Automatic Plant Watering System Using Soil Moisture Sensor and Arduino

This tutorial provides a complete guide to creating an **Automatic Plant Watering System**, focusing on controlling the water pump using **L293D** or **L298 motor drivers** instead of a relay.

Components Description

Here is a detailed description of all the components used in the **Automatic Plant Watering System** project:

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1. Arduino Uno

- **Description:**
  Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, and USB connectivity for programming and power.
- **Purpose of the Project:**
  The Arduino reads the soil moisture sensor's output and controls the motor driver to turn the pump on or off based on soil dryness.

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2. Soil Moisture Sensor

- **Description:**
  The soil moisture sensor measures the volumetric water content of the soil. It has two probes that detect the resistance in the soil, with lower resistance indicating more water content.
- **Pins:**
  - **VCC:** Connects to the Arduino's 5V supply.
  - **GND:** Connects to the Arduino's ground.
  - **Signal:** Provides an analog output based on soil moisture.
- **Purpose in Project:**
  It detects the soil's dryness and sends the data to the Arduino for decision-making.

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3. L293D Motor Driver (or L298)

- **Description:**
  L293D is a motor driver IC that allows bidirectional control of DC motors and other high-power devices. It can handle motors requiring up to 36V and 600 mA.
  L298 can handle higher current and voltage requirements, making it suitable for heavier pumps.
- **Pins:**
  - **Enable Pins:** Used to activate the motor channels.
  - **Input Pins:** Control the direction of the motor.
  - **Output Pins:** Connect to the motor terminals.
  - **VCC and GND:** Power the motor and the IC itself.
- **Purpose in Project:**
  The motor driver regulates power to the pump, enabling the Arduino to control it effectively.

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4. Submersible Water Pump

- **Description:**
  A submersible water pump is a compact, waterproof device designed to move water. The voltage and current ratings should match the motor driver and power supply.
- **Purpose in Project:**
  It pumps water to the plant when activated by the motor driver.

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5. Power Supply

- **Description:**
  A stable power source is essential for both the Arduino and the pump. This could be a 5V adapter for the Arduino and a higher voltage source (e.g., 12V) for the motor driver and pump.
- **Purpose in Project:**
  Supplies power to the components.

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6. Jumper Wires

- **Description:**
  These are flexible wires with pin connectors on either end, used for making temporary circuit connections on a breadboard or between modules.
- **Purpose in Project:**
  Connect the Arduino, sensor, motor driver, and pump.

7. Breadboard (Optional)

- **Description:**
  A breadboard is a tool for making temporary circuits without soldering.
- **Purpose in Project:**
  It allows easy and flexible connections during prototyping.

8. LED Indicators (Optional)

- **Description:**
  LEDs are light-emitting diodes used for visual indication of circuit states.
- **Purpose in Project:**
  Indicates whether the system is active or if the pump is running.

Updated Circuit Connections

Soil Moisture Sensor Connections:

