Electronics Project Group Report

Arduino Mini-Weather Station

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Abstract

An Arduino was programmed to read data from sensors measuring temperature and relative humidity, water level and light intensity. This was done to create the miniature weather station and display the data on an LCD screen. Plotting this data, we see that it compares favourably with expected and real world results.

Introduction

In the pursuit of understanding and monitoring our surrounding environment, in this project we undergo environmental data collection and analysis, leveraging the capabilities of a DHT22 sensor as our primary tool. Our objective is to monitor temperature and relative humidity (RH) levels accurately (DHT22 sensor) and to explore the integration of additional parameters, such as water (or snow) levels (HC-SR04), light intensity (LDR), and precise timing (RTC). We will also complete the construction of a plexiglass (Perspex) enclosure, providing a controlled environment for our sensor apparatus and protection from rainfall for the electronic circuitry. Through this project, we aim to create potential real-life applications of our environmental monitoring setup which can contribute to possible societal impacts.

To calculate the height of the water in the container, the distance from the sensor to the water is taken away from the distance from the sensor to the beaker's bottom.

$$h(x) = h_0 - x \quad \text{eq 1.}$$

To calculate the Light intensity Lux, we use the coefficients B, and m, and the resistance of the LDR.

$$L = BR^m \quad \text{eq 2.}$$

Experimental

To conduct this experiment, a mini weather station was created using an Arduino board, LCD, ultrasonic distance sensor, relative humidity & temperature sensor, real-time clock and an LDR. This was done by connecting the chips to their respective pins on the breadboard and Arduino,

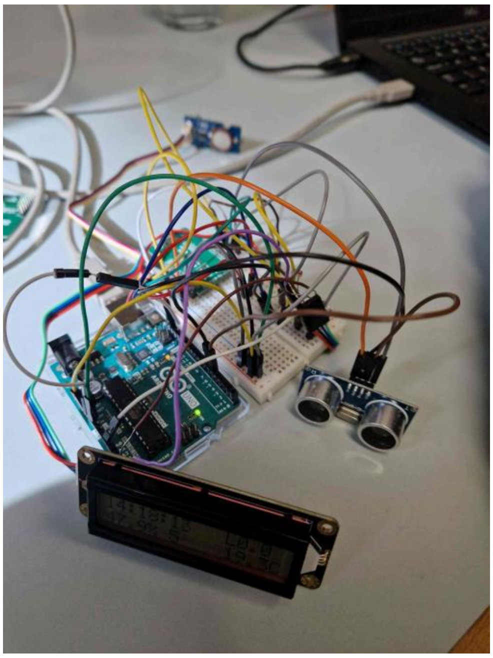

fig 1. Image of Arduino and circuit connected.

The Arduino board was programmed to measure the time, relative humidity, temperature, light levels, and distance to the nearest surface. The nearest surface was measured as it is used to calculate the amount of rain there has fallen into a container by measuring the height of the water. The Arduino was then programmed to show the levels and current time on an LCD screen.

Apparatus used: Arduino, breadboard, DS1607 RTC (clock), DHT22 2 (Humidity & Temperature), LDR (light levels), HC-SR04 (distance sensor), LCD1602 RGB backlight module v2 (screen)

