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Smart Irrigation System Using Artificial Intelligence

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ABSTRACT :

Water wastage in agriculture is a widespread issue requiring consistent monitoring to mitigate. One of the leading causes is public and administrative unawareness. While various irrigation and monitoring systems exist, manual control often hinders efficiency. This project addresses efficient water management by designing a smart irrigation system utilizing artificial intelligence. Implemented on an Arduino UNO platform, the system regulates water discharge from pipes. AI, specifically Linear Regression, establishes a scheduled timetable for field irrigation, optimizing water distribution. Additionally, the integration of IoT and AI enables real-time monitoring of water distribution, benefiting both management systems and end-users. This innovative approach aims to combat water wastage in agriculture, ensuring resources are utilized effectively while addressing global concerns about water scarcity

1. Introduction

Efficient water management is vital in contemporary agriculture for maximizing crop yields, conserving water, and maintaining ecological equilibrium. However, existing irrigation systems frequently lack accuracy, resulting in water wastage and substandard plant growth, especially evident in piped and micro irrigation networks where manual control struggles with varying soil moisture levels. The primary hurdle lies in the absence of automated mechanisms to adjust water release based on real-time soil moisture data. To tackle this challenge, an innovative solution is imperative. Utilizing artificial intelligence (AI), this solution aims to automate water release regulation in irrigation networks by integrating AI-powered soil moisture monitoring and decision-making processes. This system can dynamically adapt water distribution to fulfill crop requirements, aiming to optimize resource usage, reduce environmental impact, and enhance agricultural productivity. In conclusion, modern agriculture necessitates precise water management to fulfill crop needs while conserving resources. Existing irrigation systems often falter, particularly in responding to fluctuating soil moisture conditions. Through harnessing AI technology, a novel solution can automate water regulation, paving the way for more efficient and sustainable agricultural practices. Embedded system implementation: An embedded system is one kind of a computer system mainly designed to perform several tasks like to access, process, and store and also control the data in various electronics-based systems. Embedded systems are a combination of hardware and software where software is usually known as firmware that is embedded into the hardware. One of its most important characteristics of these systems is, it gives the o/p within the time limits. Embedded systems support to make the work more perfect and convenient. So, we frequently use embedded systems in simple and complex devices too. The applications of embedded systems mainly involve in our real life for several devices like microwave, calculators, TV remote control, home security and neighborhood traffic control systems, etc.

Objectives

The objectives of this study are:

- Develop AI-driven irrigation system for precise water management.
- Implement real-time soil moisture monitoring for optimal resource usage.
- Enhance agricultural productivity while conserving water resources.

Methodology

The methodology revolves around the creation of an advanced irrigation system propelled by artificial intelligence (AI). This includes the development of an AI-driven framework equipped with real-time soil moisture sensors. These sensors play a pivotal role in gauging soil moisture levels continuously, providing crucial data for informed decision-making. Moreover, AI algorithms are integrated into the system to automate water release. These algorithms analyze the data from the soil moisture sensors and make real-time adjustments to optimize water distribution. By harnessing the power of AI, the system can adapt dynamically to changing environmental conditions, ensuring efficient water usage tailored to the specific needs of the crops. Field trials serve as a vital step in the validation and optimization of the system. Through these trials, researchers gather empirical data on the system's performance under real-world conditions. This data is then analyzed to identify areas for improvement and refinement. The iterative nature of the process ensures systematic development and continuous enhancement of the irrigation system. Insights gained from field trials are used to refine the AI algorithms, fine-tune sensor placement, and optimize water release strategies. This iterative approach allows for ongoing improvement, leading to increasingly precise water management in agriculture. Ultimately, the goal of the methodology is to achieve precise water management in agriculture, optimizing crop yields while minimizing water waste. By leveraging AI technology and real-time data, the system aims to revolutionize irrigation practices, contributing to sustainability and efficiency in food production.

Observation and Review

In this chapter, we have given my critical evaluation & summary of all research papers that I read related to my project. For existing systems advantages and disadvantages are mentioned below.

4.1 GSM based system

Acknowledging the challenges posed by population growth, food scarcity, and water shortages for farmers, Karan Kansara's focus is on implementing an automatic irrigation system. This system aims to streamline farming operations, saving farmers valuable time, money, and energy resources. Kansara emphasizes the simplicity of installation and configuration, alongside the benefits of energy and resource conservation. By automating the irrigation process, the system mitigates human errors in adjusting soil moisture levels, enhancing efficiency. Utilizing GSM technology, the system facilitates remote control via an Android phone, optimizing resource utilization and enabling effective crop planning.

