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An IoT-Based Smart Irrigation System †

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Abstract: The automation of agriculture can transform farming from manual to dynamic, resulting in higher profits with less manual management. This article introduces the use of automatic irrigation to monitor and control soil moisture through automatic irrigation. The control unit is implemented by an ATMEGA328P microcontroller on the Uno platform. This device uses a hygrometer to measure actual humidity. This benefit ensures that the system uses water correctly, thus preventing excess/underwater. IoT is used to inform farmers about the status of the water supply. Sensor data are updated regularly via the GSM-GPRS website, and farmers can check whether the water head is open/closed at any time via the website. Sensor readings are transmitted to the object's audio channel to create an image.

Keywords: Node MCU ESP8266; soil moisture sensor; Wi-Fi; mobile app

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1. Introduction

Agriculture in India is the backbone of the country. The main problem of agriculture is water scarcity. Wastewater is generated as a result of the regular illegal use of water. Proper irrigation is still a difficult task in most agriculture. The misuse of water affects soil and plants. Monitoring or performance management may be necessary to resolve this issue. International agriculture plays an important role in the development of the global agricultural sector. Approximately 68% of the population in India makes a living from agriculture, and 1/3 of the country's capital comes from agriculture. Problems related to agriculture often hinder the country's progress. This problem can be solved with smart agriculture, and new agriculture methods can be created. The main function of this operation involves the production of water-based agricultural products, eliminating the need for land. Through a computerized hydroponic system, water and nutrients are supplied to the growing area based on feedback from sensors and electro-physical phenomenon circuits, such as temperature and humidity. The Internet of Things (IoT) era has begun to work in many areas, especially to improve city life and make many daily activities faster and easier. This smart city is one of many popular IoT brands. This article presents a gardening application based on the Internet of Things. The software is designed to help customers who want to create their own lawn with the help of the Internet of Things, showing the growth and development of their plants. Abayomi-Alli et al. (2018) [1] developed a Smart Solar Irrigation System (SMIS) for sustainable agriculture, harnessing solar energy for automated irrigation, cost-effectively conserving water. Meanwhile, Boursianis et al. (2021) [2] discuss Agriculture 4.0, integrating technologies, like the IoT, into intelligent irrigation systems, aiming for perfection in modern farming practices. Both studies emphasize advancing irrigation methods to enhance efficiency and sustainability in agriculture. Stolojescu-Crisan et al. [3] introduced Toggle, an open IoT framework for homes, including a smart irrigation system to simplify plant care and conserve resources. Mogiliand Deepak (2020) [4] present

an intelligent drone for agriculture applications, utilizing the MAVlink protocol to enhance efficiency in monitoring and managing agricultural tasks. Raja et al. (2022) [5] propose an automatic irrigation system using capacitive soil humidity detection to maintain soil moisture levels and prevent crop damage by monitoring various parameters. Tephila et al. (2022) [6] advocate for smart irrigation to optimize water use, utilizing IoT-based systems to efficiently irrigate and even reclaim barren land. Garg and Alam (2023) [7] explore Agriculture 4.0's transformative impact, utilizing the IoT, big data analytics, cloud computing, and AI for data-driven smart farming, employing the PRISMA methodology to review relevant literature. Gamal et al. (2024) [8] provide an overview of smart irrigation systems. Mogili et al. (2020) [9] study the takeoff constraints for lifting an agriculture pesticide sprinkling multi-rotor system.

2. Components and Their Functions

2.1. DC Motor

In this article, a 3V DC motor was used to move alarm mover.

2.2. Soil Moisture Sensor

Soil moisture sensors use capacitance in the soil to measure the dielectric constant of the surrounding medium, which is a function of water content. The voltage produced by the sensor is proportional to the dielectric constant and, therefore, the moisture content of the soil. The sensor calculates the average water content over the entire length of the sensor. This tool has an accuracy of two centimeters on a flat surface, but has little or no precision at the tip edges. Soil moisture sensors are used to measure water loss due to evaporation and absorption by plants, estimate optimal soil moisture for different plant species, and monitor soil moisture to manage water.

2.3. Battery

This is the lawnmower's electrical power used to operate the robot controller and motor. Since the models shown in this article are small, 12 V batteries are used.

2.4. Capacitor

A capacitor is a material that stores electrical energy. This is a passive electronic device with two connectors. A capacitor is a component designed to increase the capacitance of a circuit, even if some capacitance exists between two adjacent circuits.

2.5. NodeMCU ESP8266

A relatively inexpensive chip (SoC) known as ESP266 serves as the foundation for the open software and hardware development known as the NODEMCU (Node Microcontroller Unit). ESP8266 firmware is an open source and produced using the SDK from the chip maker. The built-in Lua programming language, which is quick and easy to use and has a large developer community, serves as the foundation for the firmware's basic programming environment.

