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Automatic Water Controlling System for Grapes Farming by using IOT with Arduino UNO Kit

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Abstract

The Automatic Water Controlling System for Grapes Farming using IoT with Arduino UNO Kit presents a novel approach to address the water management challenges in grape farming. By leveraging IoT technology and Arduino UNO microcontroller, the system automates the irrigation process based on real-time soil moisture data. The system aims to optimize water usage in grape farming by automating the irrigation process, ensuring that grape plants receive adequate moisture for optimal growth and yield. Soil moisture sensors are deployed in the grape fields to continuously monitor the moisture content of the soil. When the soil moisture falls below a certain threshold, the Arduino UNO triggers the water pumps to irrigate the plants. The system is equipped with IoT modules, enabling remote monitoring and control of the irrigation process through a web interface or smartphone application. This allows farmers to manage irrigation from anywhere, enhancing convenience and efficiency. By automating irrigation based on real-time data, the system ensures precise water delivery, leading to improved water efficiency, reduced water wastage, and optimized crop growth. This contributes to sustainable farming practices and increased productivity. The system can be easily scaled up or modified to suit the needs of different grape farms. Moreover, utilizing readily available components such as Arduino UNO makes the system cost-effective and accessible to farmers with varying resources.

Key words

Arduino UNO microcontroller, soil moisture sensors, water pumps, and IoT modules

Introduction

This paper focus on how to control water level for gardening by using IOT devices for that we have to know some concepts like what is IOT,what are types of soil and ph levels of soil also how many types of soil.The Internet of Things (IoT) refers to the network of physical objects or "things" embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the internet. These "things" can range from ordinary household items to sophisticated industrial tools. IoT is characterized by the ability of devices to collect data, communicate it to a central system, and use that data to make decisions or trigger actions automatically. Components of IoT are Sensors collect data from the environment, such as temperature, humidity, light, and motion.Actuators perform actions based on the data, such as turning on a light, adjusting a thermostat, or controlling machinery.Connectivity Devices, communicate with each other and with central systems via various network protocols such as Wi-Fi, Bluetooth, Zigbee, and cellular networks. Data Processing and Analytics Collected data is processed and analyzed, often using cloud computing or edge computing, to derive meaningful insights and trigger appropriate actions. User Interfaces Users interact with IoT systems through interfaces such as mobile apps, web dashboards, or voice commands, allowing them to monitor and control their devices remotely.

Grape farming, also known as viticulture, involves cultivating grapes for various purposes, including wine production, fresh consumption, juice, raisins, and other processed products. Grape farming based on some factors like **Site Selection**,Choosing the right location for grape farming is crucial. Factors such as climate, soil type, slope, sunlight exposure, and proximity to water sources play significant roles in determining the success of a vineyard.**Variety Selection**, There are thousands of grape varieties cultivated worldwide, each with its unique characteristics suited for specific purposes. Growers select grape varieties based on their intended use, climate suitability, disease resistance, and market demand.**Propagation**, Grapes are typically propagated through cuttings, grafting, or tissue culture. Propagation methods ensure that desirable characteristics of selected grape varieties are preserved and reproduced in new vines.**Planting**, Grapevines are usually planted in rows with adequate spacing to allow for proper airflow, sunlight penetration, and vine management. Planting density varies depending on factors such as variety, trellis system, and vineyard management practices.**Training and Pruning**,Grapevines require training and pruning to optimize yield, fruit quality, and vine health. Various trellis systems, such as vertical shoot positioning (VSP) and high-wire systems, are used to support vine growth and facilitate canopy management.**Pest and Disease Management**,Grapevines are susceptible to various pests and diseases, including fungal infections, insect infestations, and viral diseases. Integrated pest management (IPM) strategies, which combine cultural, biological, and chemical control methods, are employed to minimize damage and reduce reliance on pesticides.**Irrigation**, Adequate water management is essential for grape farming, especially in regions with limited rainfall or during drought conditions. Drip irrigation, sprinkler systems, and other irrigation methods are used to provide vines with the necessary water while avoiding excess moisture that can promote disease.**Harvesting**, Grapes are harvested at different stages of ripeness depending on their intended use. For wine production, grapes are typically harvested when sugar levels, acidity, and flavor compounds are optimal. Mechanical harvesters or manual picking may be used depending on vineyard size and terrain.**Post-Harvest Handling**, After harvesting, grapes are processed or sold fresh, depending on market demand. For wine production, grapes are crushed, pressed, and fermented to produce wine. Grapes intended for fresh consumption or processing into juice, raisins, or other products are sorted, cleaned, and packaged accordingly.Successful grape farming requires careful planning, attention to detail, and continuous monitoring of vineyard conditions. Growers must adapt their practices to changing environmental factors and market demands to ensure the long-term sustainability and profitability of their vineyards. Some time it is not possible by human being to pay continuously attentension on farming .By using IOT now we can monitoring and control farming from any where.Every farming based on soil and its water level maintained by PH level.Maintaining the right soil pH is crucial for grape cultivation as it directly impacts plant health, nutrient availability, and ultimately, grape quality. Here's some information about soil pH for grapes:

