P-16462
WIND ENERGY BASE STATION

Energy & Motion Lab

Background

Windmills are currently the most widely used instruments for generating power from the wind but are limited through materials and cost. This system attempts to replace these systems using a glider tethered to a base station that flies in a circular horizontal flight path. The lift on the glider allows the tether to generate power on the base. When facing crosswind, power is needed to reel the tether back in. The goal is to generate as much power or more than a conventional wind turbine using this reeling in and out continuous cycle.

The Team

(Left to Right)
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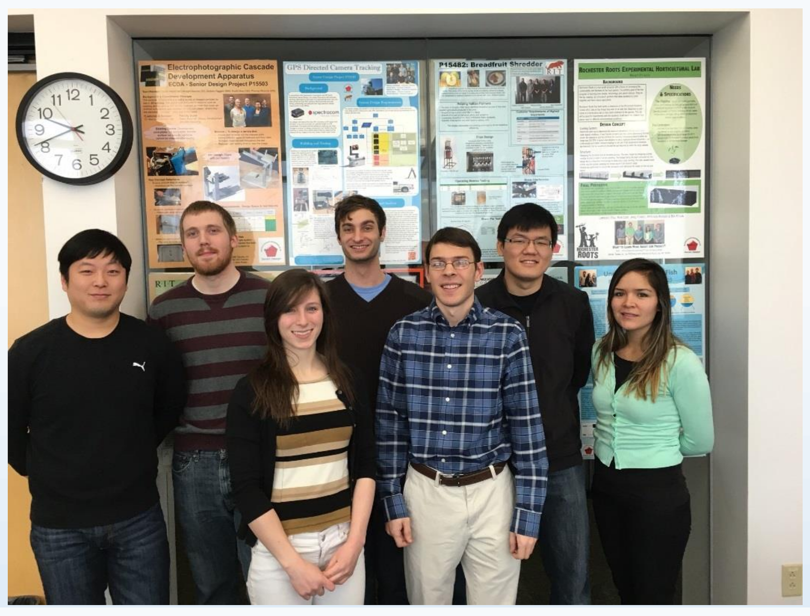
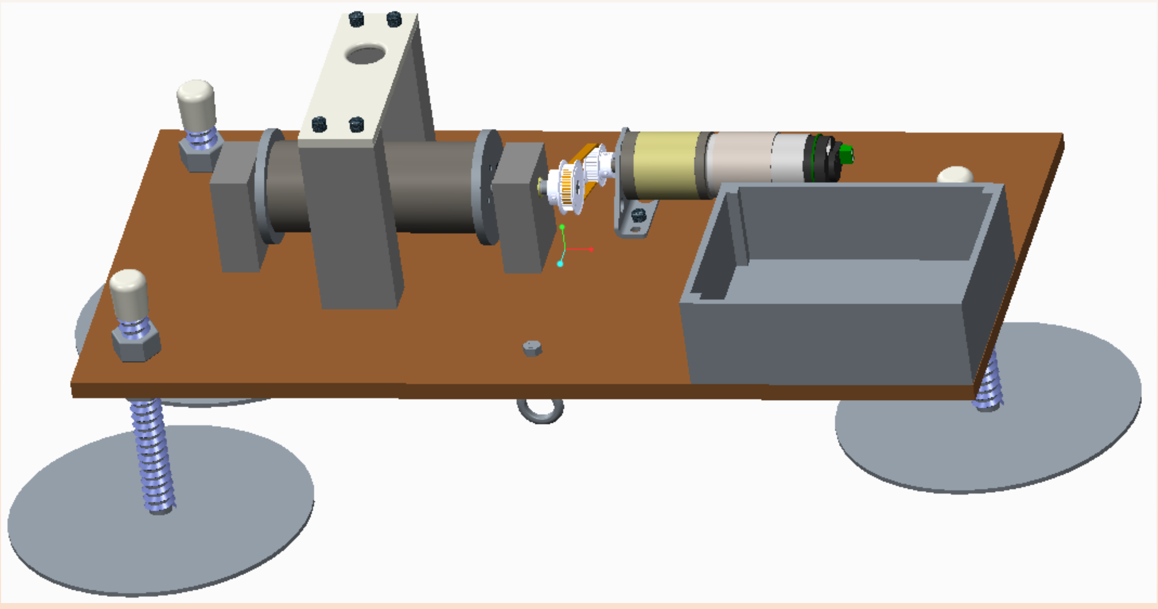
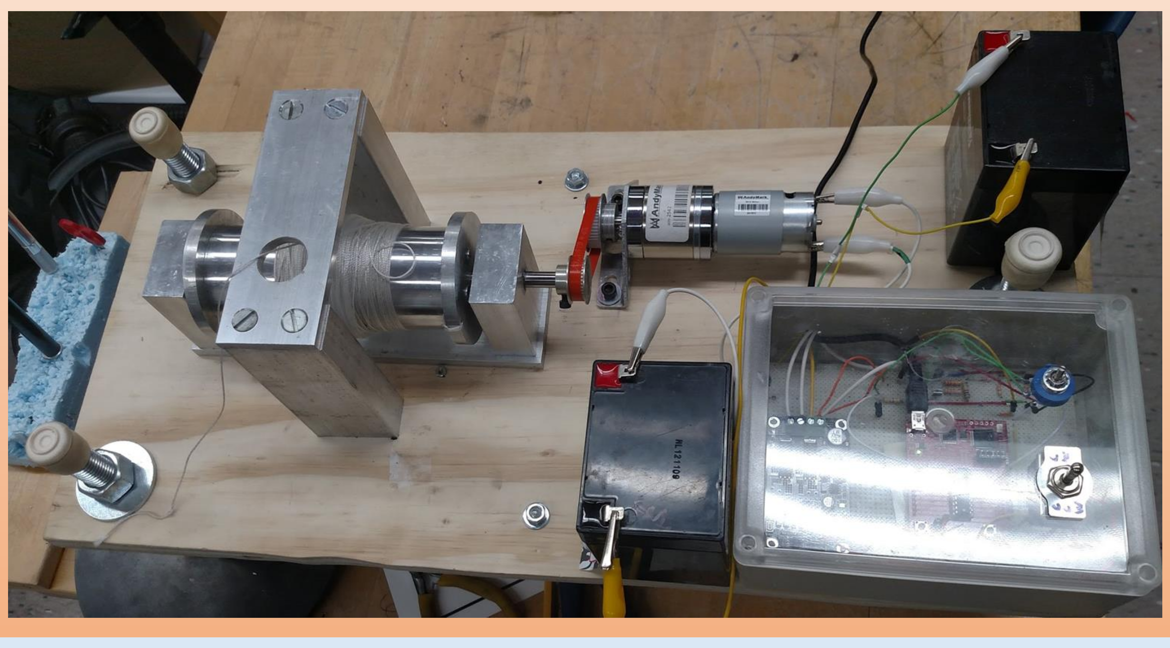


