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Review Article

The Challenges and Impacts of Automatic Watering Systems

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Abstract

Food self-sufficiency is a government program that has been actively promoted so that our country, Nigeria, can achieve food independence. Nigeria is an agricultural country with rainy and dry seasons. In the rainy season, food plants usually do not need to be watered, while in the dry season, the plants must be watered regularly according to the soil moisture conditions. Farmers usually do not grow food plants in the dry season for fear that they will not grow well due to the absence of rainfall. The farmer's dependence on the season of rain causes the production to decline and becomes a hindrance to the success of the food self-sufficiency program in Nigeria. An information and communication technology-based agricultural device is needed to overcome this problem. This research aimed to review papers based on the design of a programmed microcontroller chip to control watering automatically based on soil moisture detected using a domestic soil moisture sensor. This device was used to detect whether the soil was dry or not. The farmers did not need to do irrigation manually all the time. In addition to helping farmers, the device could also be installed on plantations, seedbed nurseries, urban parks, hotels, offices, and homes.

Keywords: Humidity Sensor, Soil Moisture Sensor, Arduino, solenoid valve, LCD, Temperature Soil.

Introduction

Some farmers in our country, Nigeria, till today, still depend on the rainy season for farming. This makes the production of agricultural products unstable. In the dry season, the prices of agricultural products increase significantly due to their small production, while in the rainy season, the production is abundant and that lowers the price due to sufficient rainfall. It causes loss and disappointment for many farmers. During the dry season, farmers who want to do farming must spend extra energy and money to do watering manually. This is because of the absence of rainfall. Henceforward, the introduction of an automatic watering plant system that works both in the rainy and the dry season needs to be designed. This device uses an Arduino Microcontroller chip programmed based on the detection of agricultural soil moisture sensors. When the soil is dry, this device will automatically water the plants in the farm, garden, or environment. Equally, if the soil was wet, the device would not water them due to the presence of the soil moisture sensor. This led to healthy plants because the need for water was fulfilled all the time. Numerous scholars have conducted research in agriculture, such as Qingmei, Zhili, and Mingzhu [1], who designed communication nodes in tractor control networks based on the ISO11783 Protocol. This tractor was equipped with a GPS module that can be controlled remotely with the CAN2.0B module with the ISO11783 protocol. Ladhake and Ahmed designed a very low-cost mobile-based embedded system for irrigation farming. The system consisted of a microcontroller ATMEGA32, an RTC DS1307, a Nokia 6610 Mobile, and a pump motor [2]. Ma Yuquan, Han Shufen, and Wang Qingzhu investigated a distributed master-slave environmental parameter monitoring and control system for greenhouses. This system consists of an air humidity sensor, a soil moisture sensor, a temperature sensor, and a microcontroller AT89C51 [3]. Girisha and Ganesh examined the embedded controller in the farmer's Solari's water pump automation. The system they designed

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consisted of solar panels, pump motors, current sensors, and a microcontroller PIC16F877A [4]. Pradeep et al. examined a PV pump farmer's automation. The system consisted of a Microcontroller PIC16F877A microcontroller, a water level sensor, and a pump [6]. Yu and Li investigated a high-accuracy temperature control system based on ARM9 using a microcontroller type S3C2440A, a temperature sensor, and control using a Fuzzy algorithm [5]. Prema studied online control of remote agricultural robots operated using fuzzy controllers and virtual instrumentation. The system in the robot consisted of a microcontroller, a DC motor, and a Fuzzy logic controller algorithm [7]. While Polpitiya et al. researched wireless agricultural sensor networks consisting of a humidity sensor, a temperature sensor, a light sensor, a PH level sensor, a microcontroller, and a WSN [8]. Idris and Muhammad Ikhsan Sani monitored and controlled the aeroponic growth system for potato production. This system consisted of a microcontroller, a temperature sensor, and pH, humidity, and fogging sensors [9]. Martin implemented wireless accelerometer mems to detect red palm beetles using MEMS sensors, microcontrollers, and Bluetooth [10].