1. **Optimal pH Range**: The ideal soil pH for grapevines typically falls within the range of 5.5 to 6.5. This slightly acidic to neutral pH range allows for the best uptake of essential nutrients like nitrogen, phosphorus, potassium, and micronutrients such as iron, zinc, and manganese.
2. **Acidic Soil**: Soil that is too acidic (pH below 5.5) can lead to nutrient deficiencies, particularly in calcium and magnesium, and may also result in aluminum toxicity. This can stunt vine growth and negatively affect grape development and ripening.
3. **Alkaline Soil**: Conversely, soil that is too alkaline (pH above 6.5) can limit the availability of certain nutrients, leading to deficiencies and poor vine performance. High pH soils may also hinder the absorption of iron, leading to chlorosis (yellowing) of leaves.
4. **Testing and Adjustment**: It's essential to regularly test the pH of the soil in grapevine growing areas. Soil pH can be adjusted using various methods, such as adding soil amendments like lime to raise pH in acidic soils or sulfur to lower pH in alkaline soils. However, these amendments should be applied judiciously and based on soil test results to avoid overcorrection.
5. **Rootstock Selection**: Certain rootstock varieties are more tolerant to specific soil pH conditions than others. When establishing a vineyard, selecting the appropriate rootstock for the soil conditions can help mitigate pH-related issues and improve vine health and productivity.

6. **Monitoring and Maintenance**: Monitoring soil pH should be an ongoing process, especially in established vineyards. Regular maintenance practices, including mulching, cover cropping, and proper irrigation management, can help stabilize soil pH levels and create a favorable environment for grapevine growth.
7. **Local Factors**: It's important to consider local environmental factors and soil characteristics when managing soil pH for grape production. Climate, precipitation patterns, soil type, and drainage conditions can all influence soil pH and may require tailored management approaches.

Literature Reviews

IOT based farming concept is not new but still in our country it is not full flashed used.**Muhammad Usman et.al(2019)** ,they focus on smarter, better, and more efficient crop growing methodologies which required in order to meet the growing food demand of the increasing world population in the face of the ever-shrinking arable land. The development of new methods of improving crop yield and handling, one can readily see currently: technology-weaned, innovative younger people adopting farming as a profession, agriculture as a means for independence from fossil fuels, tracking the crop growth, safety and nutrition labeling, partnerships between growers, suppliers, and retailers and buyers. This paper highlighted the role of various technologies, especially IoT, for making agriculture smarter and more efficient to meet future expectations.They used, wireless sensors, UAVs, Cloud-computing, communication technologies are discussed thoroughly.

Prem Rajak,et al(2023)suggested that IoT-enabled smart farming has great perspectives in future. Advanced sensors can be employed to monitor environmental factors such as rainfall, moisture, and temperature for maximum agricultural yield. IoT-enabled devices could help measure water and Nitrogen contents in soil.Based on CO2 level in farm lands, evapotranspiration rates can be effectively monitored to have better surveillance on crop health. Moreover, pest attack can be reduced by controlling pest population through IoT-enabled traps equipped with high resolution camera and other accessories. Despite such advantages, major challenges for the deployment of IoT-based smart sensors in agriculture on a larger scale include purchase and maintenance cost of sophisticated hardwares and softwares. In addition, farmers residing in rural areas lack sufficient knowledge regarding the use of IoT devices. Finally, cyber attackers might influence the automated smart farming by damaging the cloud servers where important data are stored.

