AI-Powered Smart Plant Management System

M. Sri Varsha Shwetha[1], B. Siva Raman[2], R. Rajesh [3], E. Lakshman Raj [4], S. C. Shabin Raj[5]

[1] Assistant Professor, Department of Information Technology, Meenakshi College of Engineering, Chennai, Tamil Nadu, India

[2-5]Student, Department of Information Technology, Meenakshi College of Engineering, Chennai, Tamil Nadu, India

---***---

Abstract -*An AI-based smart plant management system is designed for plant farming in the greenhouse. The idea is to measure the soil's moisture content and provide an automatic watering system to maintain the soil moisture level for the plant shown.The major goals are to increase the soil'sproductivity and to regulate the amount of water used by each plant, planted in the soil. Soil Moisture Sensor (SMS), Temperature Sensor (TS), Automatic Water System (AWS), Water Flow Controller (WFC), Solar Panel, and Battery are the hardware devices used. An AI-powered control and management algorithm is deployed for the smart management of plants in this work and also a database is created to house all of the plant data required for the management. A web application is developed that enables remote monitoring of the plant management system.*

1. INTRODUCTION

The setting of greenhouse plant farming can be improved with an intelligent plant management technology. By controlling the required devices, we will construct an experimental analysis of soil accuracy level and water flow level. The project's "CONTROL AND MANAGEMENT (C&M) ALGORITHM" is its main contribution, which accurately identifies the soil and water level. The technique is divided into the following three modules: 1.INFORMATION MODULE SYSTEM (IMS), 2.PERFORMING STATE (PS) and 3. ANALYSIS OF EXECUTION STATE (AES) for this purpose. The experimental setup shows the details of the first three techniques. Each plant and tree has been assigned a special plant ID in this intelligent plant system (for instance, "plant name: mango; plant ID: CMM03) that is maintained in a database.

2. EXISTING SYSTEM

[1]In the existing work a Deep Learning based algorithm is used in maintaining the soil Productivity. In the DL based approaches a Long-Short Term memory Network was used in connecting the hardware devices. Smart farming involve the use of smart Meters, Wireless sensor Network, Aerial vehicles, Smart camera Node, soil Moisture WSN, Satellite Imagery etc. In this project using so many sensorsLike Temperature, Humidity and soil Moisture sensor will used. To calculate the values of soil Moisture level of the plant/tree.

3. PROPOSED SYSTEM

In our proposed work a smart plant management system in green house environment is developed, using the Control & Management Algorithm. For improving the soil productivity the control part of the algorithm is usedand to maintain the water level the management part of the algorithm is used. Finally, through the Web app developed, the AI will alert the user incase if any problem is encountered in the automatic watering system, to check the status of the plant in the green house.

a. AI→DATABASE→INSTRUCTION→WEB→ALERT SMS.
b. AI→AUTOMATIC WATER SYSTEM→WATER FLOW CONTROLLER →WEB APP.
c. AI→SOIL MOISTURE SENSOR→TEMPERATURE SENSOR→WEB APP.
Above are the various AI connectives with devices. A web application is designed for controlling and monitoring the AI based system.

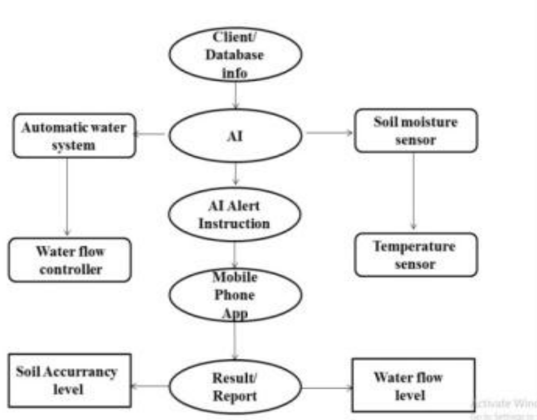


Figure 1: Block Diagram of the System

4. LIST OF MODULES

4.1. Information Module System (IMS)

The first step is the pre-process of the information which is done in the Information Module system (IMS).In this modulethe AI will be connected with different hardware devices that are required. All the information about the plantsis stored in the database and a database is created. AI gets its needed information from this database.

MY SQL Workbench

This MySQL database system contains the details about the plant and is accessible using the MySQL software.

