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Design and Development of an Online Wind Tunnel for the Aerodynamics Lab

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Design and Development of an Online Wind Tunnel for the Aerodynamics Lab

by

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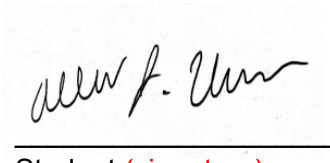

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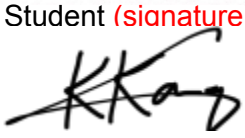

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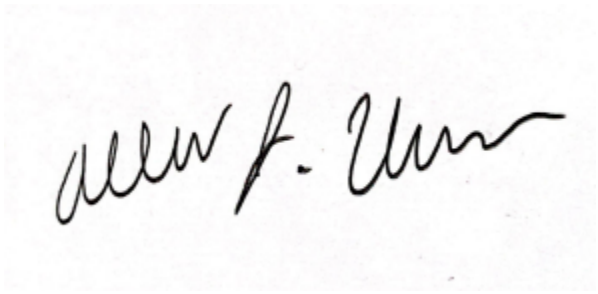

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Abstract

Wind Tunnels are commonly used to test the aerodynamic properties of objects making them vital in learning about aerodynamics. Many schools are not fortunate enough to have access to a full-scale wind tunnel for academic purposes and during the COVID-19 pandemic access to a wind tunnel became almost impossible. This project aims to combat the problem through the use of LabVIEW and Arduino by taking an existing wind tunnel and modifying it. This wind tunnel would then be used by a remote student using a webpage to access the graphical user interface. It also entails the creation of several lab experiments that could be conducted by different age groups ranging from elementary school to the collegiate level.

The Online Wind Tunnel:

This project started as a Research or Creative Experience for Undergraduates project under the supervision of Dr. Kanistras who was in charge of the UAH Aerodynamics Lab at the time. I was in charge of developing the GUI and program that would be used for remote access to the wind tunnel seen in Figure 1.

Figure 1: The Wind Tunnel

With this software, they would be able to in real-time conduct experiments and have remote access to the wind tunnel. These experiments would be similar to the ones in the MAE 331 lab such as calculating the coefficient of drag and lift of an airfoil. Not only would this project help other schools it could also be used for Outreach events with the school. Allowing kids 6-12th grade to conduct easier experiments and to learn more about aerodynamics. This project could also be upscaled to one of the bigger wind tunnels to conduct more complicated experiments. When selecting which program to use LabView was selected as it showed to be the most compatible with Arduino and the National Instruments data acquisition device connected to the Flotek 360 wind tunnel. LabView is a graphical programming environment that many engineers use to automate their systems.

Throughout the 10 weeks meetings were held every few Fridays to update Dr. Kanistras on the progress made. The first few weeks consisted of testing the wind tunnel and figuring out how it worked and figuring out which programs would work best. The tunnel came with a National Instruments data acquisition device that was connected to the strain gauge as seen in Figure 2.