2.6. Water Pump

The DC 3–6 V Mini Submersible Pump is an affordable and compact submersible pump. It works with a 2.5–6 V power supply. It can process up to 120 L of water per hour and uses a minimum current of 220 mA. Just connect the tube to the motor, put it in the water, and turn it.

2.7. Diode

A diode is a device that allows the current to flow in one direction and prevents it from flowing in the other direction. This is performed using a built-in electric field.

3. Flowchart of the Smart Irrigation System

Figure 1 represents the flow chart work carried out by the smart irrigation system.

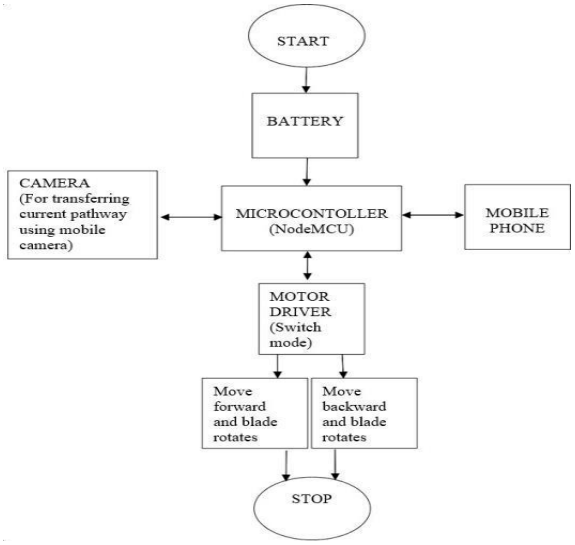


Figure 1. Flowchart of the smart irrigation system.

4. Block Diagram

The block diagram consists of four sections:

- **Humidity section:** two humidity sensors are placed here to help record the humidity level.
- **Control section:** Here we have Arduino UNO and a modem, where Arduino helps to start the pump (motor) and the modem helps to communicate with the mobile.
- **Part of IoT:** Here we talk about cloud servers, the online use of images and data, and web pages that help save the data. This is performed using the think blynk application.
- **Functionality:** Users can view information using the application. If the sensor is not working, farmers can use their phones to control the engine.

Figure 2 represents the block diagram of the proposed model.

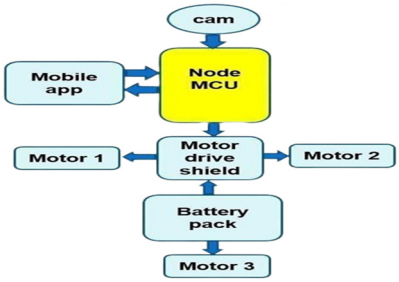


Figure 2. Block diagram of the proposed model.

5. Software Implementation

The software used in this project is Arduino IDE 1.8.19. Arduino IDE will be used to program the NodeMCU. To operate the robot, the controller is essential to turn on the robot. The NodeMCU is used as a controller in this study. The pathway and movement of the lawnmower were programmed, and it was also controlled by inputs by the user to enhance the flow. Then, the flowchart will be converted into c programming and compiled into the NodeMCU using the Arduino IDE compiler. Copy the following code onto the NodeMCU board to obtain the result you want. Figure 3 shows the program implementation of the proposed model.

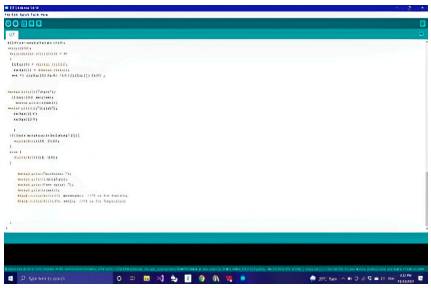
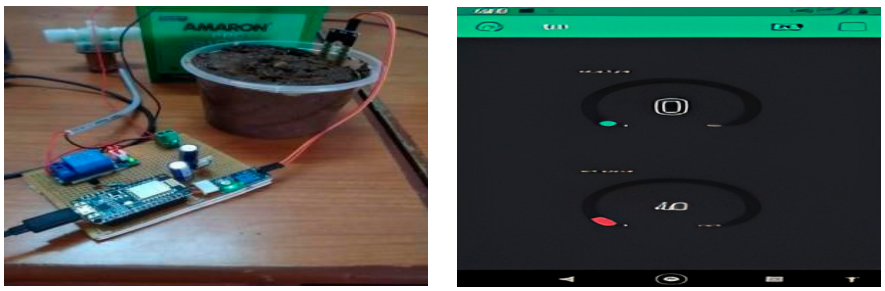


Figure 3. Program implementation of the proposed model.