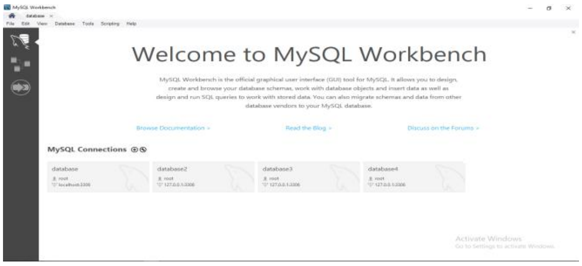
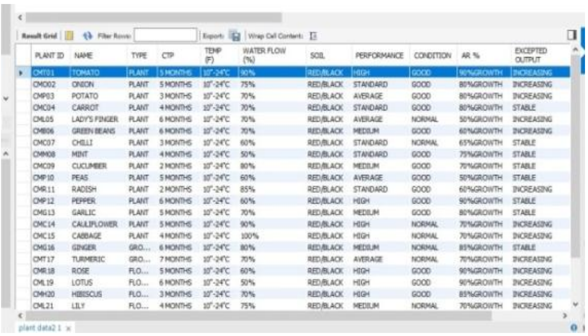


Figure 2: My SQL

Data Base

The following table shows a database list of a variety of plants, including ground plants, flowers, greenhouse plants, etc. Each data list will be represented by a unique plant ID, such as (Onion -CMO02).



PLANT ID	NAME	TYPE	CTP	TEMP (F)	WATER FLOW (%)	SOIL	PERFORMANCE	CONDITION	AR %	EXCEPTED OUTPUT
CMT01	TOMATO	PLANT	5 MONTHS	10°-24°C	90%	RED/BLACK	HIGH	GOOD	90%GROWTH	INCREASING
CMO02	ONION	PLANT	5 MONTHS	10°-24°C	75%	RED/BLACK	STANDARD	GOOD	80%GROWTH	INCREASING
CMP03	POTATO	PLANT	3 MONTHS	10°-24°C	70%	RED/BLACK	AVERAGE	GOOD	80%GROWTH	INCREASING
CMC04	CARROT	PLANT	4 MONTHS	10°-24°C	70%	RED/BLACK	STANDARD	GOOD	80%GROWTH	STABLE
CML05	LADY'S FINGER	PLANT	6 MONTHS	10°-24°C	70%	RED/BLACK	AVERAGE	NORMAL	50%GROWTH	INCREASING
CMB06	GREEN BEANS	PLANT	6 MONTHS	10°-24°C	70%	RED/BLACK	MEDIUM	GOOD	60%GROWTH	INCREASING
CMC07	CHILLI	PLANT	3 MONTHS	10°-24°C	60%	RED/BLACK	STANDARD	NORMAL	65%GROWTH	STABLE
CMM08	MINT	PLANT	4 MONTHS	10°-24°C	50%	RED/BLACK	STANDARD	GOOD	75%GROWTH	STABLE
CMC09	CUCUMBER	PLANT	2 MONTHS	10°-24°C	80%	RED/BLACK	MEDIUM	GOOD	70%GROWTH	STABLE
CMP10	PEAS	PLANT	5 MONTHS	10°-24°C	60%	RED/BLACK	AVERAGE	GOOD	50%GROWTH	STABLE
CMR11	RADISH	PLANT	2 MONTHS	10°-24°C	85%	RED/BLACK	STANDARD	GOOD	60%GROWTH	INCREASING
CMP12	PEPPER	PLANT	6 MONTHS	10°-24°C	60%	RED/BLACK	HIGH	GOOD	90%GROWTH	STABLE
CMG13	GARLIC	PLANT	5 MONTHS	10°-24°C	70%	RED/BLACK	MEDIUM	GOOD	80%GROWTH	STABLE
CMC14	CAULIFLOWER	PLANT	5 MONTHS	10°-24°C	90%	RED/BLACK	HIGH	NORMAL	70%GROWTH	INCREASING
CMC15	CABBAGE	PLANT	4 MONTHS	10°-24°C	100%	RED/BLACK	HIGH	NORMAL	70%GROWTH	INCREASING
CMG16	GINGER	GRO...	6 MONTHS	10°-24°C	80%	RED/BLACK	MEDIUM	NORMAL	85%GROWTH	STABLE
CMT17	TURMERIC	GRO...	7 MONTHS	10°-24°C	70%	RED/BLACK	AVERAGE	NORMAL	70%GROWTH	INCREASING
CMR18	ROSE	FLO...	5 MONTHS	10°-24°C	60%	RED/BLACK	HIGH	GOOD	90%GROWTH	INCREASING
CML19	LOTUS	FLO...	6 MONTHS	10°-24°C	50%	RED/BLACK	HIGH	GOOD	90%GROWTH	INCREASING
CMH20	HIBISCUS	FLO...	3 MONTHS	10°-24°C	70%	RED/BLACK	HIGH	GOOD	85%GROWTH	INCREASING
CML21	LILY	FLO...	4 MONTHS	10°-24°C	75%	RED/BLACK	MEDIUM	NORMAL	70%GROWTH	INCREASING

Database Table 1

4.2 Performing State (PS)

The second module is the Performing State, here the connectivity among the water storage and Automatic water system (AWS) and Water Flow controller(WFC) is established. In this step AI monitors the flow of water to the soiland maintains the flow to be less than or equal to (<=) Average flow level 50-60% of water level Accuracy.