While Patel et al. investigated a microcontroller-based drip irrigation system using smart sensors, this system consisted of agricultural sensors such as air humidity, temperature, and soil moisture sensors; a microcontroller; and a wireless module [11]. Thilagavathi and Sathish Kannan studied online farming based on embedded systems and wireless sensor networks. This system consisted of a soil moisture sensor, a temperature sensor, a water level sensor, a microcontroller, a water pump, and a Zigbee communication [12]. This paper aimed to design an automatic watering system for plants. Numerous references were used. Rosinski researched an unattended flower watering system using a soil moisture sensor and a comparator to replace the function of the microcontroller [13]. Csiba and Tapak used an Ethernet, a temperature sensor, a light sensor, a soil moisture sensor, a humidity sensor, a water level sensor, and a solenoid valve to investigate the watering of internet of things (IoT) plants [14]. While Selmani et al. investigated the multithreading design for irrigation systems using solar power, This system consisted of a soil moisture sensor, a temperature sensor, a water level sensor, a Raspberry PI, and a solar panel water pump [15]. Punjabi, Divani, and Patil examined an automatic watering system using a soil moisture sensor to detect the soil requiring water, a microcontroller, and a water pump [16]. Padalalu et al. investigated the smart water droplet system for agriculture, while Azam investigated a hybrid water pumping system for hilly farm locations using a microcontroller, a water pressure sensor, a flow rate sensor, and a pump motor [17]. This system consisted of a temperature sensor, a PH sensor, a soil moisture sensor, a microcontroller, and a water pump motor [18]. P et al. investigated a context-aware wireless irrigation system. This system included chemical sensors, a temperature sensor, a humidity sensor, a PH sensor, a microcontroller, and a Zigbee [19], while Shinde and Tarange Mevekari [20] investigated a web-based automatic irrigation system using wireless sensor networks and embedded Linux boards. This system consisted of a Raspberry PI, a temperature sensor, a soil moisture sensor, and a Zigbee. Ishak et al. investigated a prototype of an activated GSM watering system using a humidity sensor, a GSM module, and an Arduino microcontroller [21]. The difference between the previous study and this study is that it aims to design an automatic plant watering device utilizing a soil moisture sensor. This device is expected to be developed and help farmers overcome problems in watering their crops.

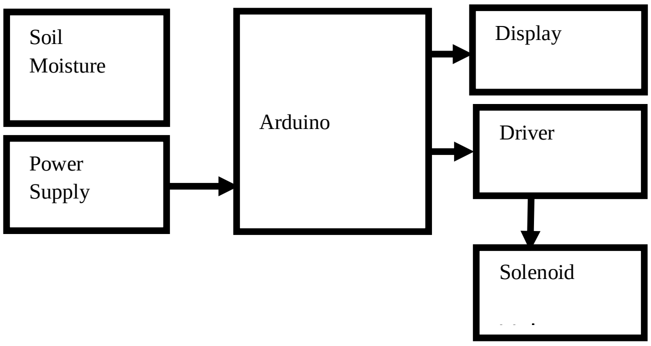

Fig 1: System block diagram

The method of implementing the Automatic Watering System

This automatic plant watering device uses a soil moisture sensor in its design and is based on specially programmed Arduino board technology. This moisture sensor detected the level of the deficiency of agricultural land. If the soil was dry, this microcontroller commanded a solenoid valve to open and water the plants, but immediately when the soil was wet, the solenoid valve closed, and the water stopped flowing. The specifications of this automatic sprinkler design were a 220V AC, a single sensor, a 12V output relay, a 220V solenoid valve AC, an AT Mega Processor, a 16x2 LCD, and a 20x40x15cm dimension [31]. The research investigated the use of a soil moisture sensor as a determinant of the time when the plants may need water to water them automatically. The soil moisture sensor by utilizing a voltage divider

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circuit was used in the research. By measuring the resistance of the soil, the value of soil moisture can be obtained. Microchip technology has developed since the discovery of semiconductor material as an electronic component. This discovery reduced the size of computers. The semiconductor as an Integrated Circuit (IC) material makes the microchip and microcomputer technology advance hastily. In this study, the researcher used an Arduino microchip or microcontroller [22], [25] that had been specifically designed to make it easier for prototype designers to test the device. The sensor used in the research was a resistive metal plate sensor to measure soil moisture converted to an analog voltage, which then was read by the microcontroller in the embedded system so that the device worked following the results of the research [26, 30].

The Advantages of Automatic Watering Systems

1. One of the most obvious advantages is that automatic watering or irrigation systems are generally hidden from view, which means there are no unsightly hoses stretched across the lawn and no more tripping hazards. Sprinkler heads pop up to spray and then retract when the job is done. Underground drip systems do their work out of sight. For families with young children and pets who share outdoor spaces, automatic systems may be a safer option.
2. Another clear advantage is the time savings afforded by an automatic sprinkler or drip irrigation system. Once installed, many systems can be set to a timer to water at specific time intervals and on certain days of the week. This means there's no need to worry about forgetting to water the lawn and coming back from vacation to find crisp, yellow grass.
3. Another advantage is that irrigation systems, particularly the drip type, can be positioned so that water is more effectively targeted where it is needed. Nozzles can be adjusted, and underground drip tubes will deliver water right to the roots, rather than spraying walkways and driveways [32].