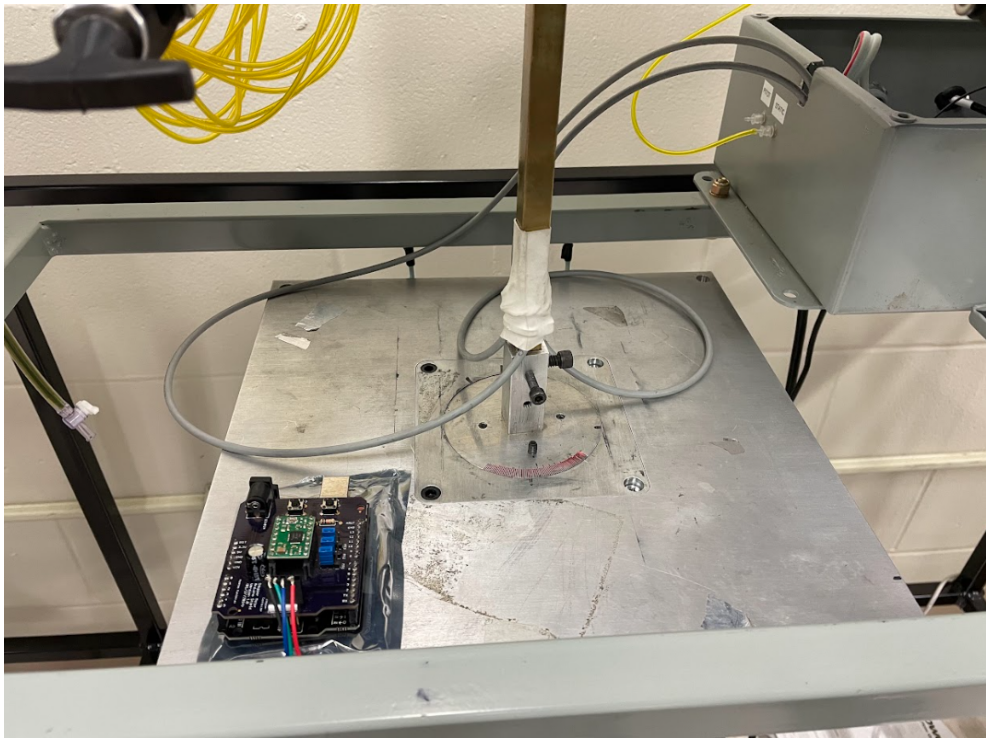

Figure 2: Strain Gauge and Base

The strain gauge would then give us a resistance that varies with an applied force. By using LabView I was able to get strain data that was unreadable as the data was noisy. By taring the data and applying filters I was able to get readable data that would be useful in calculating the coefficient of drag and lift. After the first two weeks, we began developing what we wanted to be on the graphical user interface (GUI). We wanted the user to view the angle of attack on the airfoil in the testing area, the amount of lift and drag produced, a plot of the coefficient of drag and lift, and a live feed of the airfoil itself. These features were important as this is what students in a classroom are recording. Not only did we want the user to have access to the data but they should be able to, in real-time, change the angle of attack of the airfoil, and be able to change the velocity of the wind tunnel. Controlling the wind tunnel through the GUI posed a new challenge as we had to take apart the electrical controls and install an Arduino.

By using an Arduino and stepper motor along with the plugin LabView interface for Arduino, I was able to control the base of the strain gauge to move one degree at a time using the GUI. This can be seen in Figure 3.

