Smart Watering System for *Acacia Samanea Saman* Tree Seedlings: Utilizing Soil Moisture Sensors for Optimal Water Level Detection

ICE 414 - Emerging Trends (Microcontroller)

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Introduction:

Acacia Samanea Saman trees are crucial in ecosystems, providing food and shelter for wildlife and helping to prevent soil erosion. However, effective water management is essential to ensure *Acacia Samanea Saman's* well-being, as traditional irrigation methods may compromise the trees' growth and sustainability. This project entitled *"Smart Watering System for Acacia Samanea Saman Trees: Utilizing Soil Moisture Sensors for Optimal Water Level Detection"* uses advanced technology mechanisms, such as optimizing the capability of Arduino Uno and its components, in addressing this challenge. The project will implement a smart watering system that uses soil moisture sensors to provide real-time data on the soil moisture content surrounding the Acacia tree. By analyzing this information, the system accurately determines the tree's precise water needs, helping efficient and optimal watering practices. Using soil moisture sensors not only conserves water resources by preventing unnecessary irrigation but also enhances the health and longevity of Acacia trees. This project aligns with sustainable agriculture and environmental conservation practices, showcasing the potential of technology to improve natural resource management.

Rationale:

Acacia trees require careful consideration for optimal growth. Their deep root systems make them drought-tolerant, but supplemental watering remains crucial during prolonged dry periods. Traditional irrigation methods often prove inefficient, leading to water waste and potential harm to the tree's health. A smart watering system utilizing real-time soil moisture data offers a promising solution. This system precisely determines individual water needs based on specific soil conditions, optimizing water usage and minimizing waste.

Watering Guidelines:

Understanding that Acacia trees thrive on a nuanced approach to watering, the project integrates seasonal variations into its smart system. During the rainy months,

maintaining soil moisture through careful monitoring is key. As the dry season progresses, water needs gradually increase, culminating in peak watering during the summer months. This precise control over water usage ensures the optimal health and vitality of the Acacia trees, demonstrating a deep understanding of their specific requirements.

Plant Characteristics:

The system accounts for the tree's classification as a hardy plant thriving in full sun exposure. Acacias thrive in full sun and well-drained sandy or loamy soil with a pH range of 6.0-7.5. Some delicate species might benefit from light afternoon shade in intense sunlight. Amending poorly drained soil with sand or compost is crucial. While preferring slightly acidic to neutral soil, Acacias tolerate a wider pH range (5.5-8.0). These nitrogen-fixing trees improve soil fertility and make valuable companion plants.

Maturity and Growth:

Designed to optimize water usage, this smart watering system tailors watering practices to each Acacia tree's unique growth stage, typically ranging between 5 and 10 years. Recognizing the critical need for consistent moisture during early development, it delivers deep, infrequent watering that encourages robust root systems for long-term health and resilience.
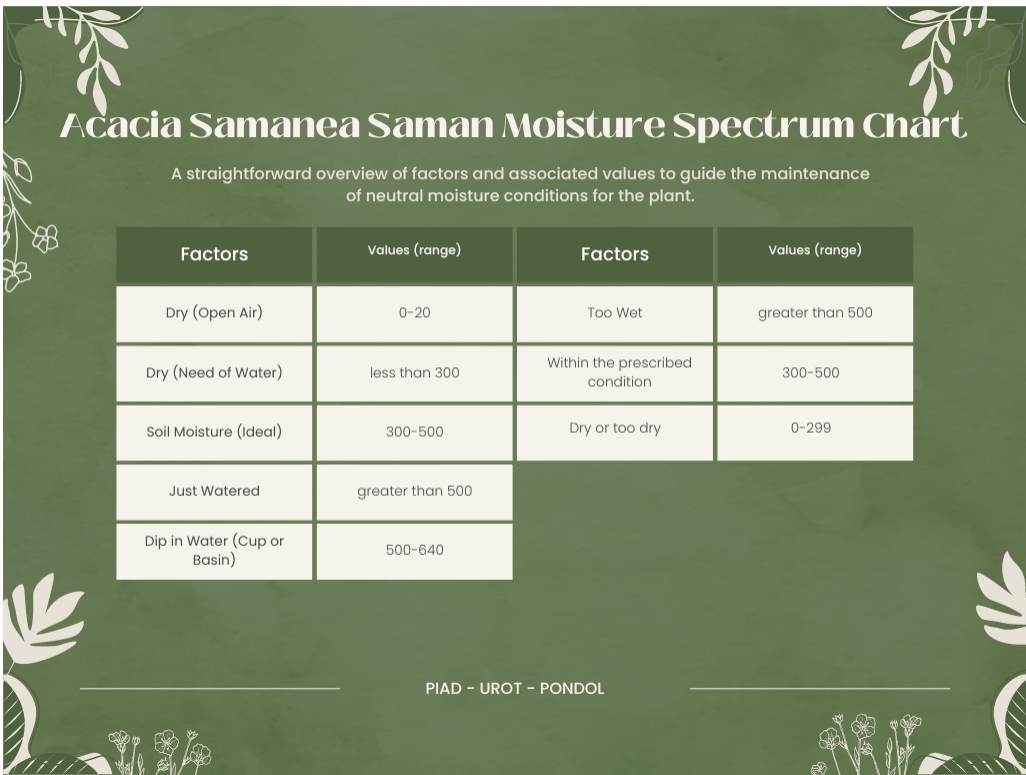
Climate Considerations:

The project considers Acacia trees' diverse temperature and humidity preferences, focusing on thriving in warm to hot climates. These trees typically fall within USDA hardiness zones 8 to 11, which encompass regions with average winter temperatures between 10°F and 40°F (USDA, 2023). As they mature, the smart watering system adapts, recognizing their inherent drought tolerance and adjusting to

drier, less humid conditions. This ensures efficient water usage and optimal growth for each tree, regardless of climate.

Humidity and Disease Mitigation:

The project actively considers the impact of humidity, particularly in regions with higher humidity levels. It emphasizes the importance of adequate air circulation and well-drained soil, which reduces the risk of fungal diseases and demonstrates a holistic approach to tree health and longevity.

***Acacia Samanea Saman* Moisture Spectrum Chart**

Acacia Samanea Saman Moisture Spectrum Chart

A straightforward overview of factors and associated values to guide the maintenance of neutral moisture conditions for the plant.

Factors	Values (range)	Factors	Values (range)
Dry (Open Air)	0-20	Too Wet	greater than 500
Dry (Need of Water)	less than 300	Within the prescribed condition	300-500
Soil Moisture (Ideal)	300-500	Dry or too dry	0-299
Just Watered	greater than 500		
Dip in Water (Cup or Basin)	500-640		

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***Acacia Samanea Saman* Tree and Its Soil Table Interpretation**

The interpretation offered provides a guideline for assessing soil moisture levels for *Acacia Samanea Saman's* Tree, determining appropriate watering practices, and ensuring optimal growth conditions for the tree.

Soil Moisture Percentage = (Moisture/600) x 100%

Factors	Values (Range)	Moisture Percentage (%)
Dry (Open Air)	0-20	**0-3.3%**
Dry (Need of Water)	Less than 300	**3.5%-50%**
Soil Moisture (Ideal)	300-500	**50%-83%**
Just Watered	Greater than 500	**84%-100%**
Dip in Water (Cup or Basin)	500-600	**100%**

Factors	Values (Range)	Moisture Percentage (%)
Too Wet	Greater than 500	**84%-99%**
Within the prescribed condition	300-500	**50%-83%**
Dry or too dry	0-299	**0-50%**

Acacia Samanea Saman's **Tree and Its Soil Table Interpretation**

Dry (Open Air):

Range: 0-20

Interpretation: The soil is considered dry when exposed to open air, with a moisture content falling within the specified range of 0 to 20.

Dry (Need of Water):

Range: Less than 300

Interpretation: When the soil moisture is less than 300, it indicates a dry condition, signaling the need for additional watering.

Soil Moisture (Ideal):

Range: 300-500

Interpretation: The ideal soil moisture range falls between 300 and 500, representing optimal conditions for the *Acacia Samanea Saman.*

Just Watered:

Range: Greater than 500

Interpretation: A soil moisture level greater than 500 suggests that the tree has been recently watered.

Dip in Water (Cup or Basin):

Range: 500-640

Interpretation: This range indicates a temporary increase in moisture temperature, possibly due to a recent watering or dipping event involving a cup full of water.

Additional Considerations:

Too Wet:

Range: Greater than 500

Interpretation: Soil conditions are considered excessively wet when the moisture content exceeds 500.

Within the Prescribed Condition:

Range: 300-500

Interpretation: The soil is within the recommended and ideal condition when the moisture level falls within the range of 300 to 500.

Dry or Too Dry:

Range: 0-299

Interpretation: Soil is classified as dry or too dry when the moisture content is 0 to 299.