The Drawbacks of Automatic Watering Systems

The primary disadvantage associated with a sprinkler system is the cost. Depending on the size of the property, these systems can be quite expensive. Additionally, portions of the lawn will have to be dug up to install pipework and attach it to the plumbing system of the home. This can equate to days or weeks without use of the yard. Afterward, the landscaping will have to be repaired. It is best to install an irrigation system before installing sod or extensive landscaping because some of it will have to be torn up. Homeowners who already have pristine yards may be turned off by this reality. Even the most efficient sprinkler systems can have their pitfalls. Wind can wreak havoc on sprinklers, directing water in the wrong direction. Underground pests may damage water-delivery systems, resulting in water pooling or broken parts. Repairing an irrigation system can be much more expensive than replacing a broken garden hose [32].

Conlusion

The design of an automatic plant watering device uses a copper plate sensor working as an electrode to measure soil resistance that is converted into analog voltage and then into digital information so that it can be processed by the Arduino Uno processor. The determination of the upper limit for the watering process is carried out by trials on different soil conditions. The use of solenoid valves to reduce the use of electricity is more effective compared to pumps that require greater electricity.

References

1. C. Qingmei, Z. Zhili, and Z. Mingzhu, "The Design of Communication Nodes in the Tractor Control Network Based on ISO11783 Protocol," in 2010 International Conference on Intelligent Computation Technology and Automation, 2010, vol. 3, pp. 772–775.
2. V. Ahmed and S. A. Ladhake, "Design of Ultra Low Cost Cell Phone Based Embedded System for Irrigation," in 2010 International Conference on Machine Vision and Human-machine Interface, 2010, pp. 718–721.
3. Ma Yuquan, Han Shufen, and Wang Qingzhu, "New environment parameters monitoring and control system for greenhouse based on master-slave distributed," in 2010 International Conference on Computer and Communication Technologies in Agriculture Engineering, 2010, vol. 1, pp. 31–35.
4. K. Ganesh and S. Girisha, "Embedded controller in farmers pump by solar energy (Automation of solarised water pump)," in 2011 International Conference On Recent Advancements in Electrical, Electronics And Control Engineering, 2011, pp. 226–229.
5. X. Li and Y. Yu, "A high accuracy temperature control system based on ARM9," in 2011 International Conference on Electrical and Control Engineering, 2011, pp. 23–26.
6. E. Pradeep, R. Ganeshmurthy, K. Sekar, and E. Arun, "Automation of PV farmers pump," in International Conference on Sustainable Energy and Intelligent Systems (SEISCON 2011), 2011, vol. 2011, no. 583 CP, pp. 163–166.
7. K. Prema, N. S. Kumar, S. S. Dash, and S. Chowdary, "Online control of remote operated agricultural robot using fuzzy controller and virtual instrumentation," in IEEE-International Conference On Advances In Engineering, Science And Management (ICAESM - 2012), 2012, pp. 196–201.

