Auto Irrigation System Using an Arduino Uno and Soil Moisture Sensor

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***Abstract*--In agriculture, there are two main ways of providing water to the crop field. It can be done by either using natural rain or by an artificial way like irrigation. In the rain-fed farming there is a high chance of irregular rainfall during the monsoon season which can damage the crop by harming its growth. But irrigation can solve this problem by using various sources like tube wells, pumps, sprinkler systems. They can also help in supplying water to the field uniformly. Our project is an auto-irrigation system which can supply water to the plants by checking their soil moisture level without human intervention.**

***Index Terms*—Arduino, Auto-irrigation, DC Pump, Irrigation Microcontroller, Relay, Soil moisture sensor, Source code, Temperature and Humidity sensor.**

I. INTRODUCTION

AGRICULTURE is vital for every country's economic sector, as we know that one of the most pressing challenges faced by humanity today is the rapid growth of the global population, which has significant implications for food security and economic development. However, traditional farming methods are no longer sufficient to meet current requirements. As a result, new automation methods are being introduced to improve efficiency and provide more job opportunities. Artificial Intelligence (AI) has become a crucial technology in various industries, including agriculture. It is transforming the agriculture industry by playing a significant role in enhancing productivity and sustainability.

In this paper, automatic irrigation system using artificial intelligence is discussed.

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Automatic irrigation is a method of irrigating crops using a device that controls the irrigation structures and regulates the flow of water from the source, without the need for manual intervention by the farmer. Automation can be achieved using various techniques and technologies, such as sensors, controllers, and relays.

II. METHODS OF AUTOMATION IN IRRIGATION

- One way to automate irrigation is by using a device to start and stop the irrigation process through supply channel outlets. This method involves installing sensors that measure soil moisture levels and communicate with the controller to turn on or off the irrigation system accordingly. This system will allow farmers to maximize their water efficiency and minimize water loss, as the irrigation is only activated when necessary.
- Another way to automate irrigation is by using relays to start or stop the pumps. Relays are electronic devices that switch on or off an electric circuit based on a signal received from a sensor or controller. In this case, the sensors would detect the soil moisture levels and send a signal to the controller, which in turn would activate or deactivate the pumps through the relays. This helps to ensure that the irrigation system is operating efficiently and effectively.

Overall, automating irrigation systems is a smart and efficient way to optimize water use and enhance agricultural productivity. With the help of advanced technologies and automation methods, farmers can monitor and control the water delivery to their crops, ensuring optimal soil moisture and avoiding water stress. This can result in significant time and cost savings, as well as improved crop quality and yield. Automation can also contribute to environmental sustainability, by reducing water consumption and runoff, and preventing soil erosion and salinization. Therefore, automating irrigation systems can be a valuable strategy for farmers who want to achieve more profitable and resilient farming outcomes.

III. ADVANTAGES OF AUTOMATIC IRRIGATION

- Improved efficiency: Automated irrigation systems offer a significant improvement in efficiency over traditional

irrigation methods. They can be customized to deliver the exact amount of water required by each plant, taking into account factors such as soil type, weather conditions, and plant stage. This minimizes water loss and maximizes plant health and productivity.

 Reduced labour costs: One of the benefits of automated irrigation systems is that they can lower labour costs for farmers. By setting up the system to run on a schedule, farmers can avoid having to manually water their crops, which can be time-consuming and expensive. Automated irrigation systems can therefore help farmers optimize their resources and increase their profitability.

 Increased crop yields: By providing plants with the optimal amount of water and nutrients, automated irrigation systems can help to increase crop yields and improve the overall quality of the produce.

 Water conservation: It automates the irrigation systems so that they can optimize water use and minimize water loss. By sensing the soil moisture and weather conditions, these systems can deliver water precisely and efficiently to the plants that need it. This can help to conserve water resources and reduce water bills, especially in regions where water is scarce or costly.

 Enhanced precision: Automated irrigation systems enable a high level of control over the delivery of water and nutrients to plants. By programming the systems to apply the optimal amount and location of water and nutrients, overwatering can be avoided and nutrient efficiency can be improved.

Overall, automatic irrigation systems offer several advantages over traditional irrigation methods, making them a popular choice among farmers and agricultural professionals.

IV. Components Required for the Automatic Irrigation System

This project is designed to be simple and straightforward, requiring only a few components to get started.