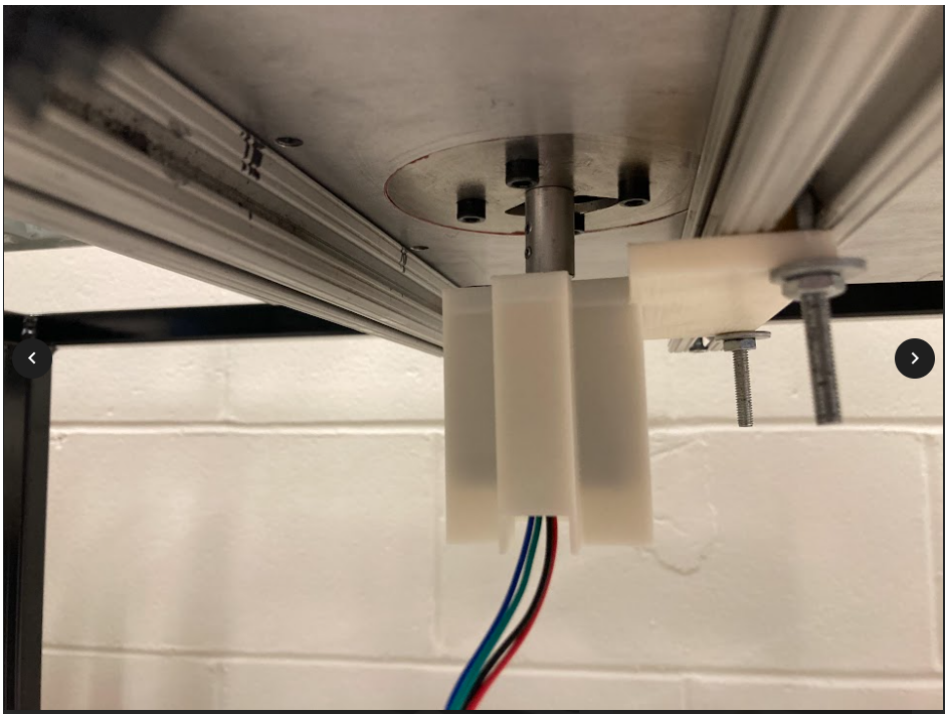

Figure 3: The Stepper Motor and Base

At this point, after weeks of testing and calibration, the RCEU program came to an end. I created a GUI, seen in Figure 4, that was capable of, turning on and off and a set of LEDs that simulated the on-and-off switch on the wind tunnel, changing the velocity of the tunnel and turning the angle of attack of the airfoil. The GUI also displayed lift and drag forces but still, I had a GUI full of bugs and graphs that were sometimes not ideal. Although it was capable of doing all these things it was not capable of doing them remotely. After talking to the IT

department we figured that it would be best to wait to implement this until after the GUI was done.