8. M. L. G. Polpitiya, G. R. Raban, W. K. S. S. Prasanna, D. T. S. Perera, D. P. Chandima, and U. K. D. L. Udawatta, "Wireless agricultural sensor network," in TENCON 2012 IEEE Region 10 Conference, 2012, pp. 1–6.
9. I. Idris and Muhammad Ikhsan Sani, "Monitoring and control of aeroponic growing system for potato production," in 2012 IEEE Conference on Control, Systems & Industrial Informatics, 2012, pp. 120–125.
10. B. Martin, V. Juliet, P. E. Sankaranarayanan, A. Gopal, and I. Rajkumar, "Wireless implementation of mems accelerometer to detect red palm weevil on palms," in 2013 International Conference on Advanced Electronic Systems (ICAES), 2013, pp. 248–252.
11. N. R. Patel, R. B. Lanjewar, S. S. Mathurkar, and A. A. Bhandekar, "Microcontroller based drip irrigation system using smart sensor," in 2013 Annual IEEE India Conference (INDICON), 2013, pp. 1–5.
12. K. Sathish kannan and G. Thilagavathi, "Online farming based on embedded systems and wireless sensor networks," in 2013 International Conference on Computation of Power, Energy, Information and Communication (ICCPEIC), 2013, pp. 71–74.
13. M. Rosinski, "An unattended flower watering system," Electron. Educ., vol. 1996, no. 2, pp. 26–28, 1996.
14. P. Tapak and M. Csiba, "LoT Plant Watering," in 2018 16th International Conference on Emerging eLearning Technologies and Applications (ICETA), 2018, pp. 563–568.
15. A. Selmani et al., "Multithreading design for an embedded irrigation system running on solar power," in 2018 4th International Conference on Optimization and Applications (ICOA), 2018, pp. 1– 5.
16. D. Divani, P. Patil, and S. K. Punjabi, "Automated plant Watering system," in 2016 International Conference on Computation of Power, Energy Information and Commuincation (ICCPEIC), 2016, pp. 180–182.
17. M. F. M. Azam et al., "Hybrid water pump system for hilly agricultural site," in 2016 7th IEEE Control and System Graduate Research Colloquium (ICSGRC), 2016, no. August, pp. 109–114.
18. P. Padalalu, S. Mahajan, K. Dabir, S. Mitkar, and D. Javale, "Smart water dripping system for agriculture/farming," in 2017 2nd International Conference for Convergence in Technology (I2CT), 2017, vol. 2017-Janua, pp. 659–662.
19. D. P, S. Sonkiya, P. Das, M. V. V., and M. V. Ramesh, "CAWIS: Context aware wireless irrigation system," in 2014 International Conference on Computer, Communications, and Control Technology (I4CT), 2014, no. I4ct, pp. 310–315.
20. P. H. Tarange, R. G. Mevekari, and P. A. Shinde, "Web based automatic irrigation system using wireless sensor network and embedded Linux board," in 2015 International Conference on Circuits, Power and Computing Technologies [ICCPCT-2015], 2015, pp. 1–5.
21. N. S. Ishak, A. H. Awang, N. N. S. Bahri, and A. M. M. Zaimi, "GSM activated watering system prototype," in 2015 IEEE International RF and Microwave Conference (RFM), 2015, no. Rfm, pp. 252–256.
22. T. K. Toai and V. M. Huan, "Implementing the Markov Decision Process for Efficient Water Utilization with Arduino Board in Agriculture," in 2019 International Conference on System Science and Engineering (ICSSE), 2019, pp. 335–340.
23. C. M. Devika, K. Bose, and S. Vijayalekshmy, "Automatic plant irrigation system using Arduino," in 2017 IEEE International Conference on Circuits and Systems (ICCS), 2017, vol. 2018-Janua, no. 1, pp. 384–387.
24. H. N. Saha et al., "Smart Irrigation System Using Arduino and GSM Module," in 2018 IEEE 9th Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON), 2018, pp. 532–538.
25. A. Al-Omary, H. M. AlSabbagh, and H. Al-Rizzo, "Cloud based IoT for Smart Garden Watering System using Arduino Uno," in Smart Cities Symposium 2018, 2018, vol. 2018, no. CP747, pp. 33 (6 pp.)- 33 (6 pp.).
26. P. Jariyayothin, K. Jeravong-aram, N. Ratanachaijaroen, T. Tantidham, and P. Intakot, "IoT Backyard: Smart Watering Control System," in 2018 Seventh ICT International Student Project Conference (ICT-ISPC), 2018, pp. 1–6.
27. K. N. Siva, R. Kumar G., A. Bagubali, and K. V. Krishnan, "Smart watering of plants," in 2019 International Conference on Vision Towards Emerging Trends in Communication and Networking (ViTECoN), 2019, pp. 1–4.
28. H. S. Alar and D. C. Sabado, "Utilizing a Greenhouse Activities Streamlining System Towards Accurate VPD Monitoring for Tropical Plants," in 2017 International Conference on Vision, Image and Signal Processing (ICVISP), 2017, vol. 2017-Novem, pp. 94– 97.
29. S. Aygun, E. O. Gunes, M. A. Subasi, and S. Alkan, "Sensor Fusion for IoT-based Intelligent Agriculture System," in 2019 8th International Conference on Agro-Geoinformatics (Agro Geoinformatics), 2019, pp. 1–5.
30. W. Wongthai, S. Chanmee, and S. Lohawet, "An Enhancement of an Automatic Plant Watering System," in 2018 22nd International Computer Science and Engineering Conference (ICSEC), 2018, pp. 1–4.
31. I. Prasojo, A. Maseleno, O. tanane, N. Shahu," Design of Automatic Watering System Based on Arduino", Journal of Robotics and Control (JRC) Vol. 1, No. 2, pp. 55-58, DOI: 10.18196/jrc.1212, March 2020,
32. https://www.1001artificialplants.com/2019/04/06/advantages-and-disadvantages-of-automatic-irrigation-systems/

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