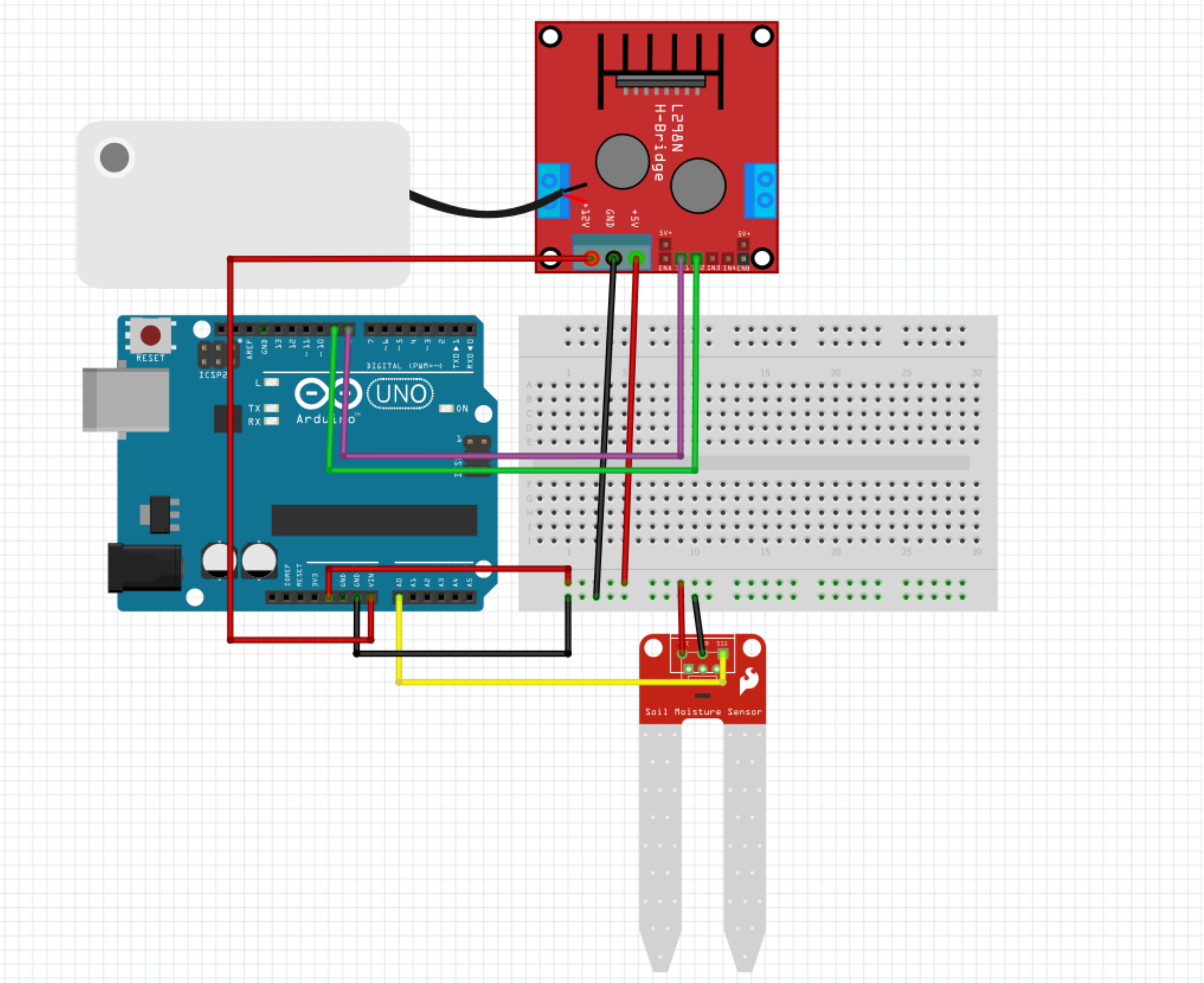
- **VCC** → Arduino 5V
- **GND** → Arduino GND
- **Signal** → Analog pin A0

L293D Motor Driver Connections:

