PURDUE UNIVERSITY

CAPSTONE/SENIOR DESIGN EXPERIENCE 2017

Corn Wind Loading

Agricultural & Biological ENGINEERING

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Purpose & Background:

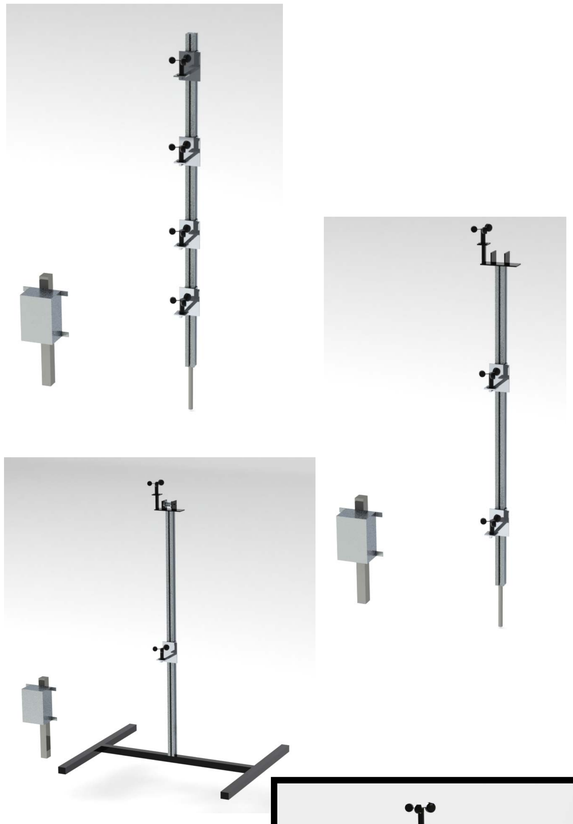
Collecting wind data is an essential part of developing corn hybrids that are structurally robust enough to withstand a full growing season. Due to varied planting populations, planting direction, field size, and terrain, the wind in a field will vary in speed and direction at different elevations. When the weather forecast projects wind speed and direction, the projections are often not what a corn plant experiences in the field. Creating a device that could measure the wind variance in a corn field at different growth stages would provide valuable data that could be used by plant breeders to create hybrids which are best fit for specific regions and planting populations.

Agricultural Impacts & Sustainability:

- Studies done with this device would influence planting decisions of farmers in the future.
- Breeders would understand more of what goes on inside the canopy of corn fields.
- Breeders would be able to make better breeding decisions.
- This device would open doors to future wind loading devices that could be used in conjunction with this device to understand what forces growing corn experiences from the wind.

Alternative Designs

- **Option 1**
  - Two-piece structure equipped with 5 stationary sensors that is anchored to the ground by a 4 foot stake, which also has a separate stand for electronics.
  - This design focused on measuring wind points and did not incorporate the entire profile.
- **Option 2**
  - Two-piece structure equipped with 3 highly advanced wind sensors which is also anchored to the ground by a stake and has a separate electronics stand.
  - This design was significantly over priced and also focused on wind points.
- **Option 3**
  - Single upright with a detachable “H” framed base that is equipped with two sensors, one stationary and one mobile. A belt connects to the mobile sensor, moving it up and down.
  - This design was overly complex and lacked a stable base to withstand the stresses placed on it.



Cost Analysis.

80/20 Frame and Hardware	$271.64
Adafruit Sensors & Electronics	$212.70
Winch System & Electrical Box	$45.23
Stepper Motor	$34.64
Battery	$59.99
Misc. Metal	$45.00
Total Cost	**$669.20**

System Data:

The program loop that the Arduino runs in order to move the stepper motor up and down is as follows,

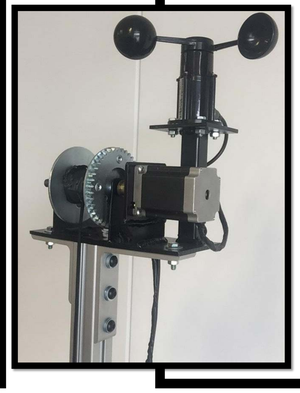
```
void loop() {
  motor.setSpeed(9);
  int steps = -2825;
  motor.step(steps);

  motor.setSpeed(11);
  steps = 2817;
  motor.step(steps);

  delay(8000);
}
```

The following data was acquired through tests using the program above:

Time: Upward	93 seconds	Time: Downward	76 seconds
Distance: Upward	84.5 inches	Distance: Downward	84.5 inches
Speed: Upward	0.9 inches/ second	Speed: Downward	1.1 inches/ Second
Cycle Time	2 minutes 49 seconds	Cycle Time with Delay	2 minutes 57 seconds

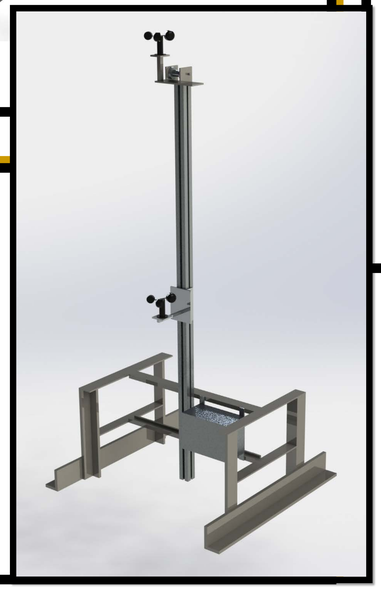
System Requirements & Goals

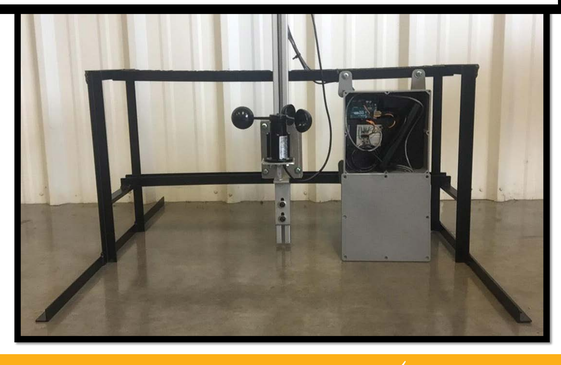
- Disturb the least amount of plants as possible.
- Be able to take measurements at a wide variety of growth stages.
- Be mobile.
- Fit between rows along with inside rows. (Based on 30 inch centers)
- Operate for at least 24 hours.
- Withstand wind and precipitation.



Final Design

- The final design met each of the system requirements.
- The base is heavily built and stable, yet still portable.
- There is a wide foot print to balance height.
- The base is designed to fit in both 20” and 30’ corn rows with minimal disturbance.
- A stepper motor drives the mobile sensor up and down the frame so it effectively covers the complete wind profile through the moving sensor.
- The high capacity battery will run the motor at full power for an estimated 26 hours.
- Electrical components are all contained and protected within the base.





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