The following components are needed to complete this project:

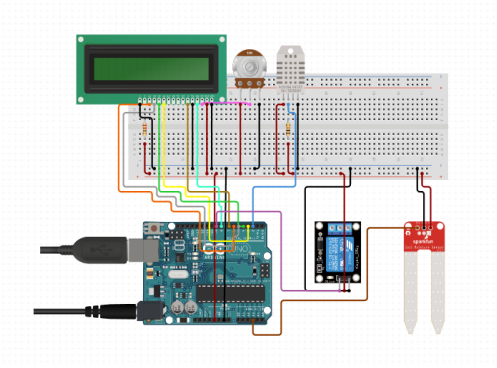


Fig. 1. Circuit Diagram showing the connections between the Arduino board and other components like soil moisture sensor, lcd, relay, dht11 sensor

TABLE 1: Components required for the project

Serial no.	Product Name	Quantity
1.	Arduino Uno (Microcontroller) R3	1
2.	Submersible Mini Water Pump (6V) DC	1
3.	Transparent silicon pipe (1m)	1
4.	9v DC (Hi-watt) battery	2
5.	Soil moisture sensor module	1
6.	5V relay module 1ch	1
7.	Jumper wires(20cm) Male-Female pins	20
8.	Jumper wires(20cm) Male-Male pins	20
9.	16×2 LCD display	1
10.	USB cable for Arduino (B to USB A)	1
11.	Resistor 1kΩ (as no potentiometer)	2
12.	9V Battery Snap with DC Jack	1
13.	DHT11 Humidity &Temperature Sensor	1

An auto irrigation system is an innovative and efficient solution for watering plants in a garden or farm. This system utilizes advanced sensors and electronic components to monitor the soil moisture, temperature, and humidity levels and then automatically adjusts the water supply based on these readings.

One such auto irrigation system is designed using an Arduino Uno microcontroller, a relay, a pump, a soil moisture sensor, humidity and temperature sensor (dht11), and an LCD screen (16*2). The system is connected and controlled as follows:

1. The moisture (soil) sensor is placed in the soil and connected to the analog input pin of the Arduino Uno. The sensor measures the moisture content of the soil and sends this information to the Arduino.
2. The humidity and temperature sensor is connected to the digital input pin of the Arduino Uno. This sensor measures the temperature and humidity levels in the environment and sends this information to the Arduino.
3. The Arduino Uno processes the data received from the sensors and uses this information to control the relay module. The relay module is used to turn on and off the water pump.
4. The LCD screen is used to display the sensor readings and the current state of the system. It is connected to the digital pins of the Arduino Uno.
5. When the soil moisture level drops below a specified threshold, the Arduino Uno activates the relay module to turn on the water pump. The pump delivers water to the plants until the soil moisture

level reaches the desired level. Once the desired level is reached, the Arduino Uno turns off the pump.

6. The system also takes into account the temperature and humidity levels in the environment. If the temperature and humidity levels are too high, the system can be programmed to reduce the amount of water delivered to the plants.

In summary, an auto irrigation system is a smart and efficient solution for watering plants. By utilizing advanced sensors and electronic components, this system can monitor and control the water supply to ensure that the plants receive the optimal amount of water for healthy growth.

V. What is an Arduino Uno board?

The Arduino Uno is a highly popular microcontroller board used in the realm of electronics and DIY projects. It is based on the ATmega328P microcontroller and offers various features, making it versatile and adaptable for diverse applications

At its core, the Arduino Uno is equipped with 14 digital input/output pins and 6 analog inputs, allowing users to interact with numerous electronic components like LEDs, sensors, and motors. Its 16 MHz quartz crystal oscillator

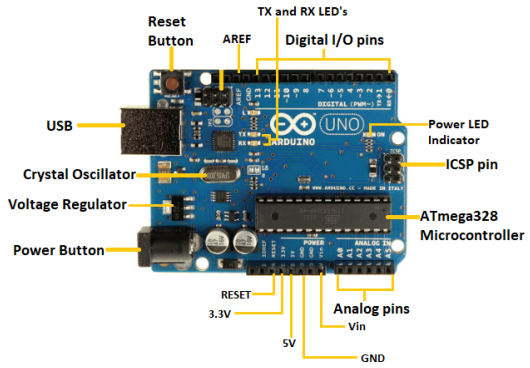


Fig. 2. The components of Arduino UNO board

ensures precise timing, enabling reliable operation of the board.

The Arduino Uno stands out for its user-friendly interface, making it accessible even to beginners. Moreover, its extensive community support has led to a vast repository of resources and libraries, aiding newcomers and seasoned developers alike.

Affordability is also a significant advantage of the Arduino Uno, as it provides a cost-effective solution for hobbyists and professionals seeking a powerful microcontroller board.

Overall, the Arduino Uno's ease of use, extensive features, and strong community support have contributed to its popularity in various projects, ranging from simple LED blinking circuits to complex robotics and automation systems.

