CPE 301 Embedded Systems Design - Final Project

Final Project for CPE 301 (Fall 2022)

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Project Overview

This project aims to implement the base functionality of the systems commonly found in evaporation cooler units. These units rely on a few systems and inputs to function correctly. This project implements the following systems:

- Temperature, humidity, and water level monitoring
- Main fan control
- Output vent adjustments
- User control (Start/Stop, Reset, Vent Control)
- Status LED output(s)
- Serial data communication (timestamped event reporting)

Hardware Description

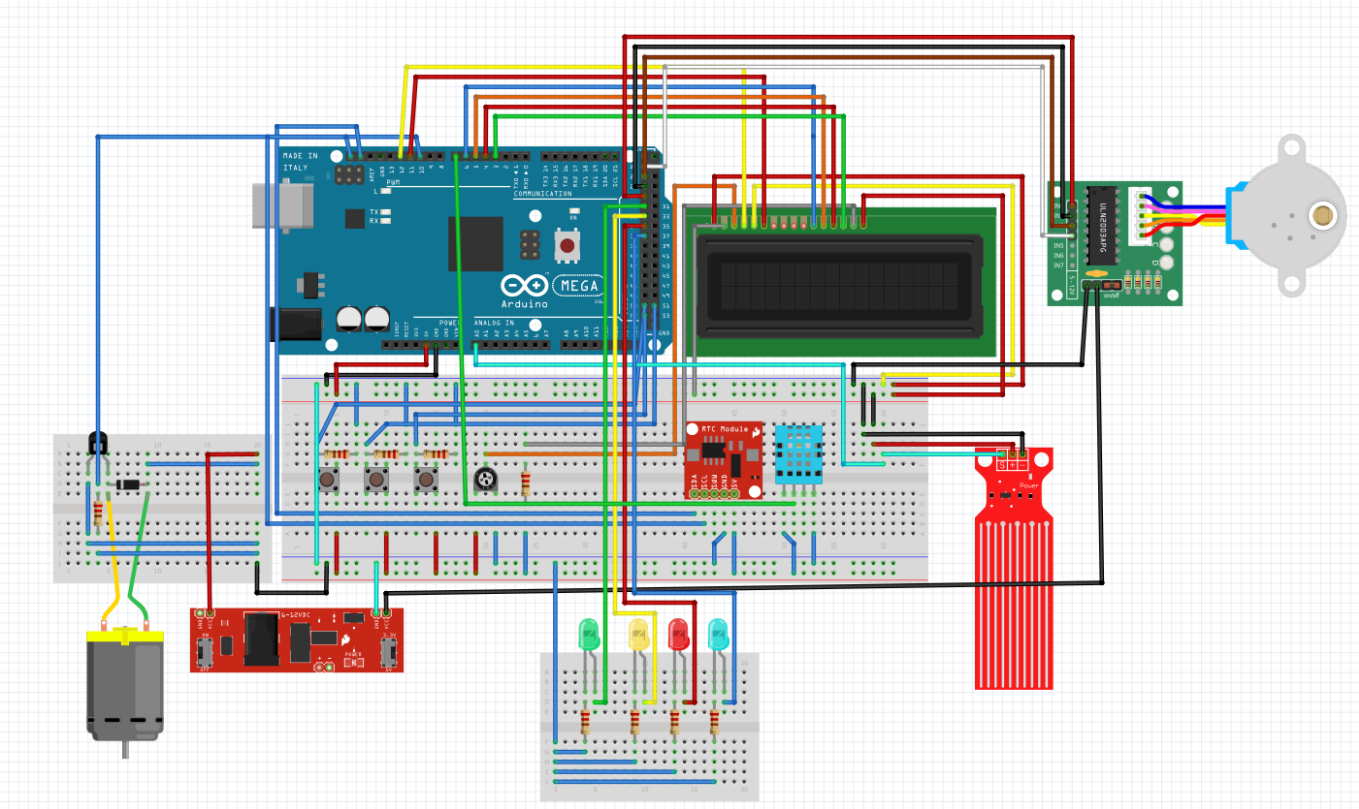
This project was built upon the Arduino ATMega 2560 microcontroller. Devices and sensors used (with datasheets):