Arduino UNO Kit

The Arduino UNO kit has been designed to communicate with devices in order to regulate programmer's functional specifications. It also has an automatic water system and a water flow controller attached to it. A Web app's AI will be linked to the AI which will detect the soil moisture level using the sensor.

Figure 3: Arduino UNO

Arduino IDE

For the smart planting system an Arduino UNO is used,it communicates with the Arduino IDE to get the data from the sensors. Additionally, a Web app that is connected will automatically alert and notify. And it serves as a bridge between the Arduino Nano Board and the web app.

5V Relay module

To regulate the load, for powering the lighting system, motor, or solenoid.We utilize the 5V relay module. Aside from that, it can switch between AC and DC voltages. The relay's specs determine the maximum voltage and current that the 5V relay module can regulate.

Figure 4: 5V Relay

4.3 Analysis of Execution State (AES)

The Third step is the On-Process which is carried out in the Analysis of Execution state module. In this modulethe soil moisture sensor will detect the soil Accuracy/Water level, and if any decrease in moisture level is noticed the AI will detect it and send an alert notification to theWeb app.

Soil Moisture Sensor

The soil moisture sensor measures how moist the soil is. Two parallel-aligned probes are present in this sensor. This sensor's detecting method involves running current through its probes and measuring the resistance present in the space between them. Less water is present when the soil is dry. Probes show more resistance and less current flow through this water. Similar to this, more water-containing soil conducts electricity through these sensors, causing less resistance to be observed. By using this resistance, the sensor's controlling module determines the moisture level.

Figure 5: Soil Moisture Sensor Module.

Web Application

In this project, using a web application of site will be used a Node MCU ESP8266 of Wi-Ficonnected to Arduino uno of kit. It will be programmed for user can create or using existing to see the plant status and have alert message to particular Web number or manually setup the Web number. Also shown a plant ID Report and details for particular plant system.

CONTROL & MANAGEMENT ALGORITHM

STEP 1 : Pre-Process of IMS

STEP 2 : AI connected

STEP 3 : >>CONTROL ALGO<< (1-5)

STEP 4 : AI check in DATABASE

STEP 5 : CONDITION 1-about Plant Details

STEP 6 : CONDITION 2-AI instruction to Web.

STEP 7 : CONDITION 3- Web app to Alert a message is

a. Seed name and
b. Perimeter of Distance.

STEP 8 : WORKING PROCESS of Performing state, AI Programmed.

STEP 9 : CONDITION 4-AI connected with AWS

STEP 10 : CONDITION 5-Water motor and water system

STEP 11 : >>MANAGEMENT ALGO<< (6-10)

STEP 12 : CONDITION 6-Automated Water system (AWS) connected with Water Flow Controller (WFC)

STEP 13 : CONDITION 7-Attach solar panel with battery for power charge to SMS

STEP 14 : ON-PROCESS of AES, AI INSTRUCTION BASED.

STEP 15 : CONDITION 8- processing with sensor

STEP 16 : CONDITION 9- AI monitoring the sensor

STEP 17 : CONDITION 10- Hence AI Alert to WebApp

STEP 18 : Switch case REPORT (C&M)

STEP 19 : PRE-PROCESS

STEP 20 : WORKINGPROCESS

STEP 21 : ON-PROCESS

5. SYSTEM FLOW CHART

This project's work will serve as a smart plant management system for greenhouse farming, and project-related experimental work will be used to maintain the garden. For instance, when there is no water flow in the soil, AI/SMS will recognize it and send a notification to the Web app. Additionally, theWeb app will inform on whether the water flow is increasing or decreasing. All of these experimental labor procedures will be based on algorithm requirements for certain greenhouse plants.