VI. What can the Arduino Uno Do?

The Arduino Uno can do the following:

- Control digital inputs and outputs: The Arduino Uno has a number of digital input and output pins that can be used to control devices such as LEDs, motors, and other electronic components.
- Control analog inputs and outputs: The Arduino Uno has a number of analog input pins that can be used to read analog signals, such as those generated by sensors, and a number of PWM (pulse-width modulation) output pins that can be used to generate analog signals, such as those needed to control motors.
- Communicate with other devices: The Arduino Uno has several communication protocols built-in, including UART (serial), SPI, and I2C, which allow it to communicate with other devices, such as sensors, displays, and other microcontrollers.
- Run programs and algorithms: The Arduino Uno can run programs and algorithms that are written in the Arduino programming language, which is based on C/C++. These programs can be stored on the board's flash memory and run independently of a connected computer.
- Interface with other software: The Arduino Uno can interface with other software, such as MATLAB and Processing, through its serial port, allowing it to be used in a wide range of applications.

Overall, the Arduino Uno is a powerful tool that can be used to control and interact with a wide range of electronic devices and sensors, making it a popular choice for hobbyists, students, and professionals alike.

VII. Soil moisture sensor:

A soil moisture sensor is an electronic device designed to measure the moisture content of soil in fields, gardens, or other applications. It operates by using two metal probes that are inserted into the soil to create a circuit with the sensor's internal components. A small electric current pass between the probes, and the amount of current flow is directly related to the moisture content of the soil.

To withstand the harsh soil conditions over time, the metal probes are typically made of corrosion proof materials like stainless steel or copper. As the soil's moisture level changes, the resistance between the probes varies accordingly. Dry soil exhibits higher resistance, resulting in less current flow between the probes. Conversely, wet soil offers lower resistance, allowing more current to pass between the probes.

The resistance value measured in ohms is then converted into a moisture level reading using a calibration curve or formula. This moisture level reading is then communicated to an Arduino or other microcontroller for further processing. The data can be used to trigger specific actions, such as activating a watering system or sending alerts to the user when the soil moisture levels are outside desired parameters.

The primary application of soil moisture sensors is in agriculture and gardening to help monitor and regulate the water levels in the soil around plants. By providing real-time data on soil moisture, these sensors enable efficient irrigation practices, ultimately promoting healthier plant growth and conserving water resources.

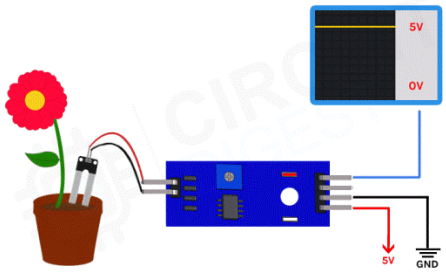


Fig. 2.1. Soil moisture sensor working animation

VIII. RELAY:

A relay is an electronic switch that is controlled by an electrical signal. It consists of a coil of wire that creates a magnetic field when an electrical current flows through it. This magnetic field then pulls a metal switch, which opens or closes an electrical circuit. In the case of an auto irrigation system, the relay is used to control the water pump. When the Arduino detects that the moisture level in the soil is below the threshold value, it sends a signal to the relay to close the switch, which then activates the water pump. Conversely, when the moisture level reaches the desired level, the Arduino sends a signal to the relay to open the switch, which stops the water flow.

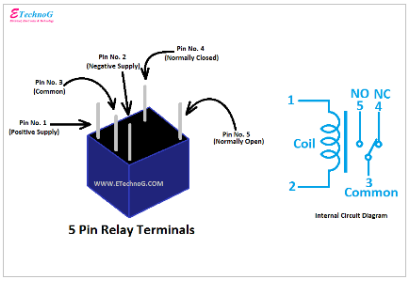


Fig. 2.2. Circuit diagram of the 5 pin Relay

IX. HUMIDITY AND TEMPERATURE SENSOR (DHT11):

The humidity and temperature sensor is a device that measures the relative humidity and temperature in the surrounding environment. It works by using a thermistor and a capacitive humidity sensor, which are combined into a single module. The thermistor measures the temperature, while the humidity sensor measures the water vapor in the air. When the humidity sensor absorbs moisture, its electrical resistance changes, which the sensor then converts intoa humidity reading. The sensor then sends both the temperature and humidity readings to the Arduino for processing. The readings can be used to adjust their irrigation system's settings, such as the duration and frequency of watering, based on the specific environmental conditions. The readings can be used to adjust the irrigation system's settings, such as the duration and frequency of watering, based on the specific environmental conditions.