The process initiates with power supplied to the GSM, followed by moisture level checks, triggering irrigation when levels are insufficient, and halting the process upon completion. While the system boasts advantages such as water and time savings, its limitation lies in its focus solely on irrigation automation, lacking additional advanced features.

4.2 Solenoid valve controlling system

Karan Kansara's project revolutionizes farm irrigation through an automated system driven by soil humidity sensors. This innovative approach optimizes irrigation efficiency by precisely adjusting water delivery based on real-time soil moisture levels. The microcontroller activates solenoid valves accordingly, while Java facilitates seamless communication between the microcontroller and server, ensuring timely updates on irrigation status. Beyond irrigation, the system enhances crop management by monitoring soil pH, temperature, and recommending suitable crops and fertilizer applications. Continuous monitoring via a PC host provides farmers with valuable insights into crop conditions, leading to improved production outcomes. By limiting water usage to the system's requirements and providing real-time updates via the server, Kansara's project empowers farmers with greater control and knowledge over their fields, regardless of location.

4.3 Arduino and raspberry pi driven

This paper presents a novel design for an automatic water supply system tailored for farmland utilization, employing Raspberry Pi 3, Arduino microcontrollers, a WiFi module, GSM shield, relay boards, and a variety of sensors. The selected components ensure a comprehensive, scalable, and dynamic implementation. By leveraging moisture levels in the soil and daylight intensity, the system accurately determines the optimal timing for watering plants, while also monitoring water levels to prevent root waterlogging. Analog data captured by sensors is seamlessly transmitted as digital signals via the Arduino's WiFi module to the Raspberry Pi 3 for processing. Additionally, the system features administrative customization and interaction via SMS commands, enhancing its versatility and user-friendliness. This innovative solution not only caters to farmland needs but also extends its applicability to small-scale plant cultivation. By adopting this technology, significant advancements in plant sustainability and care are achieved through a scientific approach. Post-assembly, rigorous testing was conducted to validate system responsiveness across various scenarios, ensuring its reliability and efficacy.

4.4 Data Collection with Wireless Sensor Networks

smart farming sector. They have focused their research on developing sustainable solutions for agricultural automation, aiming to enhance efficiency and productivity. Their innovative approach involves the creation of a portable measurement technology, comprising soil moisture, air humidity, and air temperature sensors. These sensors facilitate the collection of crucial environmental data and enable remote control of irrigation systems via smartphones. The primary objective of their experiment is to optimize irrigation control by comparing automated and manual methods using smartphone interfaces. To achieve this, they have devised a wireless sensor network communication protocol for seamless data collection and irrigation control. The experimental findings reveal impressive accuracy rates of 96% for irrigation control commands and 98% for environmental data collection. However, challenges persist in accurately determining watering volumes, attributed to variables such as rainfall, soil composition, and crop specifications. Addressing these challenges is crucial for enhancing the precision and effectiveness of smart farming practices.

4.5 Threshold value decision based on environmental condition

Addressing the challenge of uneven rainwater distribution, farmers face significant hurdles in managing water allocation across their crops. The complexity of this task demands an irrigation solution adaptable to diverse weather conditions, soil types, and crop varieties. Greenhouses emerge as a viable remedy, offering precise environmental control and management. Leveraging sensor networks across expansive agricultural areas, greenhouses can create tailored environments conducive to optimal crop growth. This technological infrastructure, powered by cloud computing and IoT, enables real-time monitoring and control of environmental parameters from any location. A key focus lies in devising algorithms capable of accurately assessing present conditions and establishing crop-specific thresholds. When these thresholds are breached, IoT sensors detect parameter changes, facilitating data transmission to farmers for informed decision-making. The integration of IoT and cloud computing empowers greenhouse management, resulting in enhanced crop yields, extended production periods, improved quality, and reduced reliance on harmful chemicals.

