Sensors and Environmental Monitoring: Science and Technology

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Introduction

- How can sensors make environmental monitoring more efficient?
- How can we get the most function for the least space, energy, and expense?
- How can we relate our findings to building technologies?

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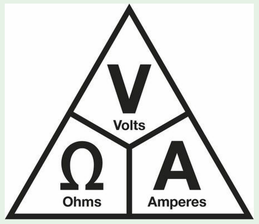
Background

- Ohm's Law: Voltage(Volt) = Resistance(Ohm) x Current(Ampere).
- A multimeter can be used to measure the voltage, amperage, and resistance of a circuit.
- Voltage is the force required to move electrons
- Current is the flow of electrons.
- Resistance is the opposition to the flow of current
  - The resistance of an object is determined by material, thickness, and length .
- Power(Watt) = Voltage x Current.
- An adapter can convert from AC to DC.
- Sensors collect information from stimuli.
- In the United States, each household socket provides 110 volts.

The Triangle to the right shows the units for each aspect of Ohms law.

https://www.jadelearning.com/wp-content/uploads/2019/08/Ohm-law-triangle-v2.jpg



Materials

Hardware:

- Arduino Uno-circuit board: the control center. Contains many ports that supply voltage, act as ground, or receive/transmit information from/to sensors
- Breadboard-solderless circuit board that allows for easy construction of circuits to demonstrate the idea.
- Resistors-resist and moderate current.
- Wires/Wire Kits-used to easily connect parts of a circuit without using solder.
- LED-light emitting diodes that emit light in either red, green, or blue
- Numerous sensors, the ones that were primarily used include: temperature, humidity, motion, and photosensor (light.)
- A multimeter that allowed us to determine the voltage, current, and resistance of our circuit components.

Software:

- When coding in the Arduino software, the C++ language must be used.

Methods

During these two weeks, the Arduino was programmed to allow it to respond to environmental stimuli like temperature, light, and humidity. The following includes a list of components and their methods of use:

- LED-A - light emitting diode that was the primary indicator of a stimulus; helpful in verifying the accuracy of a circuit or code. Also came in different colors and allowed for the indication of multiple different conditions
- Serial-Monitor - built into the programming software that displays text and sensor readings; helps with adjusting the program to properly react to sensor values and allows one to read sensor information much easier
- LCD - liquid crystal display that shows text but is directly connected to the circuit and allows the circuit to be more portable and less reliant on a computer. However, the display is smaller and takes up more ports
- Sensors - main form of collecting data from the environment. Sensors come in different forms that collect different environmental parameters from their surroundings
- Relay - switch that can control whether the circuit is open or closed. Allows for a low-power microcontroller to control a high-power circuit (A/C, lamp, etc.)

Throughout the week, data was collected using a temperature and relative humidity sensor in several different locations at set times, which were decided on by the group. This data was recorded in a sheet.

Snippet of code that took readings of the temperature and printed it out in the Serial monitor

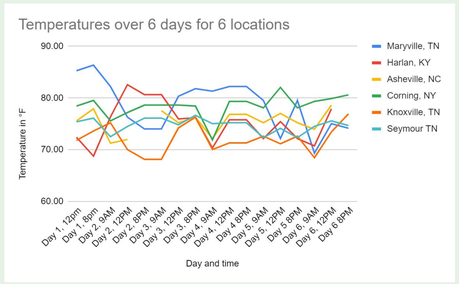
```
float t_F = mySensor.readTemperature(true);
Serial.print("Temperature in Fahrenheit: ");
Serial.print(t_F);
Serial.println("°");
```

Results

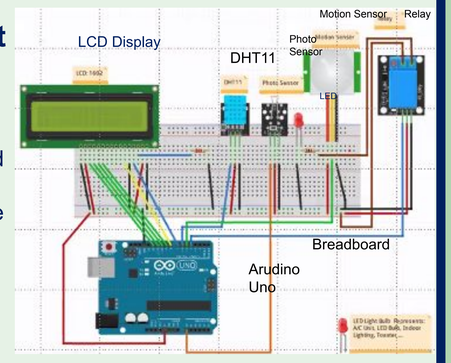
During the program, many experiments were performed with different sensors that do many different things. These experiments helped us answer the questions that was thought of at the beginning of the program.

One of the experiments that was performed during the program involved the use of the Temperature & Humidity sensor. Using the sensor and the Arduino Uno, we measured the temperature and relative humidity in 6 different locations over a 6-day span.

- Data trends help to connect with energy-saving opportunities



Finished Circuit



This is the finished circuit that was created involving lots of components that were introduced throughout the program.
This circuit allows you to view the Temperature, Humidity, Light Level, and Motion on the LCD screen. There was also an LED that lit up when light levels were low or motion was detected.

Conclusions

The research demonstrates how sensors make environmental monitoring more efficient, how to get the most function for least space, energy and expense, how to incorporate these results into building technologies
The scope of the project was accomplished by utilizing these materials:

- Arduino Uno
- Breadboard
- Resistors
- Wires/Wire Kitts
- LED lights
- Motion sensors
- Relay-switch
- Photoresistor

The created circuit board provided information regarding temperature, humidity, lighting, and motion. LCD screen was used to display the information that it is gathering. Research started out creating circuits of the individual items and figuring out how each sensor was able to collect data. After designing and building circuit for each sensor, a sensor system was demonstrated. Such a sensor system concept can directly used for buildings application. As we learned, data trends are important to connect with energy saving opportunities within buildings. To demonstrate the capabilities of our sensor system, research and data was taken in 7 different places over 7 days to collect temperature and humidity as an example on what sensors can accomplish in the environment.

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