Components Used:

Name	Quantity	Component
Arduino	1	Arduino Uno R3
L1	1	Red LED
L2	1	Green LED
L3	1	Blue LED
R1, R2, R3	3	220 Ω Resistor
SERVO1	1	Positional Micro Servo
SEN2	1	Soil Moisture Sensor
LCD	1	MCP23008-based, 32 LCD 16 x 2 (I2C)
Syringe	1	12 mL/cc Syringe
Stop Watch	1	Any form of stopwatch

Schematic View:
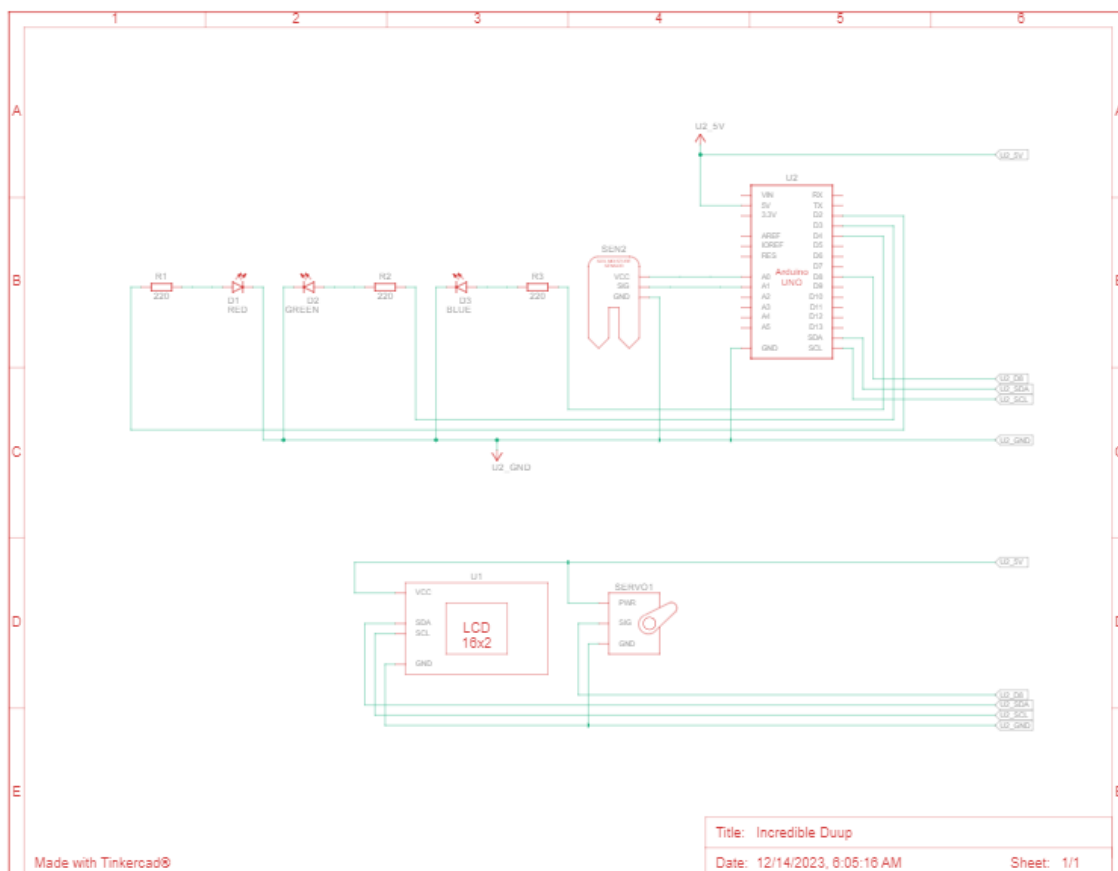
Watering Effects on _Acacia Samanea Saman_ Moisture Levels Over Time: A 1-Hour Observation

Time (minutes)	Water Poured (ml)	Moisture Level (Range)	Description
0	12	201 **(3.4%)**	Initial conditions before watering
1	12	515-563 **(86%-94%)**	Moisture level range one minute after watering
3	12	494-497 **(82%-83%)**	Moisture level range three minutes after watering (Ideal moisture for the plant)
60	12	467 **(78%)**	Moisture level one hour after watering

Conclusion During the Observation:

This Project entitled _"Smart Watering System for Acacia Samanea Saman Trees"_ showcases the potential of technology in addressing the specific watering needs of **_Acacia Samanea Saman Tree Seedlings._** This is made possible by combining a deep understanding of plant characteristics, growth stages, climate considerations, and

technology integration; the Project might also contribute to sustainable agribusinesses and environmental preservation.

With this, the researchers' observed the watering effects (12 ml/cc) over time (1 hour) highlighting the system's effectiveness in maintaining optimal soil moisture conditions for Acacia Samanea Saman tree seedlings.

References:

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