CJones Final Report

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1 Introduction

The goal of this project was to create an embedded system that simulates a swamp cooler. Typically, a swamp cooler takes advantage of water evaporation to cool hot and dry environments. For this project, the cooler utilizes a fan connected to a DC motor to circulate cool air into the environment. A stepper motor is used to control the position of an output vent. A DHT11 sensor measures relative humidity, and therefore the current temperature of the environment. Another important sensor is a water sensor, which prevents the system from running if the integrated water reservoir is too low. To provide information to the user, an LCD screen is connected to print alerts and updates. As well as this, the cooler sends an update for when the cooler is on or off to a connected computer with a timestamp. This timestamp is created by a DS1307 real-time clock module, which keeps track of the current time. If the user changes the position of the air vent, the system determines which direction the vent is turning, as well as the moment the user releases the button, and sends this information to the serial monitor with another timestamp. There are a total of four buttons. One is used to start/stop the system that allows the user to manually activate/ deactivate the cooler. Another button is used to reset the system if the error state is activated. The last two buttons allow the user to move the air vent, either clockwise or counterclockwise.

1.1 States

In this system, there are four main states: running, idle, disabled, and error. In the initial disabled state, most functions are deactivated. However, the system still sends the message "Cooler off" as well as a timestamp to the Serial monitor when powered on. The associated yellow LED is also activated. When the user presses the start button, there are two states the system can move into. If the water level of the reservoir is too low, then the system triggers the error state. Otherwise, the system moves to the idle state. In the idle state, the LCD screen displays the measured humidity and temperature values calculated from the DHT11 sensor every minute. The green LED is turned on, and the system will stay in this state unless the read temperature is greater than the given threshold(running) or if the measured water level is too low(error). In the case

that the system returns to the idle state after the running state, the "Cooler off" message is sent to the Serial monitor. When the temperature read from the DHT11 is greater than the determined threshold of 23°C, the running state is initiated. This state activates the fan connected to the DC motor. The running state carries over the humidity/ temperature updates from the idle state, and the blue LED is activated. The message "Cooler on" and the timestamp are sent to the Serial monitor. If the temperature decreases below the threshold, the system returns to the idle state. The water levels are also being monitored in this state, and will move to the error state if it is too low. In the error state, the humidity and temperature values are not displayed on the LCD screen. Instead, the message "Error: water level low" is displayed on the LCD. If the cooler is not already off, then the "Cooler off" message is sent to the Serial monitor. The DC fan will deactivate, and the red LED will be activated. The system will stay in the error state unless the reset button is pressed. This will return the system to the idle state. In every state besides disabled, the user can control the position of the air vent and send an update to the Serial monitor.

2 Components

Each component is listed with what functions it provides for this project:

DC motor This motor in this system functions as the cooler fan, and activates through specific inputs via the L293D driver. The PWM of the motor is set to 255, making the rotations rapid enough to be an effective fan.

L293D Driver This controls the fan DC motor. Only one side of the driver is used, while the other is completely open.

28BYJ-48 Stepper Motor This stepper motor is used to turn the air vent in the system. This motor is set to a small interval of steps to prevent loop interruptions in the program. Connected to the breadboard power supply module to prevent Arduino board damage. The motor is connected to the ULN2003 Stepper Motor module to allow this external connection

ULN2003 Stepper Motor Module This module allows the control of the stepper motor, as well as supplying power to it.

Power Supply Module This module is used for systems that require a lot of power. The 9V1A Adapter included in the kit works well to supply as much power as needed to the system.

9V1A Adapter This adapter supply power to the bread board power supply module. It supplies much more current than a standard 9V battery, which is useful for high-voltage systems.

16X2 LCD This screen is used to display the error message, as well as the humidity/temperature updates. It is connected to a potentiometer to change the brightness of the screen.

10k Potentiometer This component is used to control the brightness of the LCD screen. It can be adjusted, even while under an electric load.

Push Button (X4) There are four push buttons included in this project. They are serve different functions(start/stop, reset, cw/ccw rotation), but all act as ways for the user to interact with the system.

LED (X4) There are also 4 LEDs in this system which indicate which stage it is in. They are useful components that are easy to observe.

Water Sensor The water sensor in this project is used to monitor the level of the water and to move the system to an error state. The sensor sends an analog value to the microprocessor, which is then compared to the predetermined threshold value.

DHT11 sensor This sensor determines the relative humidity of the environment. The relative humidity can be used to calculate the respective humidity and temperature. This data is sent to be displayed on the LCD every minute. The temperature value is used to determine if the system moves into the running state.

DS1307 RTC module This is the real-time clock module that is used to create the timestamps for when The cooler activates/deactivates or when the stepper motor rotates cw/ccw. The RTC needed to be calibrated at first before it could display the time correctly.

Resistor (X9) There are a total of 9 resistors in this project. There are 4 100 Ohm pull-down resistors used to control the voltage on each of the four push buttons. There are also 4 330 Ohm resistors that are used to lower the current flowing into each LED, preventing damage to them. Finally, another 330 Ohm resistor controls the voltage for the anode of the LCD screen.

3 Circuit Diagram/States

Below is a diagram of the circuit done in Cirkit Designer, as well as an image of each state transition.