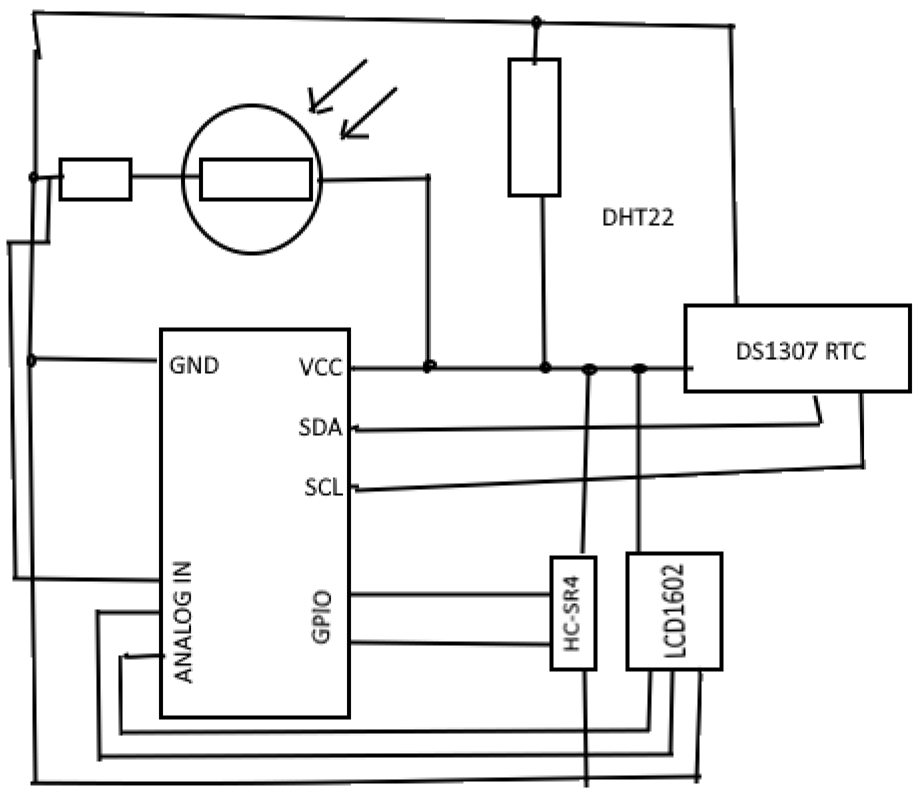

fig 2. Circuit diagram.

An experiment was then conducted to measure the change in temperature and relative humidity due to a bag of ice being placed on the sensor.

Another experiment was conducted to measure the flow rate of water from a tap, by measuring the height of the water as it rises in its container. This was done twice, once at a high flow rate and short period of time, and again at a lower flow rate and longer period. The height of the water was calculated using eq 1.

Finally, a third experiment was performed to measure the light intensity, this was done by measuring an LDR value and calculating the Lux value, and then covering the LDR before shining a phone torch onto it. The Lux value was calculated by running eq 2. in the Arduino code.

Results & Analysis

During the temperature experiment we saw a drop in the temperature for as long as the ice was on the sensor.

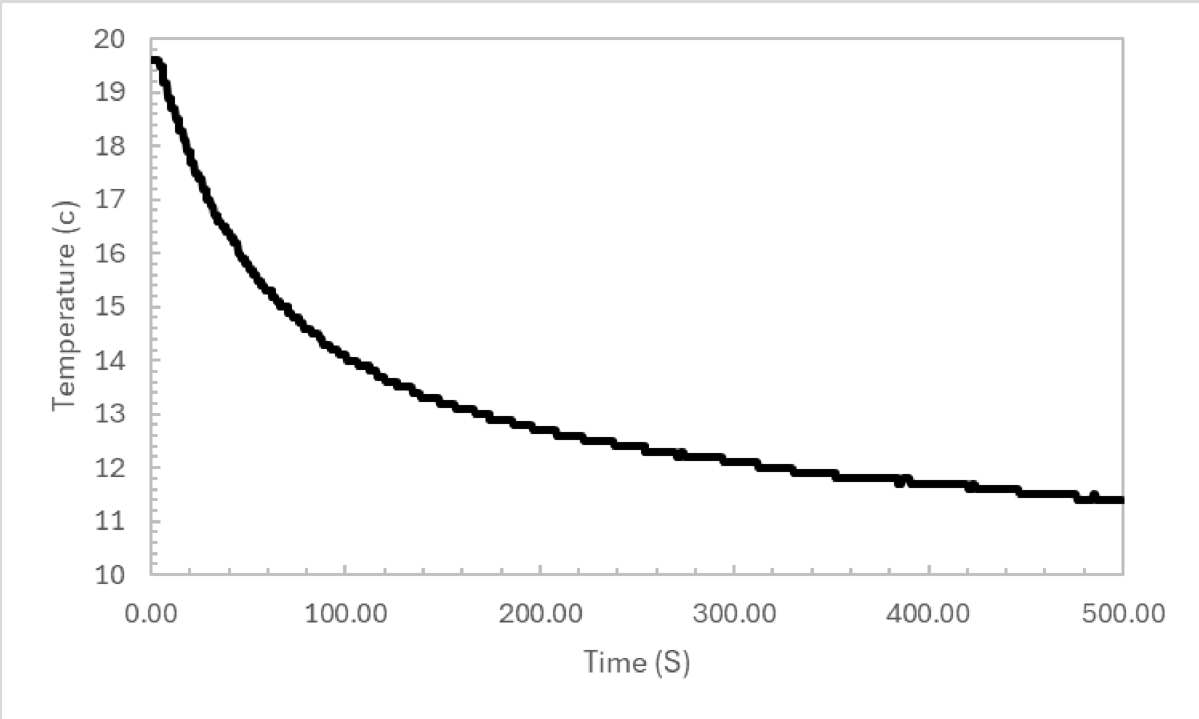

fig 3. Temperature vs Time

During this experiment we also saw a drop in the relative humidity and then a slow rise as the experiment went on.

