JOURNAL LA MULTIAPP

VOL. 04, ISSUE 02 (049-058), 2023
DOI: 10.37899/journallamultiapp.v4i2.845

The Climate Smart System with Water Machine Control

Huda Al-Nayyef[1]

[1]*Department of Computer Science, College of Science, Mustansiriyah University, 10052 Baghdad, IRAQ*

**Corresponding Author: Huda Al-Nayyef*

Article Info

Article history:
Received 13 September 2023
Received in revised form 9 October 2023
Accepted 27 October 2023

Keywords:
Water Machine Control
Smart system
Climate
Moisture sensors
Internet of things (IoT)
Microcontroller ESP32

Abstract

Agriculture is important in shaping economies all across the world. For several years, agricultural goods have been stagnating. As a result, methods to boost agricultural productivity efficiency are required. So, the aim of this paper is to implement and design a smart system to make agriculture smarter. The proposed system is composed of Microcontroller ESP32, DH11 and soil moisture sensors, wi-fi shield, fan, water pump, relay. The system enables to sense the environment and give the reaction based the input data. The system can measure and control the temperature and humidity of the environment. If the temperature and humidity rise, the system can reduce it until reach to satisfied level. Also, the system can auto irrigation the soil when the water level is decreases than pre-define threshold. Furthermore, the system sends an alarm message to the owner over wi-fi network by making a telegram bot when the degree of temperature increased and the level of water decreases. Internet of things (IoT) is utilities to developing this system.

Introduction

Agriculture is regarded as the foundation of human life because it is the main provider of grains for food and other basic supplies. It is critical to the nation's economic growth. We are all intrinsically connected to farming. The most productive farming practices are not always the conventional methods. The development of the country's economic status depends on the farming industry's expansion. But many farmers continue to cultivate their farms using out-of-date methods, which lowers food yields. However, everywhere technology has been applied and mechanical equipment has taken the place of human labor, the ultimate product has improved. Therefore, cutting-edge science and technology must be used in the farming industry in order to improve production. However, cutting-edge technologies might enable any agricultural to reach its maximum potential. Because there are fewer assets than there are people, we must produce as much as we can with what we do have. Therefore, it is essential that we make the most of technology (Gondchawar & Kawatikar, 2016; Azadi et al., 2021; Chopra & Whig, 2022).

Modern agriculture is undergoing fast change. The cost, supply chain, and delivery of food goods are impacted by the growing world population and changing trade rules. In the meantime, consumer preferences, particularly in western nations, are turning toward more labor-intensive organic foods and sustainably farmed fruits and vegetables. There are currently shortages of staff and increasing labor expenses in the farming industry, which pose challenges for meeting evolving and rising industry expectations (Sushanth & Sujatha, 2018; Prathibha et

ISSN: 2716-3865 (Print), 2721-1290 (Online)
Copyright © 2023, Journal La Multiapp, Under the license CC BY-SA 4.0

al., 2017). Over the past decade, fluctuating rainfall patterns, attributed to climate change, have prompted the adoption of "smart agriculture" or climate-smart practices in recent times. Leveraging the Internet of Things (IoT), intelligent agriculture has emerged as an autonomous and guided technological system. Its primary objective is to gather real-time information about the farming area, simplifying access to agricultural services such as SMS warnings and advice on weather patterns and crops (Patil & Kale, 2016).

This paper presents the development of a smart system based on microcontrollers and sensors, further enhancing its intelligence. Following this introduction, we will delve into Section 2, which explores related works. Section 3 outlines the proposed system, while Section 4 discusses the results and provides a comprehensive analysis. Finally, in Section 5, we offer our conclusion and recommendations.

Related work

Many researchers developed similar systems. In (Napa et al., 2019), their project centered on developing an efficient moisture control-based Modern Irrigation System (MIS) utilizing Arduino Nano boards and numerous plants. The main objective of this initiative is to prevent excess water use, then protecting plants against damages. There are various Arduino ideas and models for autonomous irrigation, but these projects are only efficient for one crop. Because various agricultural products require varied moisture conditions for growth and in order to expand. A proposed technique is adaptable to different types of crops.

