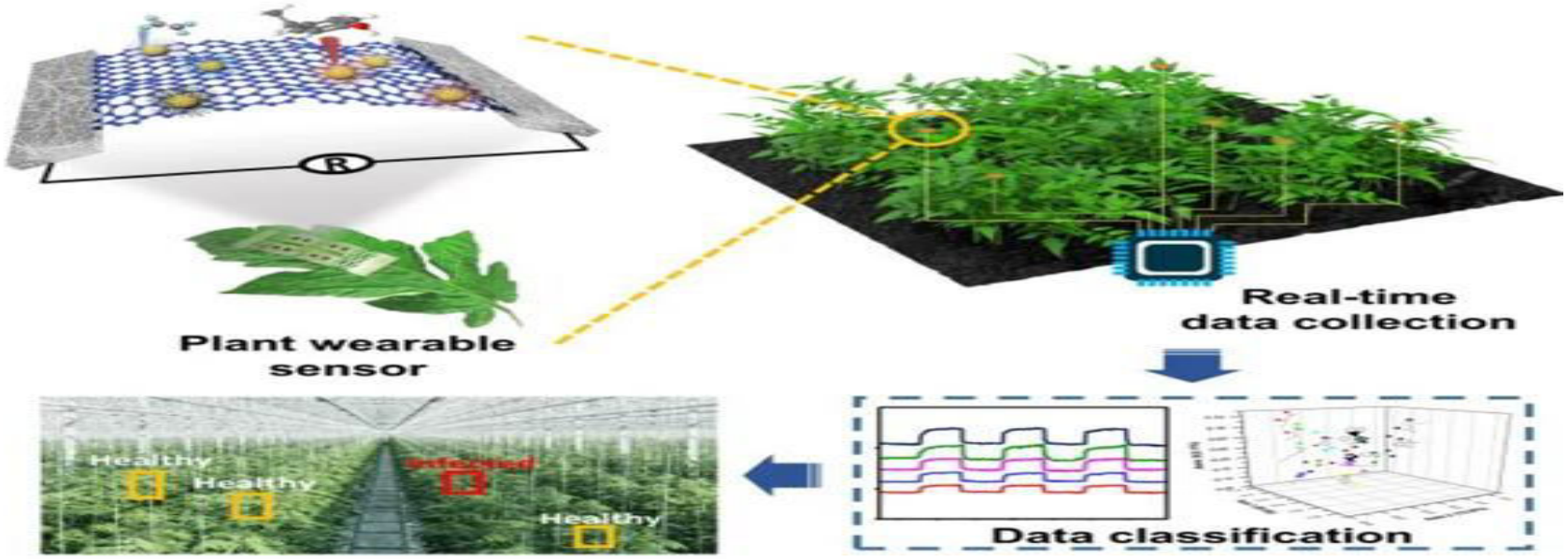
- Improves precision and decision-making
- Automates key agricultural processes
- Reduces cost, time, and human intervention

Role of AI in Agriculture

- Crop monitoring and early disease detection
- Predictive irrigation and sustainable resource use
- Supports precision agriculture practices