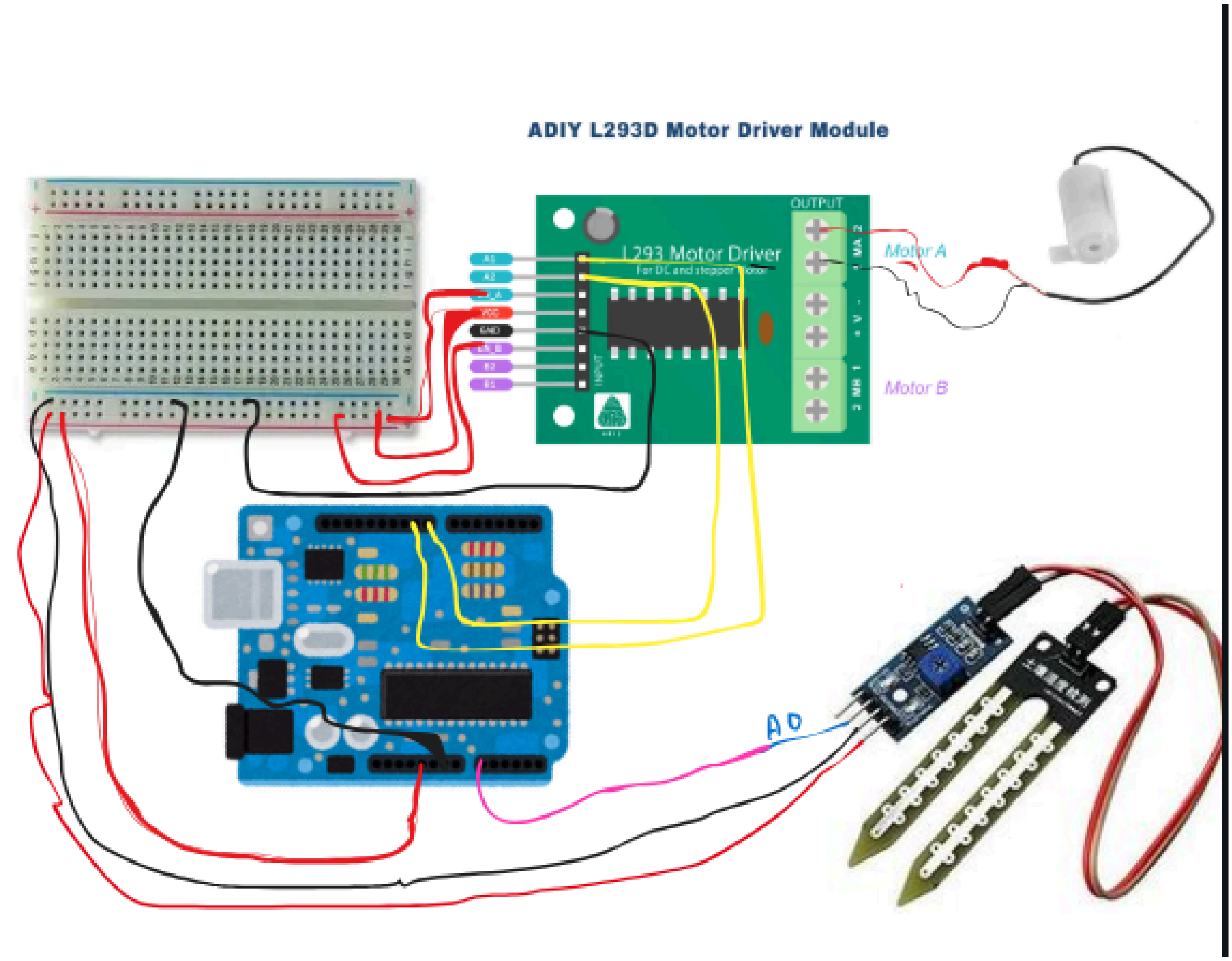
- **Enable Pin (1,2EN):** → Arduino Pin 2 (PWM for speed control, if needed)
- **Input Pins (IN1 and IN2):**
  - **IN1** → Arduino Pin 2 for L298 motor driver module and Pin 8 for L293D motor driver module
  - **IN2** → Arduino Pin 3 for L298 motor driver module and Pin 9 for L293D motor driver module

    Note: You can change the pin connections as per your requirements.

- **Output Pins (OUT1 and OUT2):**
  - Connected to the two terminals of the submersible water pump.
- **VCC:**
  - Connect to the power supply for the pump (e.g., 12V for a 12V pump).
  - Ensure that the voltage matches the pump's specifications.
- **GND:** Connect to the common ground.



1) Above one with L298 module



2) This above circuit is for L293D module

Code Explanation

Here’s the updated code and explanation:

Code for L293D/L298 Motor Driver

```
int sm = A0; // Soil moisture sensor connected to analog pin A0
int MA1 = 8; // Motor pin 1 connected to L293D
int MA2 = 9; // Motor pin 2 connected to L293D

void setup() {
  pinMode(sm, INPUT);  // Soil moisture sensor is an input
  pinMode(MA1, OUTPUT); // Motor pin 1 is an output
  pinMode(MA2, OUTPUT); // Motor pin 2 is an output
  Serial.begin(9600);  // Start serial communication for debugging
}

void loop() {
  int x = analogRead(sm);  // Read the value from the soil moisture sensor
  Serial.print("Soil moisture value is: ");
  Serial.println(x);

  if (x <= 300) {          // If soil is dry (value below threshold 300)
    digitalWrite(MA1, HIGH); // Turn on the motor in one direction
    digitalWrite(MA2, LOW);
    delay(3000);            // Keep the motor running for 3 seconds
  } else {
    digitalWrite(MA1, LOW); // Turn off the motor
    digitalWrite(MA2, LOW);
  }
  delay(100);              // Small delay before the next reading
}

```

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Code Explanation

Pin Assignments

1. **`sm` (A0):**

    - Reads the soil moisture sensor value.
    - Output is an analog voltage, with lower values indicating drier soil.

2. **`MA1` and `MA2` (Pins 8 and 9):**
    - Control the motor via the L293D motor driver.
    - `HIGH` on `MA1` and `LOW` on `MA2` turns the motor on in one direction (water pumping).
    - Both `MA1` and `MA2` set to `LOW` stops the motor.

