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IOT-Based Smart Temperature Sensor in Home Balcony Garden

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Abstract: **Green thumbs are common in agricultural nations like India. The majority of individuals enjoy growing plants at home, but they frequently don't give their plants much thought due to work schedules. Intelligent plant growth monitoring with the modernization of conventional gardening techniques is the only way to solve this issue. Thus, the goal of the suggested system is to use automation and Internet of Things technologies to intelligently monitor system expansion, and numerous applications for crop development and growth condition monitoring are available through the Internet of Things (IoT). This project's primary goal is to improve plant development circumstances by using a moisture sensor and a temperature sensor to maintain an appropriate moisture level and temperature. This project helps crops grow while using less water by giving users access to an automated watering system. An effective water management system should be created because people frequently waste a lot of time watering the plants. Automatic watering will be carried out by the suggested system based on the data generated by the sensors and temperature. This system's main benefits are its ability to reduce water use and provide a climate that is conducive to plant growth.**

1. INTRODUCTION

Plants play a vital role in sustaining life and purifying the air from harmful pollutants. While some individuals take on the responsibility of planting trees, others pursue it as a hobby. However, growing plants involves much more than simply placing a seed into the soil. Various factors need to be considered for their healthy development. Certain plants demand extra care to thrive, while others are cultivated for decorative purposes or small-scale agriculture. Plants require specific environmental conditions and periodic watering to facilitate processes like photosynthesis. Additionally, not all plants can grow optimally in the same type of soil or with identical nutrients, as each species has unique needs for maximizing its growth and yield.

To address these challenges, a monitoring system is proposed. This system not only tracks the plant's growth but also provides alerts in case of any issues, ensuring an appropriate environment for their well-being. The concept can be realized through the Internet of Things (IoT), which enables devices and systems to function seamlessly via internet connectivity.

1.1 GENERAL INTRODUCTION

Gardening is a popular pastime and a healthy trend, especially among urban households with limited space, such as balconies. To promote growth, several factors, such a soil moisture, temperature, humidity, and consistent watering, must be present; simply planting the seeds is not enough. Due to hectic schedules, many people in today's fast-paced society are unable to regularly tend to their plants. Therefore, it is now more important than ever to have an intelligent, automated system to keep an eye on and take care of plants. Thanks to technological improvements, especially the Internet of Things (IoT), we can now monitor environmental conditions and plant health in real time and take appropriate measures.

1.2 PROBLEM STATEMENT

Balcony gardens in urban areas, in particular, are usually limited by the inability of gardeners to regularly take care of the plants due to busy schedules. Traditional methods for irrigation and check systems typically include overrated ratings and manual treatments that can lead to underwatering. Uneven resource allocation leads to waste of water, hindering plant growth and lowering overall productivity. Furthermore, there is no direct way to check temperature, air humidity, or soil moisture in real time. These obstacles make it difficult for urban residents and gardeners to care for the plants. Plus, most gardeners can't afford a cost-effective smart solution and practice simple tasks. Systems currently available in the market tend to be too expensive or too complicated for the average user. As a result, there are inexpensive and automated systems that can provide appropriate care without constant human participation. The system must be able to make automatic changes based on the specific requirements of the system and actual monitoring. Filling this gap will promote sustainable urban garden technology and better plants.

2. LITERATURE SURVEY

William et al., (2019) presented a solution that integrates a wireless sensor network for monitoring environmental factors like air temperature, humidity, and light intensity within agricultural fields, with the ability to remotely access the data. The system includes sensor nodes that are equipped with specialized sensors and radio frequency modules designed for small-scale applications. These nodes send data through a radio frequency link to a centralized computer for logging and analysis. To enhance accessibility, the data can be uploaded to the internet, allowing farmers to monitor the system from remote locations. Additionally, the sensor nodes can be reprogrammed via the computer terminal to adapt to the changing needs of the farm, eliminating the need for redeploying the network for every adjustment. To conserve energy, which is a critical factor in the operation of the system, the core components of the nodes are put into sleep mode when not in use.

