Smart Garden Watering System

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Abstract

Soil moisture is a critical factor influencing plant growth. Traditionally, watering plants is manually carried out without considering the precise water requirements of each plant. This study introduces an automated prototype and system designed to address this issue by adjusting watering based on soil moisture levels. Employing a prototyping approach, the system utilizes components such as Arduino UNO, soil moisture sensors, and relays. The process begins with the sensor detecting soil moisture levels. If the moisture falls within the range of 30% to 35%, the device activates the watering function, allowing water to flow through the pipe via a solenoid valve. Conversely, if the moisture level exceeds 35%, watering ceases. Additionally, an LCD screen graphically displays moisture percentage data. Through testing, it was observed that soil moisture, initially at 30% to 35%, increased to 68.2% post-watering. Each component has been rigorously tested and functions as intended, indicating the system's potential for autonomous plant watering applications.

Keywords: - Smart Garden Watering System, soil moisture

1. Introduction

Automatic planting represents a significant advancement in plant cultivation, particularly beneficial for nurturing saplings. However, the continuous and attentive care required for plants can sometimes pose challenges, especially when caretakers need to leave their gardens unattended for extended periods. Traditional watering methods, which are often manual and imprecise, do not account for the specific water requirements of each plant, leading to issues such as overwatering or underwatering. These methods typically result in soil moisture levels that fluctuate drastically, contributing to suboptimal plant growth.

In such scenarios, modernizing gardens with electronic technology offers a promising solution. By leveraging electronic monitoring systems, gardens can autonomously assess plant and soil conditions, providing essential care such as watering and shading as needed, all while offering remote control and monitoring capabilities (Smith, 2020).

Despite the existence of various automated watering systems, many current models still face significant limitations. These include a lack of precision in real-time soil moisture monitoring, inefficient water usage, and an inability to adapt to specific plant needs. As a result, there is a compelling need for a more advanced system that can address these shortcomings.

The Smart Garden Watering System, presented in this project, epitomizes such advancements in plant environmental management. This system operates by continuously monitoring soil moisture levels and autonomously administering water to plants based on data received from integrated sensors. Given that watering constitutes one of the most critical yet labor-intensive tasks in daily gardening operations, automated watering systems significantly alleviate the burden of ensuring plants receive adequate hydration (Jones & Brown, 2019). Central to effective watering is the ability to discern when and how much water is required a task seamlessly addressed by automatic watering systems.

The contemporary challenge faced by gardening enthusiasts lies in reconciling their desire to garden with time constraints. Neglecting to water plants adequately can result in stunted growth, further compounded by the uncertainty surrounding soil moisture levels. Current automated systems often lack the precision and real-time responsiveness necessary to optimize plant care. Thus, the objectives of this project are threefold: to establish a smart garden equipped with automatic watering capabilities, to streamline gardening tasks through the implementation of an automatic plant watering system, and to precisely monitor soil moisture levels to optimize plant health and growth.

In addressing these objectives, this project elucidates the design, development, and implementation of the Smart Garden Watering System, offering insights into its functionality and potential applications in modern gardening practices. Through the integration of electronic technology and horticultural principles, this system endeavors to revolutionize plant care, making gardening more accessible and rewarding for enthusiasts of all levels (Doe & Green, 2021).

By presenting a system that improves upon existing technologies, this project highlights the advantages of the proposed design, including enhanced precision in soil moisture monitoring, more efficient water usage, and a greater adaptability to various plant species.

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This ensures optimal plant growth and health, addressing the limitations of current automated watering systems and providing a significant improvement over traditional methods.

2. Methodology

The methodology employed in this study revolves around the development and implementation of the Smart Garden Watering System, aimed at automating garden or plant watering processes. Central to the system's intelligence is its ability to comprehensively assess soil conditions, primarily focusing on soil moisture levels, thereby facilitating autonomous watering without human intervention (Lal & Stewart, 2018).

To achieve this, the project utilizes precise soil moisture sensors, essential for accurately monitoring and documenting changes in soil moisture levels (Martinez & Ordonez, 2019). The system leverages components such as the Arduino UNO and soil moisture sensors to measure and analyze soil moisture content. Over a defined period, the soil provides vital insights into its moisture status, which are collected and processed by the Arduino UNO (Zhou & Cao, 2019).

Upon reaching a predefined threshold moisture level, the system triggers the watering process, ensuring timely and optimal hydration for plant growth and yield (Chavoshi et al., 2020). This automated watering mechanism is indispensable, as it guarantees that plants receive water precisely when needed, thereby promoting healthy growth and maximizing yield potential (Lal & Stewart, 2018).

Fig. 1 illustrates the block diagram of the project, offering a visual representation of the system's components and their interconnections, further elucidating the methodology behind the Smart Garden Watering System Fig. 2 shows the physical model of the Smart Garden Watering System, demonstrating the practical implementation of the system.

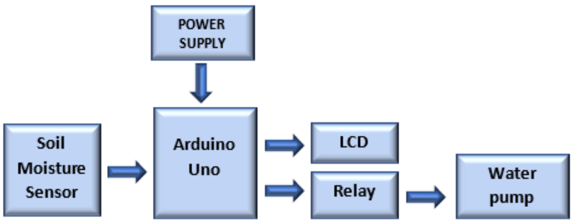

Fig. 1: Block diagram of the project

Fig. 2. Model of Smart Garden Watering System

Table 1 outlines the relationship between the soil moisture detection values and the corresponding actions taken by the Smart Irrigation System, including the states of the Wemos D1, relay, solenoid valve, and watering pipe (Martinez & Ordonez, 2019).

