Evaporation Cooling System

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Abstract

This project outlines the design and implementation of an evaporation cooling system, colloquially known as a swamp cooler, using the Arduino Mega2560 and sensors from a standard Arduino kit. The cooler is designed to provide an energy efficient alternative to air conditioners in dry, hot climates by utilizing the evaporation of water to cool and humidify incoming air. Key functionalities include monitoring water levels, displaying air temperature and humidity, controlling a fan motor based on temperature thresholds, adjusting vent direction, and enabling/disabling the system via user input. The project emphasizes the use of specific components such as water level sensors, stepper motors, LCD displays, real-time clock modules, and temperature/humidity sensors, while imposing constraints on the usage of Arduino libraries to promote deeper understanding and application of embedded system concepts. The system operates through a series of states facilitated by state transitions triggered by user inputs or environmental changes, with continuous monitoring and reporting facilitated by the real-time clock.

Contents

1 Overview

The design of the evaporation cooling system, or swamp cooler, revolves around utilizing Arduino Mega2560 and various sensors from a standard Arduino kit to create an energy-efficient cooling solution suitable for dry, hot climates. The system operates by pulling outside air through a water-soaked pad, where evaporation occurs, resulting in cooled and humidified air.

1.1 Constraints

1.1.1 Operating Temperatures

The system is optimized for operation in hot climates where evaporation cooling is most effective. While specific temperature ranges for the module are not provided, the DH11 temperature and humidity module was tested in a 25- to 27-degree Celsius room. The threshold for fan distribution was thus set at 26 degrees Celsius.

1.1.2 Power Requirements

Power requirements are primarily dictated by the electrical components used in the system; the Arduino Mega2560 provides the general 5V power to all components excluding the DC motor. A separate 9V battery connected via an external power supply board is provided for the fan motor to prevent damage to the Arduino's output circuitry. Efficient power management strategies are employed to ensure optimal performance while minimizing power consumption.

1.1.3 Component Selection

The design specifies the use of specific components, including a water level detection sensors, stepper motor, LCD1602 display module, DS1307 real-time clock (RTC) module, DHT11 dual temperature-humidity sensor, and a 3-6V DC motor and fan blade. These components are selected based on compatibility with the Arduino Mega2560 and presence in the starter Elegoo kit.

1.1.4 Arduino Library Usage

In order to promote a deeper understanding of embedded system concepts, constraints are imposed on the usage of Arduino libraries. While certain libraries are permitted for specific components (LiquidCrystal.h for LCD, Stepper.h for stepper, DHT11.h for temperature and humidity sensors, DS3231.h and Wire.h for clock), the use of library functions such as the ones within the Serial library is prohibited. Instead, usage of predefined macros for registers and pin positions as well as UART functions is employed throughout the code, creating a more hands-on approach to embedded programming and system implementation. The relevant documentations are linked in this section.

2 Deliverables

2.1 GitHub Repository

Link: https://github.com/sapphiregaze/CPE-301-Final-Project

2.2 Video of Operation

Link: https://www.youtube.com/watch?feature=shared&v=ANGQSHI6QOw

2.3 Photos of System

See Figure 1.

