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**Rajarambapu Institute of Technology, Rajaramnagar**

**(An Autonomous Institute)**

**Synopsis**

**Environmental Science Project**

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| **Program:** Computer Engineering 2025-26  **Course name and code:** Environmental Science (SH2174)  **Class:** S.Y. B. Tech (Semester-III)  **Proposed Title:**  Automated Soil Moisture Irrigation  **Name of the students in project group:**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Sr. No. | Name | Roll No. | Mobile No. | Email ID | Signature | | 01 | Ms. Srushti T. Yadav | 2403037 | 8080978292 | 2403037@ritindia.edu |  | | 02 | Ms. Pranita P. Nikam | 2403038 | 7028348671 | 2403038@ritindia.edu |  | | 03 | Mr. Harshal U. Jadhav | 2403039 | 9145582324 | 2403039@ritindia.edu |  | | 04 | Ms. Vaishnavi M. Patil | 2403040 | 8262032040 | 2403040@ritindia.edu |  |   **Project Guide Project Co-ordinator Head of Department**  **1.INTRODUCTION:**  Urban farming and small-scale gardening often face challenges due to irregular watering, which can negatively impact plant growth and yield. Manual irrigation is highly dependent on human judgment and availability, which frequently results in problems such as overwatering, underwatering, and unnecessary water wastage. These issues make it difficult for plants to receive the precise amount of water required for healthy growth.  The primary challenges associated with traditional irrigation methods are:   * **Soil Moisture Problem:** Without accurate monitoring of soil moisture levels, plants may receive too little water, causing wilting, or too much water, which can damage roots. * **Manual Irrigation:** Hand-watering is time-consuming, labor-intensive, and often inconsistent, particularly in urban household setups where regular monitoring is difficult.   Smart irrigation systems that integrate automation, sensors, and renewable energy have been shown to conserve water and reduce farmers’ dependence on manual labor [1]. To overcome these limitations, an automated irrigation system using Arduino has been developed. The system employs a capacitive soil moisture sensor to monitor soil conditions in real time. When the soil becomes dry, the Arduino triggers a relay module that activates a submersible water pump. As soon as the soil retains adequate moisture, the system automatically turns off the pump.  This automated approach ensures optimal water supply, conserves resources, and enhances plant health. The system is cost-effective, user-friendly, and well-suited for urban applications such as home gardens, balconies, and rooftop farming. By reducing manual involvement and improving irrigation efficiency, it provides a practical solution that promotes sustainable and healthy urban farming practices. |

**2.PROBLEM STATEMENT:**

Urban farming and small-scale gardening face significant challenges in providing consistent and adequate irrigation. Manual watering often leads to overwatering or underwatering, which can damage plant roots, reduce growth, and lower overall productivity. It is time-consuming and labor-intensive, requiring constant monitoring to ensure plants receive the right amount of water at the right time. In urban areas, where space, water, and time are limited, these problems are more pronounced. Existing manual irrigation methods are inefficient, waste water, and may fail to respond to changing soil conditions. Therefore, there is a need for a low-cost, automated irrigation system that can monitor soil moisture in real-time, supply water only when necessary, save water, reduce human effort, and maintain healthy plant growth in small-scale and urban gardening setups.

**3.RELEVANCE:**

This project addresses two major challenges in small-scale and urban gardening—irregular watering and water wastage. By implementing an affordable automated irrigation system, it can:

* Promote water conservation.
* Reduce manual labor in plant care.
* Support urban gardeners with limited time and space.
* Ensure consistent soil moisture for healthier plant growth.
* Offer a scalable solution for small and larger setups.
* Encourage smart, sustainable, and eco-friendly gardening practices.

Small innovations like this make gardening more efficient, accessible, and environmentally friendly.

**4.LITERATURE REVIEW** :

[1] Malwe, P. D. (2025) – “A Solar-Powered Automated Irrigation System Using Arduino and Moisture Sensors for Efficient Water Management in Agriculture” This research presents a smart irrigation system that combines automation, renewable energy, and sensor technology to improve agricultural water management. The system is designed using an Arduino Uno microcontroller, which receives input from a capacitive soil moisture sensor placed in the field. When the soil moisture level drops below a pre-set threshold, the Arduino signals a solar-powered water pump to start irrigation. This eliminates the need for constant human supervision and ensures that water is supplied only when required, thus preventing both under- and over-irrigation. By incorporating solar energy, the system becomes energy-independent, which is especially beneficial in remote or rural areas where electricity is either costly or unavailable. Malwe emphasizes that the system not only conserves water but also reduces farmers’ dependence on manual labor, allowing them to focus on other agricultural tasks. Field trials demonstrated reliability, adaptability to different soil conditions, and strong energy efficiency, proving its practicality for large-scale agricultural applications. The system highlights a move toward sustainable smart farming, aligning with global efforts to conserve natural resources while improving productivity.

[2] Capalit, B. F. B., et al. (2025) – “Project Naiad: An Automated Smart Irrigation Revolution for Urban Home Gardens Using Arduino UNO R4 Wi-Fi” Capalit and colleagues developed Project Naiad, a system tailored for urban home gardening, where users often face challenges such as limited time, small growing spaces, and inconsistent watering practices. The design is based on the Arduino UNO R4 Wi-Fi board, which enables wireless communication and integration with digital platforms. The system uses soil moisture sensors to detect when plants need water, a water level sensor to check tank availability, and a raindrop sensor to prevent unnecessary irrigation during rainfall. A GSM module is included for sending SMS alerts, while a web interface allows remote monitoring and control through smartphones or computers. This dual connectivity ensures that users can keep track of their gardens anytime, anywhere. Testing showed high accuracy in sensing soil conditions and rainfall, strong connectivity, and minimal water wastage. By combining smart technology with urban gardening, Project Naiad addresses the growing need for efficient water management in cities, where resources are limited, and people often lack time for manual plant care. Its key strength lies in remote accessibility, making it an ideal solution for busy urban dwellers who want healthy, well-maintained home gardens without constant attention.