Apurva A. Londhe .et.al(2020) paper concluded the concept of merging agriculture with state of the art technology can be achieved by integrating technology into the heart of agriculture, its traditional and primitive techniques. The complete real-time and historical environment information is expected to help to achieve efficient management and utilization of resources. By using the proposed approach, received updated information allows the farmers to cope with and even benefit from these changes. Farming can be made more efficient & accurate with the implementation of IoT device. IoT can be used in different domains of agriculture. The system is designed to remotely monitor the field parameters such as Humidity, Soil moisture, Temperature and Leaf Wetness, this information can be collected by the farmers with the help of cloud account and internet connection. The application of the latest innovations in technology, sensing and communications will allow for substantial improvements in precision agriculture practices and management solutions. By using sensors the crop field that is connected to internet, an appropriate decision can be taken.

Objective:

To develop a smart irrigation system using IoT to optimize water usage in grapes gardening

Implementation

System Model Development

For development of system model there are needs of following points

1. **System Architecture**:
   - The system uses wireless sensor networks to monitor soil moisture, temperature, humidity, and other relevant environmental parameters.
   - Sensors such as soil moisture sensors, temperature sensors, and humidity sensors are deployed in the vineyard.
   - Data collected by these sensors are transmitted to a central IoT platform using devices like the ESP32 microcontroller.
2. **Data Processing and Control**:
   - The data from sensors are processed in real-time to make irrigation decisions.

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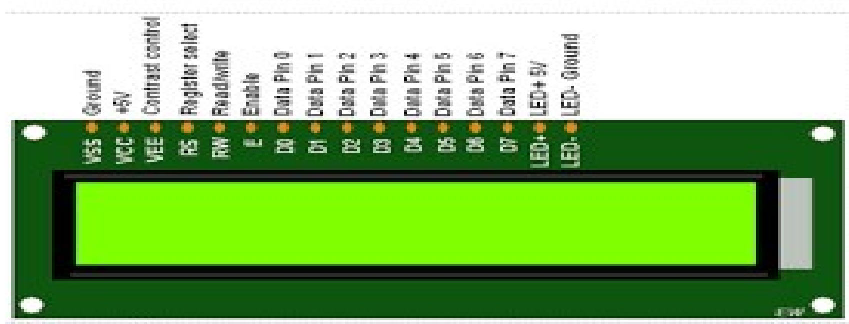
- The system employs a cloud-based server to store and analyze the data, which helps in automating the irrigation process.
- An application like the Blynk app can be used for monitoring and manual control if needed.

3. **Automation and Optimization**:
   - The system can automatically open and close solenoid valves to control water flow based on soil moisture levels.
   - The duration and amount of irrigation are adjusted dynamically based on sensor readings and predefined thresholds.
   - This ensures efficient water usage, reducing waste while maintaining optimal soil conditions for grape growth.
4. **Testing and Results**:
   - Field tests demonstrate the effectiveness of the system in maintaining soil moisture at desired levels, thereby enhancing grapevine growth and yield.
   - The system is tested for its ability to adapt to different environmental conditions and its impact on water conservation.
5. **Benefits and Future Work**:
   - Significant water savings compared to traditional irrigation methods.
   - Real-time monitoring and remote control capabilities.

components-

16x2 LCD Display: Provides real-time feedback on soil moisture levels, system status, and relevant messages. The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.



Water Pump Motor: Dispenses water to the plant when triggered by the Arduino Uno. A **water pump** controlled by an Arduino microcontroller is a type of system that uses an **Arduino** to control the operation of a **water pump**. The **Arduino** can be used to turn the pump on and off, as well as to control the flow rate and direction of the water. This type of system can be used for various applications such as irrigation, water treatment, and industrial process control.

