The Portable Local Lightning and Weather Detection Apparatus

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Abstract

The Portable Local Lightning & Weather Detection Apparatus (PLLAWDA) is a portable weather station that uses an Arduino Due computer, an AS3935 Lightning Detector, and a BME280 sensor to gather data on temperature, humidity, pressure, altitude, and lightning. Additionally, there is a real-time clock and a sound system to alert when lightning is nearby. This data is instantaneously displayed on an LCD screen for easy viewing. To make this device easy to power, a 9-volt battery is used. All components are stored inside a container that is both weather and drop-proof with a rigging system for easy storage onto a backpack. This project was evaluated in the Colorado Rocky Mountains during the Summer of 2022. These summer trials tested the accuracy, power duration, and handiness of the apparatus. This testing prompted the addition of a real-time clock and a sound system to alert when lightning is nearby. The end goal for this project is to have a portable device that detects the current weather and increases safety for users.

Keywords: Technology, Weather, Arduino, Lightning

Introduction

Many people who venture out to places that have no cell service for a long duration of time may find that it can be difficult to know when dangerous weather is nearby and when it is best to seek shelter. To help with this issue, the Portable Local Lightning and Weather Detection Apparatus (PLLAWDA) was created. PLLAWDA is a device that collects data on the local weather conditions and displays that information on a screen for easy viewing. This device's purpose is to serve as a tool to prevent weather-associated dangers such as nearby lightning for users out there for a safer outdoor experience.

Methodology

At the beginning of this project, I had to figure out how to code the Arduino computer to work with both the AS3935 and BME280 sensors. The AS3935 is a lightning-detecting sensor that has a 40 km radius (about 24 miles). The BME280 is a sensor that senses temperature, pressure, humidity, and altitude. There is an openLog for data storage. I originally intended to work with an Arduino Uno, but because of the limited number of pins it had, I had to resort to using an Arduino Due. I was eventually able to integrate the code for all of the sensors and modules. Next, I integrated the screen. This part was mostly just going through the code and putting in when and what I wanted the screen to display at specific times. During the start-up, I included a diagnostic point to let me know if the sensors were working properly. Finally, with everything integrated, I had to make it fit in its container. This required hours of wire management, soldering, as well as other methods of manipulation to fit the hardware. With sensors, modules and the screen now integrated and fitting inside its container, it was ready to face the trials that awaited at the beginning of the summer.

During the Summer of 2022, PLLAWDA was tested on its accuracy, power duration, and handiness. This testing prompted the addition of a real-time clock and a sound system to alert when lightning is nearby. The audio alert system follows the “Simple Audio Amplifier” schematics from Arduino that includes an 8-ohm speaker and a Micro-SD Breakout Board. I also added a real-time clock for data collection and convenience purposes.