- ATMega 2560
  - https://pdf1.alldatasheet.com/datasheet-pdf/view/107092/ATMEL/ATMEGA2560.html
- 16-pin LCD Display
  - https://components101.com/sites/default/files/component_datasheet/16x2%20LCD%20Datasheet.pdf
- DS3231 RTC Module
  - https://pdf1.alldatasheet.com/datasheet-pdf/view/254832/MAXIM/DS3231.html
- 28BYJ-48 5v DC Stepper Motor (w/ control board)
  - https://components101.com/sites/default/files/component_datasheet/28byj48-step-motor-datasheet.pdf
- 5v DC Motor (w/ fan blade)
- DHT11 Sensor
  - https://components101.com/sites/default/files/component_datasheet/DHT11-Temperature-Sensor.pdf
- Resistive Water Level Sensor
- 3x Axial Push Buttons
- 4x LEDs (Green, Yellow, Red, and Blue)
- 10k Potentiometer
- 1x 220 Ohm Resistor
- 4x 330 Ohm Resistors
- 3x 1K Ohm Resistors

- 2N2222 NPN Transistor
    - https://components101.com/sites/default/files/component_datasheet/2N2222%20NPN-transistor%20datasheet.PDF
- 1N4007 Diode
    - https://components101.com/sites/default/files/component_datasheet/1N4001.pdf
- 5v Powersupply
- 3x Breadboards (Large, Medium, and Small sized)
- Tons of Jumper Wires

Schematic

Basic schematic layout for the assembled system.



Operation Demonstration

A link to a video demonstration of the assembled project can be found below:

https://youtu.be/vFcBLB3sc3c

Operation Description

This system operates within 1 of 4 states. The system can operate in the:

- `DISABLED` State
    - In this state many of the main functions are disabled.
    - Indicated by a YELLOW status LED and the `(DISABLED)` message displayed to the LCD.
    - Temperature, humidity, and water-level monitoring is disabled.
    - The fan motor is turned OFF.
    - System will exit this state when the Start/Stop button is pressed (enters `RUNNING`).

- `IDLE` State
  - In this state most functions are enabled.
  - Indicated by a GREEN status LED and the `IDLE` message displayed to the LCD.
  - Temperature, humidity, and water-level monitoring is enabled and output to the LCD.
  - The fan motor is turned OFF.
  - System can exit this state in several ways:
    - Exits upon press of the Start/Stop button (enters `DISABLED`)
    - Exits upon temperature falling outside of the threshold (enters `RUNNING`)
    - Exits upon water-level falling outside of the threshold (enters `ERROR`)
- `ERROR` State
  - In this state most functions are disabled.
  - Indicated by a RED status LED and the `ERROR` message displayed to the LCD.
  - Temperature, humidity, and water-level monitoring is disabled.
  - The fan motor is turned OFF.
  - An error message is displayed to the LCD.
  - System can exit this tate in several ways:
    - Exits upon press of the Start/Stop button (enters `DISABLED`)
    - Exits upon press of the Reset button if water-level threshold is satisfied (enters IDLE)
- `RUNNING` State
  - In this state all functions are enabled.
  - Indicated by a BLUE status LED and the `RUNNING` message displayed to the LCD.
  - Temperature, humidity, and water-level monitoring is enabled and output to the LCD.
  - The fan motor is turned ON.
  - System can exit this tate in several ways:
    - Exits upon press of the Start/Stop button (enters `DISABLED`)
    - Exits when temperature threshold is satisfied (enters `IDLE`)
    - Exits when water-level threshold is violated (enters `ERROR`)