Project Objectives

- Automate plant health monitoring using AI

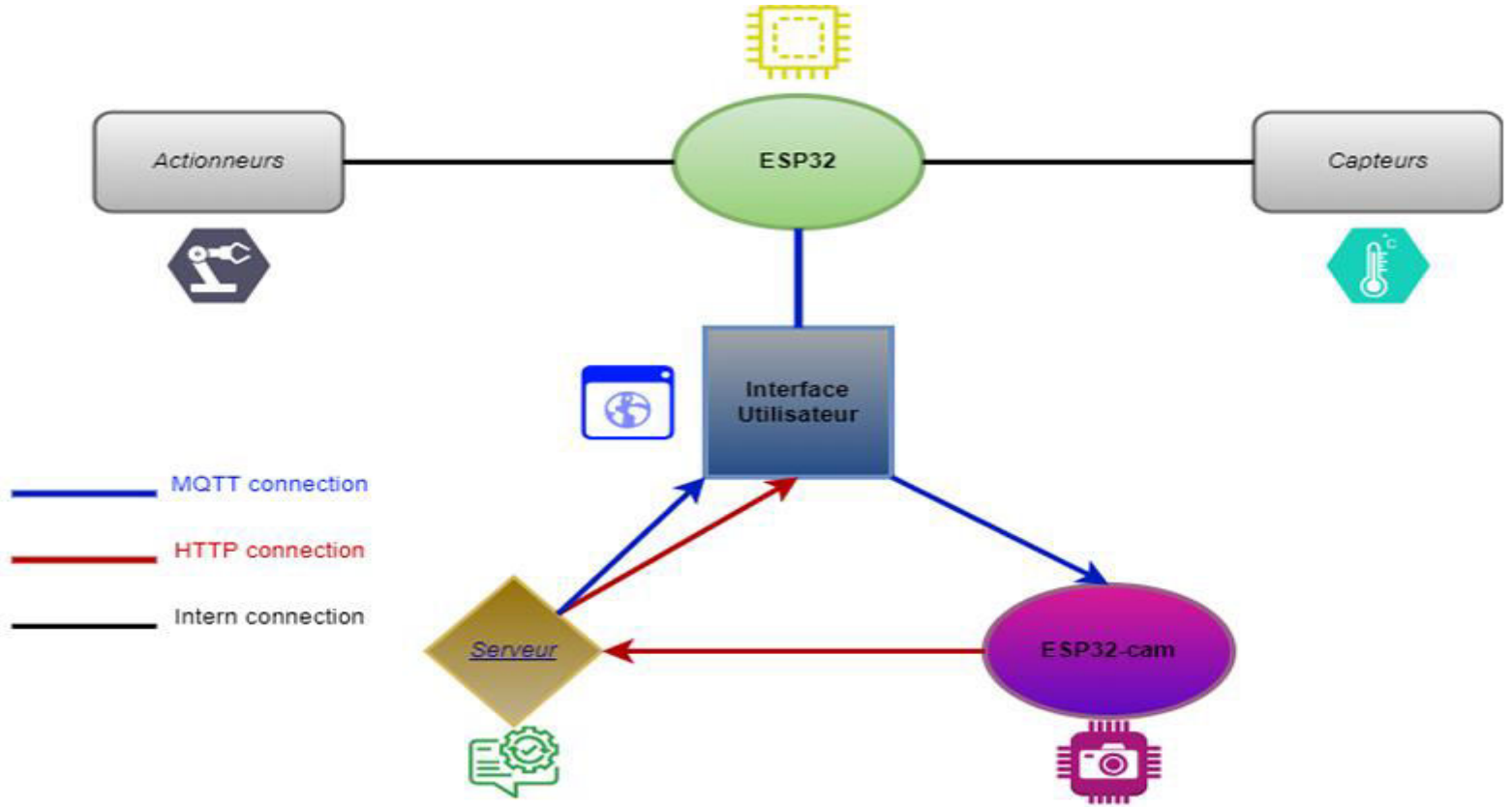


Project Objectives

- Optimize irrigation and solar exposure
- Provide real-time user interface for farmers

System Architecture

- Data flow: Sensors → ESP32 → AI Server → Node-RED UI



System Overview

- Integration of sensors, actuators, AI models, and user interface
- ESP32 acts as the system's central controller

Sensors & Actuators Used

- FC-28 (Soil Moisture), DHT22 (Temp & Humidity)
- LDR (Light Sensor), MAX471 (Current)
- ESP32-CAM (Imaging), Pumps, Servos, Relays

AI Model – ResNet-50

- Trained on PlantVillage dataset with 98% accuracy
- Classifies plants as Healthy or Diseased
- Fine-tuned for specific plant disease detection

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Software Stack

- Arduino IDE – microcontroller programming
- Python & TensorFlow – AI model training
- Node-RED – dashboard visualization
- Mosquitto MQTT – data communication

Plant Health Detection Module

- ESP32-CAM captures plant images
- AI model performs analysis and sends results
- Alerts displayed in real-time on the dashboard

Environmental Monitoring Module

- Continuous soil and air condition tracking
- Automatic irrigation activation based on thresholds

Solar Tracking & Dome Control

- LDR sensors adjust servos for solar optimization
- Dome opens/closes automatically for plant protection