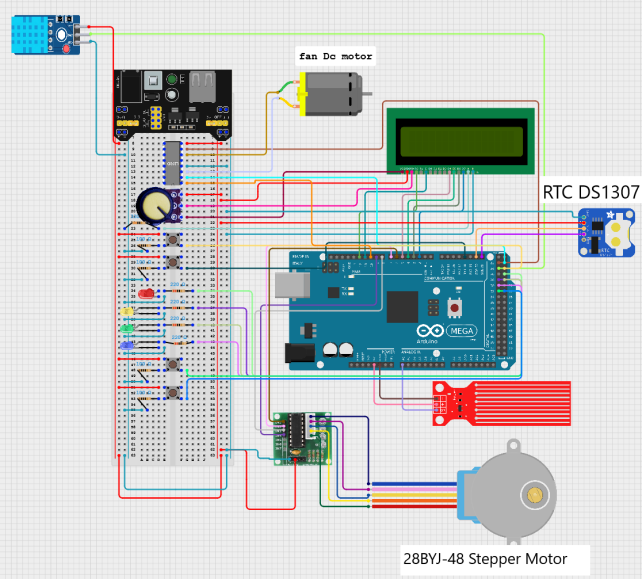

Figure 1: Diagram of circuit

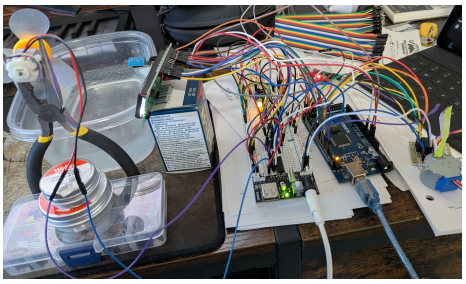

Figure 2: Real Circuit

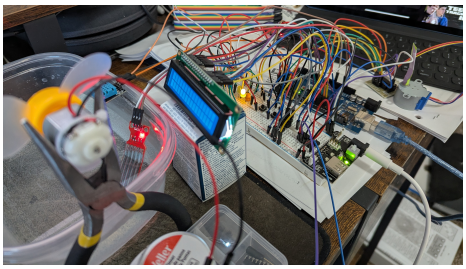

Figure 3: Circuit with initial conditions upon start up.

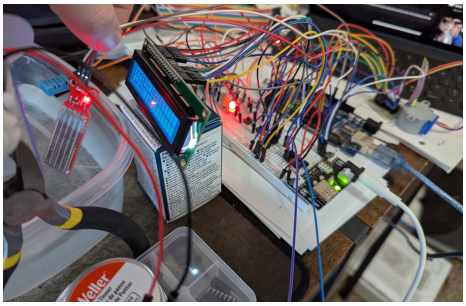

Figure 4: Circuit in the error state

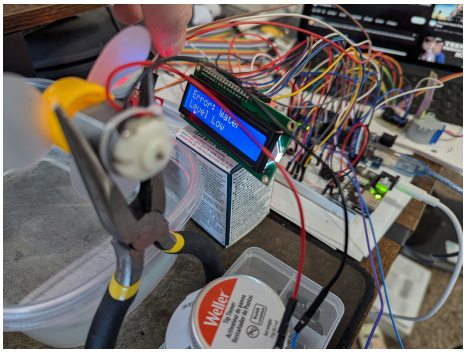

Figure 5: Error message displayed on the LCD.

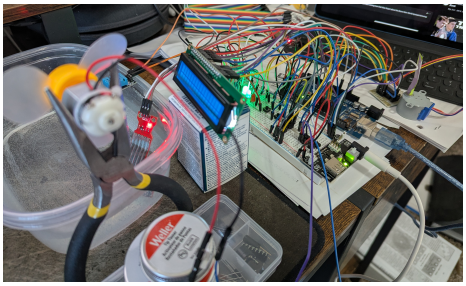

Figure 6: Circuit in initial idle state.

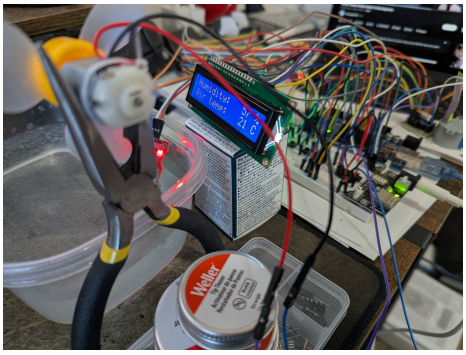

Figure 7: Humidity/temperature readings displayed to LCD after 1 minute in the idle state.

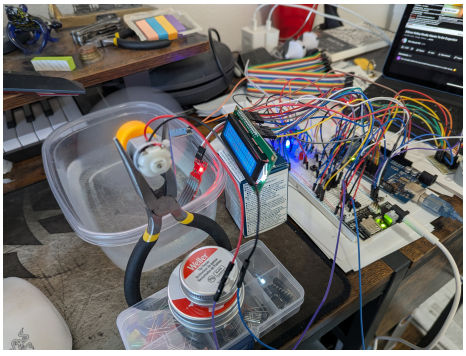

Figure 8: Circuit in the running state. Fan is on.