In (Prasojo et al., 2020), They designed an agricultural equipment that uses information and communication technology. The device is required to address the issue of wasted water and mistake in farmers. The study's goal was to create a programmable Arduino microcontroller that would autonomously manage watering using soil moisture sensor. The system monitors whether or not the soil is wet. Farmers no longer need to water by hand when using this system. the system can be using on plantations, seedbed nurseries, urban parks, hotels, workplaces, and in residences with gardens or plants that require frequent watering.

In (Agarwal et al., 2021), Thet developed a smart farming system. The system makes use of an Arduino UNO and sensor devices, as well as an ESP8266 Wi-Fi module. The tests and results reveal the surrounding temperature and relative humidity, in addition to the soil moisture of the piece of ground. The sensors are used to collect temperature measurements from the surroundings and store the information on the Thinkspeak Service. In this endeavour, the ESP8266 Wi-Fi module was used for connecting to the web and save information on the Thinkspeak server.

In (Gupta et al., 2022), they offered a methodology for developing an automated model that will spot crop degradation in its early stages, which are invisible to human eyes. This approach aids in avoiding of large losses while also saving a significant amount of time as well as labor. The suggested approach creates a detection architecture by utilizing sensors such as humidity, wetness, temperature, and plant-specific leaf colour. The information collected from the sensors is sent to the Arduino Cloud, which examines the information and aids in recognizing signs of plant degradation. The internet of things is going to have an important role in the intelligent agricultural system over the next years.

In (Suji et al., 2022), in rural areas, they suggest an intelligent farming management and monitoring system based on Wireless Sensor Networks. It was created to substitute the present agriculture evaluation technology. A secure network server is built and linked to a gateway, which is which receives information or indications from end nodes and sends them to the cloud server. The data can be used in end-user applications. the proposed fulfills the network's

ISSN: 2716-3865 (Print), 2721-1290 (Online)
Copyright © 2023, Journal La Multiapp, Under the license CC BY-SA 4.0

gateway by resolving communication issues and transmitting data in an energy-efficient manner. This smart farming platform enhances agricultural technique performance.

In (Alagarsamy et al., 2023), they proposed a plan based on automation and internet of things technology for making agricultural smarter. The primary purpose of this research is to identify the least amount of water required for growing plants. The majority of farmers waste an excessive amount of time on their fields instead of focusing on the water that plants need at the proper time. The proposed method measures the necessary quantity of water to be used based on sensor data. The system used two sensors to transmit data to the main station on the temperature of the soil, the humidity, the average daily quantity of sunlight, and the soil warmth. The proposed remedies must establish the amount of water required for cultivation based on these criteria.

In (Sridhar et al., 2023), they presented a solar-powered agricultural robot powered by the ESP32. The primary goal of their research is to decrease personnel by constructing a robot that does tasks such as seeding, blowing, and watering. Also, they are employing a soil sensor to evaluate the moisture level of the soil. Solar panels are utilized to provide energy backup. They are creating an application for Android in embedded C that will link to the ESP32 and allow us to provide instructions to the robot. The product is primarily utilized for agricultural purposes and rural farming. The benefits of robotics include reduced human intervention and efficient asset utilization. **Error! Reference source not found.** illustrates the comparison of the proposed system to the related works.

Table 1. comparison of the proposed system to the related works

System	Methodology	The problem solving
Previous Works	They use traditional methods in model design and construction	The previous studies almost manipulate one problem to solve it.
Proposed Work	The proposed methodology is depended about new approach. It was developed based on the object-oriented programming approach which perceived as a group of objects. The objects share the state, and each object manages its state data.	The proposed system can solve more than one problem in the same time: • Measure the weather parameters • Reduced the temperature to get the plants climate condition • Automatic irrigation. The amount of water that need depends on the plant's climate condition • The system can Monitor and Control remotely using IoT technology via Chabot Telegram. • Alarm the farmer Owner by Wi-Fi network.

