Smart Agriculture Using IoT

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Abstract- *AGRICULTURE sector is facing significant challenges due to factors such as climate change, population growth, and limited natural resources. In response, Smart Agriculture Systems (SAS) have emerged as a promising solution to enhance productivity, sustainability, and efficiency in farming practices. This paper explores the key components and benefits of SAS, including Internet of Things (IoT) devices, data analytics, and automation technologies. By integrating sensors, drones, and other IoT devices, SAS enable real-time monitoring of environmental conditions, soil moisture levels, crop health, and livestock behavior. Data collected from these sources are analyzed to provide actionable insights and optimize resource allocation, leading to improved yields, reduced costs, and minimized environmental impact. Additionally, automation technologies such as robotic systems and precision agriculture equipment further streamline farming operations, enabling farmers to make data-driven decisions and achieve higher levels of productivity. This abstract highlights the potential of SAS to revolutionize the agricultural industry and address the growing demand for sustainable food production in the face of global challenges*

I. INTRODUCTION

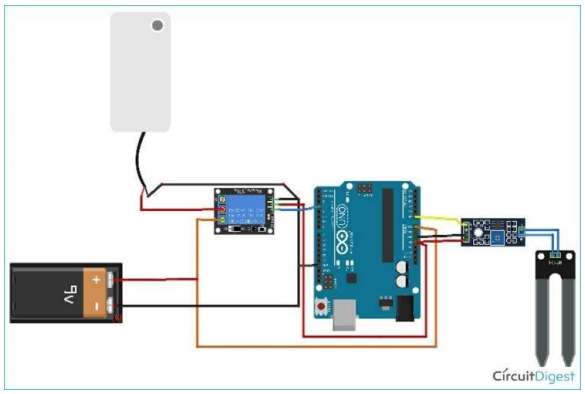
By using the concept of modern irrigation system a farmer can save water up to 50%. This concept depends on two irrigation methods those are: conventiona irrigation methods like overhead sprinklers, flood type feeding systems i.e. wet the lower leaves and stem of the plants. The area between the crop rows become dry as the large amount of water is consumed by the flood type methods, in which case the farmer depends only on the incidental rainfalls. The crops are being infected by the leaf mold fungi as the soil surface often stays wet and is saturated after irrigation is completed. Overcoming these drawbacks new techniques are being adopted in the irrigation techniques, through which small amounts of water applies to the parts of root zone of a plant.

The plant soil moisture stress is prevented by providing required amount of water resources frequently or often daily by which the moisture condition of the soil will retain well. The diagram below shows the entire concept of the modern irrigation system. The traditional techniques like sprinkler or surface irrigation requires / uses nearly half of water sources. Even more precise amounts of water can be supplied for plants. As far as the foliage is dry the plant damage due to disease and insects will be reduced, which further reduces the operating cost.

The dry rows between plants will leads to continuous federations during the irrigation process. Fertilizers can be applied through this type of system, and the cost required for will also reduce. The erosion of soil and wind is much reduced by the recent techniques when compared with overhead sprinkler systems. The soil characteristics will define the form of the dripping nature in the root zone of a plant which receives moisture. As the method of dripping will reduce huge water losses it became a popular method by reducing the labor cost and increasing the yields. When the components are activated, all the components will read and gives the output signal to the controller, and the information will be displayed to the user (farmer). The sensor readings are analog in nature so the ADC pin in the controller will, convert the analog signals into digital format. Then the controller will access information and when the motors are turned On/Off it will be displayed on the LCD Panel.