Prabhushankar et al., (2021) highlighted the crucial role of agriculture in sustaining the livelihood of a majority of people in India and its significant contribution to the country’s economy. However, in dry regions or areas experiencing inadequate rainfall, managing irrigation becomes a challenging task. To address this, they proposed an automated system using wireless sensor networks and embedded technology to regulate water flow in irrigation systems, such as sector-based, sprinkler, or drip irrigation. The proposed solution is cost-effective in terms of hardware, labor, and energy consumption. Continuous monitoring of water level is essential, particularly in agricultural areas where crops like coconuts, bananas, and vegetables rely on drip irrigation. Traditionally, maintaining the water level requires constant manual supervision, which becomes cumbersome, especially during nighttime or power outages. Often, water and electricity are wasted due to human oversight, or the task becomes too difficult for the farmer. This system offers a practical solution by automating the irrigation process: when the irrigation motor is activated, sensors monitor and control the water flow. Once the water reaches a pre-set level, the system automatically adjusts or halts the water flow, minimizing manual labor and reducing resource wastage.

Suresh et al., (2022) noted that greenhouse-based farming has become a vital aspect of modern agriculture across India. This technology allows for precise control over the temperature and humidity levels, which is crucial for the healthy growth of plants. However, varying atmospheric conditions across different parts of a large farm can make it challenging to maintain uniform environmental conditions manually. To address this issue, they proposed a system that utilizes GSM technology to provide real-time updates on irrigation status. These reports are sent via SMS to an Android mobile device, ensuring that farmers can stay informed remotely. The system’s performance and outcomes are simulated using Keil software, offering a practical solution for managing large-scale greenhouse environments efficiently.

Shikha et al., (2016) highlighted the growing prominence and widespread use of wireless sensor technology in the scientific field. WSNs have significantly contributed to the progress of rapidly evolving technologies. Key challenges in this area include power management, cost reduction, and minimizing labor requirements. The paper reviews existing and proposed systems that utilize different technologies, with a specific focus on a generic automated irrigation system based on WSN, incorporating GSM and ZigBee for remote monitoring and control. The goal is to leverage these wireless communication technologies to create a cost-effective automated irrigation solution that can monitor soil conditions while reducing energy consumption. The system allows farmers to keep track of critical parameters such as air temperature, humidity, and soil moisture. In cases of irregular conditions, the system alerts the farmer, enabling them to take corrective actions remotely via GSM. With its low energy use and affordability, the system is especially beneficial for regions with limited water resources, such as semi-arid or arid areas.

Mahir et al., (2022) emphasized the growing importance of conserving freshwater resources in agricultural areas, given the increasing water demand. The optimal use of water resources has been significantly enhanced by automation technologies and tools such as solar power, drip irrigation, sensors, and remote control systems. Traditional irrigation methods that rely on a wired system and discrete instrumentation often face challenges, particularly when applied to large geographical areas. This paper presents a solution using wireless sensor networks for low-cost, wireless-controlled irrigation and real-time monitoring of soil moisture content. The system uses solar-powered wireless acquisition stations to collect data and control irrigation valves. The system consists of three main components: the base station, the valve unit, and the sensor unit. This innovative irrigation approach not only helps avoid moisture stress and soil erosion, salinization, but also promotes efficient use of fresh water. Additionally, it eliminates the need for manual labor involved in conventional flooding irrigation methods. The system was successfully implemented in a central Anatolian region, covering 8 acres, for managing drip irrigation for dwarf trees.

Harishankar et al., (2020) proposed that solar power offers an economical and sustainable solution to address energy needs, particularly for Indian farmers. Their system integrates a solar-powered water pump with an automatic flow control mechanism, utilizing a moisture sensor to regulate water usage. This approach is seen as a potential solution to the ongoing energy crisis in India, benefiting farmers by reducing reliance on grid power systems. Photovoltaic technology, specifically for irrigation systems, is an efficient way to harness solar energy. By incorporating solar-powered irrigation, farmers can reduce energy costs and ensure efficient water use, making it a green and cost-effective solution after the initial investment.

3. EXISTING METHODOLOGY

Farming continues to employ antiquated methods and lacks access to real-time data on crop health, pH, and soil water content. This could result in water waste, decreased crop productivity, and overwatering or underwatering of crops. With the world's population growing and water becoming more scarce, there is a greater need than ever to enhance agricultural operations. Technologies such as CWIS use sensors that measure the atmospheric temperature and humidity, as well as the plant's to show when crops need to be watered. Using wired or wireless technologies like ZigBee and CAN, greenhouse sensors collect data and send it to a control center. They are made up of cutting-edge technology that produces healthier plants, saves water, and enhances food output to meet future demands.