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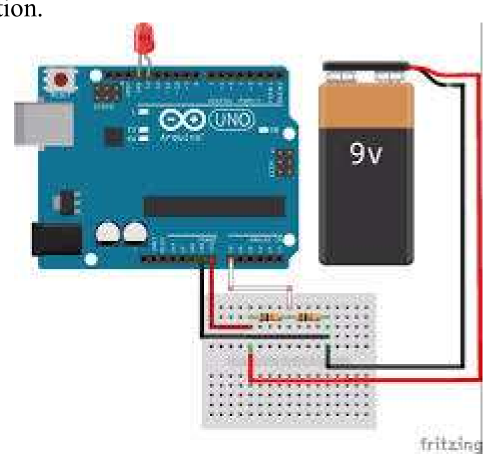
To control a **water pump** with an **Arduino**, need to connect the pump to the **Arduino**'s digital output pins. The pump typically has two wires, one for power and one for ground. These wires can be connected to the Arduino's 5V and GND pins, respectively. Once the connections are made, you can use the **Arduino**'s digital output pins to control the pump.
The use **Arduino**'s digitalWrite function to turn the pump on and off and the analog Write function to control the pump's speed. Also use a library like the AccelStepper library to control the direction of the pump.
It's important to follow the pump's datasheet and the manufacturer's instructions when using a **water pump** with an **Arduino**, also, keep in mind to use a suitable relay to switch the pump on and off, as the pump might require more current than the **Arduino** can handle. Also, it is important to ensure that the system is properly sealed and protected from water damage, and to keep in mind any safety concerns when working with water and electricity.

Battery: Powers the system, ensuring uninterrupted operation even in the absence of a direct power source. Arduino Uno needs 5 volts power to run, then we need at least 7.4 volts to 9 volts battery. Since Arduino pins support only 5 volts maximum, then we need a Voltage Divider. It is simply made up of two resistors in series. To divide the voltage to half, we need two resistor with the same value. 1K to 20K resistors can be used, but the larger the resistance the lower the power consumed by the Voltage Divider. I am not that good in calculating such thing but that is what I summarize from sources I read. You can correct me if I am wrong and any better explanation to this is most welcome on the comment section.



IoT Connectivity: Enables remote monitoring and control of the system via internet connectivity, allowing users to access real-time data and make adjustments as needed.It is Serves as the central processing unit, executing program logic and interfacing with various components.

Arduino UNO kit

The Arduino UNO is a standard board of Arduino. Here UNO means 'one' in Italian. It was named as UNO to label the first release of Arduino Software. It was also the first USB board released by Arduino. It is considered as the powerful board used in various projects. Arduino.cc developed the Arduino UNO board Arduino UNO is based on

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an ATmega328P microcontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc. The board consists of digital and analog Input/Output pins (I/O), shields, and other circuits.The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. It is programmed based on IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms.

- **ATmega328 Microcontroller**- It is a single chip Microcontroller of the ATmel family. The processor code inside it is of 8-bit. It combines **Memory (SRAM, EEPROM, and Flash), Analog to Digital Converter, SPI serial ports, I/O lines, registers, timer, external and internal interrupts, and oscillator.**
- **ICSP pin** - The In-Circuit Serial Programming pin allows the user to program using the firmware of the Arduino board.
- **Power LED Indicator**- The ON status of LED shows the power is activated. When the power is OFF, the LED will not light up.
- **Digital I/O pins**- The digital pins have the value HIGH or LOW. The pins numbered from D0 to D13 are digital pins.
- **TX and RX LED's**- The successful flow of data is represented by the lighting of these LED's.
- **AREF-** The Analog Reference (AREF) pin is used to feed a reference voltage to the Arduino UNO board from the external power supply.
- **Reset button**- It is used to add a Reset button to the connection.
- **USB**- It allows the board to connect to the computer. It is essential for the programming of the Arduino UNO board.
- **Crystal Oscillator**- The Crystal oscillator has a frequency of 16MHz, which makes the Arduino UNO a powerful board.
- **Voltage Regulator**- The voltage regulator converts the input voltage to 5V.
- **GND**- Ground pins. The ground pin acts as a pin with zero voltage.
- **Vin**- It is the input voltage.
- **Analog Pins**- The pins numbered from A0 to A5 are analog pins. The function of Analog pins is to read the analog sensor used in the connection. It can also act as GPIO (General Purpose Input Output) pins.

The technical specifications of the Arduino UNO are listed below:

- There are 20 Input/Output pins present on the Arduino UNO board. These 20 pis include 6 PWM pins, 6 analog pins, and 8 digital I/O pins.
- The PWM pins are Pulse Width Modulation capable pins.
- The crystal oscillator present in Arduino UNO comes with a frequency of 16MHz.
- It also has a Arduino integrated WiFi module. Such Arduino UNO board is based on the Integrated WiFi ESP8266 Module and ATmega328P microcontroller.
- The input voltage of the UNO board varies from 7V to 20V.
- Arduino UNO automatically draws power from the external power supply. It can also draw power from the USB.