4.6 Xbel modules operation

Nikhil Agrawal and Smita Singhal have proposed a home automation system design utilizing cost-effective, energy-efficient devices such as Raspberry Pi, Arduino microcontrollers, Xbee modules, and relay boards. This selection of components ensures an economical, scalable, and resilient system implementation. User commands are processed by the Raspberry Pi using Python programming language. Arduino microcontrollers receive on/off commands from the Raspberry Pi via Zigbee protocol, with a star Zigbee topology facilitating communication between the Raspberry Pi and end devices. Acting as the central coordinator, the Raspberry Pi communicates with various routers serving as end devices. As a proof of concept, a low-cost and energy-efficient drip irrigation system is implemented. This versatile design finds applications in large agricultural fields and small gardens alike, enabling plant watering through simple email commands to the system. The paper provides comprehensive guidance on the installation of the system, covering both hardware and software aspects.

4.7 Zigbee communication

The primary objective is to automate water supply for both home gardening and agricultural irrigation systems, achieved through soil moisture and temperature sensors positioned at the plant root level. These sensors detect moisture levels and temperature variations, transmitting the data to a base station. The base station collects field data and uploads it to the internet via WiFi technology, while also alerting users to any abnormal conditions such as low moisture or high temperature. The effectiveness of this method has been validated across diverse climates and moisture levels, particularly in crops like red chili weeds. Catering to the interests of home gardeners and the practical needs of agricultural irrigation, this system facilitates real-time monitoring of temperature and moisture levels. Utilizing ZigBee modules for data transmission, the received values are compared with set points. The WiFi module (ESP8266) interfaces with the microcontroller to upload temperature and soil moisture data to the web. Visual Basic on a personal computer receives values from the ZigBee receiver, enabling the plotting of temperature and moisture graphs over time. The system's outcomes include efficient automation of irrigation, deemed suitable and cost-effective for accessing water sources in agricultural management. This approach enables farming in water-scarce areas, contributing to water conservation and agricultural sustainability.

4.8 Wireless sensors and data monitoring

In their paper, Prof. Rashmi Jain and colleagues highlight the critical role of agriculture and food production in India, particularly given the country's reliance on unpredictable monsoons for water supply. To address this challenge, irrigation systems are pivotal in delivering water to agricultural fields. The emergence of modern greenhouse-based agriculture industries has ushered in advanced technologies for precisely regulating plant humidity and temperature. However, maintaining consistent environmental conditions across large farmhouses proves challenging due to varying atmospheric conditions. To address this issue, the paper introduces a ground-breaking concept: utilizing an Android phone to control irrigation systems, thereby enabling the maintenance of uniform environmental conditions. The primary objective of the study is to develop a smart wireless sensor network (WSN) customized for agricultural environments. Monitoring factors such as soil moisture, temperature, and humidity, alongside other variables, holds significant importance. Traditionally, measuring these factors in agricultural settings required manual interventions, with individuals taking measurements at different intervals. The paper explores a remote monitoring system employing RF modules. These nodes wirelessly transmit data to a central server, which collects, stores, analyses, and displays the data as necessary, including relaying it to client mobile devices. This innovative approach streamlines agricultural monitoring and management, ultimately enhancing efficiency and productivity in farming practices.

4.9 Manual control system using Arduino for ON/OFF the water pump

In this paper, the authors underscore the paramount importance of agriculture in Indian households, emphasizing its pivotal role in national development. With agriculture contributing significantly to the country's GDP and exports, the efficient utilization of water resources becomes imperative. The proposed project, titled "Arduino-based Automatic Irrigation System using IoT," aims to address water wastage and time inefficiencies commonly associated with traditional irrigation methods. By integrating various sensors such as temperature, humidity, and soil moisture sensors, the system can accurately monitor soil parameters. Based on the soil moisture levels, the system automatically controls the irrigation process by toggling the motor ON/OFF. Additionally, the status of these sensors and the motor is displayed on a user-friendly Android application, enhancing accessibility and ease of monitoring. Leveraging Internet of Things (IoT) technology, the project enables remote monitoring and control, empowering users to oversee device functions via mobile devices. IoT facilitates the interconnection and communication of devices installed at disparate locations, enabling seamless data exchange. The primary objective of the project is to streamline the irrigation process, thereby conserving time, money, and energy for farmers. By automating irrigation tasks, the system minimizes the need for manual intervention, thus optimizing agricultural efficiency and productivity.