The Proposed System

Given the importance of agriculture in an individual's life, this system was developed to keep pace with technological development and sustainable development. The system consists of a

ISSN: 2716-3865 (Print), 2721-1290 (Online)
Copyright © 2023, Journal La Multiapp, Under the license CC BY-SA 4.0

number of sensors that collect information from the environment. These sensors were applied to an agricultural field. It senses the temperature and humidity of the farm’s weather, and based on this, information is sent to the microcontroller to interpreted the signal and processed so that it can issue a decision regarding the its response of the sensor signals. It was not limited to this only. Smart automatic irrigation has been implemented based on the percentage of water in the soil. If the soil moisture is less than a certain value, irrigation is done automatically and without the farmer’s intervention.

The system is developed to suitable for farming environments. it is composed of hardware and software. The hardware represented by, ESP32 microcontroller, DH11 sensor, soil moisture sensors, water pumps, relay with power supply to provide the electricity to devices. **Error! Reference source not found.** illustrates the block diagram of the system. **Error! Reference source not found.** shows the details of equipment that used in developing the system.

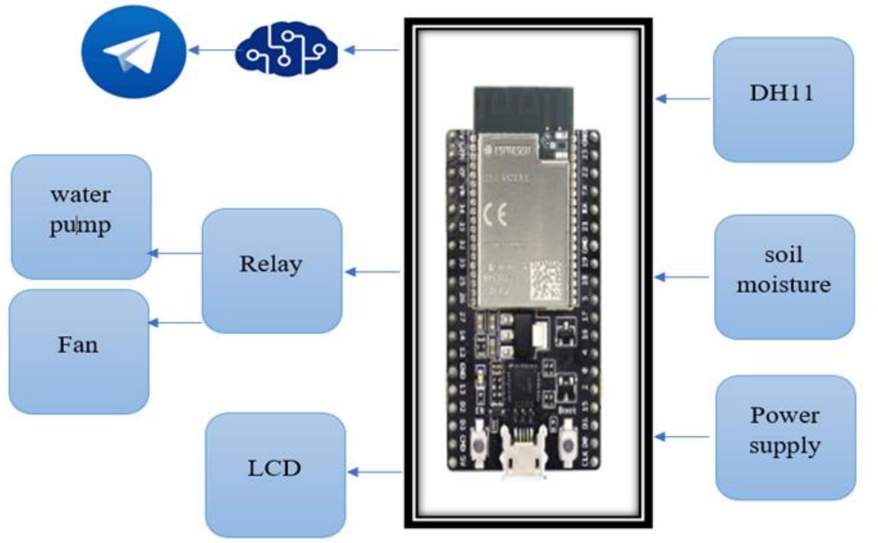
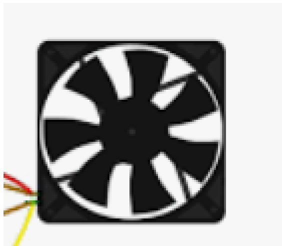


Figure 1. The block diagram of the system

Table 2. The description of equipment’s details

Name	Description	The utility	Module’s image
ESP32 Board	It is a low-footprint, minimal system development board powered by ESP-WROOM-32 module. It is a strong and small module that fuses Bluetooth and Wi-Fi to serve a variety of applications that need wireless and internet connectivity (Komalapati et al., 2021).	It represents the heart of the system that controlling about all connected devices.	
DH11 sensor	It is a digital sensor for measure both temperature and humidity. This sensor is a low-cost digital device that measures temperature and humidity which connects with many types of	It used to measure the temperature and humidity of the farmer environment.	