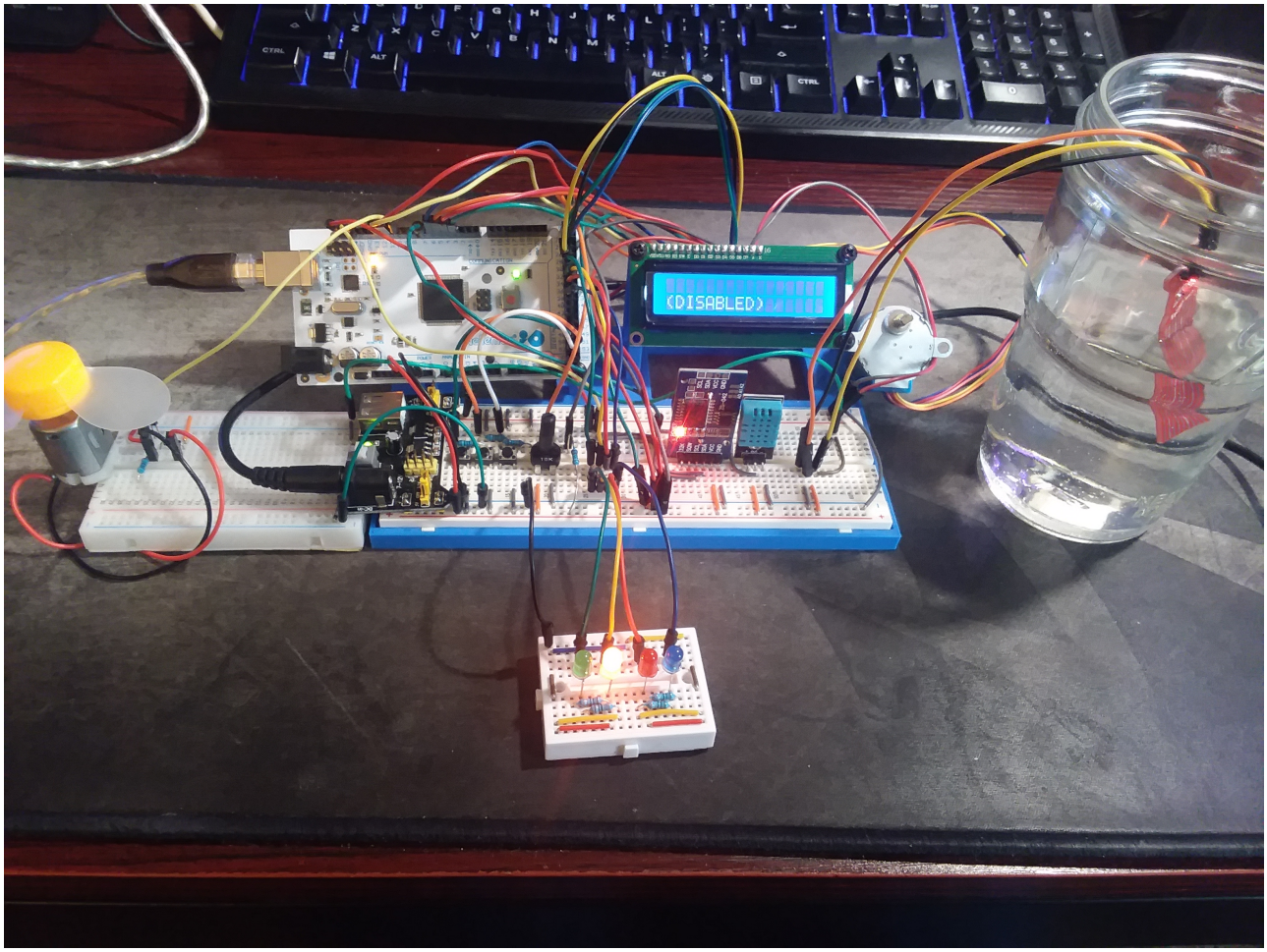
State transitions are reported to the serial monitor with time and date stamps.

In all states, control of the vent positioning is enabled.