CONSTRUCTION

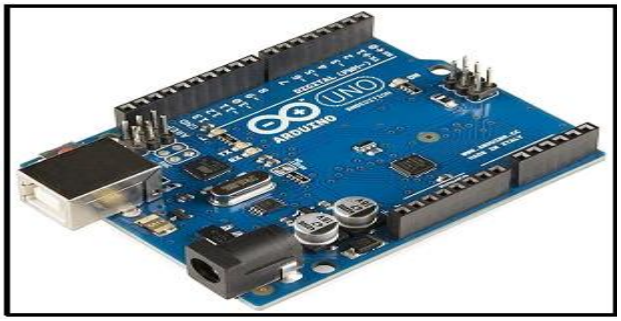
The creation of a smart agriculture for farmer using Arduino entails a number of procedures and elements, such as:



Hardware Technology:

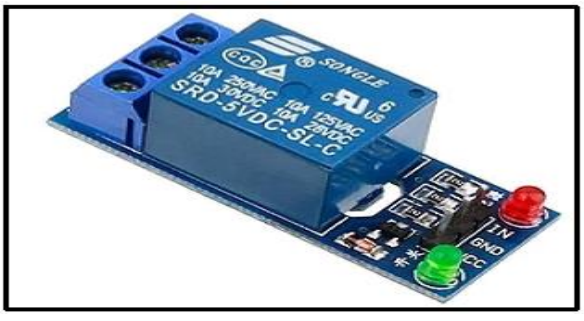
1) Arduino:

The Arduino Uno is an open-source microcontroller board designed for beginners and hobbyists. It is equipped with digital and analog input/output pins that allow users to connect various sensors and actuators to the board. This enables users to build interactive projects, like robots, temperature monitors, and light shows. The board is programmed using the user-friendly Arduino IDE software and can be powered by a USB cable or battery, making it convenient for portable projects. Released in 2010, the Arduino Uno is the successor of the Arduino Duemilanove and remains the most popular board in the Arduino family due to its ease of use, affordability, and vast community support.



2) **Relay Module:**

Relay modules come in various types, allowing you to control multiple appliances based on your needs. They work by using a low voltage signal from a microcontroller to activate a switch, which then controls the power supply to the connected appliance. When choosing a relay module, it's crucial to consider factors like input voltage, contact rating, and switching capacity to ensure it can handle the intended electrical load. The module is wired to both the microcontroller and the appliance, and the microcontroller sends a signal to turn the appliance on or off. These modules are widely used in home and industrial automation settings, and similar applications where remote control of high-power devices is necessary.

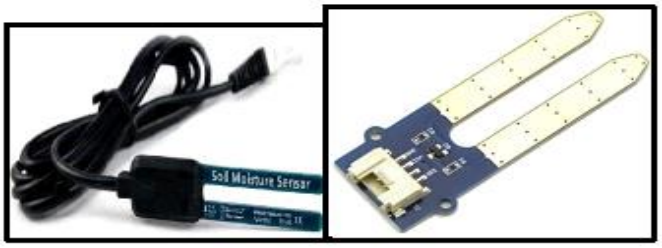


3) S**OIL MOISTURE SENSOR:**

Although soil water status can be determined by direct (soil sampling) and indirect (soil moisture sensing) methods, direct methods of monitoring soil moisture are not commonly used for irrigation scheduling because they are intrusive and labor intensive and cannot provide immediate feedback. Soil moisture probes can be permanently installed at representative points in an agricultural field to provide repeated moisture readings over time that can be used for irrigation management. Special care is needed when using soil moisture devices in coarse soils since most devices require close contact with the soil matrix that is sometimes difficult to achieve in these soils. Most of the currently available volumetric sensors suitable for irrigation are dielectric. This group of sensors estimate soil water content by measuring the soil bulk permittivity (or dielectric constant) that determines the velocity of an electromagnetic wave or pulse through the soil. In a composite material like the soil (i.e., made up of different components like minerals, air and water), the value of the permittivity is made up by the relative contribution of each of the components. Since the dielectric constant of liquid water is much larger than that of the other soil constituents, the total permittivity of the soil or bulk permittivity is mainly governed by the presence of liquid water.