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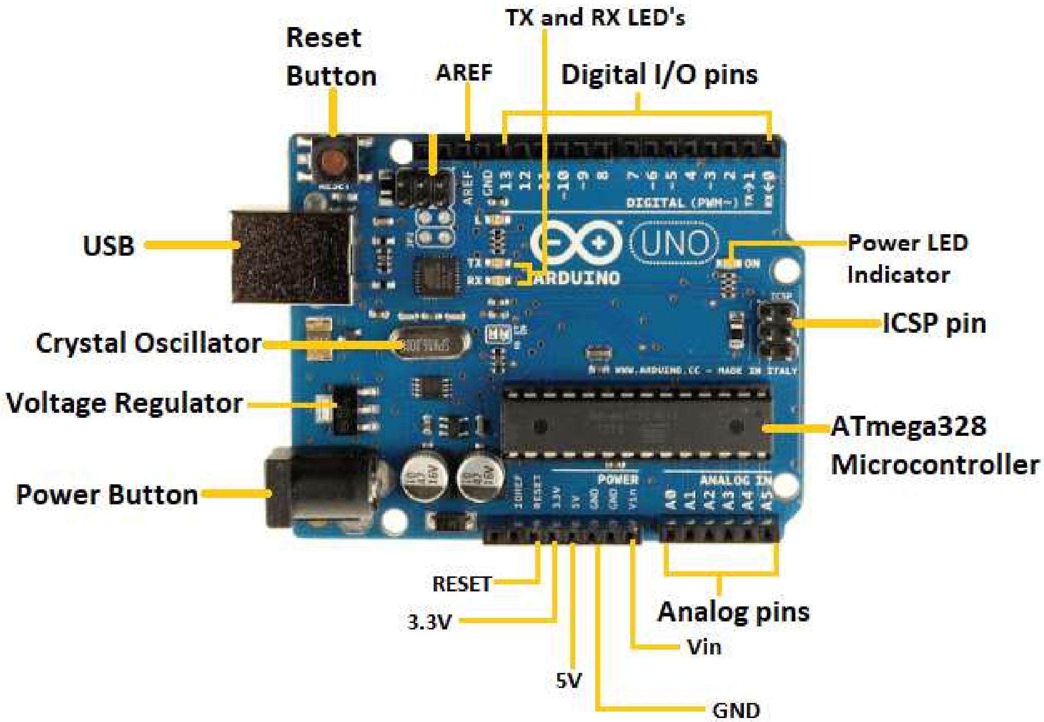

soil moisture sensor

It is used to Measures soil moisture content to determine the need for watering.**Soil moisture sensors** measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. Soil moisture sensors typically refer to sensors that estimate volumetric water content. Another class of sensors measure another property of moisture in soils called water potential; these sensors are usually referred to as soil water potential sensors and include tensiometers and gypsum blocks.

temperature and humidity sensor: Temperature and humidity sensor (or rh temp sensor) is devices that can convert temperature and humidity into electrical signals that can easily measure temperature and humidity. Temperature humidity transmitters on the market generally measure the amount of temperature and relative humidity in the air, and convert it into electrical signals or other signal forms according to certain rules and output the device to the instrument or software to meet the environmental monitoring needs of users.

