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Smart Automated Irrigation System using Wireless Technology

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Abstract: The need for agricultural output has surged due to the exponential rise of the world population, resulting in a strain on water supplies and a need for more effective irrigation systems. The goal of this project is to optimize water utilization in agricultural settings by presenting an automated and intelligent irrigation system. Based on current soil moisture levels, the system monitors and regulates irrigation using soil moisture sensors, an Arduino Nano, and a Raspberry Pi 3B+. By converting analog signals from the soil moisture sensor into digital data, the Arduino Nano serves as an analog-to-digital converter. This digital data is sent to the Raspberry Pi 3B+, which acts as the central control unit. A MOSFET is then triggered to activate a relay that is coupled to a 5V DC water pump when the moisture levels drop below a certain threshold.

The system also has wireless connection, which enables remote control and monitoring via an Android application. Users have the ability to manually override the automatic system if needed, monitor the moisture content of the soil, and turn on or off the water pump. This feature improves the usability and flexibility of the system.

Keywords: Irrigation system, Raspberry pi, IOT

I. INTRODUCTION

Irrigation is the technique of delivering water to land or crops to promote growth and flourish. It entails the regulated distribution of water by channels, pipelines, or other ways.

To ensure that plants get enough moisture. Irrigation systems in agriculture augment natural rainfall, particularly in places with low water supplies or during droughts. They may also be used in landscaping and gardening to help plants stay healthy. Irrigation aims to optimize water consumption while also increasing agricultural yields or plant growth.

Wireless communication is the transfer of information or data without physical connected connections. It uses electromagnetic waves to transmit information between devices, using electromagnetic waves like radio, infrared, or microwave communications. Wireless communication technologies encompass Wi-Fi, Bluetooth, cellular networks (2G, 3G, 4G, and 5G), satellite communication, and more. These technologies help gadgets communicate.

Data may be sent over short or long distances, making it convenient and flexible for applications including mobile phones, laptops, IoT devices, and wireless networks. Importance of soil moisture data for irrigation. Raspberry Pi moisture sensing uses a tiny and inexpensive computer to properly monitor and quantify soil moisture levels.

This data is important for many uses, including agriculture, gardening, and environmental studies. Understanding soil moisture content is essential for farmers to optimize their operations Irrigation procedures. Monitoring soil moisture levels allows farmers to identify the best time to irrigate crops, avoiding overwatering or underwatering, which can harm plant health and production. Raspberry Pi can properly monitor and measure soil moisture content at a low cost. It helps farmers, gardeners, and researchers make educated decisions on irrigation, plant health, and water conservation. Raspberry Pi enables soil moisture detection for a larger audience, leading to more efficient and sustainable agriculture operations.

Monitoring soil moisture is crucial for successful irrigation. Farmers can decide the best time and amount of irrigation by analysing the moisture levels in their soil.

This data-driven strategy helps to avoid overwatering, which may cause root rot and other plant health problems, and underwatering, which can limit plant development and lower yields.

II. BACKGROUND OF THIS WORK

A. Android Application for Monitoring Soil Moisture using Raspberry Pi:

As the human population grows, so does the need for water, which affects Indonesian crops. Proper watering is critical for plant growth since little or excessive water can damage plants.

Soil moisture measurements are used to determine soil quality in plantation fields. To increase plant quality and fertility, real-time monitoring technology such as sensors and Raspberry Pi are employed. Android Studio, released in 2013, is the official IDE for Android programming that uses Java for memory management.

Python 2.7 is an open-source programming language that can be used to write independent programs and scripts. It is the final major version in the 2.x series.

Raspberry Pi is a Linux-based computer featuring GPIO ports for custom circuits, built-in Wi-Fi, and Bluetooth that can be used for a variety of applications like document processing and gaming. To identify the presence of water, soil moisture sensors compare wet and dry earth conductivity values. When the moisture level reaches a predefined capacity, the sensor transmits a signal to the controller, which may be set on the sensor.

B. IOT based Smart Irrigation system and Nutrient Detection with Disease Analysis:

Agriculture contributes considerably to India's GDP, although technical advances in this area are limited. We identified significant challenges for paddy farmers after consulting with Kerala Agricultural University in Mannuthy and the Kerala Rice Research Station in Vytilla.

