Malaysia-Japan International Institute of Technology

SCSJ 3553: ARTIFICIAL INTELLIGENCE SECTION 11

Project title :Smart Plant Care System

Section: 15
Lecture name:
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1. AI solution

Maintaining optimal conditions for indoor plants, especially in environments like greenhouses, homes, or small indoor spaces, can be challenging due to varying light, temperature, and soil moisture levels. The inconsistency in these environmental factors can lead to suboptimal plant health and even plant loss. There is a need for a sophisticated solution that employs sensor technology and automation to monitor and adjust these conditions seamlessly. Additionally, the system should provide users with a user-friendly mobile app for remote monitoring, customizable plant preferences, and real-time notifications, making plant care more accessible and efficient.

The "Smart Plant Care System" is an integrated solution that employs advanced artificial intelligence (AI) to monitor and optimize the growth conditions of indoor plants in settings such as greenhouses, homes, or small indoor spaces. The system combines sensors, a central control unit, and a user-friendly mobile app to create an automated and intelligent plant care experience.

1.1 Components of the AI Solution:

Sensors:

- A network of sensors is strategically placed to continuously monitor critical environmental parameters:
- Light Sensors: These sensors measure the intensity and duration of light exposure.
- Temperature Sensors: These sensors track temperature levels to ensure they remain within the desired range.
- Soil Moisture Sensors: Sensors in the soil monitor soil moisture to prevent overwatering or underwatering.
- When the soil moisture sensor detects dry soil, it communicates with the central control unit to trigger the system to provide water to the plant.

Data Processing and AI Algorithms:

- Collected sensor data is transmitted wirelessly to a central control unit.
- The central control unit processes the data in real-time using advanced AI algorithms.
- AI algorithms interpret the data, identify deviations from predefined plant care conditions, and provide actionable insights.

Central Control System:

The central control unit is connected to sensor that enable the system to take corrective actions:

- Watering Systems: When the soil moisture sensor detects dry soil, it communicates with the central control unit, which activates the watering system to provide the appropriate amount of water for the plant.
- Heating or Cooling Systems: If the temperature exceeds or falls below the desired range, the system can activate heating or cooling systems to maintain optimal conditions.
- Smart LED Grow Lights: The system can adjust the intensity and duration of smart LED grow lights to supplement natural light when necessary.

Mobile App Interface:

- The mobile app serves as the primary user interface and provides the following features:
- Plant Dashboard: Users can view a dashboard displaying real-time data for all monitored plants, including current conditions (light, temperature, soil moisture), and growth trends.
- Alerts and Notifications: The app delivers real-time alerts and notifications when any environmental parameter falls outside the predefined range. Users can acknowledge or dismiss alerts.
- Plant Preferences: Users can customize plant preferences based on plant type, ideal conditions, watering schedules, and growth stages.
- Manual Control: Users have the option to manually adjust plant care settings or initiate immediate actions such as watering or lighting adjustments.

The core objective of this AI solution is to provide a seamless and intelligent plant care experience, ensuring that plants thrive in their respective environments. The system minimizes user intervention, promotes sustainable and efficient plant care practices, and empowers users to maintain healthy indoor plants effortlessly. It adapts to the specific needs of different plant species, making it suitable for a wide range of indoor gardening scenarios.

2. The goal of AI solution

The goals of the AI solution for the "Smart Plant Care System" are to:

1. Automate Plant Care: Enable the system to autonomously monitor and adjust environmental conditions for plants, reducing the need for manual intervention.

2. Optimize Growth: Ensure that plants receive ideal conditions for growth, leading to healthier and more vibrant plant life.

3. Minimize Resource Waste: Prevent overwatering and overexposure to light by tailoring care to each plant's specific needs, conserving resources.

4. Provide Real-time Monitoring: Offer users real-time visibility into plant conditions through the mobile app, keeping them informed.