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Relay Module:-

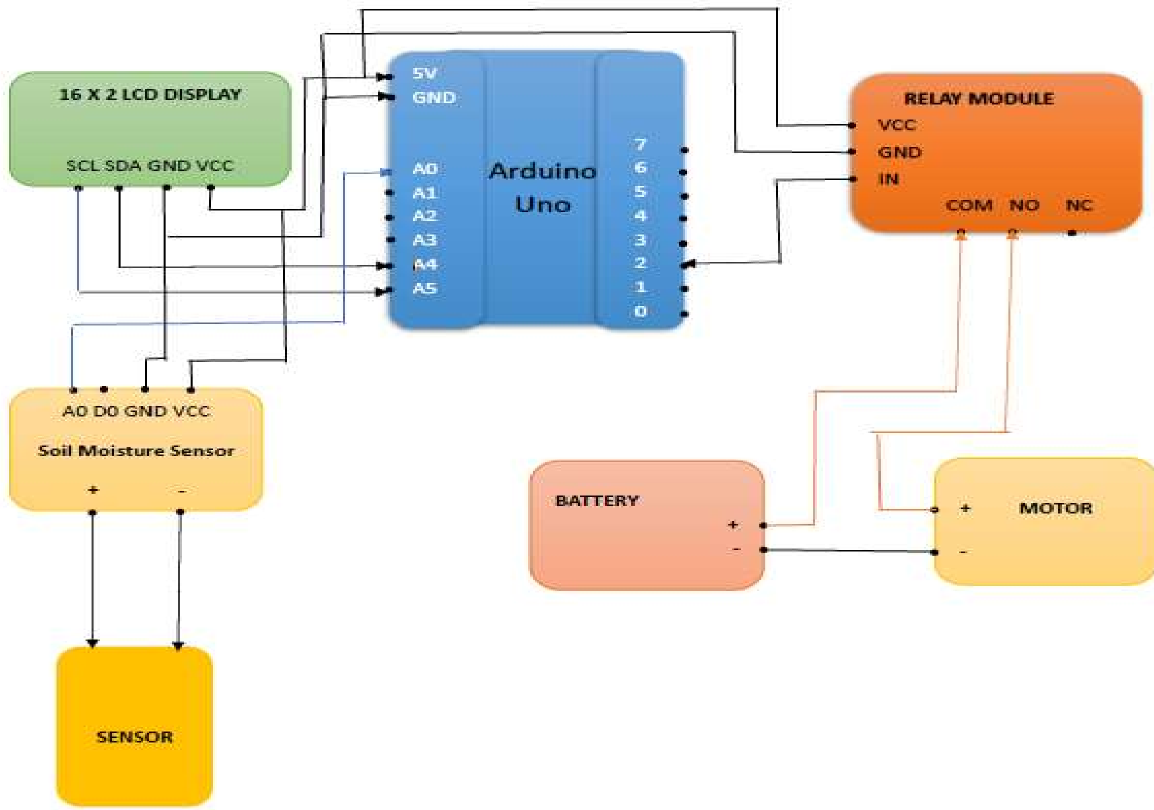
It is used to Controls the water pump motor, enabling automated watering based on moisture sensor readings.The primary function of a relay module is to switch electrical devices or systems on and off. It also serves to isolate control circuits, ensuring that low-power devices, such as microcontrollers, can safely control higher voltages and currents. The operation of a relay module is relatively straightforward. When a control signal is applied, the electromagnet within the relay activates, leading to the closure of the switch contacts. This action allows the current to flow through the circuit. Conversely, when the control signal is removed, the electromagnet deactivates, opening the switch and interrupting the current flow.

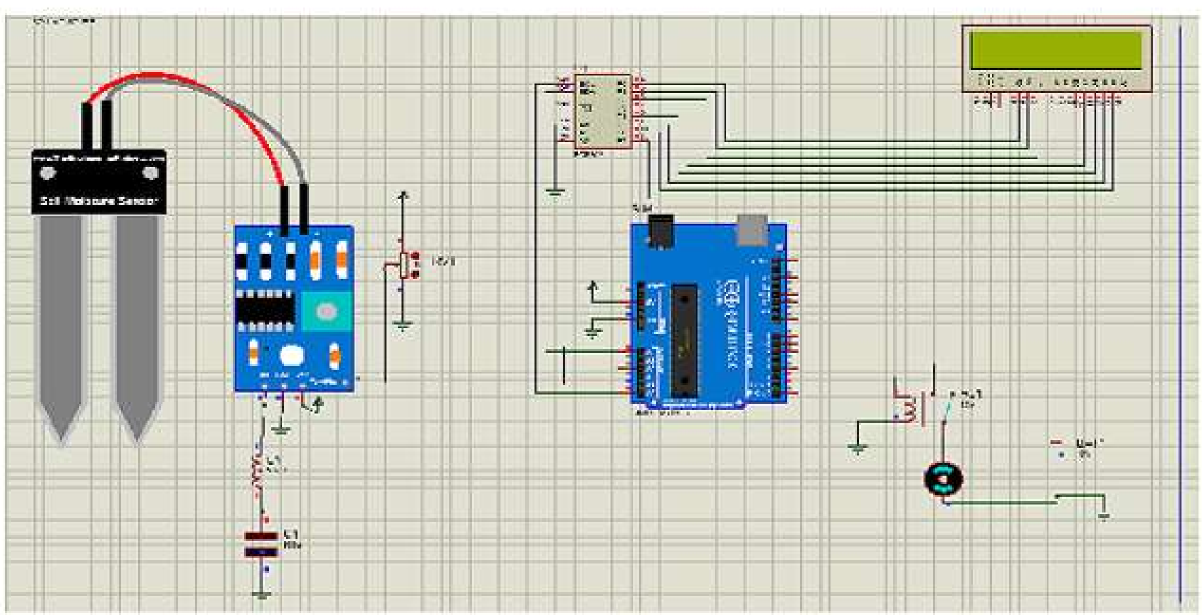
Control signals are essential for the operation of a relay. These low-power signals determine when the electromagnet gets energized. Typically sourced from a microcontroller or sensor, these signals act as the trigger. When the control signal is applied, the relay activates, and when the signal is removed, the relay returns to its default state. This allows for precise control over the relay, enabling its function in a wide array of applications, from flipping a light switch to firing a motor.