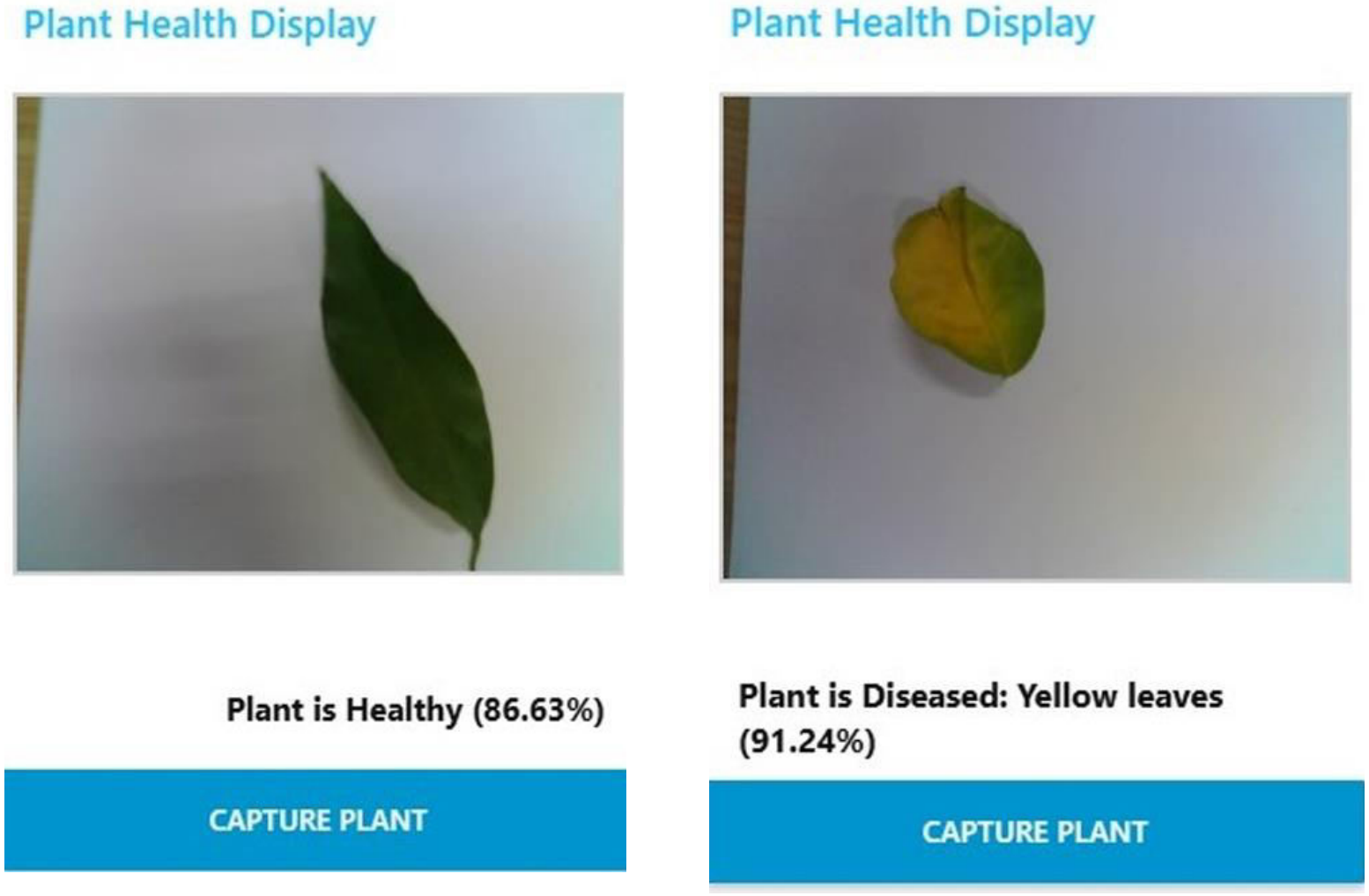
User Interface (Node-RED)

- Interactive dashboard for monitoring and control
- Manual and automatic modes available
- Notifications and historical data access

Experimental Results

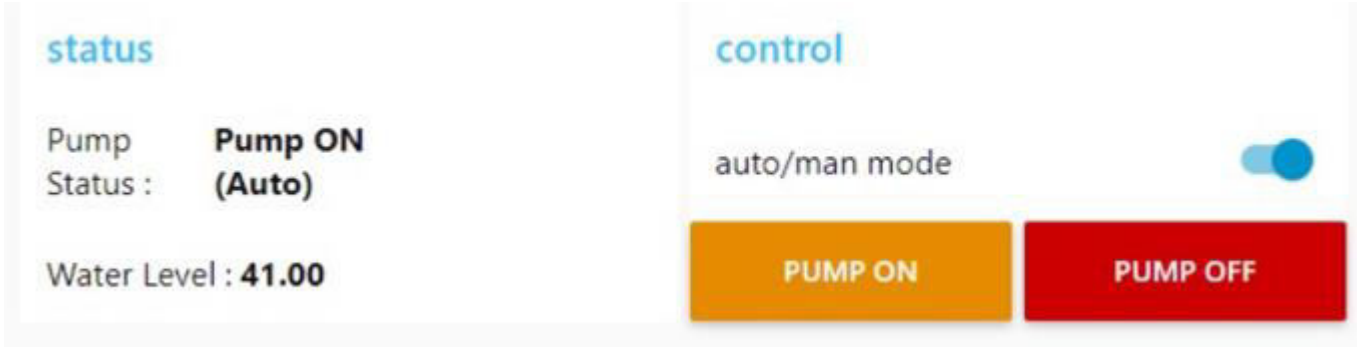
- Sensor data visualized in Node-RED dashboard
- AI model achieved 98% accuracy
- Real-time predictions: Healthy vs Yellow Leaves

Experimental Results



Database – Irrigation

- Records irrigation events: Time, Status, Mode
- Supports performance analysis and history tracking



Future Perspectives

- Multi-model AI for diverse crops and diseases
- Web-based UI using React or Vue.js
- Predictive analytics and energy optimization

Conclusion

- Smart integration of AI and IoT improves farming efficiency
- System enables automation, monitoring, and sustainability

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Thank you!

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