ISSN: 2716-3865 (Print), 2721-1290 (Online)
Copyright © 2023, Journal La Multiapp, Under the license CC BY-SA 4.0

	different microcontroller (Myint & Tun, 2020).		
Soil moisture	It is a sensor that is wired to an irrigation system controller that checks the amount of soil moisture in the activated zone of roots prior of each schedule watering event. If the reading is higher than a defined by users set point, the entire process is skipped (Yu et al., 2021)	This sensor measures the water levels in the soil.	
LCD	a form of flat-panel display, relies heavily on liquid crystals to function. LEDs have numerous uses for both individuals and businesses due to their widespread use in different system (Gabriel & Kuria, 2020).	It used to display the value of temp and humidity values	
Relay	Relays are electrically operated switches that, like all switches, can be turned on or off to allow electricity to flow through them or not. It allows us to control high voltages like 12V, 24V, or mains power (Agrawal & Singhal, 2015).	It used to control in operating fan and water pump	
Fan	Based on the decision of the microcontroller, all other modules are control this device (Junizan et al., 2019).	It used to control to the weather environment. It can reduce the high temperature if it rises above predefined threshold	
Water pump	It is an electromechanical device that raises the flow of water so that it can be transported from one place to another (Ratnadewi et al., 2018).	It used to provide the soil with the water	

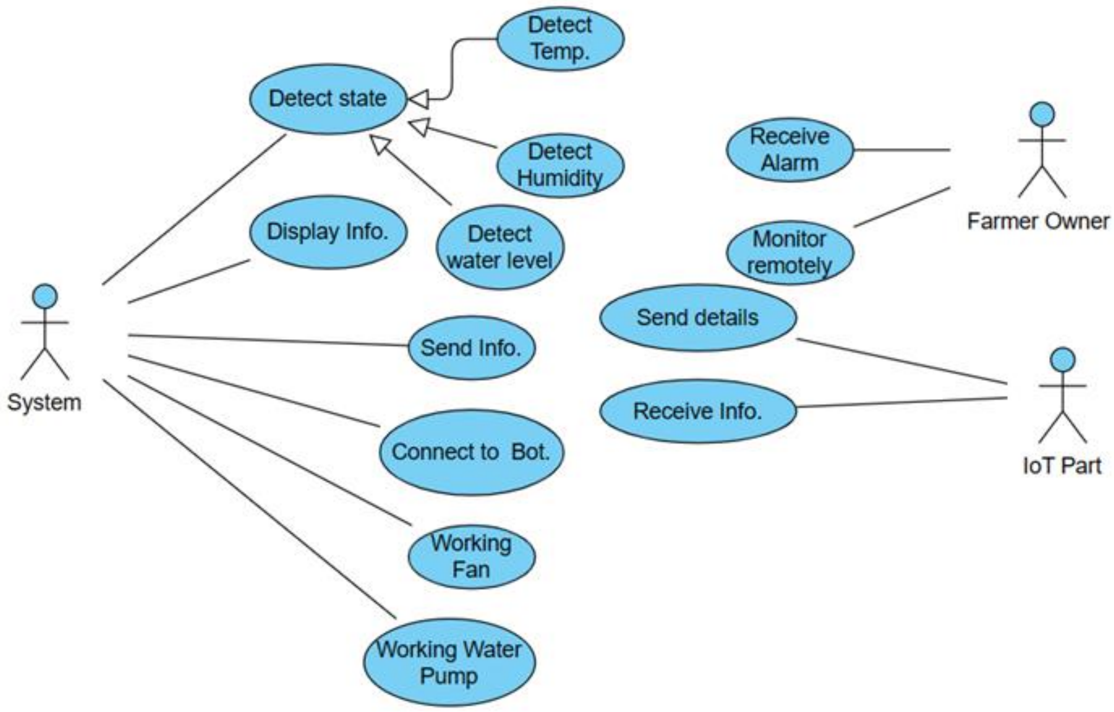
Error! Reference source not found. illustrates the final system design for each component. The DH11 sensor measures the temperature and humidity of the farm. If the temp greater or equal to a specified threshold, the system sends alarm message to the farm owner and the fan will operate automatically to reduce the temperature until reaching the satisfied values regarded temperature and humidity. The threshold depended on the type of the plants, fruits, vegetables which be cultivated. Furthermore. The soil moisture measures the humidity of the water continuously, and if it is less than the allowable limit, in accordance with the cultivated plants,

ISSN: 2716-3865 (Print), 2721-1290 (Online)
Copyright © 2023, Journal La Multiapp, Under the license CC BY-SA 4.0

it will work with automatic irrigation by operate the water pump to provide the soil with the water.