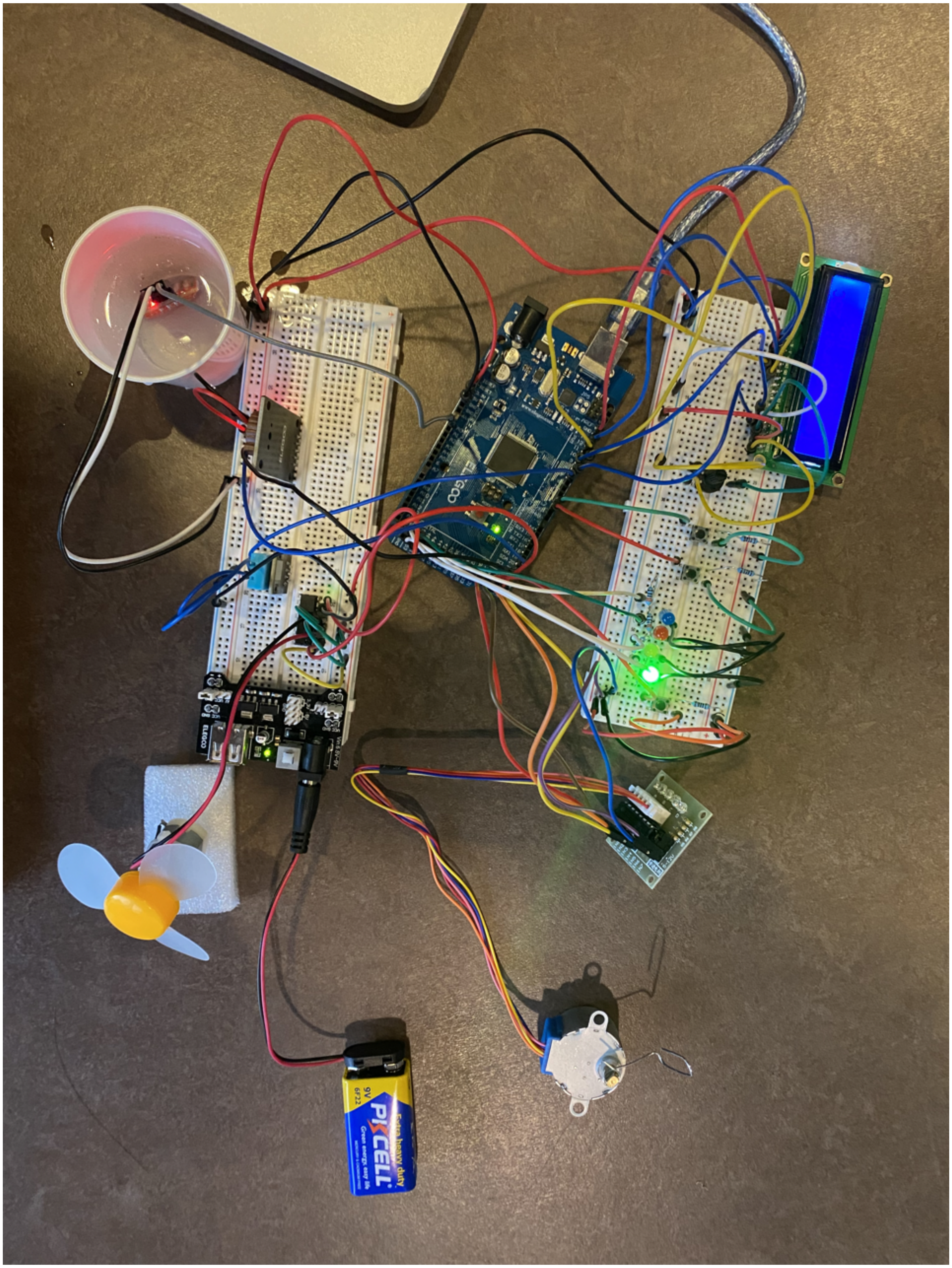

Figure 1: A top-down view of the circuit in an IDLE state. The water sensor is submerged in water. A paper clip is attached to the stepper motor to visualize vent movement.

3 Schematics & Specifications

A complete schematic design of the circuit can be seen in Figure 2. A list of all components used in the circuit can be seen below. All of the components used in this circuit were modules included in Elegoo's "The Most Complete Starter Kit" for the ATMega2560. Specifications for the below components can be found in the following user document: HTTPS://M.MEDIA-AMAZON.COM/IMAGES/I/D1oC-c3G5TS.PDF. Pin-outs used for the microcontroller ports on the ATMega2560 can be derived from the following document: HTTPS://DOCS.ARDUINO.CC/RESOURCES/PINOUTS/A000067-FULL-PINOUT.PDF.