3.1. DISADVANTAGE

* Home balcony gardening is dependent on hand monitoring, where house owners must regularly check soil moisture and temperature levels.
* There is no real-time data collection, and therefore, it is challenging to accurately assess plant conditions.
* Wastage of water is a common occurrence since manual watering fails to have specific control over the amount of water needed.
* No remote monitoring of plant conditions implies that homeowners cannot monitor or control plants when they are not at home.
* Excessive maintenance effort is required since taking care of multiple plants becomes more time-consuming.
* Irregular plant growth is experienced due to uncontrollable environmental conditions like temperature and humidity fluctuations.

4. PROPOSED METHODOLOGY

The proposed solution is an IoT-powered smart gardening system designed for household use, balcony gardens. It employs sensors that track critical aspects such as moisture the soil temperature, and humidity. These sensors communicate with an Arduino Microcontroller that analyzes data and regulates a water pump. In case of diminishing moisture levels, the system runs in autopilot mode to ensure ideal plant conditions without human intervention. Such a setup serves to save water and ensure good plant growth at an efficient cost. The system involves a NodeMCU module used to transmit live data to a cloud server. To simplify usability, a smartphone application enables individuals to monitor their garden remotely and receive notifications when in need, and receive manual control through the app. It also offers functionality to control and manage plants directly from anywhere without any hassle the system is capable of being designed low-cost efficient and energy-smart thus finding its best suitablility for small-scale or urban-scale gardeners by using this solution users can attend to their plants with ease as well as become part of saving water and ensuring smart gardening.

4.1. ADVANTAGE

* Automated plant monitoring is achieved through IoT-based sensors that track soil moisture, temperature, and humidity in real-time.
* Remote monitoring and control allow users to track plant conditions and control irrigation through a mobile application from anywhere.
* User-friendly interface in the mobile application makes it easy for both technical and non-technical users to operate the system.
* Scalability allows the system to be expanded to accommodate more plants without increasing manual effort.
* Low-cost and sustainable design ensures affordability while promoting smart and sustainable urban gardening practices.

4.2. BLOCK DIAGRAM

The block diagram explains how the hardware components are connected, and how the sensor data is collected in analog pins converted into temperature degrees from volts. It shows how the Sensors, NodeMCU, LCD, relay, motor, pump, etc., have been connected.

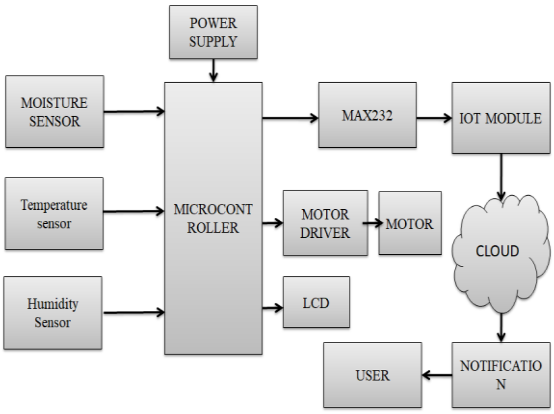

Figure 01: Block diagram of the Hardware setup

It also helps us in seeing the relevant data of the plants parameters like temperature, humidity, and soil moisture of the plants and also if the moisture content of the soil is less, then the motor will turn on automatically and the water pump will turn on, and after the moisture level of the soil gets normal, it will turn off the motor.

5. RESULT

The implementation of the IoT-based smart monitoring system for home balcony gardening has significantly enhanced plant care by automating the monitoring and irrigation processes. The system successfully tracks real-time soil moisture, temperature, and humidity levels using sensors, ensuring precise water management and reducing manual effort. By integrating an automated irrigation system, it optimizes water usage, preventing both overwatering and underwatering.