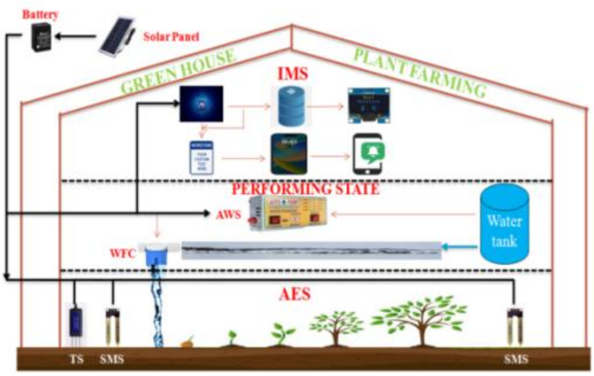


Figure 5: Architecture Diagram

6. Result and Discussion

This project effort uses artificial intelligence to represent the goal of smart planting for greenhouse farming. The IMS's first stage is the pre-processing phase, during which the AI will be linked to various hardware and need components. All plant-related information is kept in a database. AI is able to access information from databases.

The second stage of the AI working process is the connection between the water storage and the automatic water system (AWS) and water flow controller (WFC). Water is flowing into the soil for less than or equal to (=) to an average flow level of between 50% and 60% of the accuracy of the water level.

The third phase of the on-process analysis is the detection of the soil moisture sensor, the soil accuracy/water level will be decreased, and AI will identify and alert a notification to the Web app.

Figure 6: Prototype image

Figure 6 was obtained when a prototype or data gathering module was being tested utilizing solar power, a renewable source of energy. The prototype testing was conducted correctly, and the required safety measures were taken to ensure effective data transfer. Based on the data gathered, data are submitted in the Arduino board.

7. CONCLUSIONS

The project's experimental results show that the plant growth rate is consistent with the ambient environment. The main findings of this investigation agree with our expected results even though the soil moisture during the experiment was around 65%.The project's goal is to determine the soil moisture level accurately using the sensor, once this is done, the automatic water flow range will be regulated by AI of AES to maintain the moisture content of the soil required by the plant sown in the soil. This research will be beneficial for greenhouse farming and gardening maintenance systems. In future the smart plant management technique can be designed in such a way it can be extended to actual farming in large scale lands and farmers can be profited from this smart planting technique.

ACKNOWLEDGEMENT

Our involvement in this project as students of information technology of engineering will be helpful for GREEN house farming and gardening with the aid of fully experimental procedure that is successfully operating.

REFERENCES

[1] V. Nasir and F. Sassani, “A review on deep learning in machining and tool monitoring: Methods, opportunities, and challenges,” Int. J. Adv. Manuf. Technol., vol. 115, no. 9, pp. 2683–2709, May 2021.

[2] L.-R. Jácome-Galarza, M.-A. Realpe-Robalino, J. Paillacho-Corredores, and J.-L. Benavides-Maldonado, “Time series in sensor data using state of-the-art deep learning approaches: A systematic literature review,” in Communication, Smart Technologies and Innovation for Society. Singapore: Springer, 2022, pp. 503–514.

[3] A. Khanna and S. Kaur, “Evolution of Internet of Things (IoT) and its significant impact in the field of precision agriculture,” Comput. Electron. Agricult., vol. 157, no. 1, pp. 218–231, 2019.

[4] M. Catelani, L. Ciani, A. Bartolini, C. Del Rio, G. Guidi, and G. Patrizi, “Reliability analysis of wireless sensor network for smart farming applications,” Sensors, vol. 21, no. 22, p. 7683, Nov. 2021.

[5] M. Lezoche, J. E. Hernandez, M. D. M. E. Alemany Díaz, H. Panetto, and J. Kacprzyk, “Agri-food 4.0: A survey of the supply chains and technologies for the future agriculture,” Comput. Ind., vol. 117, May 2020, Art. no. 103187.

[6] T. Ojha, S. Misra, and N. S. Raghuwanshi, “Wireless sensor networks for agriculture: The state-of-the-art in practice and future challenges,” Comput. Electron. Agric., vol. 118, pp. 66–84, Oct. 2015.

[7] R. Rayhana, G. G. Xiao, and Z. Liu, “Printed sensor technologies for monitoring applications in smart farming: A review,” IEEE Trans. In strum. Meas., vol. 70, pp. 1–19, 2021.

[8] K. Alibabaei et al., “A review of the challenges of using deep learning algorithms to support decision-making

in agricultural activities," Remote Sens., vol. 14, no. 3, p. 638, Jan. 2022.

[9] K. Alibabaei, P. D. Gaspar, and T. M. Lima, "Crop yield estimation using deep learning based on climate big data and irrigation scheduling," Energies, vol. 14, no. 11, p. 3004, May 2021.

[10] K. Alibabaei, P. D. Gaspar, E. Assunção, S. Alirezazadeh, and T. M. Lima, "Irrigation optimization with a deep reinforcement learning model: Case study on a site in Portugal," Agricult. Water Manage., vol. 263, Apr. 2022, Art. no. 107480.