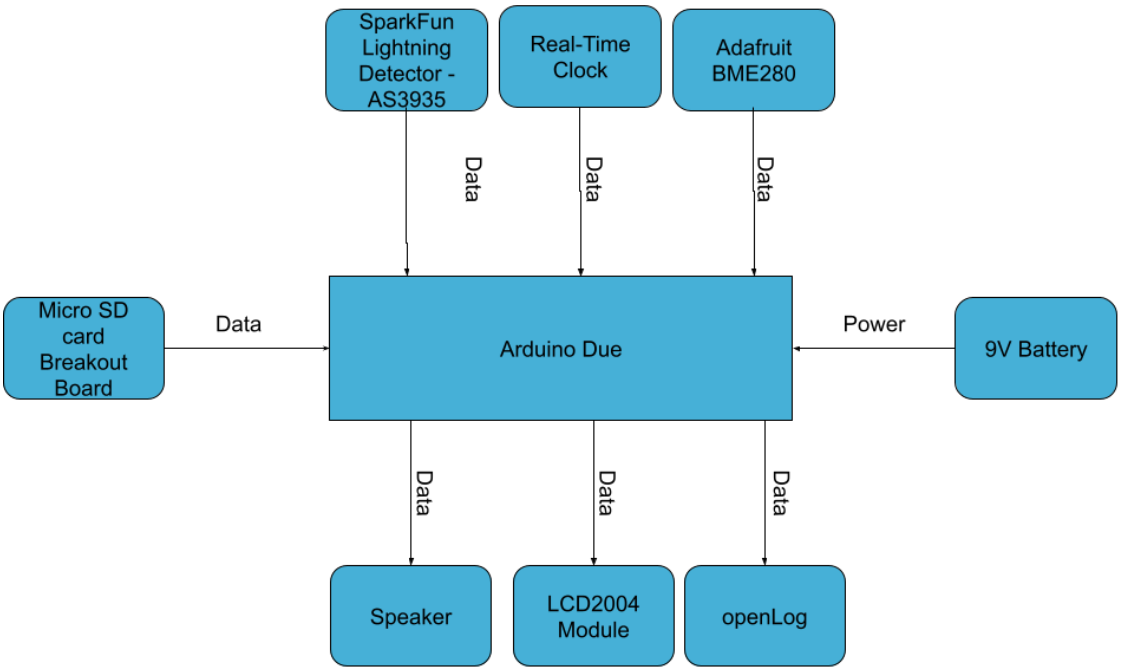

Figure 1: PLLAWDA Block Diagram

Testing

The majority of the testing took place in the Rocky Mountains during the Summer of 2022. PLLAWDA was tested on its capability to have accurate readings, the durability of the hardware, and the general handiness of the device.

The following data was recorded on June 6, 2022, around 6:10-6:20 pm. Please note that these readings were taken inside a heated building, and thus only some of the readings could be properly compared to local weather station readings and the Apple Compass app.

	PLLAWDA	Actual Conditions (WeatherBug & Compass)	Timeanddate.com (At 6:50 pm)
Temperature (°F)	79.68	51	64
Humidity (%)	35.02%	90%	64%
Pressure (millibar)	738.0	1021.33	1008.81
Altitude (Ft)	~8507	~8790	N/A

This next set of data was recorded on July 8, 2022, at about 4-5 pm. This data was taken outside thus making the data viable for comparison. Altitude is not among this set of compared data as altitude was not checked during the time of observation.

	PLLAWDA	Timeanddate.com
Temperature (°F)	80.56	83
Humidity (%)	44.27%	44%
Pressure (millibar)	745.9	1017.95
Altitude (Ft)	~8231	N/A

Based on the data shown, almost all of the data points were very close to each other except for the pressure readings. I believe the cause of the difference is that weather stations usually measure their pressure using sea-level measurements. This causes the pressure reading from weather stations to be much higher than they would be at Colorado's elevations. I was able to come to this conclusion based on findings found in the Adafruit Forums.

Another set of data that was collected was on how accurate the AS3935 was in terms of detecting lightning within its radius. On July 8, 2022, a thunderstorm was rolling in in the late afternoon. From my observation spot, the wind was picking up, and the lightning was striking very close to my location. Close enough that PLLAWDA should have been able to pick it up with its ~24-mile radius of range. PLLAWDA was not functioning properly and didn't report the lightning that was within about five miles of my location. It was later found that the sensor malfunction was caused by faulty wiring.

Throughout the summer the container went along for hikes, climbing, and other such activities and sustained very minor scratches. While generally compact, I found PLLAWDA to be a little too chunky in size to be fully comfortable to carry around, but it wasn't dysfunctional because of it. The carabiner that was included with the container did take some damage. The spring inside broke, and the carabiner wouldn't stay closed. Early in the summer, a wire broke off the circuit board and caused power failure to the BME280 sensor and the openLog. This was fixed on June 7, 2022. This fix solved some of the power failures, but there were other issues with the power. The LCD screen would remain dim regardless of replacing the battery and checking to make sure the wires were in their proper place, and the openLog failed to work. When the summer finished, I examined all of the wirings; I found that I had forgotten to include a wire to connect the ground strip to the ground pin in the Arduino Due. This solved all of the power issues PLLAWDA was having.

Later on in the following spring semester, I worked on the additions of the real-time clock and the lightning audio alert system. When testing the real-time clock, I found that the clock was about 30 seconds faster than the actual time. For the lightning alert system, I was able to get the audio to play, but the speaker that was being used was not playing clear audio. This

will hopefully be fixed by using a different speaker. At that point in time, the system had not been synced to the lightning sensor for alerting purposes, so there is no data for how well the audio system responds to the lightning sensor yet.

Future Plans

Based on the data that was collected and other observations, I wish to continue to work on and improve PLLAWDA. I want to work on a potentially better power source, upgrading and or replacing the wiring, and see if low power mode is possible. I also want to continue to look at downsizing the device for better handling.

Conclusion

Overall, the prototype of PLLAWDA was generally successful. It sensed the temperature with about 2.9% error, humidity with about .6% error, pressure with about 27.1% error, and altitude with about 4.8% error. The lightning sensor failed to detect any lightning as well as any other electrical signals. The general durability of the actual hardware could be better, but the casing pulled through with minimal damage. Many fixes and several additions were made including a real-time clock and a lightning audio alert system. Moving forward, PLLAWDA will continue to be tested on its abilities and built upon for improvement.

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