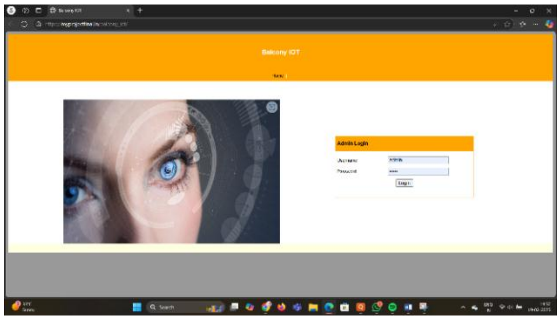

Figure 02: Login Page of Web Application

The mobile app enables users to remotely check plant conditions and manage irrigation, thereby making gardening more accessible and convenient. Besides that, real-time notifications inform users of unsuitable environmental conditions, allowing for prompt action. The system proved to improve plant health, reduce water wastage, and present an energy-saving solution ideal for urban gardening.

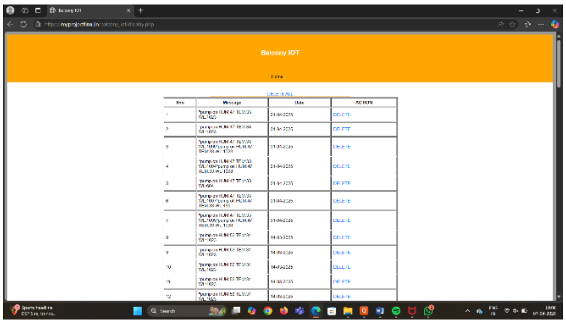

Figure 03: Real-time data of Plants

The web page that shows the parameters of the plant, such as temperature, humidity, and soil moisture, also in which the status of the water pump, whether it is on or off, and we can remove the particular data from the web page, which is uploaded at 15 seconds intervals, and we can also remove all the data in the web page if we do not want to.

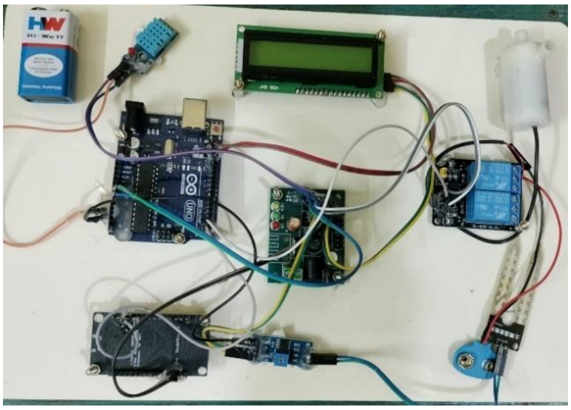

Figure 04: Hardware setup of the IoT Project

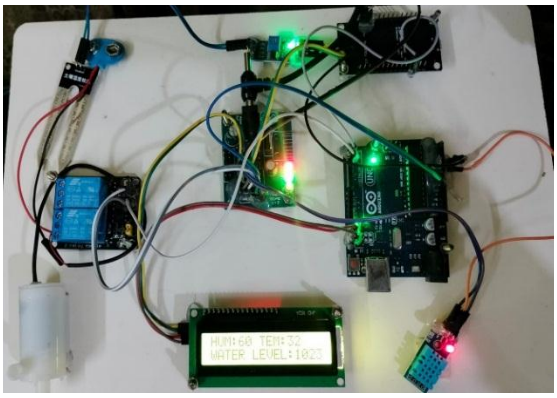

Figure 05: Simulation of the Hardware setup

In this case, the voltage value is converted into a temperature value in degrees by the NodeMCU, which receives the sensor data via analog pins and shows it on the LCD. The water pump is positioned and controlled by the transistor and relay. When it drops below the range value, it automatically activates the water pump. It measures the quantity of moisture in the soil. Additionally, it automatically shuts off the water pump when the moisture range stabilizes. Generally speaking, it is an affordable, environmentally friendly, and low-maintenance way to keep plants healthy.

6. CONCLUSION

As suggested, the IoT-based smart gardening system has overcome the problems involved in traditional home balcony gardening by introducing automation, remote control, and real-time monitoring. Integrating sensors, wireless data transmission, and automatic watering provides effective water conservation, better plant health, and reduced maintenance. The mobile app simplifies the user experience with real-time alerts and remote management, rendering it user-friendly even for non-experts. Additionally, the system's scalability and energy efficiency allow it to be applied in small domestic gardens as well as large city parks. At a time when water efficiency and sustainability are critical, this smart gardening system is a convenient and innovative means to adopt urban farming. Using IoT technology, it facilitates individuals to maintain healthy plants easily, and home gardening becomes more efficient, convenient, and eco-friendly.

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