These include issues with over- or under-watering, the requirement for manual irrigation, and the lack of computerized disease monitoring for rice fields. Rice, Kerala's major crop, lacks automated tools for detecting nutritional deficits. Our research describes a low-cost system for automated irrigation and fertigation, paired with MATLAB-based image analysis to identify illnesses and nutritional deficits in rice fields.It focuses on two essential nutrients: magnesium and nitrogen. The hardware configuration includes a Raspberry Pi, a DHT11 temperature and humidity sensor, and solenoid valves.

Farmers can use an Android application to monitor the weather and, if needed, take direct control of the conditions.

C. MQTT based monitoring system for Urban farmers using ESP32 and Raspberry Pi:

Urban farming involves raising plants in urban locations when large-scale farming is not viable. Urban farming involves creating regulated conditions for maximum plant development, whether indoors or outdoors.

Urban farming is becoming increasingly important due to the world's rapidly growing urban population. As more people relocate to cities for jobs, urban food consumption rises as rural population declines.

IoT devices and low-power sensors. Sensor nodes are strategically deployed across plants to collect complete data for analysis and decision-making. The Raspberry Pi 3

Model-B computer stores data in a database. The dashboard, constructed with the NodeRed flow-based programming tool, may be accessed through a web browser. Additionally, the data is accessible on a locally hosted server's webpage.

This cost-effective monitoring device enhances plant development efficiency and produces data to improve cultivation procedures.

D. IoT based Smart Irrigation System using Raspberry Pi:

In this paper, an Android application was used to help with soil moisture monitoring. The sensor attached to the Raspberry Pi 3 provides data to this application. This information will be transmitted to the server and shown on the Android app. An LED indicator is included to let you know when the plants are getting water. The ultimate outcome of this study is a system application that allows an analog sensor's data to be transformed into percentages and shown in an Android application. Users can adjust the sensor's indicator to turn on the LED based on this percentage. Additionally, users can manage plant data for the database, analyse graphs derived from percentage data, and configure the application.

During the study of the Android application, multiple sensors were utilized to see the effectiveness of the applications and to weigh the accuracy of the device. Using the system over an area of effective soil of 10X10X10 size, a few inferences were drawn. These were then used for further modifications in the application and system.

E. Remote control of a domestic equipment from an Android application based on Raspberry pi card

Home automation has grown in popularity as technology advances, allowing for more convenience and energy efficiency throughout the home. This article covers a system for remotely controlling home appliances via an Android application, with a Raspberry Pi card serving as the system's backbone. The following major characteristics describe the system's functioning and prospective applications:

Remote Operate via Android App: The suggested system's main feature is the ability to control various home gadgets from a distance. Users may control equipment such as shutters using an Android application, which communicates via a Raspberry Pi card.
Database-Driven Command Verification: The Raspberry Pi frequently examines a database for new commands provided by the Android app. This technique allows users to transmit commands remotely via their mobile phones, guaranteeing that the Raspberry Pi always has the most recent instructions to execute on.
Extensibility to Other Devices: Although the system's primary function is to operate shutters, the underlying technology can also handle other household devices. This might include lights, air conditioners, and other items. The system's design follows REST principles, with data communication expressed in JSON. This design decision encourages scalability and interoperability with a variety of devices.

III. LITERATURE REVIEW

A. Raspberry Pi

Fig. 1. Raspberry Pi 3 Model B+

Memory: 1 GB of LPDDR2 SDRAM is included, which is more than enough for the majority of instructional and light-duty applications.
Wireless Connectivity: The Raspberry Pi 3B+ is equipped with Bluetooth 4.2 and dual-band Wi-Fi (2.4 GHz and 5 GHz), which allow for wireless communication and Internet of Things features.
Ethernet: It comes with a 300 Mbps Gigabit Ethernet adapter, which enables dependable and quick wired network connections.
The board features a 40-pin General-Purpose Input/Output (GPIO) header that may be used to interface with sensors, LEDs, and other electronics, in addition to four USB 2.0 ports for connecting peripherals.
HDMI and Audio Output: It supports multimedia projects and displays with an HDMI video output and a 3.5mm audio connection.
Operating System: The Raspberry Pi 3B+ is generally powered by Linux-based operating systems, such as Raspbian and Raspberry Pi OS, which offer a large selection of applications and flexibility.

