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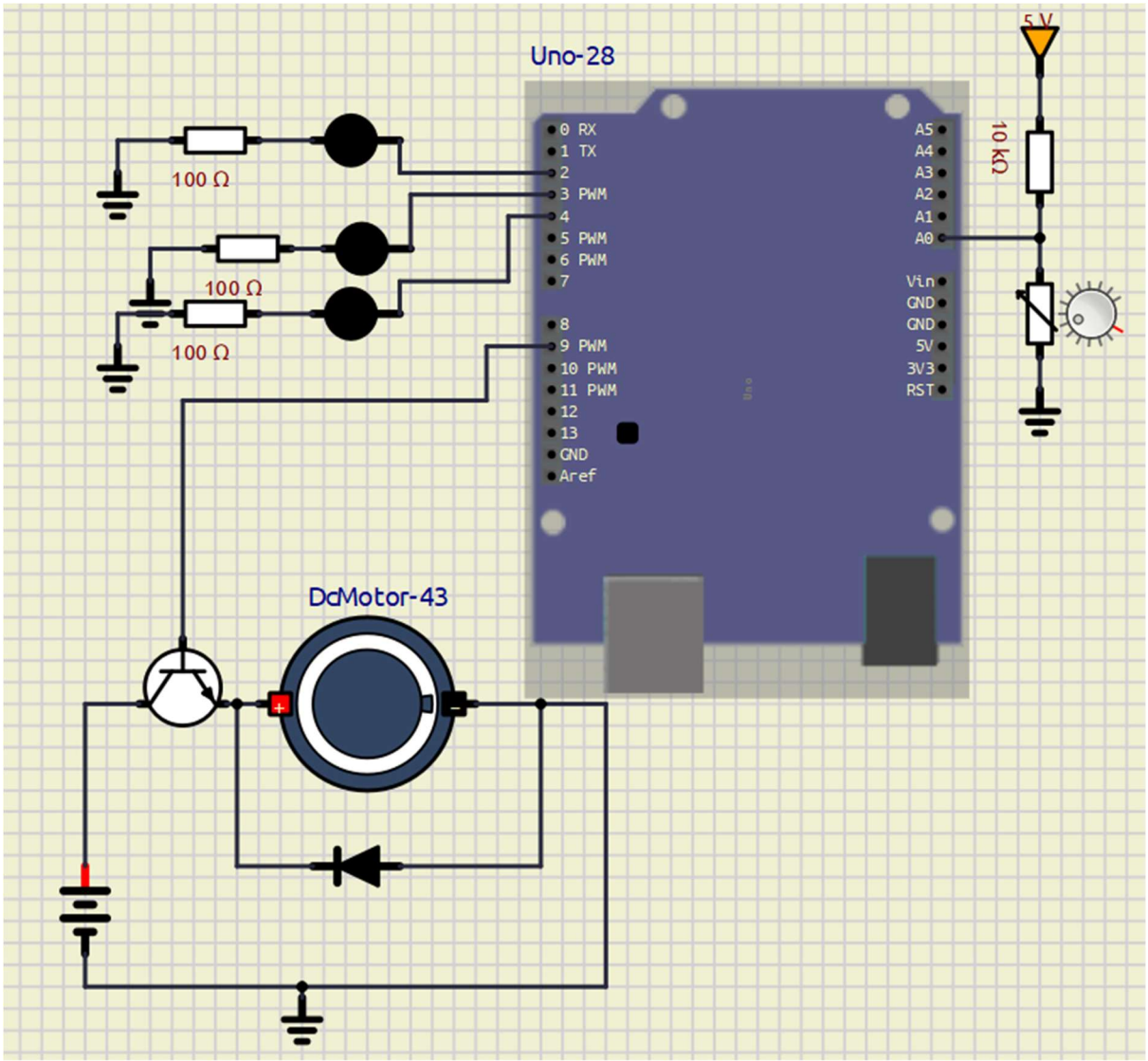
CS2



Smart Temperature-Controlled Fan System

1. Introduction

The Smart Temperature-Controlled Fan System is an embedded system that monitors temperature and automatically controls fan speed with LED indicators. The system uses Arduino, LM35 temperature sensor, three LEDs, and a DC motor to create an intelligent cooling solution.

System Operation:

- **Safe Zone (≤25°C): Green LED, fan off**
- **Warm Zone (26-35°C): Yellow LED, variable fan speed**
- **Hot Zone (>35°C): Red LED, maximum fan speed**

2. Hardware Design

2.1 Components

- **Arduino Uno (ATmega328P)**
- **LM35 temperature sensor**
- **3 LEDs (Green, Yellow, Red) with 220Ω resistors**
- **DC motor with NPN transistor driver (2N2222/TIP120)**
- **Flyback diode (1N4007) for motor protection**
- **1kΩ base resistor for transistor**

2.2 Pin Configuration

- **A0: Temperature sensor input**
- **Pin 2: Green LED**
- **Pin 3: Yellow LED**
- **Pin 4: Red LED**
- **Pin 9: PWM Motor Control**

2.3 Circuit Design

Motor Driver: Arduino cannot drive motor directly due to low current capacity. The transistor acts as a switch controlled by PWM signal. The flyback diode protects against voltage spikes from the inductive motor load.

Temperature Reading: LM35 outputs 10mV per °C. The Arduino ADC converts this to digital value (0-1023), then to voltage and temperature.

3. Software Implementation

3.1 Temperature Calculation

1. ADC reading (0-1023)

2. Voltage = (ADC × 5.0) / 1024

3. Temperature = (Voltage - 0.5) × 100

3.2 PWM Control Logic

The fan speed varies linearly in the warm zone:

- **PWM = 25.5 × (Temperature - 25)**
- **At 25°C: PWM = 0 (off)**
- **At 30°C: PWM = 127.5 (50% speed)**
- **At 35°C: PWM = 255 (full speed)**

3.3 Programming Approaches

The code uses both high-level Arduino functions and low-level AVR register manipulation for educational purposes, demonstrating different abstraction levels in embedded programming.

4. Results and Conclusion

4.1 System Performance

The system successfully demonstrates automatic temperature monitoring, proportional fan control, and visual feedback through LEDs. Testing confirmed correct operation across all temperature ranges.

4.2 Key Achievements

- **Accurate analog sensor interfacing**
- **PWM-based motor speed control**
- **Proper transistor switching circuit**
- **Multi-state visual indication system**

4.3 Possible Improvements

- **Add LCD for numerical temperature display**
- **Implement adjustable temperature thresholds**
- **Include multiple sensors for better coverage**
- **Add data logging for temperature history**