`void setup()`

1. **Pin Modes:**
    - `sm` is set as an input for reading soil moisture.
    - `MA1` and `MA2` are outputs to control the motor via the L293D driver.
2. **Serial Communication:**
    - Used for debugging, the serial monitor displays real-time soil moisture readings.

`void loop()`

1. **Sensor Reading:**
    - The soil moisture value is read using `analogRead(sm)` and printed to the serial monitor.
    - This allows monitoring and debugging of soil moisture levels.
2. **Motor Control Based on Soil Moisture:**
    - If `x <= 300` (dry soil):
        - `MA1` is set to `HIGH` and `MA2` to `LOW`, turning the motor on.
        - The motor runs for 3 seconds (`delay(3000)`), simulating water pumping.
    - If `x > 300` (moist soil):
        - Both `MA1` and `MA2` are set to `LOW`, turning the motor off.
3. **Delay:**
    - A short delay (`delay(100)`) ensures the system rechecks the soil moisture without overloading the microcontroller.

Circuit Description

1. **Soil Moisture Sensor:**
    - Consists of two probes that measure the soil's resistance to estimate moisture levels.
    - Outputs an analog signal read by the Arduino on pin `A0`.
2. **L293D Motor Driver:**
    - Allows control of the pump motor.
    - Input pins (`MA1` and `MA2`) receive signals from Arduino pins 2 and 3.
    - Outputs power to the motor (Pins Motor A: OUT1, OUT2).
3. **Pump Motor:**
    - Connected to the **Motor A** terminals of the L293D driver.
    - Pumps water when soil is dry (controlled via `MA1` and `MA2`).

Key Points for Students

1. **Why Use L293D Instead of Relay?**
    - An L293D motor driver is more versatile and can control motor direction and speed.
    - A relay is simpler but offers no motor direction control.
2. **Threshold Adjustment:**
    - The `300` value can be fine-tuned depending on soil conditions or specific project requirements.
3. **Debugging with Serial Monitor:**
    - Use the serial monitor to observe soil moisture readings and system behavior in real time.

Note: you can set pins as according to your needs!

Key Points for Students

1. **Threshold Adjustment:**
    - The value `300` is a threshold for dry soil. This can be adjusted based on the soil type and sensor calibration.
2. **Relay Behavior:**
    - The relay acts as a switch, allowing the Arduino to control the pump using a small control signal.
3. **Power Considerations:**
    - Ensure the pump has an adequate power source, as the Arduino cannot directly supply the required current.
4. **Customization:**
    - Use the optional LED (`b`) to indicate the pump's status, e.g., ON when the pump is running.

You can customize the code as per your requirements!!

Working Principle

1. **Sensor Functionality:**
    - The soil moisture sensor measures the soil's moisture level and sends the data to the Arduino.
2. **Pump Activation:**
    - If the soil moisture level is below the defined threshold (e.g., 300), the Arduino activates the motor driver to turn on the pump, watering the plant.
3. **Cycle Continuation:**
    - The system continuously monitors the soil moisture level, turning the pump on and off as needed to maintain optimal moisture.

Advantages of Using L293D/L298 Over Relays

- **Bidirectional Control:**
  The motor driver allows forward and reverse control, which is useful for specific pump types.

- **PWM Support:**
  L293D/L298 can control the pump speed using PWM signals.
- **Integrated Circuitry:**
  These drivers simplify the circuit by combining control and power handling in one IC.

Additional Notes for Students

1. **Component Selection:**
   - Ensure the motor driver matches the pump's voltage and current ratings.
   - The L298 is better for high-power pumps.
2. **Power Supply:**
   - Use separate power supplies for the Arduino and motor driver if the pump requires a higher current.
3. **Threshold Adjustment:**
   - Test and adjust the moisture threshold value based on soil conditions and sensor calibration.
4. **Enhancements:**
   - Add an LCD or OLED display to show real-time soil moisture levels.
   - Implement a water-level sensor to prevent dry-running of the pump.

Conclusion

This **Automatic Plant Watering System** integrates Arduino, sensors, and actuators to provide an efficient and automated solution for plant care. By using motor drivers instead of relays, the system gains flexibility and scalability, making it a robust choice for students and hobbyists.

Working of the System
- The moisture sensor will detect this change when the soil dries up.
- The Arduino will turn on the relay, which starts the pump and waters the plant.
- After a set duration, the pump turns off, and the cycle continues to monitor the moisture level.