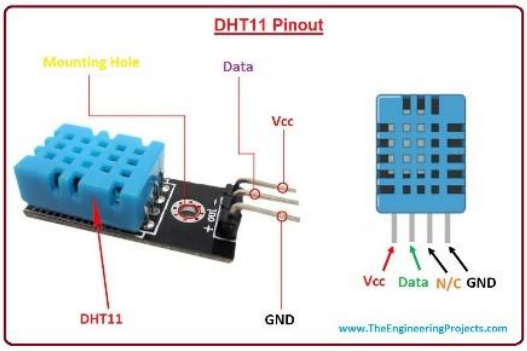


Fig. 2.3. Humidity and Temperature (DHT11) module pin outs

X. HOW DOES OUR AUTO-IRRIGATION SYSTEM WORK?

The auto irrigation system is a smart device that monitors and controls the water supply for the plants. It has several components, such as sensors, valves, pumps, and relays, that work together to ensure the plants receive the water in fixed quantity at regular intervals. The system can be programmed to adjust the water flow according to the weather conditions, soil moisture, and plant growth stages. The Arduino Uno is the brain of the system, which controls the operation of the other components. It is connected to a relay, which in turn controls the pump that delivers water to the plants. The soil moisture sensor measures how wet the soil is, and the humidity and temperature sensor measure the environmental conditions. LCD provides visual feedback to the user. The LCD screen shows the user the values of the sensors and the status of the system.

The system monitors the water content of the top soil using the Soil Moisture Sensor, which transmits a signal to the Arduino. The Arduino then evaluates the signal and compares it with a preset threshold value. If the moisture level falls below the threshold value,the Arduino triggers the relay, which consequently triggers the pump to supply water to the plants. The system maintains watering the plants until the moisture level attains the desired level.

In addition to the moisture level, the system also monitors the temperature and humidity levels in the environment using the humidity and temperature sensor. The readings are displayed on the LCD screen in real-time, allowing the user to monitor the conditions in the garden or farm. If the temperature or humidity level reaches a critical level, display alert the user.

The auto irrigation system is highly customizable and adaptable to different environments and plant types. The threshold values for the moisture level, temperature, and humidity can be easily adjusted using the code, allowing the user to optimize the system for their specific needs. The system can also be expanded with additional sensors and components, such as light sensors and fertilization systems, to further improve the plant growth and health.

One of the key benefits of an auto irrigation system is its ability to save water and reduce water waste. The moisture

sensor monitors the water content in the soil and adjusts the irrigation frequency accordingly. This way, the system prevents overwatering and wastage of water, and provides optimal hydration for the plants. This not only conserves water but also helps to prevent microbial growth in water logged regions, which can lead to plant diseases and other problems.

Another benefit of the system is its ease of use and low maintenance requirements. Once the system is set up and programmed, it can operate automatically, without the need for constant monitoring or adjustment. The user can simply check the LCD screen from time to time to monitor the system status and make any necessary adjustments.

In conclusion, an auto irrigation system is a highly effective and efficient solution for watering plants in a garden or farm. By using sensors and electronic components to monitor the soil moisture content, temperature in Celsius, and relative humidity level, the system ensures that the plants receive the specific amount of water which is required by a specific plant at fixed intervals. With its customizable and adaptable design, low maintenance requirements, and water-saving benefits, the system is an ideal choice for anyone looking to improve the health and growth of their plants while conserving water and reducing waste.

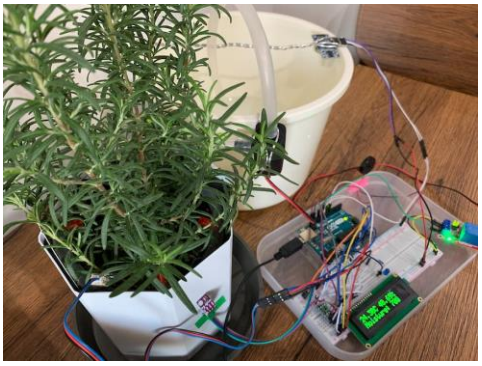
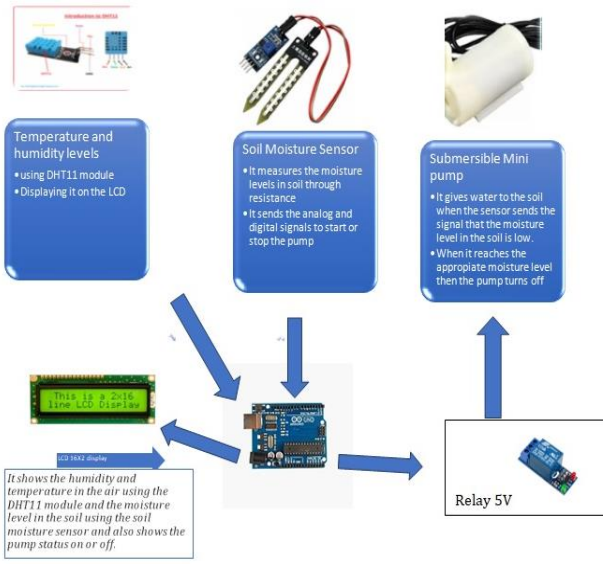