Relay modules can be designed with either normally open (NO) or normally closed (NC) switch configurations. In a NO switch setup, the switch remains open when the electromagnet is not activated and closes upon activation. On the other hand, an NC configuration works oppositely.

To ensure the relay module's longevity and prevent potential damage, components like flyback diodes are incorporated. These diodes protect against harmful flyback voltages that can arise when the electromagnet is deactivated. Additionally, optocouplers are sometimes used to offer higher levels of isolation between the control and load circuits.

Circuit diagram





Functionality

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1. For this IOT program used code in c programming language to control the water level in soil for controlling LCD display via I2C communication used **LiquidCrystal_I2C.h file**,
2. It initializes an object of the **LiquidCrystal_I2C** class with the memory address, representing the I2C address of the LCD module, and the dimensions **16** columns and **2** rows.
3. once the program starts called setup() function.
4. For Initializes serial communication at a baud rate of 9600 for debugging purposes.
5. For initializes the LCD display use init()function.
6. To turns on the backlight of the LCD used backlight() function.
7. **For** clears the display used clear() function.
8. It sets pin 2 to HIGH, which seems to control the water pump. This turns the water pump off initially.
9. For this code sets the cursor position to the first column of the first row.
10. It reads the analog input value from pin A0, which appears to be connected to a moisture sensor.
11. To prints the analog value to the serial monitor for debugging purposes used **Serial.println(value)**
12. Used conditional statements control the behavior of the water pump based on the moisture level read from the sensor:
    - If the moisture level is above 950, the water pump is turned on and "Water Pump is ON" is displayed on the LCD.
    - If the moisture level is below 950, the water pump is turned off and "Water Pump is OFF" is displayed on the LCD.
13. Another set of conditional statements prints the moisture level on the LCD:
    - If the moisture level is below 300, "Moisture : HIGH" is displayed.
    - If the moisture level is between 300 and 950, "Moisture : MID" is displayed.
    - If the moisture level is above 950, "Moisture : LOW" is displayed.

Results:

These are some results which measured from this devices

Moisture: 950 Or Above (Moisture Low), Soil Dry - Water Pump On
Moisture: Between 950-300 (Moisture Medium), Soil wet - Water Pump On
Moisture: 300 Or Less (Moisture High) , Soil Wet - Water Pump OFF
By using IOT devices

- **Water Conservation**: The smart system significantly reduces water usage compared to traditional irrigation methods.
- **Yield Improvement**: Optimized water usage leads to better grape yield and quality.
- **Cost Efficiency**: Reduced water consumption and labor costs associated with manual irrigation.

Conclusion:

The IoT-enabled irrigation system proves to be efficient in managing water resources, enhancing grape production, and can be a model for other agricultural applications. this code controls an irrigation system based on the moisture level detected by a sensor and provides real-time feedback on an LCD display. When the moisture level is 950 or above, indicating low moisture content in the soil, the system turns on the water pump.The message "Soil Dry - Water Pump On" is displayed. When the moisture level is between 950 and 300, indicating medium moisture content in the soil, the system keeps the water pump on.The message "Soil Wet - Water Pump On" is displayed. When the moisture level is 300 or less, indicating high moisture content in the soil, the system turns off the water pump.The message "Soil Wet - Water Pump Off" is displayed.It shows how the irrigation system behaves based on different moisture levels, ensuring appropriate watering of the soil to maintain optimal conditions for plant growth.

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