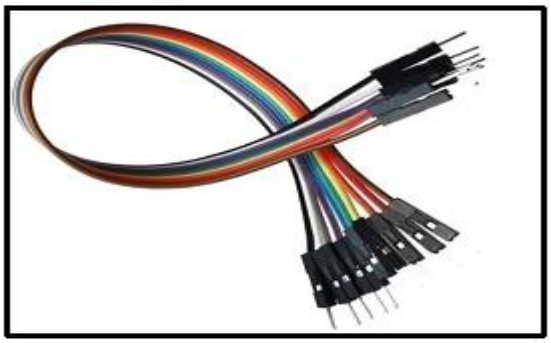
The dielectric methods use empirical (calibrated) relationships between volumetric water content and the sensor output signal (time, frequency, impedance, wave phase). These techniques are becoming widely adopted because they have good response time (almost instantaneous measurements), do not require maintenance, and can provide continuous readings through automation. Although these sensors are based on the dielectric principle the various types available (frequency domain reflectometry-FDR, capacitance, time domain transmission-TDT, amplitude domain reflectometry-ADR, time domain reflectometry-TDR, and phase transmission) present important differences in terms of calibration requirements, accuracy, installation and maintenance requirements and cost. Soil moisture is an important component in the atmospheric water cycle, both on a small agricultural scale and in large-scale modelling of land/atmosphere interaction. Vegetation and crops always depend more on the moisture available at root level than on precipitation occurrence. Water budgeting for irrigation planning, as well as the actual scheduling of irrigation action, requires local soil moisture information. Knowledge of the degree of soil wetness helps to forecast the risk of flash floods, or the occurrence of fog. Soil water content is an expression of the mass or volume of water in the soil, while the soil water. potential is an expression of the soil water energy status. The relation between content and potential is not universal and depends on the characteristics of the local soil, such as soil density and soil texture. The basic technique for measuring

soil water content is the gravimetric method. Because this method is based on direct measurements, it is the standard with which all other methods are compared. Unfortunately, gravimetric sampling is destructive, rendering repeat measurements on the same soil sample impossible. Because of the difficulties of accurately measuring dry soil and water volumes, volumetric water contents are not usually determined directly. Measuring soil moisture is very important in agriculture to help farmer for managing the irrigation system. Soil moisture sensor is one who solves this. This sensor measures the content of water. Soil moisture sensor uses the capacitance to measure the water content of soil. It is easy to use this sensor. Simply insert this rugged sensor into the soil to be tested, and the volumetric water content of the soil is reported in percent.



4) Jumper Wires:

Jump wires, also known as DuPont wires, are electrical wires with connectors on each end that enable the creation of circuits without soldering. They are frequently used on breadboards, which have slots specifically designed to receive these connectors. Different connector types exist, including solid tips for breadboards and crocodile clips for temporary connections to various components. Additionally, jump wires come in various sizes and colors, aiding in distinguishing different signals within a circuit.



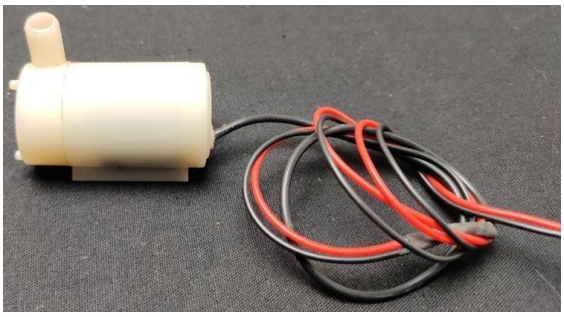
5) Arduino Programming Cable:

An Arduino programming cable connects your computer to your Arduino board, letting you upload code and power your projects. It's a USB cable with a standard Type-A connector for your computer and a Type-B (or C on newer boards) connector for your Arduino. While any matching USB cable technically works, consider cable length, quality, and features when choosing one. You can find them online or at electronics stores.

Here are some quick tips: handle with care, unplug safely, and try a different cable or USB port if you have connection issues.With a reliable cable, you're all set to create amazing Arduino projects!