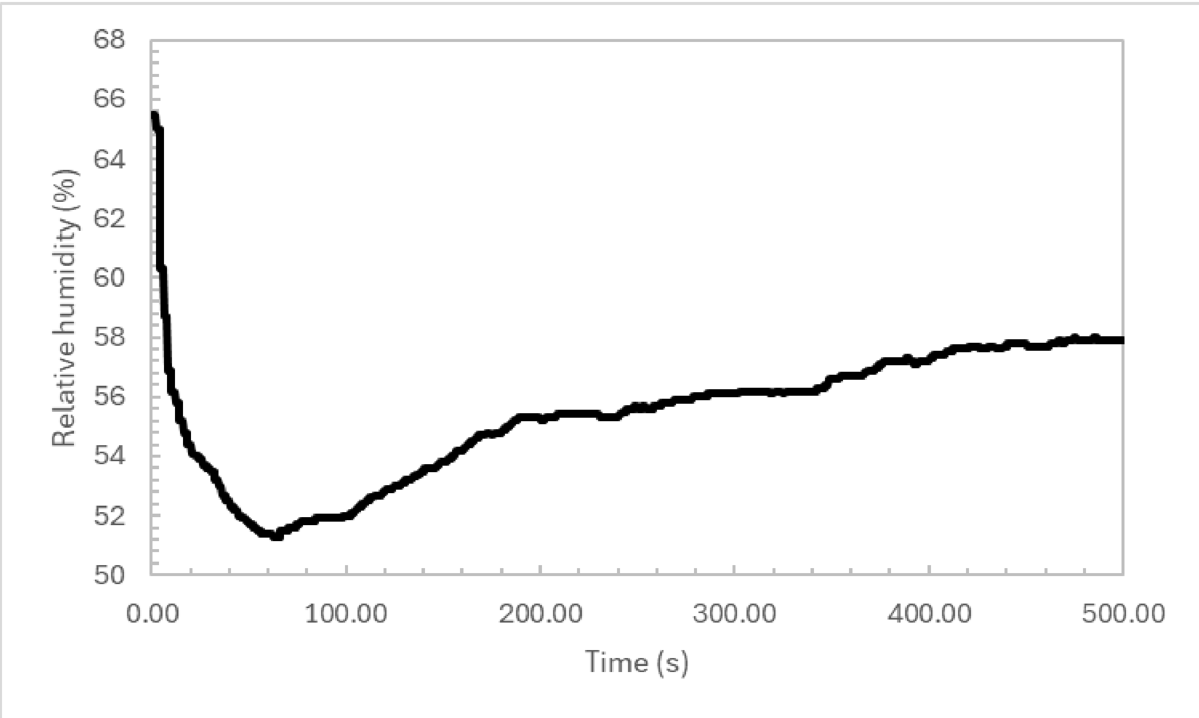

Fig 4. Relative Humidity vs Time

From figures 3 and 4 we can tell that the ice being placed on the sensor caused the temperature to lower in a seemingly logarithmic way, which in turn caused the relative humidity to drop quickly and then rise while the ice began to melt or slowdown in its cooling.

During the water flow experiment we saw as the water level rise as time progressed.