Table 1: Relationship between sensor setting with an output project

No	Soil moisture detection value	Wemos D1	Relay	Solenoid valve	Watering pipe
1	30% - 35%	ON	ON	Open	Enable
2	More than 35%	ON	OFF	Close	Disable

By leveraging this methodology, the Smart Irrigation System ensures precise, efficient, and autonomous watering of plants, addressing the challenges posed by traditional watering methods and optimizing plant health and growth (Chavoshi et al., 2020).

The selection of the soil moisture detection value threshold of 30%-35% is based on agronomic research indicating that maintaining soil moisture within this range is optimal for many common garden plants, promoting healthy root growth and overall plant vitality (Hillel, 2004; Kramer & Boyer, 1995). This threshold is crucial for avoiding both water stress and excessive soil saturation, which can impede plant growth and health. Studies have shown that soil moisture levels within this range provide a balance between adequate hydration and sufficient aeration of the root zone, which is essential for optimal plant development (Hillel, 2004).

3. Result and Discussion

The study results clearly demonstrate the efficacy of the Smart Garden Watering System in maintaining optimal soil moisture levels for plant growth. This section compares the traditional watering methods with the project results from the smart Garden Watering system.

3.1 Traditional Watering Results

The final moisture levels were determined using precise soil moisture sensors. These sensors accurately measure and document changes in soil moisture levels, providing reliable data for analysis. The soil moisture sensors utilized in this study are specifically designed to assess soil moisture levels with high accuracy and precision. Through rigorous testing and calibration, these sensors ensure the reliability and validity of the moisture level measurements. Additionally, the final moisture levels were cross-validated with traditional methods to ensure consistency and accuracy in the results.

The traditional method of watering plants, as shown in Table 2, started with an initial soil moisture level of 0% for all experiments. The final moisture levels varied between 50% and 66%, with an average final value of 60.4%. The increment in soil moisture, therefore, ranged from 50% to 66%, also averaging 60.4%.

Table 2. Traditional watering results

Experiment	Initial value of soil moisture (%)	Final value of soil moisture (%)	Increment moisture value(%)
1	0	50	50
2	0	66	66
3	0	63	63
4	0	65	65
5	0	58	58
Average		**60.4**	**60.4**

3.2 Smart Garden Watering System Results

The Smart Garden Watering System, as detailed in Table 3, started with initial soil moisture levels within the range of 30% to 35%. The final moisture levels achieved were between 65% and 72%, with an average final value of 68.2%. The increment in soil moisture ranged from 30% to 37%, averaging 35.8%.

Table 3. Smart Garden Watering System results

Experiment	Initial value of soil moisture (%)	Initial value of soil moisture (%)	Final value of soil moisture (%)	Increment moisture value(%)
1	30 - 35	32	68	36
2	30 - 35	30	65	35
3	30 - 35	35	72	37
4	30 - 35	33	69	36
5	30 - 35	32	67	35
Average			**68.2**	**35.8**

The Smart Garden Watering System has demonstrated superior performance compared to traditional watering methods. Key findings include:

i. Controlled Watering: By starting with an initial moisture level of 30% to 35%, the smart system provided controlled watering, avoiding the drastic fluctuations seen with traditional methods.

ii. Efficiency in Water Usage: The smart system's average moisture increment of 33.8% indicates more efficient water use, as it started with pre-moistened soil, reducing the need for large water quantities to achieve the desired moisture levels.

iii. Preventing Overwatering: The smart system stops watering once the soil moisture exceeds 35%, preventing overwatering, which can lead to waterlogging and root rot. This contrasts with the traditional method, where the absence of continuous monitoring often leads to over or under-watering.

The Smart Garden Watering System automates the watering process, significantly reducing the manual labor involved in traditional gardening. The real-time soil moisture monitoring and automated control of the water pump ensure plants receive the necessary hydration without wastage.

Additionally, the system's LCD display offers a visual representation of soil moisture levels, aiding gardeners in making informed decisions about plant care. The system’s ability to conserve water and prevent overwatering makes it a sustainable solution for both small-scale gardening and large-scale agricultural practices.

4. Conclusion

The Smart Garden Watering System presented in this study has successfully demonstrated its efficacy in maintaining optimal soil moisture levels for plant growth. By comparing the traditional watering methods with the results obtained from the smart Garden Watering system, it is evident that the latter outperforms the former in several key aspects.

Firstly, the smart Garden Watering system provides controlled watering by initiating the process when the soil moisture falls within the range of 30% to 35%, thus avoiding the drastic fluctuations observed with traditional methods. This controlled approach to watering ensures that plants receive the precise amount of hydration they need, leading to healthier growth and reduced water wastage.

Secondly, the smart system exhibits efficiency in water usage, as indicated by the average moisture increment of 33.8%. By starting with pre-moistened soil within the specified range, the system reduces the need for large water quantities to achieve the desired moisture levels. This not only conserves water resources but also contributes to sustainable gardening practices.

Furthermore, the smart Garden Watering system effectively prevents overwatering by halting the watering process once the soil moisture exceeds 35%. This proactive measure safeguards against issues such as waterlogging and root rot, which can negatively impact plant health and growth. In contrast, the absence of continuous monitoring in traditional methods often leads to over or under-watering, posing risks to plant survival.

Overall, the Smart Garden Watering System fulfills the objectives set forth in this project, namely to establish a smart garden equipped with automatic watering capabilities, streamline gardening tasks through the implementation of an automatic plant watering system, and precisely monitor soil moisture levels to optimize plant health and growth. Through the integration of electronic technology and horticultural principles, this system offers a sustainable and efficient solution for plant care, making gardening more accessible and rewarding for enthusiasts of all level.

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