B. Arduino Nano

Fig. 2. Arduino Nano

Microcontroller: The ATmega328P microcontroller is used, with 1 KB of EEPROM, 2 KB of SRAM, and 32 KB of flash memory. This provides it with sufficient space to store permanent data and run a variety of Arduino programs.
Form Factor: Its pin configuration and compact dimensions (about 1.7 by 0.7 inches) make it perfect for embedding into small projects for breadboarding.
Digital and Analog Pins: The Arduino Nano has eight analog input pins and fourteen digital input/output pins, six of which can be used as PWM outputs. This versatility allows for a variety of connections for sensors and actuators.

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Power Supply: An external power supply (6-20V) or a Mini-B USB connection can be used to power it. It has a voltage regulator that can provide either 3.3V or 5V as output to power the board and any connected parts.
Connectivity: Programming and serial communication on a computer are made simple by the USB port. Sketches are uploaded to the Arduino Nano via a bootloader, making it simple to build with the Arduino IDE.
Typical Uses: The Arduino Nano is well-liked for wearable technology, robots, IoT devices, and DIY electronics because of its compact size and adaptability. It's frequently employed in tasks requiring quick prototyping or with restricted space.

C. Soil Moisture Sensor

Fig. 3. Soil Moisture sensor

Durability: They have a longer lifespan because there isn't any direct metal-to-soil contact, which prevents corrosion.
Consistency: They are less susceptible to changes in salinity and soil composition.
Low Maintenance: Compared to resistive sensors, they require less maintenance.
Agricultural, gardening, and environmental monitoring automatic irrigation systems frequently use capacitive soil moisture sensors. Smart gardening and Internet of Things (IoT) applications can benefit greatly from their integration with microcontrollers such as Arduino or Raspberry Pi, which enable wireless communication and remote monitoring.

D. Raspbian

Debian-Based: Raspbian is based on the popular Linux distribution Debian, which offers a stable and reliable base.
Lightweight: Even on older or lower-spec Raspberry Pi models, it ensures efficient performance because it is tailored for the hardware of the Raspberry Pi.
Graphical User Interface (GUI): It has a lightweight desktop environment that provides an easy-to-use graphical interface for managing applications and system settings. This desktop environment is usually LXDE or a version.
Pre-Installed Software: Python, Scratch, and a number of other teaching and development tools are among the pre-installed applications that come with Raspbian and are frequently used with Raspberry Pies. Web browsers, media players, and productivity tools are also included.
Development Tools: It is appropriate for educational projects and programming since it provides a variety of software development tools, such as Python, C, C++, and others.
Support from the Community: Raspbian, the official operating system for the Raspberry Pi, has a sizable and vibrant community. This offers a wealth of material, tutorials, and assistance.

E. Android Studio

IntelliJ-Based IDE: Android Studio is a powerful code editing, refactoring, and code navigation tool that is built upon IntelliJ IDEA.
With the Visual Layout Editor, developers can design app screens by simply dragging and dropping UI elements into the tool to create user interfaces.
Gradle Build System: The IDE's use of Gradle allows for flexible configuration of builds for various environments and device kinds as well as automatic builds and dependency management.
Device Emulator: To test apps on virtual Android devices and allow developers to simulate various devices and Android versions, Android Studio comes with an emulator.
Tools for Code Analysis: The IDE provides tools for static code analysis, enabling developers to see any problems and enhance the quality of their code.
Version Control Integration: Git and other version control systems are supported by Android Studio