Figure 2. The proposed system design for each component

Error! Reference source not found. illustrates the use case diagram for proposed system. The diagram consists of interaction between actors and use cases. There are ten basic use cases and three actors with an associations and generalization relations.



ISSN: 2716-3865 (Print), 2721-1290 (Online)
Copyright © 2023, Journal La Multiapp, Under the license CC BY-SA 4.0

Figure 3. Use case modeling of the system

Results and Discussion

The greenhouse's soil moisture can be monitored in this system in all the times, also in real-time rainfall. The suggested system contributes to enhancing agricultural health. The system can alter the watering cycle and irrigation system to maintain the plants' ideal moisture levels, as seen in Figure 4. The system ensures that both indoor and outdoor plants are kept at the ideal moisture level because overwatering is the most harmful to plants. It is significant to remember that all vegetables require soil moisture levels between 41% and 80%, whereas the majority of plants such as flowers, trees, and bushes need moisture rates between 21% and 40%. Additionally, 41% to 80% of the soil moisture is needed for all plants.

Figure 4. The ideal moisture levels of plants

A simulation is a model that assesses how well an existing or proposed system performs by enabling the testing of various scenarios or process changes. It offers proof for making

ISSN: 2716-3865 (Print), 2721-1290 (Online)
Copyright © 2023, Journal La Multiapp, Under the license CC BY-SA 4.0

decisions. **Error! Reference source not found.** illustrates the simulation circuit for the esp32 module with the two basic sensors.

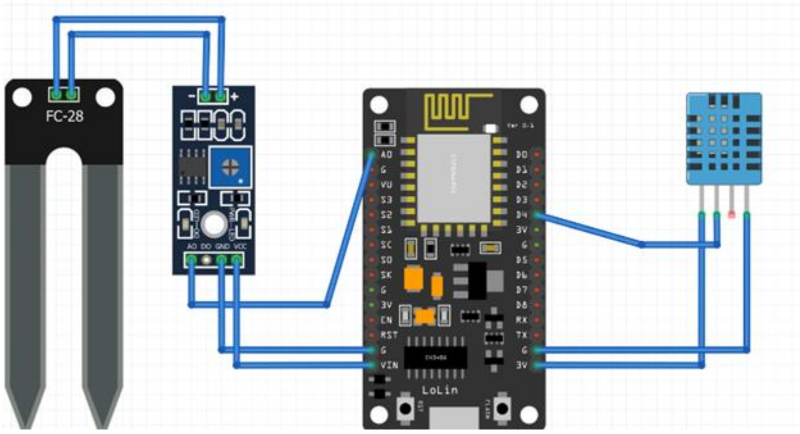


Figure 5. The simulation circuit for basic two sensors

The system collects data from connected devices and transmits it via a Wi-Fi network. The technology enabling communication between devices and the cloud is IoT (Internet of Things). When the system detects high temperatures and/or low soil moisture levels, it can automatically send a message to the farm owner, allowing them to monitor their work online. **Error! Reference source not found.** displays the alarm message sent via the Wi-Fi network through the Telegram app during a BOT.