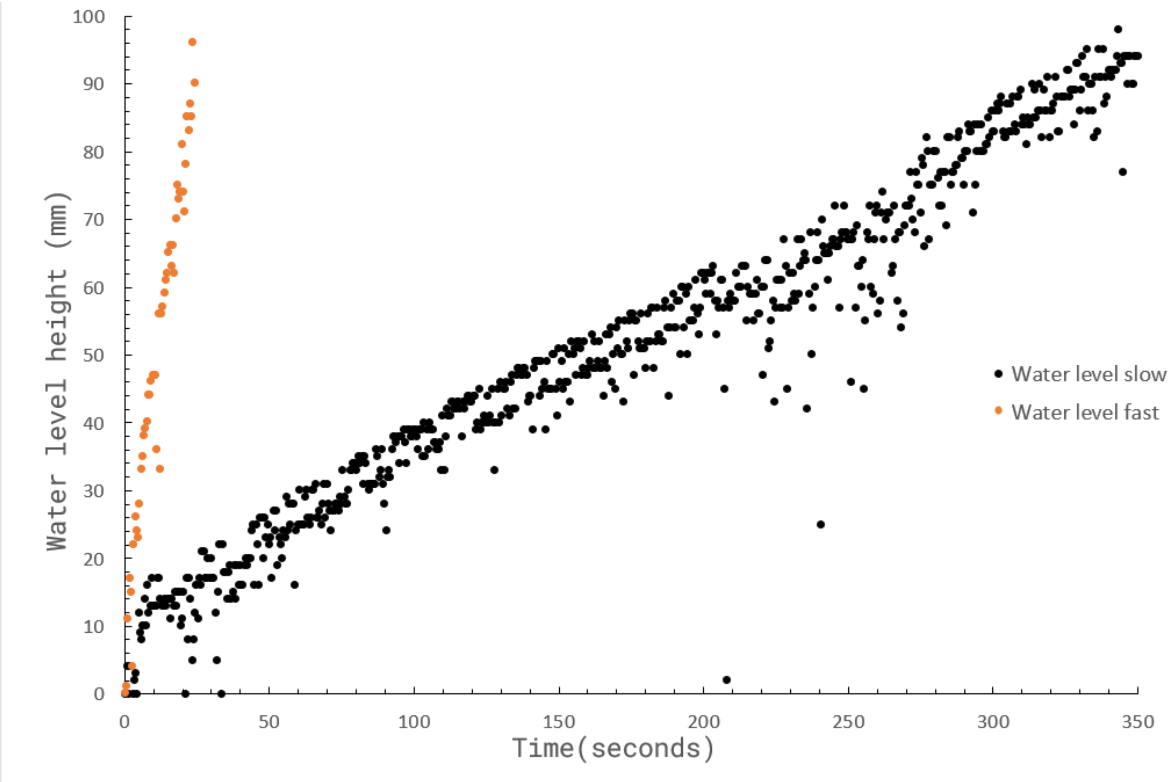

Fig 5. Water flow using Water Level vs Time.

In the slower flow rate experiment, a clear gap can be seen between the data points, where a trend could be found by using the average of these points, as splashing of the water causes noise in the plot.

Finally, the light intensity graphed in main stages: normal light levels, covered from light, and torch shining upon it.