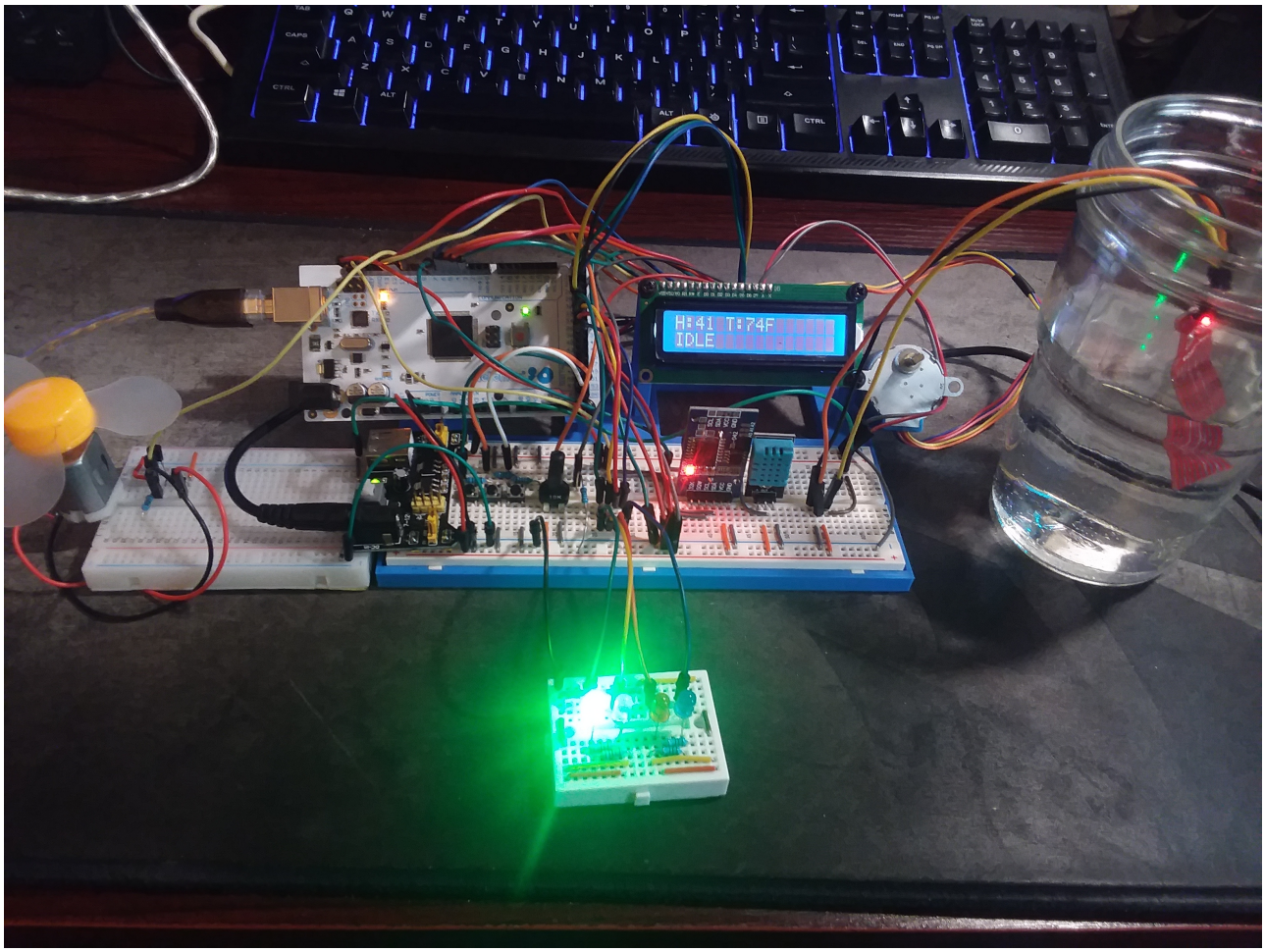
System Images

Below are a few images of the system in the various states of operation.