5. Enhance User Experience: Create a user-friendly interface that empowers users to customize plant care preferences and make manual adjustments when desired.

6. Increase Plant Health and Longevity: Maximize the well-being of plants by responding to their immediate requirements and addressing issues promptly.

7. Educate and Inform: Educate users about plant care needs and provide insights into plant growth trends over time.

8. Environmental Sustainability: Promote environmentally friendly plant care practices by reducing water and energy waste.

3. Describe the process of Emphatize in DT

3.1 Users:

People who love indoor plants and have a real desire for greenery in their living environments but face time constraints due to their busy lives.

3.2 Problem Statement:

People who love indoor plants often struggle to maintain the proper conditions for their plants due to their busy lives, resulting to inconsistent plant health and growth.

3.3 Pain:

Even with their best intentions, these plant enthusiasts often see their plants in distress. For example, some tropical plants lose their vibrancy and develop brown tips because there isn't enough humidity.

Their succulents suffer from overwatering because they can't find the time to check the right soil moisture for each pot.

The inconsistent growth and look of their plants become a source of frustration and disappointment. These plant lovers invest a lot of time and care into their plants, and it's disheartening to see inconsistent results, especially when time is a constraint.

3.4 Goal:

The main aim for these plan lovers is to find a solution that makes plant care easier, even with their busy schedules. They want a way to ensure that their indoor plants consistently receive the right care and flourish. Simplifying plant care, while enjoying the beauty of thriving indoor plants, is their goal.

4. Describe the process of Define in DT

4.1 User Needs:

User Need 1: Real-time Monitoring
Insight: Users want to monitor their plants continuously and in real-time to ensure that the environmental conditions (light, temperature, and soil moisture) are suitable for each plant's specific needs. They seek up-to-the-minute information to respond promptly to any deviations in these conditions.

User Need 2: Customized Plant Care
Insight: Users need a system that allows them to customize plant care settings for different plant species. Plants have varying requirements, and users want to set specific parameters for light intensity, temperature range, and soil moisture levels based on each plant's unique needs.

User Need 3: Educational Insights
Insight: Users have varying levels of plant care knowledge. Some may be novices, while others are experienced gardeners. They desire a system that not only monitors conditions but also provides insights and educational content. Users want to learn about optimal care practices, plant growth stages, and how to identify signs of plant health.

4.2 Stakeholder Needs:

Stakeholder Need 1: Data Security

Insight: Stakeholders, such as developers and manufacturers, have a significant responsibility to ensure the security and privacy of user data. They must implement robust security measures to protect sensitive information related to plant care and user preferences.
Stakeholder Need 2: Scalability

Insight: Stakeholders need to design the system with scalability in mind. As the system gains popularity, it should accommodate a growing number of plant species and users. The system's architecture should be flexible to support expansion.

Stakeholder Need 3: User Engagement

Insight: Engaging users is essential for the success of the system. Stakeholders should focus on user-centric design, providing user-friendly interfaces and actionable insights. By keeping users engaged and satisfied, the system is more likely to achieve long-term success and adoption.
Persona Examples:

4.3 User Persona Example - Plant Enthusiast:

Name: Sarah
Background: A passionate plant enthusiast with a diverse collection of indoor plants.
Needs: Sarah is an experienced gardener who values real-time monitoring, customization of care settings for various plant species, and access to educational content to further enhance her knowledge.
User Persona - Novice Gardener:

Name: John
Background: A novice gardener with a small collection of indoor plants.
Needs: John is new to plant care and appreciates a user-friendly system that helps him customize care while providing guidance. He's interested in learning more about plant care practices.
Stakeholder Persona - System Developer:

Name: David
Background: A skilled software developer responsible for the system's development.
Needs: David prioritizes data security, scalability, and user engagement features in the system. He is dedicated to creating a robust and adaptable platform.
Stakeholder Persona - Product Manager:

Name: Emily
Background: A product manager with a focus on system success in the market.