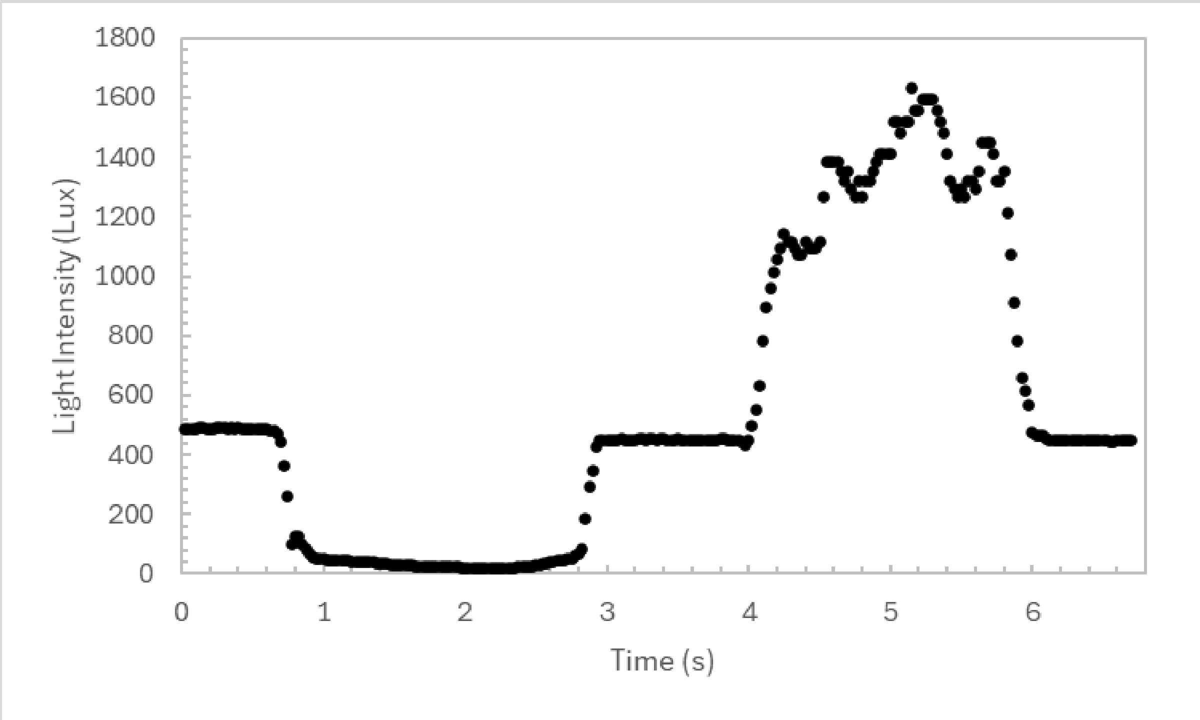

Fig 6. Light Intensity vs Time

All these values were displayed on an LCD screen during the experiments.

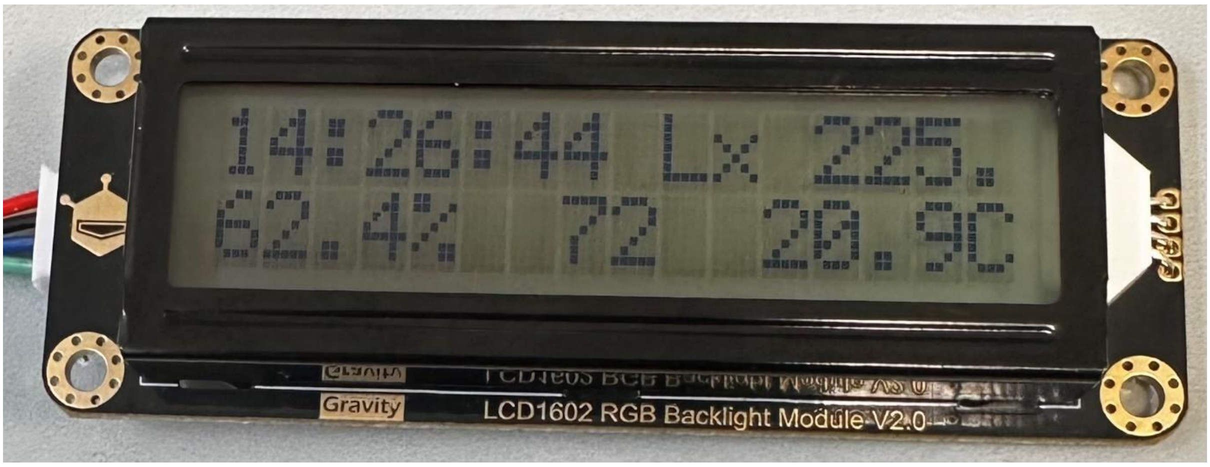

fig 7. LCD displaying time, light intensity (lx), relative humidity, water level (mm), and temperature (°C).

Discussion

During the temperature and humidity experiment, we saw an expected drop in temperature, decreasing at an exponential rate, while the relative humidity drops rapidly before steadily increasing again.

The slope of fig 5. can be used to find the flow rate of the tap during each experiment. A few points of data can be found with lower values than they are supposed to be, we believe this could have been caused by the splash of the water as it fell into the container.

The values seen for light intensity are found to be in line with the real world measurements of the lux, with a bright office measuring between 300-500 lx, while dark areas would show light levels of less than 100 lx and overcast daylight being between 1000-5000 lx.

To further develop this miniature weather station, an appropriate container for the circuit could be used to house the measurement equipment and if placed outside, would be able to take accurate measurements for all of our sensors instead of being simulated by us. Another method of further development could be to add an anemometer to measure the speed and direction of the wind. If this equipment is unavailable to us, a dynamo may be suitable to measure the speed of the wind.

Conclusion

The temperature and relative humidity both fell as expected, but while the temperature continued to decrease the humidity slowly began to rise again as the ice was melting.

The flow rate can be seen to be higher for the fast experiment its plot is significantly steeper, while the slow experiment shows a slower flow rate as it reaches the same water level over a longer amount of time.

The light intensity is consistent with real world light levels for a dark room, office lighting and overcast daylight.