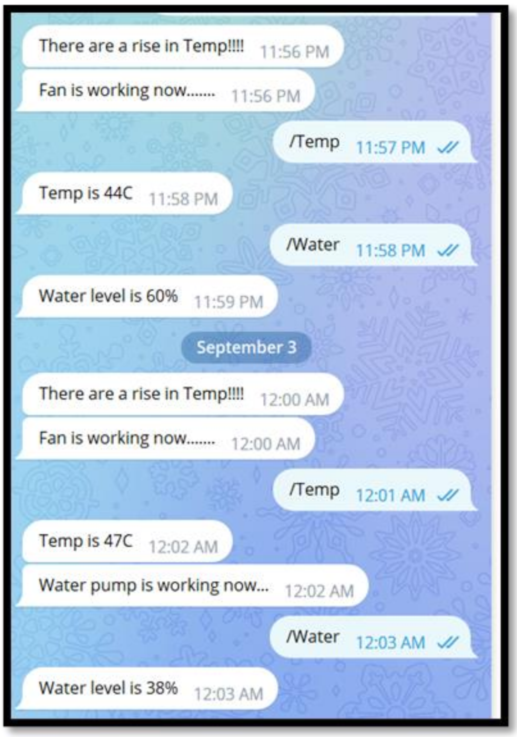


Figure 6. IoT Bot on Telegram

Conclusion

Smart agriculture is a forward-looking system that leverages advanced technology to cultivate food sustainably and ethically, all while optimizing the utilization of water and other natural resources. The primary aim of smart farms is to yield environmentally responsible and higher-

ISSN: 2716-3865 (Print), 2721-1290 (Online)
Copyright © 2023, Journal La Multiapp, Under the license CC BY-SA 4.0

yield crops through a resource-efficient approach. This system employs cutting-edge techniques to gauge weather conditions and employs fans to reduce temperature spikes automatically. Additionally, an automated irrigation system has been developed to efficiently distribute water. IoT (Internet of Things) technology plays a crucial role in remotely monitoring and controlling the entire system.

To further enhance farm security, we suggest connecting multiple sensors. Moreover, integrating GPS devices into the system can help pinpoint the location of affected soil, especially when applied across multiple farms.

Acknowledgment

The author would like to thank Mustansiriyah University at (www.uomustansiriyah.edu.iq) for the kindly support to finish this work.

References

Agarwal, A. K., Ather, D., Astya, R., Parygin, D., Garg, A., & Raj, D. (2021, December). Analysis of Environmental Factors for Smart Farming: An Internet of Things Based Approach. In 2021 10th International Conference on System Modeling & Advancement in Research Trends (SMART) (pp. 210-214). IEEE. https://doi.org/10.1109/SMART52563.2021.9676305

Agrawal, N., & Singhal, S. (2015, May). Smart drip irrigation system using raspberry pi and arduino. In International Conference on Computing, Communication & Automation (pp. 928-932). IEEE. https://doi.org/10.1109/CCAA.2015.7148526

Alagarsamy, M., Devakadacham, S. R., Subramani, H., Viswanathan, S., Johnmathew, J., & Suriyan, K. (2023). Automation irrigation system using arduino for smart crop field productivity. Int J Reconfigurable & Embedded Syst ISSN, 2089(4864), 4864. https://doi.org/10.11591/ijres.v12.i1.pp70-77

Azadi, H., Moghaddam, S. M., Burkart, S., Mahmoudi, H., Van Passel, S., Kurban, A., & Lopez-Carr, D. (2021). Rethinking resilient agriculture: From climate-smart agriculture to vulnerable-smart agriculture. Journal of Cleaner Production, 319, 128602. https://doi.org/10.1016/j.jclepro.2021.128602

Chopra, G., & Whig, P. (2022). Smart agriculture system using AI. International Journal of Sustainable Development in Computing Science, 4(1).

Gabriel, M. M., & Kuria, K. P. (2020). Arduino uno, ultrasonic sensor HC-SR04 motion detector with display of distance in the LCD. International Journal of Engineering Research and Technical Research, 9, 936-942. https://doi.org/10.17577/IJERTV9IS050677

Gondchawar, N., & Kawitkar, R. S. (2016). IoT based smart agriculture. International Journal of advanced research in Computer and Communication Engineering, 5(6), 838-842.

