Wind Sensor: Final Presentation Advisor: Dr. Kuh

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Summary

Project background & motivation

Goal for your project

Acoustic & Ultrasonic:

- Block Diagrams
- Description, Methods & Issues
- Final Status & Remaining problems

Motivation

- Knowing the wind patterns (speed and direction) allows for predicting where buildings can be built so that there’s natural ventilation

- Traditional wind sensors are large, have moving parts, and are generally expensive

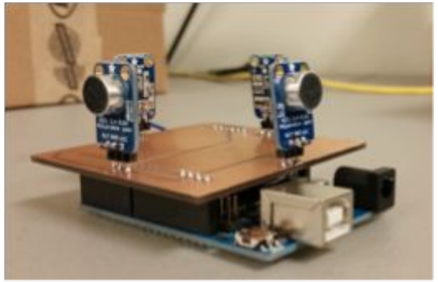
- We want something that is small, has no moving parts, and is inexpensive to manufacture, something that can be integrated with the weatherbox

Some examples of traditional wind sensors

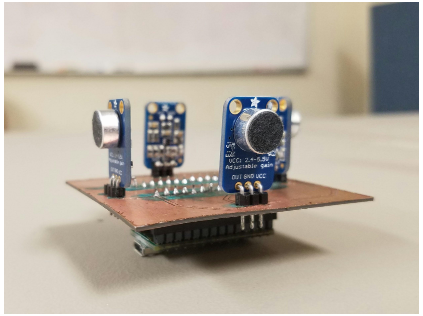
Project Overview

Objective: To build a small, static, and inexpensive, wind sensor that is able to:

- Gather accurate data in real-time on wind speeds and directions using microphones and signal processing
- Be integrated into a weatherbox design



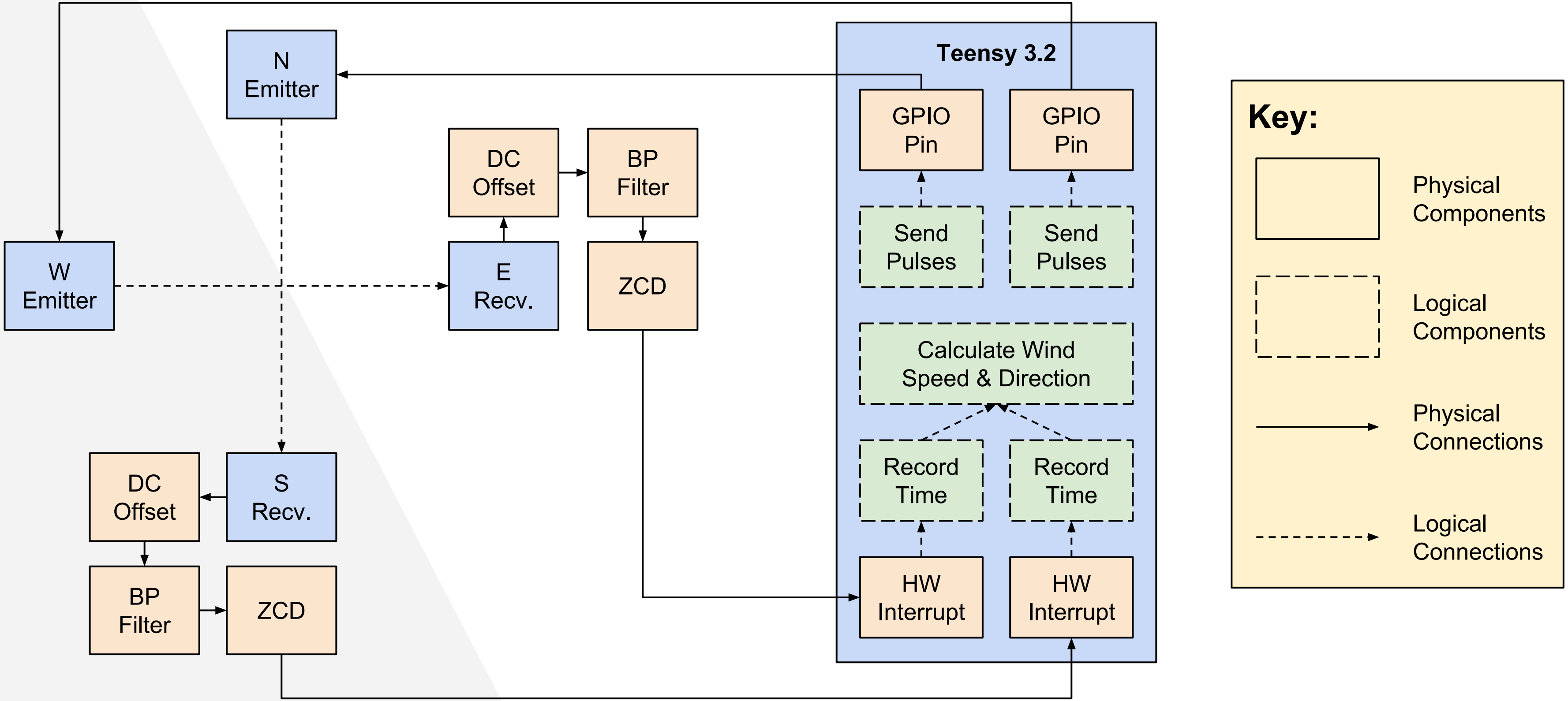
First iteration of the wind sensor using an Arduino and 4 omnidirectional microphones