Hardware and Software Details

5.1 Arduino UNO

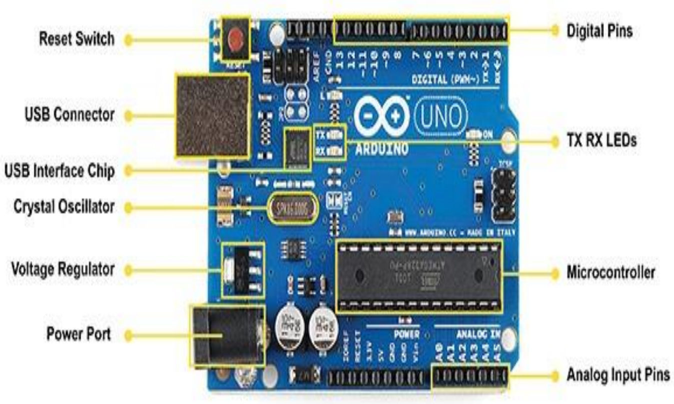


Fig.2: Arduino Uno

Arduino originated at the Ivrea Interaction Design Institute with a focus on providing an accessible tool for rapid prototyping, particularly aimed at students lacking prior experience in electronics and programming. As its user base expanded, the Arduino board evolved to meet new demands and challenges, diversifying its offerings beyond simple 8-bit boards to cater to applications such as IoT, wearable technology, 3D printing, and embedded systems.

The Arduino Uno, developed by Arduino.cc, is a prominent microcontroller board within the Arduino ecosystem. It is based primarily on the AVR microcontroller Atmega328 and operates as an open-source electronics platform. The latest iteration of the Arduino Uno features a USB interface, 6 analog input pins, and 14 digital I/O ports for connecting with external electronic circuits. Among these ports, 6 pins are capable of PWM (Pulse Width Modulation) output, providing versatility in controlling various devices and peripherals.

5.2 Power Supply (SMPS)

fig.3: SMPS

The project employs two distinct voltage levels to accommodate the requirements of different components. Initially, a 12V voltage is sourced from an adapter. However, since this voltage level isn't compatible with the electronic components, it undergoes reduction to 5V using an IC-7805. Additionally, a 24V voltage level is utilized to power the solenoid valves, also obtained from an adapter. This dual voltage setup ensures proper operation of the various components within the system while meeting their specific power needs.

5.3 Water Pump

fig.4: Water pump

The Micro DC 3-6V Micro Submersible Pump is a compact and affordable option suitable for various applications such as fountain gardens and mini water circulation systems. Operating within a voltage range of 3 to 6V, this pump can deliver up to 120 liters of water per hour while consuming a low current of 220mA. To use the pump, simply connect a tube or pipe to the motor outlet, submerge it in water, and provide power. It's important to ensure that the water level remains higher than the motor to prevent damage from dry running, which can lead to overheating and noise production. With its small size and efficient performance, this submersible pump is a versatile solution for small-scale water pumping needs.

5.4 Relay

fig.5: 5V Relay with internal structure

An electromagnetic relay is composed of a wire coil encircling a soft iron core, alongside an iron yoke facilitating a smooth path for magnetic flux, a movable iron armature, and multiple sets of contacts (as depicted, there are two). The armature is affixed to the yoke via hinges and interconnected mechanically with one or more sets of mobile contacts.

5.5 Solenoid Valve

fig.6: 24V Solenoid Valve

A sensor that exhibits high sensitivity to ambient light is a photodiode. A solenoid valve operates through electrical control. It comprises a solenoid—a coil of wire with a movable ferromagnetic core (plunger) positioned within. In its default state, the plunger blocks a small opening. Upon passing an electric current through the coil, a magnetic field is generated, exerting an upward force on the plunger, thus opening the orifice. This fundamental concept governs the functioning of solenoid valves, enabling them to open and close as required.

5.6 GSM Module

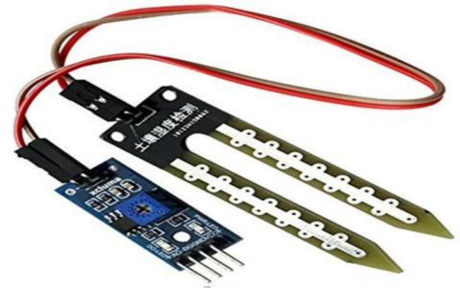
fig.7: GSM Module

GPRS, or General Packet Radio Service, is an extension of the GSM network that provides an efficient means of transferring data using the same GSM network resources. A GSM/GPRS module is an integrated circuit or chip that utilizes a SIM (Subscriber Identity Module) and radio waves to connect to the GSM network. Typical radio frequencies used are 850MHz, 900MHz, 1800MHz, and 1900MHz.