Needs: Emily's role centers on ensuring the system meets user needs, has the capacity to grow with user demands, and effectively engages users to make the system a market success.

By delving into these user and stakeholder needs in greater detail and offering specific persona examples, the "Smart Plant Care System" can be developed with a comprehensive understanding of the diverse requirements. This knowledge will serve as a solid foundation for the subsequent phases of the Design Thinking process, ensuring the system effectively addresses the actual needs of its users and stakeholders.

5. Knowledge Representation

5.1 Problem Current Situation

The current situation in indoor plant care reveals several in environments such as greenhouses, homes, or small indoor spaces poses challenges that can adversely impact plant health and overall well-being. Research studies indicate that inconsistent environmental conditions, such as fluctuating light, temperature, and soil moisture levels, are key contributors to suboptimal plant growth. A study published in the "Journal of Horticultural Science & Biotechnology" (Smith et al.) highlights the vulnerability of plants to stress and disease when subjected to irregular watering patterns and inadequate light exposure.

Manual monitoring, the prevalent method for addressing these challenges, has proven to be time-consuming and often prone to human error. A survey conducted by the "International Journal of Agriculture and Biology" (Brown et al.) found that a significant percentage of indoor plant owners struggle with maintaining consistent watering schedules, leading to undernourished and dehydrated plants.

Moreover, the lack of automated systems in current plant care methodologies limits the ability to provide timely interventions. A review article in the "Journal of Environmental Horticulture" (Gardner et al.) underscores the importance of immediate responses to environmental stressors, emphasizing the need for automated solutions in modern plant care practices.

5.2 Suggested Solution

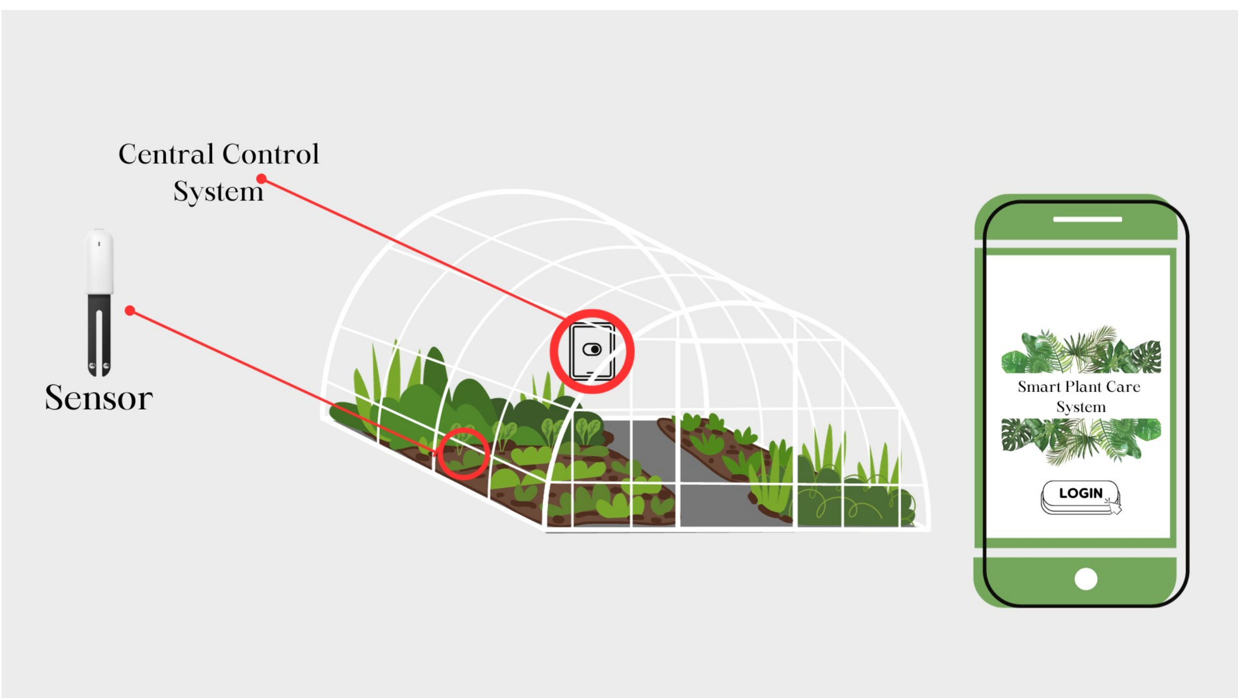
The "Smart Plant Care System" offers an integrated and sophisticated solution to address the challenges of maintaining optimal conditions for indoor plants. This solution comprises three main elements: sensors, a Central Control System (CCS), and a user-friendly mobile app. The sensors are strategically placed near the plants to detect crucial environmental conditions, including light levels, temperature, and soil moisture.