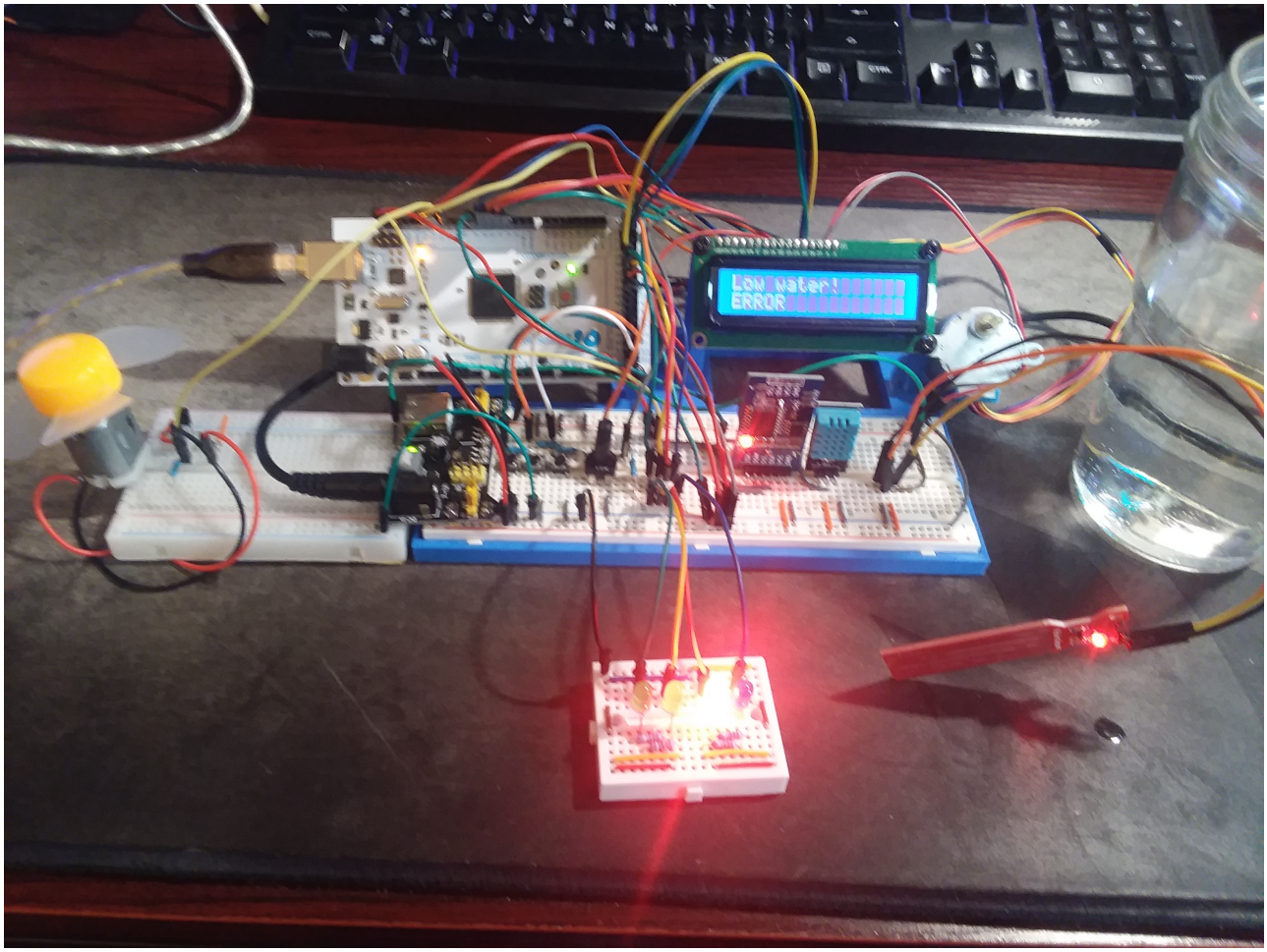
- DISABLED



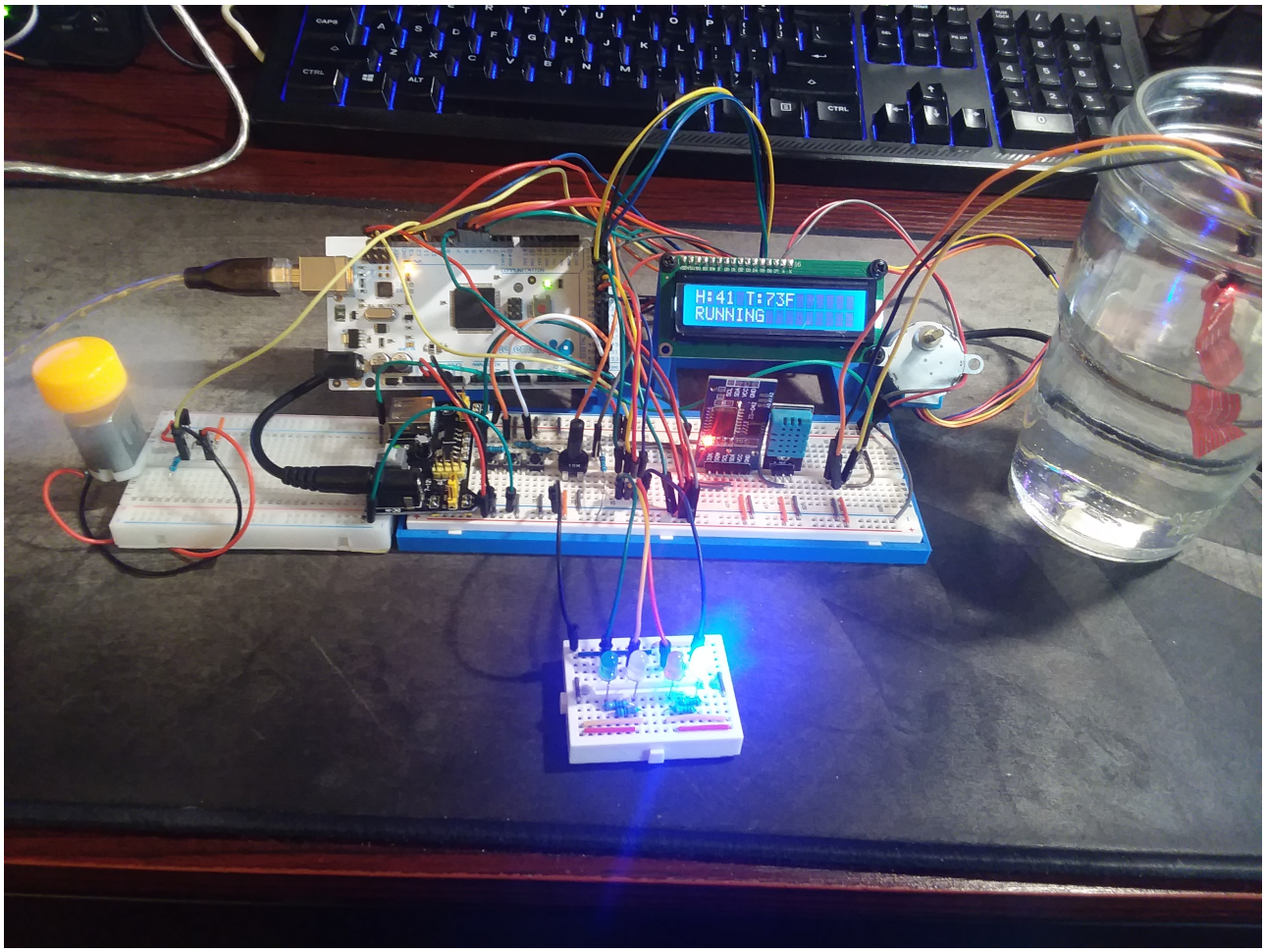
- IDLE



- ERROR



- RUNNING



Below is a screenshot of the serial output which records system state changes.