Gupta, B., Madan, G., & Md, A. Q. (2022). A smart agriculture framework for IoT based plant decay detection using smart croft algorithm. Materials Today: Proceedings, 62, 4758-4763. https://doi.org/10.1016/j.matpr.2022.03.314

Junizan, N. A., Razak, A. A., Balakrishnan, B., & Othman, W. A. F. W. (2019). Design and implementation of automatic room temperature-controlled fan using Arduino Uno and LM35 heat sensor. International Journal of Engineering Creativity & Innovation, 1(2), 8-14.

Copyright © 2023, Journal La Multiapp, Under the license CC BY-SA 4.0

Komalapati, N., Yarra, V. C., Kancharla, L. A. V., & Shankar, T. N. (2021, March). Smart fire detection and surveillance system using iot. In 2021 International Conference on Artificial Intelligence and Smart Systems (ICAIS) (pp. 1386-1390). IEEE. https://doi.org/10.1109/ICAIS50930.2021.9395841

Myint, H., & Tun, M. Z. (2020). Arduino based Fire Detection and Alarm System Using Smoke Sensor (Doctoral dissertation, MERAL Portal).

Napa, K. K., Dhamodaran, V., & Rogith, C. (2019). An Effective Moisture Control based Modern Irrigation System (MIS) with Arduino Nano. An Effective Moisture Control based Modern Irrigation System (MIS) with Arduino Nano.

Patil, K. A., & Kale, N. R. (2016, December). A model for smart agriculture using IoT. In 2016 international conference on global trends in signal processing, information computing and communication (ICGTSPICC) (pp. 543-545). IEEE.

Prasojo, I., Maseleno, A., & Shahu, N. (2020). Design of automatic watering system based on Arduino. Journal of Robotics and Control (JRC), 1(2), 59-63. https://doi.org/10.18196/jrc.1213

Prathibha, S. R., Hongal, A., & Jyothi, M. P. (2017, March). IoT based monitoring system in smart agriculture. In 2017 international conference on recent advances in electronics and communication technology (ICRAECT) (pp. 81-84). IEEE. https://doi.org/10.1109/ICRAECT.2017.52

Ratnadewi, R., Nurdiyanto, H., Najmurrokhman, A., Prabowo, C., Idmayanti, R., Eteruddin, H., ... & Rahim, R. (2018, September). Control and Notification Automatic Water Pump with Arduino and SMS Gateway. In IOP Conference Series: Materials Science and Engineering (Vol. 407, p. 012160). IOP Publishing. https://doi.org/10.1088/1757-899X/407/1/012160

Sridhar, B., Nikitha, S., Sireesha, G., Ruch Soitha, B., & Shivani, P. (2023, May). Solar power based agricultural robot using ESP32. In AIP Conference Proceedings (Vol. 2492, No. 1). AIP Publishing. https://doi.org/10.1063/5.0113333

Suji Prasad, S. J., Thangatamilan, M., Suresh, M., Panchal, H., Rajan, C. A., Sagana, C., ... & Sadasivuni, K. K. (2022). An efficient LoRa-based smart agriculture management and monitoring system using wireless sensor networks. International Journal of Ambient Energy, 43(1), 5447-5450. https://doi.org/10.1080/01430750.2021.1953591

Sushanth, G., & Sujatha, S. (2018, March). IOT based smart agriculture system. In 2018 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET) (pp. 1-4). IEEE. https://doi.org/10.1109/WiSPNET.2018.8538702

Yu, L., Gao, W., R Shamshiri, R., Tao, S., Ren, Y., Zhang, Y., & Su, G. (2021). Review of research progress on soil moisture sensor technology. https://doi.org/10.25165/j.ijabe.20211404.6404

ISSN: 2716-3865 (Print), 2721-1290 (Online)
Copyright © 2023, Journal La Multiapp, Under the license CC BY-SA 4.0