Second iteration of the wind sensor using a Teensy and 4 omnidirectional microphones

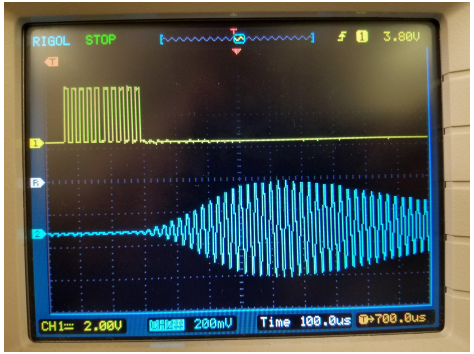
Ultrasonic Wind Sensor

Block Diagram

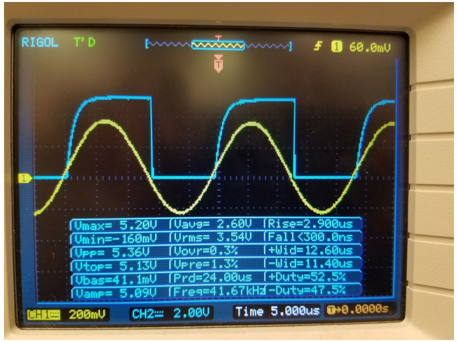


Methods

- Measuring propagation time:
  - Send pulses with the emitter, saving the emit times
  - Use the falling edge of the ZCD to determine the receive time
  - Subtract the emit time from the receive time to get the measured propagation time
  - Average measured propagation time over a large amount of samples



yellow = emitter, blue = receiver



yellow = receiver, blue = ZCD

Methods (cont.)

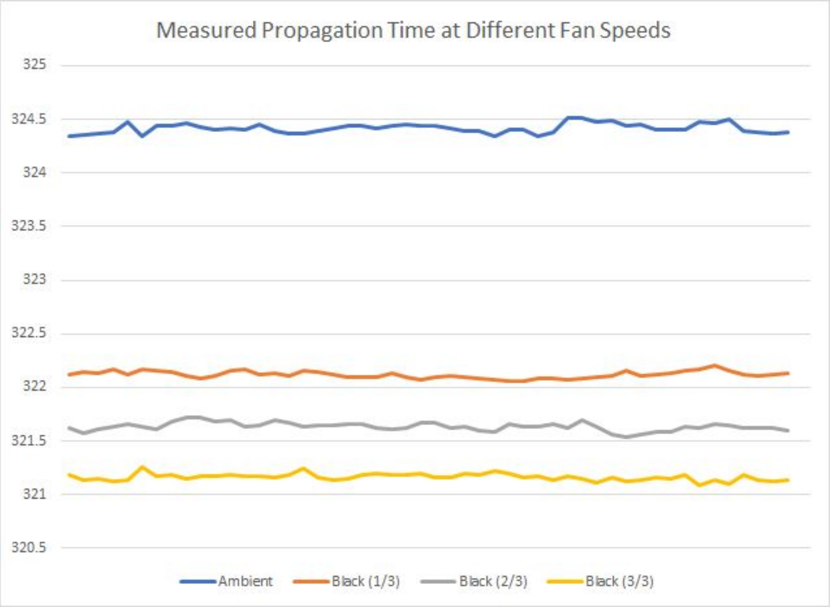
- Determining wind speed:
    - Use the difference between the measured propagation time and expected propagation time based on the speed of sound

$$V_{wind} = \frac{d}{t_{prop}} - V_{sound}$$

Issues

- Measured propagation times are significantly higher than what they should be
- At the distance and temperature we were measuring at, the propagation time should be ~ 204μs
- We believe there may be a constant time delay present, turning our previous equation into:

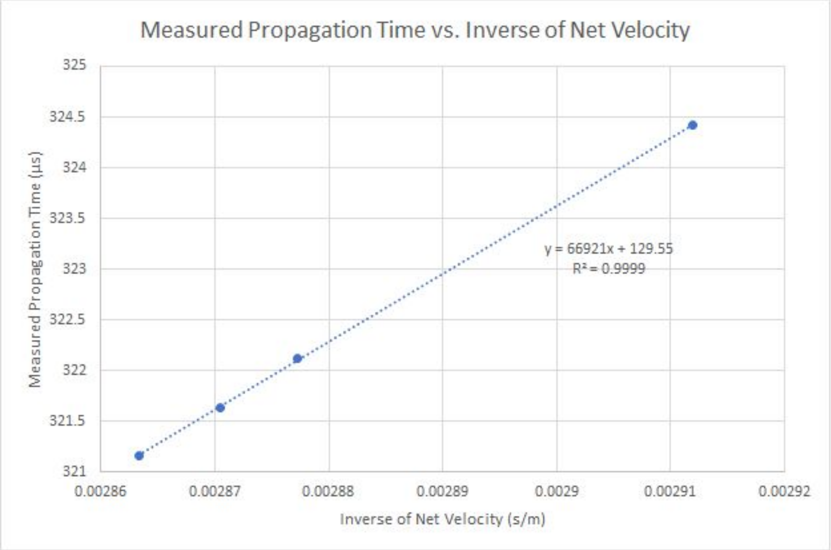
$$V_{wind} = \frac{d}{t_{meas} - T_{delay}} - V_{sound}$$



Results

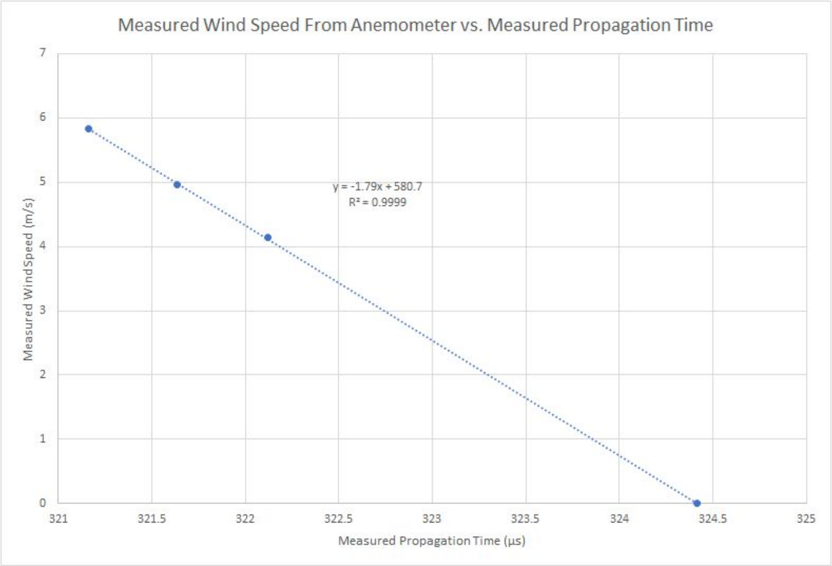
- Took wind speed measurements using the anemometer
- To find the time delay, we plotted the measured propagation time against the inverse of net velocity $(V_{sound} - V_{wind})^{-1}$
- The slope of the plot is the distance
- The y-intercept is the time delay

$$t_{meas} = \frac{d}{V_{sound} + V_{wind}} + T_{delay}$$



Results (cont.)

- We also plotted the measured wind speed against the measured propagation time to get a direct relationship between the two
- We could use this direct relationship to go straight from a measured propagation time to wind speed, but only at a certain temperature



Future Goals

Semester Goals:

- Add current findings to wind-speed algorithm and compare results with anemometer
    - Find a fan with more speed settings (high-powered computer fans--can vary wind speed by changing DC voltage)
- Add a band-pass filter to block out unwanted noise
- Implement direction calculation using two sets of emitter-receiver pairs

Stretch Goals:

- Design an aerodynamic housing and custom PCB
- Integrate into weatherbox design

The end.

Any questions?