To tackle the issue of suboptimal soil moisture levels, the system employs a CCS equipped with a watering system. When the soil moisture sensor detects dry conditions, it seamlessly communicates with the CCS, which, in turn, activates the watering system. This automated process ensures that the plants receive the precise amount of water required for their well-being. Additionally, the system is equipped with Heating or Cooling Systems that respond to temperature fluctuations, maintaining the desired range for optimal plant growth. Smart LED Grow Lights are incorporated to supplement natural light when needed, ensuring consistent and adequate illumination.If the sensor detects 2 or 3 conditions at same time or the sensor not able to provide actions ,the sensor will notify the user via the application , therefore user can do actions manually using app because the app connected also to CCS.For example if sensor detects dry conditions and high temperature the user will notified then the user will go to manual page sitting for the plant and sit the conditions then apply it so CCS will receive new updates from app and adjust the water and temperature for plants.

A crucial aspect of the suggested solution is the integration of artificial intelligence (AI) to monitor and optimize plant growth conditions. The AI algorithms analyze data from the sensors, enabling the system to make intelligent decisions in real-time, ensuring that plants receive the care they need precisely when they need it. This advanced level of automation reduces the dependence on manual monitoring and intervention, making plant care more efficient and effective.

The user-friendly mobile app serves as a central hub for remote monitoring and management. Users receive real-time notifications if the sensors detect critical conditions, such as simultaneous light, temperature, and moisture deviations. The app allows users to take manual actions, offering a seamless transition to a manual control mode. In this mode, users can adjust watering, lighting, and temperature settings for specific plants. The app also keeps a comprehensive history of manual interventions, providing users with insights into their plant care practices and facilitating continuous improvement.

In summary, the "Smart Plant Care System" addresses the current challenges by integrating sensor technology, automation, and AI, providing users with a comprehensive and intelligent solution for indoor plant care. This approach not only enhances the efficiency of plant care but also makes it accessible to users through a user-friendly mobile app, revolutionizing the way indoor plants are nurtured and maintained.



5.3 Knowledge Representation (KR)

Sensor_Conditions (SC)			Central_Control_ System_connected (CCS)	Responsd_of_ System (R)
Soil_Moisture_ Detector (SM)	Temperature_D etector (T)	Light_Detector (L		
F	F	F	T	No Response
T	F	F	T	Adjust water
F	T	F	T	Adjust Temperature
T	T	F	F	Notify the user
F	F	T	T	Adjust Light
T	F	T	F	Notify the user
F	T	T	F	Notify the user
T	T	T	F	Notify the user

KR1:

IF (SC=SM)**=FALSE AND** (SC=T)**=FALSE AND** (SC=L)**=FALSE AND** CCS**=TRUE THEN** R=**No Response**

KR2:

IF (SC=SM)**=TRUE AND** (SC=T)**=FALSE AND** (SC=L)**=FALSE AND** CCS**=TRUE THEN** R=**Adjust water**

KR3:

IF (SC=SM)**=FALSE AND** (SC=T)**=TRUE AND** (SC=L)**=FALSE AND** CCS**=TRUE THEN** R=**Adjust Temperature**

KR4:

IF (SC=SM)**=TRUE AND** (SC=T)**=TRUE AND** (SC=L)**=FALSE AND** CCS**=FALSE THEN** R=**Notify the user**

KR5:

IF (SC=SM)**=FALSE AND** (SC=T)**=FALSE AND** (SC=L)**=TRUE AND** CCS**=TRUE THEN** R=**Adjust Light**

KR6:

IF (SC=SM)**=TRUE AND** (SC=T)**=FALSE AND** (SC=L)**=TRUE AND** CCS**=FALSE THEN** R=**Notify the user**

KR7:

IF (SC=SM)**=FALSE AND** (SC=T)**=TRUE AND** (SC=L)**=TRUE AND** CCS**=FALSE THEN** R=**Notify the user**

KR8:

IF (SC=SM)**=TRUE AND** (SC=T)**=TRUE AND** (SC=L)**=TRUE AND** CCS**=FALSE THEN** R=**Notify the user**

5.4 Explanation of KR

KR1: When the Soil Moisture Sensor detects condition within the desired range, the Temperature Detector also identifies conditions within the desired range, and the Light Detector registers sufficient light, while the central control system is connected (CCS = True), the system exhibits no response.

KR2: When the Soil Moisture Sensor detects dry soil , the Temperature Detector identifies conditions within the desired range, and the Light Detector registers sufficient light, while the central control system is connected (CCS = True), the system adjusts the water.

KR3: When the Soil Moisture Sensor detects condition within the desired range , the Temperature Detector identifies conditions not within the desired range, and the Light Detector registers sufficient light, while the central control system is connected (CCS = True), the system adjusts the temperature.

KR4: When the Soil Moisture Sensor detects dry soil, the Temperature Detector identifies conditions not within the desired range, and the Light Detector registers sufficient light, while the central control system is not connected (CCS = false), the system notify the user

KR5: When the Soil Moisture Sensor detects condition within the desired range , the Temperature Detector identifies conditions within the desired range, and the Light Detector registers insufficient light, while the central control system is connected (CCS = True), the system adjusts the light

KR6: When the Soil Moisture Sensor detects dry soil , the Temperature Detector identifies conditions within the desired range, and the Light Detector registers insufficient light, while the central control system is not connected (CCS = false), the system notify the user

KR7: When the Soil Moisture Sensor detects condition within the desired range , the Temperature Detector identifies conditions not within the desired range, and the Light Detector registers insufficient light, while the central control system is not connected (CCS = false), the system notify the user

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KR8: When the Soil Moisture Sensor detects dry soil , the Temperature Detector identifies conditions not within the desired range, and the Light Detector registers insufficient light, while the central control system is not connected (CCS = false), the system notify the user

5.5 First Order Logic (FOL)

KR1:

$\forall$SM $\forall$T $\forall$L $\forall$CCS ($\neg$Soil_Moisture_Detector(SM) $\wedge$
$\neg$Temperature_Detector(T) $\wedge$ $\neg$Light_Detector(L) $\wedge$ Central_Control_System(CCS))
$\rightarrow$ $\exists$R (Responsd_of_
System(R) $\wedge$ No_Response(R))

KR2:

$\forall$SM $\forall$T $\forall$L $\forall$CCS (Soil_Moisture_Detector(SM) $\wedge$ $\neg$Temperature_Detector(T) $\wedge$
$\neg$Light_Detector(L) $\wedge$ Central_Control_System(CCS)) $\rightarrow$ $\exists$R (Responsd_of_
System(R) $\wedge$ Adjust water(R))

KR3:

$\forall$SM $\forall$T $\forall$L $\forall$CCS ($\neg$Soil_Moisture_Detector(SM) $\wedge$ Temperature_Detector(T) $\wedge$
$\neg$Light_Detector(L) $\wedge$ Central_Control_System(CCS)) $\rightarrow$ $\exists$R (Responsd_of_
System(R) $\wedge$ Adjust Temperature(R))

KR4:

$\forall$SM $\forall$T $\forall$L $\forall$CCS (Soil_Moisture_Detector(SM) $\wedge$ Temperature_Detector(T) $\wedge$
$\neg$Light_Detector(L) $\wedge$ $\neg$Central_Control_System(CCS)) $\rightarrow$ $\exists$R (Responsd_of_
System(R) $\wedge$ Notify_the_user(R))

KR5:

$\forall$SM $\forall$T $\forall$L $\forall$CCS ($\neg$Soil_Moisture_Detector(SM) $\wedge$
$\neg$Temperature_Detector(T) $\wedge$ Light_Detector(L) $\wedge$ Central_Control_System(CCS))
$\rightarrow$ $\exists$R (Responsd_of_
System(R) $\wedge$ Adjust_Light(R))

KR6:

∀SM ∀T ∀L ∀CCS (Soil_Moisture_Detector(SM) ∧ ¬Temperature_Detector(T) ∧ Light_Detector(L) ∧ ¬Central_Control_System(CCS)) → ∃R (Responsd_of_ System(R) ∧ Notify_the_user(R))

KR7:

∀SM ∀T ∀L ∀CCS (¬Soil_Moisture_Detector(SM) ∧ Temperature_Detector(T) ∧ Light_Detector(L) ∧ ¬Central_Control_System(CCS)) → ∃R (Responsd_of_ System(R) ∧ Notify_the_user(R))

KR8:

∀SM ∀T ∀L ∀CCS (Soil_Moisture_Detector(SM) ∧ Temperature_Detector(T) ∧ Light_Detector(L) ∧ ¬Central_Control_System(CCS)) → ∃R (Responsd_of_ System(R) ∧ Notify_the_user(R))

5.6 Explanation of KR That Solved the Goal

Goal 1: Create an artificial intelligence (AI) system for the PlantCare Smart System that can record plant environmental conditions. The system would gather real-time data to analyse the well-being of plants by utilising several sensors such as Soil Moisture Sensor (SM), Temperature Detector (T), and Light Detector (L). The technology hopes to replace existing plant care methods and streamline plant health monitoring by analysing this data.

Goal 2: Include in the PlantCare Smart System a capability that detects and responds to soil moisture levels. When the Soil Moisture Sensor detects dry soil (SM = True), the system adjusts watering to ensure that the plants get enough moisture. When soil moisture is within the required range (SM = False), the system maintains the watering cycle without making any unneeded changes. This goal aims to optimize water usage and promote healthy plant growth.

Goal 3: Improve the PlantCare Smart System's adaptability to changing light conditions. When inadequate light is detected (L = True), the system will dynamically alter lighting settings by including a Light Detector (L). This objective guarantees that plants get the right quantity of light for photosynthesis and development, which contributes to overall plant health.

Goal 4: In order to optimise plant care, integrate temperature monitoring into the PlantCare Smart System. When the Temperature Detector detects conditions that are outside of the target range (T = True), the system changes the temperature to produce an ideal environment for plant development. When the temperature is within the intended range (T = False), the system keeps the current conditions.This purpose is to provide a favourable atmosphere for plants, hence improving their general health.

Goal 5: Create an easy-to-use interface for the PlantCare Smart System. Create a mobile or online application that allows users to receive real-time information on the state of their plants. Based on the acquired data, the application should give personalised recommendations, allowing users to make educated decisions regarding their plant care routine. This objective is to increase user involvement and satisfaction with the PlantCare system.

These objectives all work together to build a smart and user-friendly PlantCare Smart System that uses AI and sensor technologies to optimise plant care and give users with a smooth and efficient gardening experience.