The module typically consists of components such as the GSM/GPRS module itself, a SIM card slot, a connection for interfacing with a computer or microcontroller (usually through an RS-232 interface), LED indicators for status, power supply connections, and connections for microphone and speaker. Each GSM/GPRS module has a unique IMEI (International Mobile Equipment Identity) number, a 15-digit identifier used to distinguish it.

Using a GSM/GPRS module, various tasks can be performed:

- Making, receiving, or rejecting voice calls
- Sending, receiving, or deleting SMS messages stored in the SIM card
- Managing contacts stored in the SIM card (adding, reading, searching)
- Sending and receiving data to/from the GSM/GPRS network via GPRS technology.



5.7 Soil Moisture Sensor

Fig.8: Soil Moisture Sensor

Soil moisture sensors play a crucial role in assessing soil water content, aiding in the estimation of water stored within the soil profile. These sensors do not directly measure soil water; rather, they detect alterations in a specific soil characteristic that correlates reliably with moisture levels.

Conclusion

The described automatic irrigation system promises a methodical and scientifically driven approach to plant care, ultimately enhancing productivity. Its construction is both straightforward and economical. As sensor technology continues to advance, the system's efficiency and utility are poised to improve. For example, sensor data can optimize water supply, minimizing waste. By monitoring environmental parameters and transmitting data via cloud, the system empowers farmers to tailor cultivation methods to meet plant requirements, resulting in increased yield, extended production cycles, improved quality, and reduced chemical usage. Furthermore, the system conserves electricity used for water supply and significantly reduces human labor. This paradigm of smart irrigation represents a step towards agricultural automation and mechanization on a global scale.

REFERENCES :

1. Karan Kansara, Vishal Zaveri, Shreyans Shah, Sandip Delwadkar, Kaushal Jani, 2015 “Sensor based Automated Irrigation System with IOT: A Technical Review,” IJCSIT, 5331-5333.
2. G. Parameswaran, K.Sivaprasath, 2016, “Arduino Based Smart Drip Irrigation System Using Internet of Things,” IJESC, 5518-5521.
3. Nomusa Dlodlo, Josephat Kalezhi, 2015, “The Internet of Things in Agriculture for Sustainable Rural Development”, IEEE, 13-18.
4. Nattapol Kaewmard, Saiyan Saiyod, 2014, “Sensor Data Collection and Irrigation Control on Vegetable Crop Using Smart Phone and Wireless Sensor Networks for Smart Farm,” IEEE Conference on Wireless Sensors (ICWiSE), 106-112.
5. Sheetal Vatari, Aarti Bakshi, Tanvi Thakur, 2016, “Green House by using IOT and Cloud computing,” IEEE, 246-250.
6. Nikhil Agrawal, Smita Singhal, 2015, “Smart Drip Irrigation System using Raspberry pi and Arduino,” International Conference on Computing, Communication and Automation (ICCCA),928-932.
7. M. Kranthi Kumar, K. Srenivasa Ravi, 2016 “Automation of Irrigation System based on Wi-Fi Technology and IOT,” Indian Journal of Science and Technology, DOI- 10.17485/ijst/2016/v9i17/93048.
8. Ahmed Imteaj, Tanveer Rahman, Muhammad Kamrul Hossain, Saika Zaman, 2016 “IoT based Autonomous Percipient Irrigation System using Raspberry Pi,” 19th International Conference on Computer and Information Technology, 563-568.
9. Prof. Rashmi Jain, Shaunak Kulkarni, Ahtesham Shaikh, Akash Sood, 2016, “AUTOMATIC IRRIGATION SYSTEM FOR AGRICULTURE FIELD USING WIRELESS SENSOR NETWORK (WSN),” International Research Journal of Engineering and Technology (IRJET), 1602-1605.
10. Pavankumar Naik, Arun Kumbi, Vishwanath Hiregoudar, Chaitra N K, Pavitra H K, Sushma B S, Sushmita J H , Praveen Kuntanahal, 2017 “Arduino Based Automatic Irrigation System Using IoT,” International Journal of Scientific Research in Computer Science, Engineering and Information Technology, 881-886.