Fig. 3. The protype of working model (auto-irrigation system)



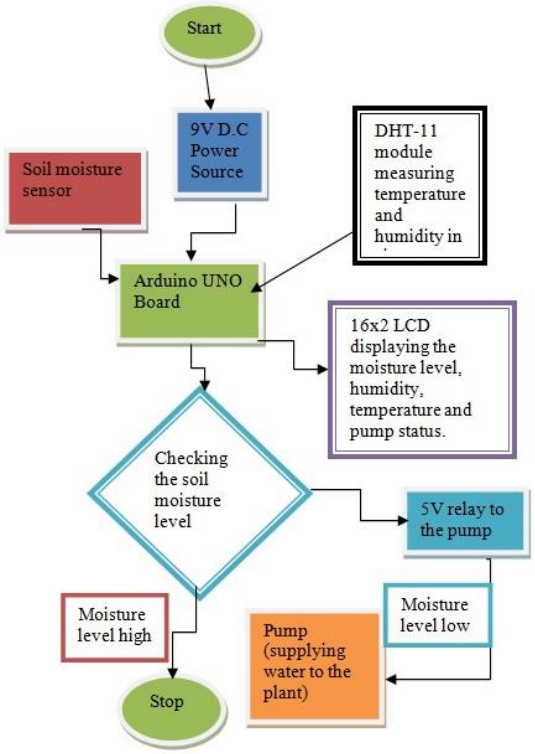


Fig. 3.1. Flowchart showing the working components and modules of the auto irrigation system

XI. SOURCE CODE FOR THE ARDUINO

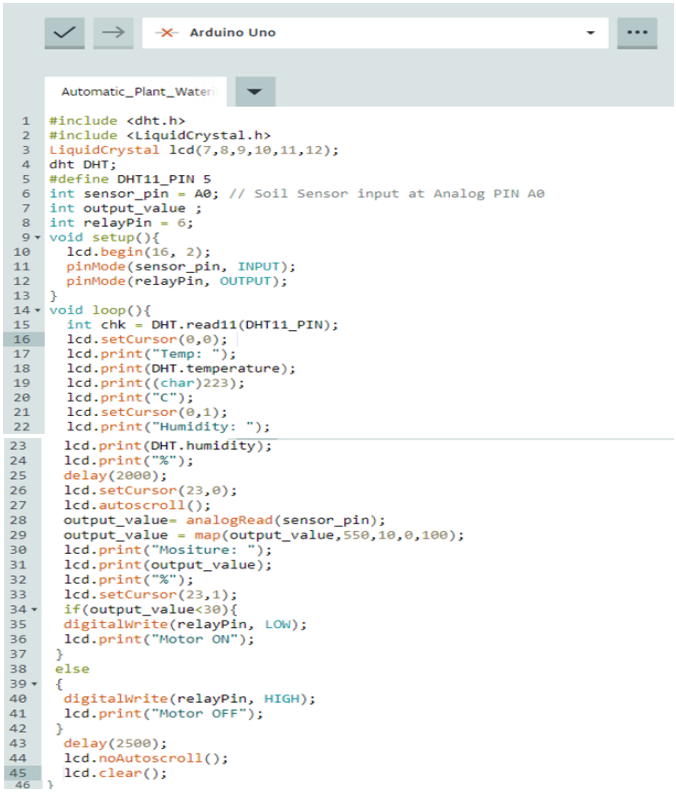


Fig. 3.2. Source Code for the Arduino board

XII. CONCLUSION:

The goal of our project is to build a auto-irrigation system which would measure the temperature and humidity in the air using the DHT11 module and display it on the LCD and it also has a soil moisture sensor which will measure the moisture level in the soil by passing though the soil and checking its resistance, if the resistance is high then low moisture level and if lower resistance then it shows higher moisture level. And it will send the analog signal to the Arduino board and it will then trigger the relay module turning the pump on or off. Its main objective is to save water by stopping the wastage of water and stop leeching of nutrients from the soil by surface run-off. And it will decrease the workload of humans by robotic automation.

XIII. ACKNOWLEDGMENT

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