6) Water Pump:

The water pump is used to artificially supply water for a particular task. It can be electronically controlled by interfacing it to a microcontroller. It can be triggered ON/OFF by sending signals as required. The process of artificially supplying water is known as pumping. There are many varieties of water pumps used. This project employs the use of a small water pump which is connected to a HBridge.The pumping of water is a basic and practical technique, far more practical than scooping it up with one's hands or lifting it in a hand-held bucket. This is true whether the water is drawn from a fresh source, moved to a needed location, purified, or used for irrigation, washing, or sewage treatment, or for evacuating water from an undesirable location. Regardless of the outcome, the energy required to pump water is an extremely demanding component of water consumption. All other processes depend or benefit either from water descending from a higher elevation or some pressurized plumbing system.



DESCRIPTION OF ATMEGA 328P MICRO CONTROLLER:

The ATmega48PA/88PA/168PA/328P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single cloccycle,theATmega48PA/88PA/168PA/328P achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed .TheATmega48PA/88PA/168PA/328P provides the following features: 4K/8Kbytes of In-System Programmable Flash with Read-While-Write capabilities, 256/512/512/1K bytes EEPROM,512/1K/1K/2K bytes SRAM,23generalpurposeI/Olines, geaprpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte-oriented 2-wire Serial Interface, an SPI serial port, a 6channel 10-bit ADC (8 channels in TQFP and QFN/MLF packages), a programmable Watchdog Timer with internal Oscillator, and five software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, USART, 2-wire Serial Interface, SPI port, and interrupt system to continue functioning.

The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or hardware reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/Omodules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low power consumption. The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle.The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset. The device is manufactured using Atmel's high density nonvolatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip Boot program running on the AVR core. The Boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true ReadWhile-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega48PA/88PA/168PA/328P is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications. The Boot program can use any interface to download the application program in the Application Flash memory. This allows very fast start-up combined with low power consumption. on the toolbar. The first time you run the Arduino software, it will automatically create a directory for your sketchbook.

You can view or change the location of the sketchbook and optimized opcodes for register file and I/O register access, all can still be addressed and manipulated as if they were in SRAM. In the ATMEGA variant, the working register file is not mapped into the data address space; as such, it is not possible to treat any of the ATMEGA's working registers as though they were SRAM.

B. **Software Technology:**

1)**Arduino IDE:**

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.
The Arduino Software (IDE) uses the concept of a sketchbook: a standard place to store your programs (or sketches). The sketches in your sketchbook can be opened from the File > Sketchbook menu or from the Open button

II. RESULT, CONCLUSION AND FUTURE SCOPE

Result:

Now place the moisture sensor into the soil. Place the sensor as close to the roots of the plants as possible for higher accuracy.

Future Scope:

Day by day, the field of electronics is blooming and have caused great impact on human beings. The project which is to be implemented is an automated irrigation method and has a huge scope for future development. The project can be extended to greenhouses where manual supervision is far and few in between. The principle can be extended to create fully automated gardens and farmlands. Combined with the principle of rain water harvesting, it could lead to huge water savings if applied in the right manner. In agricultural lands with severe shortage of rainfall, this model can be successfully applied to achieve great results with most types of soil.

By developing a Smart Wireless Sensor and by using upcoming techniques a farmer can increase his profit by solving different problems that are faced by the farmer in his routine life. And also to involve Arduino – Controller with a video capturing by using an MMS facility about the crop positive.

Conclusion:

The primary applications for this project are for farmers and gardeners who do not have enough time to water their crops/plants. It also covers those farmers who are wasteful of water during irrigation. As water supplies become scarce and polluted, there is a need to irrigate more efficiently in order to minimize water use and chemical leaching. Recent advances in soil water sensing make the commercial use of this technology possible to automate irrigation management for vegetable production. However, research indicates that different sensors types perform under all conditions with no negative impact on crop yields with reductions in water use range as high as 70% compared to traditional practices.

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