Autonomous Drone Flight for Real-Time Air Quality Monitoring

Justine Pendergraft

Abstract

This project was focused on plotting and analyzing data from an Atmotube (a Bluetooth LE air quality sensor), and integrating that with a drone (DJI Matrice 100). I wrote code to read the Bluetooth advertising packets, used ROS to get GPS data from the drone, simulated the drone flying around while plotting the data over a map of Portland in real time, and performed a Gaussian Process Regression on the data to interpolate the data over a larger area. This was all done in Python and is documented on GitHub. This project laid strong foundations for using algorithms with the drone to find the boundary between two surfaces, such as the border of a forest fire.

Process

- Our drone is the DJI Matrice 100. It has a simulator that takes commands that are fed into the drone and runs them on the simulator instead of in real life.

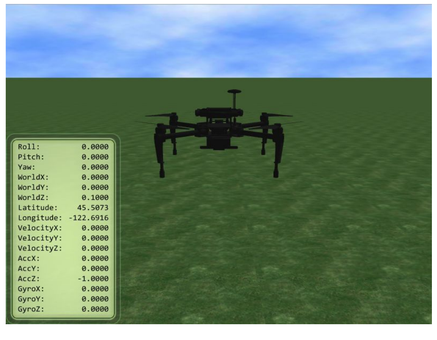

Figure 1: The drone simulator. It is connected to the drone over USB, and can be "flown" around using the drone's controller.

- The sensor: The Atmotube. A handheld air quality sensor that reports VOC, temperature, and humidity over BLE. Its data is read through the computer's Bluetooth adapter, as it doesn't support sending data over a wired connection.
- ROS is also known as Robot Operating System. It works based off of a series of topics that can be subscribed to in order to read the data that is present in those topics. The program on the computer subscribed to the ROSTopic for GPS data and then was able to pair the GPS data with the Atmotube data.
- A Gaussian Process Regression is a method that takes in a prior (in this case the Atmotube/GPS datapoints) and uses that to generate predictions of the surrounding data.

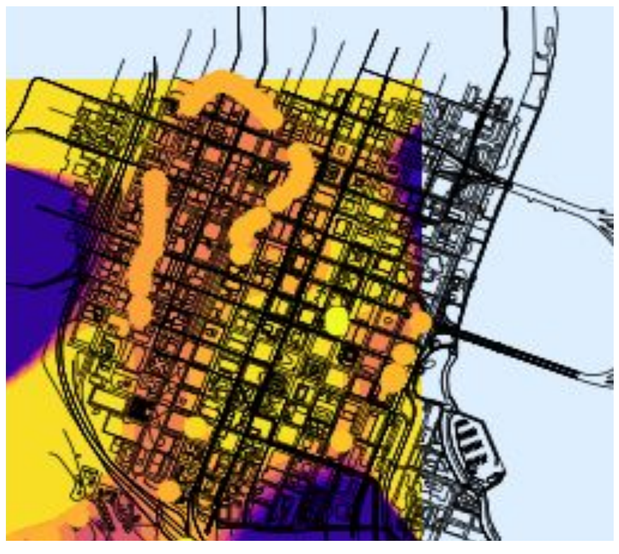

Figure 2: The model of portland based on simulated GPS data and moving the Atmotube closer to and further from a heat lamp.

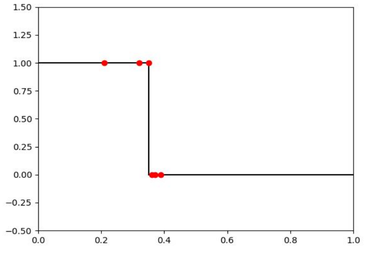

Figure 3: A side project with the drone. The drone searched for a simulated boundary, and the points where it took measurements are plotted here.

Figure 4: Taking the drone out for a test flight at the park. It has a battery life of about 30-40 minutes, which makes it very good for research purposes.

Conclusion

This work will provide a good starting point for field tests with the drone. The map gives a very good visualization of not only the area surrounding the data points, but also of the places where more data needs to be taken in order to increase the accuracy of the model.
The purple areas of the map are very close to other data points though, and this leads us to be a bit suspicious of the gaussian process code. However, for the most part, it gives a rather good idea of the temperature of the area.

Acknowledgements

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