Quantity	Component
x1	DHT11
x1	Power Supply Module
x1	3-6V DC Motor
x1	9V Battery
x1	Snap-on Battery Connector Clip
x1	Water Level Detection Sensor
x1	DS1307 RTC Module
x1	Arduino Mega 2560
x1	Rotary Potentiometer
x1	ULN2003 Stepper Motor Driver
x1	Stepper Motor
x1	L293D Integrated Circuit
x1	2-Pin LED (Red)
x1	2-Pin LED (Blue)
x1	2-Pin LED (Green)
x1	2-Pin LED (Yellow)
x3	Dip Pushbutton
x4	220-Ohm resistor
x3	1K-Ohm resistor
x1	LCD1602 Display

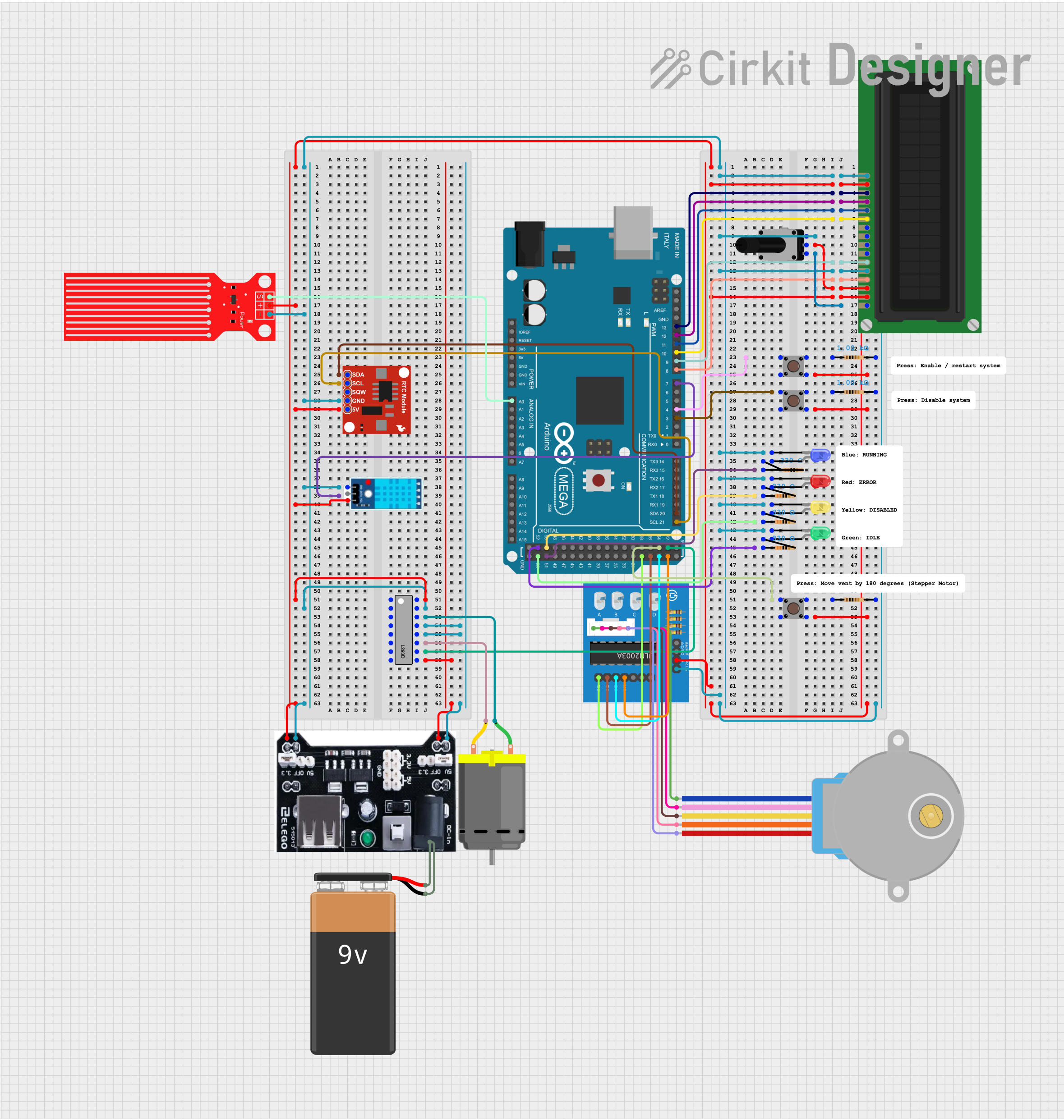

Figure 2: A schematic diagram of the swamp cooler circuit created in CirKit software.