6. Hardware Implementation

The kit consists of a pump, soil moisture sensor, and NodeMCU. Connect according to the diagram. When the system is powered by a 12 V battery, the controller operates according to user commands. Users can provide feedback to the controller through a mobile app. Before logging in, users must connect their system to the mobile application, as shown in Figure 4. To adjust the operating humidity, users must connect their mobile phone to the Wi-Fi. Figure 4 shows the hardware implementation of the proposed work.



(**a**) (**b**)

Figure 4. Hardware implementation of the proposed model: (**a**) prototype and (**b**) mobile application.

7. Existing Method

According to the traditional method, farmers have to turn on the engine manually and go out to water the plants. On the other hand, in some cases, such as using a mobile phone, the engine can be controlled by messages or calls sent to the SIM card connected to the engine and the timer system to turn the engine on and off on time. In timer mode, the main disadvantage of the above method is that farmers have no information about soil moisture.

8. Proposed Method

The plan is to measure and monitor moisture in the plants. Arduino will monitor and control the motor while detecting the humidity level. The information received will be saved and uploaded to the cloud for future use. A mobile application will be developed to bring farmers and regulators together.

9. Results and Conclusions

The application of agricultural network technology is necessary to the development of agriculture today and an important indicator of the development of agriculture in the future. From the construction of agricultural hardware, to the analysis and study of network-level features, to the operation of agricultural irrigation systems and related software, we can use the Internet of Things to achieve the security of agriculture and create changes in measurement, maintenance, monitoring, etc. As the IoT develops further in the coming years, these systems will become better, faster, and cheaper.

10. Future Scope

In the future, smart irrigation systems could be connected to other IoT systems, similar rainfall detectors and soil humidity detectors, to optimize water operation even further. Machine literacy is a subset of AI that allows computers to learn from data and ameliorate over time. IoT-grounded smart irrigation systems will also reduce payments made to human beings.

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References

1. Abayomi-Alli, O.; Odusami, M.; Ojinaka, D.; Shobayo, O.; Misra, S.; Damasevicius, R. Smart-Solar Irrigation System (SMIS) for Sustainable Agriculture. In *Applied Informatics*; Florez, H., Diaz, C., Chavarriaga, J., Eds.; Springer International Publishing: Cham, Switzerland, 2018; Volume 942, pp. 198–212.
2. Boursianis, A.D.; Papadopoulou, M.S.; Gotsis, A.; Wan, S.; Sarigiannidis, P.; Nikolaidis, S.; Goudos, S.K. Smart Irrigation System for Precision Agriculture—The AREThOU5A IoT Platform. *IEEE Sens. J.* **2021**, *21*, 17539–17547. [CrossRef]
3. Stolojescu-Crisan, C.; Butunoi, B.P.; Crisan, C. An IoT Based Smart Irrigation System. *IEEE Consum. Electron. Mag.* **2022**, *11*, 50–58. [CrossRef]
4. Mogili, U.R.; Deepak, B.B.V.L. An intelligent drone for agriculture applications with the aid of the MAVlink protocol. In *Innovative Product Design and Intelligent Manufacturing Systems: Select Proceedings of ICIPDIMS 2019*; Springer: Singapore, 2020; pp. 195–205.
5. Raja, M.; Nithish, N.M.; Shankar, B.S.; Sadhurwanth, D. Automatic Irrigation and Crop Protection System Based on IoT. In *Disruptive Technologies for Big Data and Cloud Applications*; Peter, J.D., Fernandes, S.L., Alavi, A.H., Eds.; Springer: Singapore, 2022; Volume 905, pp. 355–363.
6. Tephila, M.B.; Sri, R.A.; Abinaya, R.; Lakshmi, J.A.; Divya, V. Automated Smart Irrigation System Using IoT with Sensor Parameter. In Proceedings of the 2022 International Conference on Electronics and Renewable Systems (ICEARS), Tuticorin, India, 16–18 March 2022; IEEE: Piscataway, NJ, USA, 2022; pp. 543–549.
7. Garg, D.; Alam, M. Smart Agriculture: A Literature Review. *J. Manag. Anal.* **2023**, *10*, 359–415. [CrossRef]
8. Gamal, Y.; Soltan, A.; Said, L.A.; Madian, A.H.; Radwan, A.G. Smart Irrigation Systems: Overview. *IEEE Access* **2024**, 1-1. [CrossRef]
9. Mogili, U.R.; Deepak, B.B.V.L. Study of takeoff constraints for lifting an agriculture pesticide sprinkling multi-rotor system. In *Advances in Materials and Manufacturing Engineering: Proceedings of ICAMME 2019*; Springer: Singapore, 2020; pp. 203–210.

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