[3] IJSRET (2025) – “Design and Implementation of an Intelligent IoT-Based Smart Irrigation System Using Arduino Nano” The study published in IJSRET (2025) focuses on building an intelligent irrigation system with IoT capabilities for agricultural plots. The system is powered by an Arduino Nano, chosen for its compact size and cost-effectiveness, making it easy to replicate and scale. Key components include soil moisture sensors for measuring real-time soil conditions, an LCD display to provide on-site feedback to farmers, and a GSM module that sends SMS alerts regarding soil moisture status and pump activation. The irrigation pump is automatically turned on when the soil moisture drops below a threshold and turned off once the required level is reached, ensuring precise water delivery. During testing, the system demonstrated significant water conservation, user-friendly operation, and reliable communication between sensors and the user’s mobile device. Unlike the previous systems, this design strongly emphasizes IoT integration, which allows farmers to stay informed even when away from their fields. One limitation noted is its dependence on traditional power sources, but the authors recommend integrating solar energy in future versions to enhance sustainability. This study highlights the role of IoT and automation in modern agriculture, showing how technology can provide efficient, reliable, and scalable irrigation solutions for small and medium-scale farmers.

**5.OBJECTIVES:**

* To design and implement an automated soil moisture monitoring and irrigation system for basket-based farming setups.
* To reduce water wastage by irrigating plants only when the soil moisture level drops below a predefined threshold.
* To eliminate the need for manual watering and intervention in small-scale urban farming, thereby saving time and effort.
* To improve plant health by maintaining consistent and optimal soil moisture levels suitable for healthy growth.
* To create a low-cost, scalable, and easy-to-use system that is suitable for home gardens, balconies, rooftops, and other small urban farming spaces.

**6.** **METHODOLOGY:**

1. The methodology follows the Waterfall model with sequential stages to achieve water conservation, automation, and reliability.
2. Planning: Identify the problem of inefficient manual irrigation and define the goal of creating an automated system using soil moisture sensors, Arduino, relay, and water pump.
3. Design: Select necessary components, prepare the circuit diagram, and plan the water distribution layout for even irrigation.
4. Implementation: Assemble the hardware, connect components as per the circuit, and program the Arduino to process sensor data and control the pump.
5. Testing: Calibrate the sensor under dry and wet soil conditions, set threshold values, and test the irrigation cycle for correct pump activation and deactivation.
6. Validation: Verify continuous monitoring, ensure efficient water use, confirm prevention of over-irrigation, and evaluate system reliability and robustness.
7. Technical Workflow: Sensor detects soil moisture → Arduino processes data → Relay activates or deactivates the pump → Pump irrigates soil → Continuous monitoring loop maintains optimal moisture.

Hardware Requirements:

* Arduino Uno → Acts as the central controller of the system.
* Capacitive Soil Moisture Sensor → Measures soil moisture accurately without corrosion.
* Relay Module → Controls the submersible water pump.
* Submersible Water Pump → Supplies water to the garden based on sensor input.
* Connecting Wires, Breadboard / PCB → For making reliable electrical connections.
* Laptop/Desktop with minimum 4 GB RAM → To program the Arduino and monitor data.
* 3×3 feet Basket Setup → For testing the irrigation system in small-scale gardening.
* Internet Connection (optional) → For accessing Arduino libraries, datasheets, and troubleshooting support.

**7.Project Outcome:**

* Automates irrigation by activating the water pump only when soil moisture falls below a preset threshold.
* Saves water by preventing unnecessary irrigation and minimizing wastage.
* Reduces manual effort and time spent on watering plants.
* Maintains optimal soil moisture levels to promote healthy plant growth.
* Demonstrates reliable and consistent operation during testing.
* Offers a cost-effective solution suitable for small-scale urban gardening.
* Provides scalability for future integration with IoT or solar power.

**8.REFERENCES:**

1. Malwe, P. D. (2025). A solar-powered automated irrigation system using Arduino and moisture sensors for efficient water management in agriculture. *European Transport and Aerospace Research*, 30(1), 112-126.
2. Capalit, B. F. B., Cruz, J. P., Hernandez, A. M., & Reyes, S. T. (2025). Project Naiad: An automated smart irrigation revolution for urban home gardens using Arduino UNO R4 Wi-Fi. *International Journal of Scientific & Engineering Research*, 15(7), 45-60
3. IJSRET. (2025). Design and implementation of an intelligent IoT-based smart irrigation system using Arduino Nano. *World Journal of Advanced Engineering, Technology and Science*, 11(3), 210-225.

**9.APPROXIMATE EXPENSES:**

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| **Components** | **Cost** |
| Arduino Uno | 335 |
| Capacitive Soil Moisture Sensor v1.2 | 170 |
| 1-Channel 5V Relay Module | 130 |
| Submersible Water Pump | 90 |
| Battery | 40 |
| Plastic Tubes | 20 |
| Connecting Wires | 50 |
| Baskets for Plants | 150 |
| Water Container / Tank | 50 |
| **Total** | **1035** |