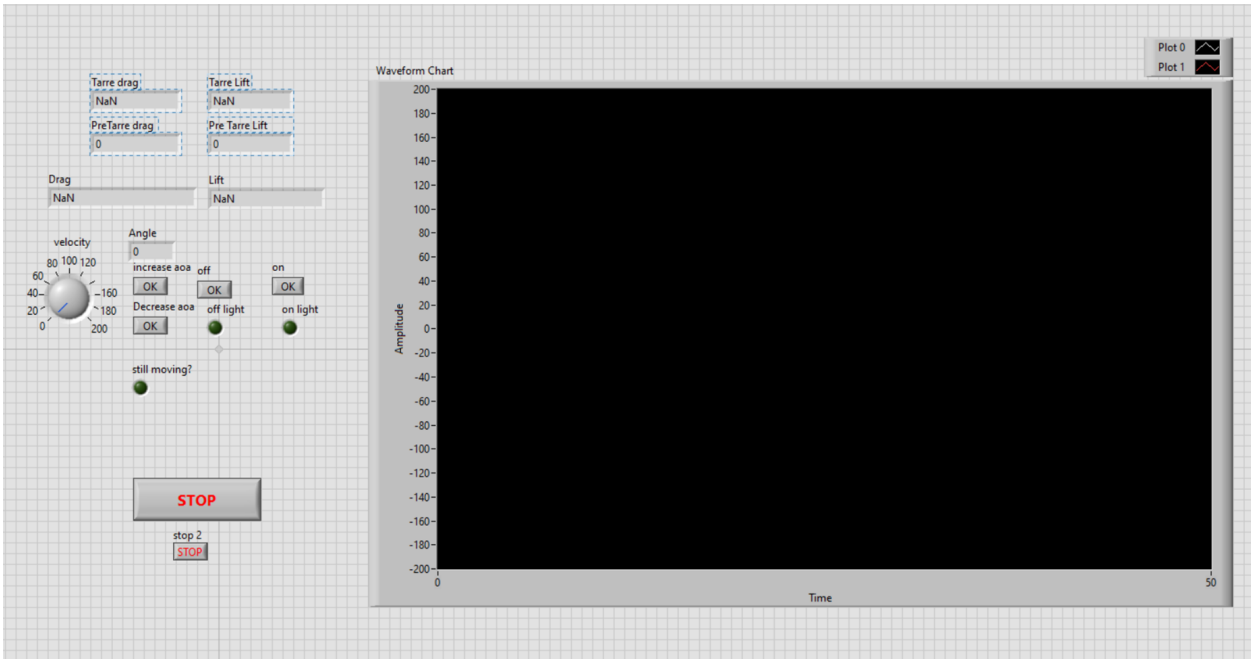

Figure 4: Graphical User Interface

During the Spring 2021 semester, the project continued. During this time meetings were held every Friday to inform Dr. Kanistras of the progress made. During these weeks, I implemented a coefficient of drag and lift graph into the GUI along with an inactivity timer that would turn off the tunnel and reset for the next person. The labs for the high school students were put together along with an information website where they can go and learn more about aerospace engineering (https://sites.google.com/uah.edu/aerolab/high-school/experiment-1). Throughout the next few weeks, most of my time was spent debugging the code and adding features into the code for remote use such as a login screen and inactivity timer. Time was also spent on making the coefficient of drag and lift graphs from the measured strains to produce better results. Figure 5 shows the final draft of GUI at the time of this document.

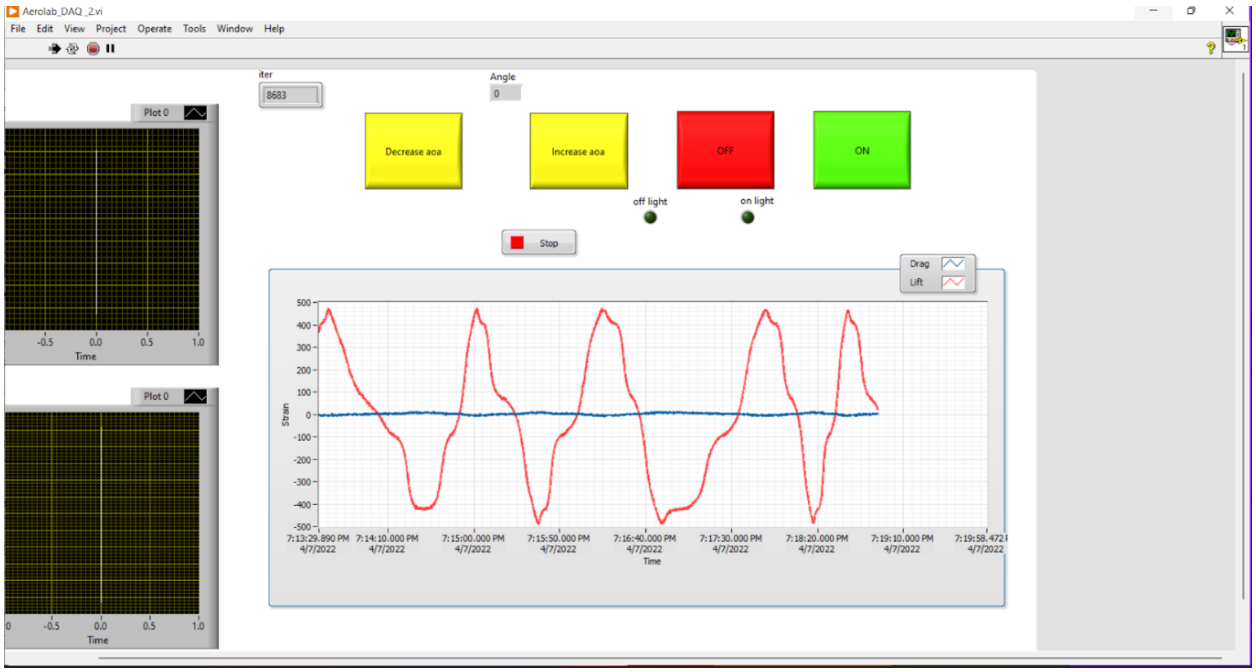

Figure 5: Final draft of GUI

Conclusion

At the end of the 2021 spring semester communication with Dr. Kanistras stopped until he sent a message notifying us that he was no longer employed by the university. In the end, most of the requirements set for the GUI were met. The GUI was capable of controlling the power and speed of the wind tunnel and displaying drag and lift forces along with the coefficient of drag and lift. Although we were not able to set up a server so that the tunnel could be controlled remotely the GUI had met all other requirements.