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IV. SYSTEM IMPLEMENTATION

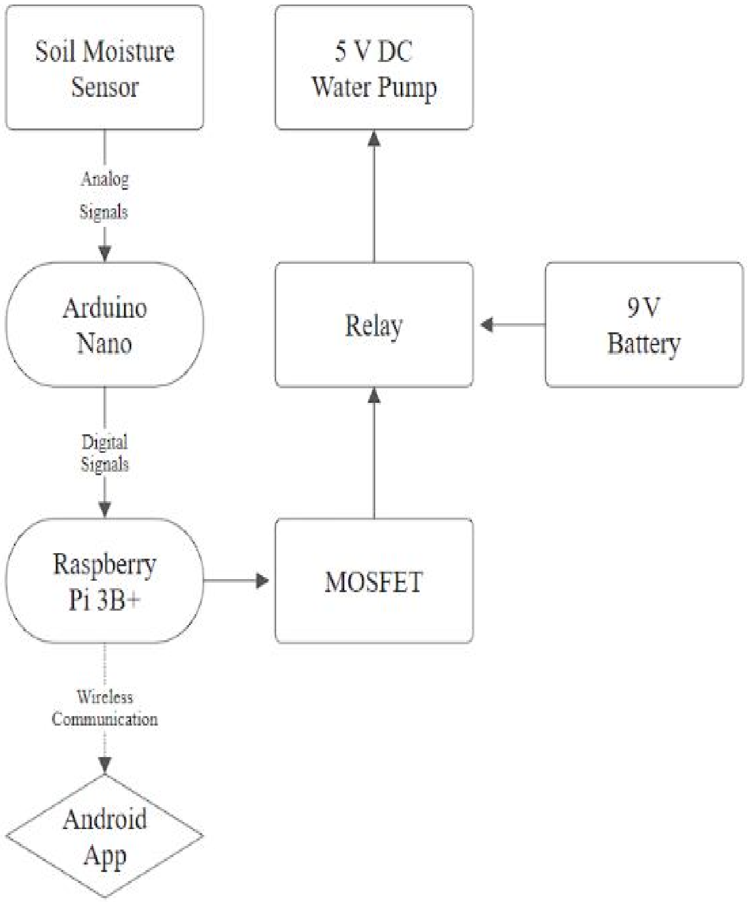

Fig. 4. Block Diagram Representation of Proposed System

With the intention of maximizing agricultural productivity and minimizing water consumption, you have created an automated and intelligent irrigation system. Using state-of-the-art technology, this system ensures effective water management by monitoring soil moisture levels and making adjustments accordingly.

The tiny but mighty Arduino Nano microcontroller is the brains behind this system. It performs the function of an analog-to-digital converter (ADC), converting the soil moisture sensor's analog impulses into digital data with ease. The Raspberry Pi 3B+, which acts as the central control unit and plans the entire operation, receives this digital data after that.

The powerful Raspberry Pi 3B+ is in charge of evaluating the moisture information that the Arduino Nano sends it. The Raspberry Pi acts by delivering a signal to a MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor) when the moisture levels fall below a preset threshold. This MOSFET then turns on a relay that is attached to a water pump that runs on 5V DC.

The irrigation process commences when the water pump, which is powered by a 9V battery, comes to life. It replenishes the moisture levels in the soil by providing a constant stream of water. The Raspberry Pi recognizes when the soil progressively returns to the appropriate level of moisture and deactivates the MOSFET, so turning off the relay and stopping the water pump.

This system's ability to connect wirelessly is one of its best qualities. Users of smartphones or tablets may conveniently monitor and control the irrigation system remotely thanks to the Raspberry Pi 3B+'s flawless communication with an Android app. This feature gives users total control over the irrigation process by giving them access to real-time data on soil moisture and the option to manually override the system if necessary.

Through the application of advanced technology and the integration of many components, this automated irrigation system maximizes water use, protecting this valuable resource while also encouraging more robust crop development and yield. It is an importasnt step toward sustainable agricultural methods and a perfect example of how creativity can be used to solve pressing environmental issues.

V. CONCLUSION

To sum up, the automated and intelligent irrigation system effectively illustrates how technology can be used to improve farming methods. The project provides automatic irrigation that reacts to soil moisture levels in real-time by combining the accuracy of soil moisture sensors with the control capabilities of Arduino Nano and Raspberry Pi 3B+. In addition to automating irrigation and eliminating the need for human interaction, this technology saves water by only irrigating when necessary.

Users may monitor soil moisture levels and remotely regulate the irrigation system thanks to the project's connection with an Android application, which offers flexibility and ease. The system's practicality and ease of implementation in actual agricultural contexts are enhanced by its wireless connectivity and user-friendly interface.

Furthermore, the experiment has demonstrated that by guaranteeing plants receive the right amount of hydration and lowering the possibility of over- or under-irrigation, this kind of irrigation can boost crop health and output. The system's potential for wider applications in agriculture is highlighted by its successful installation and encouraging user response, indicating that it may prove to be a useful tool for resource conservation and sustainable farming.

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