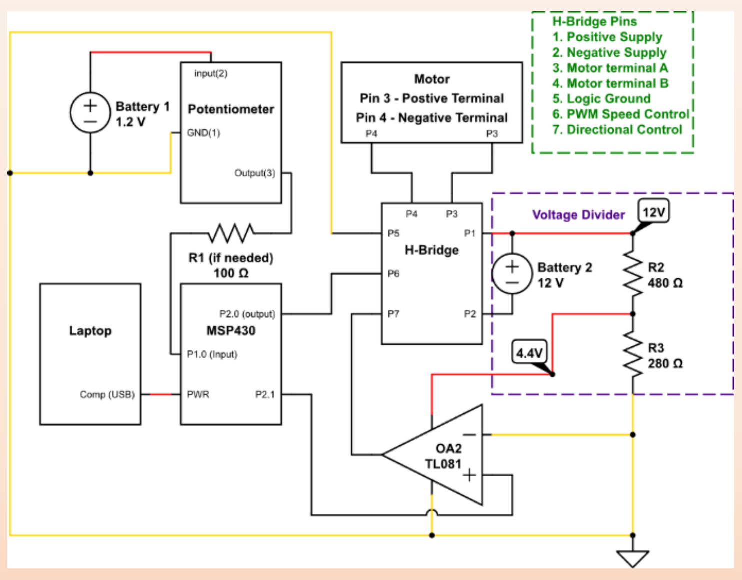
Base Station and Reel

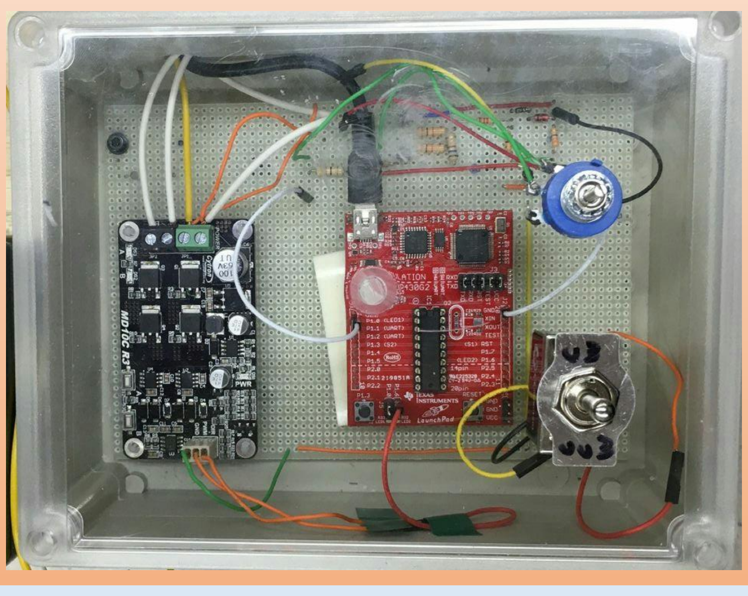




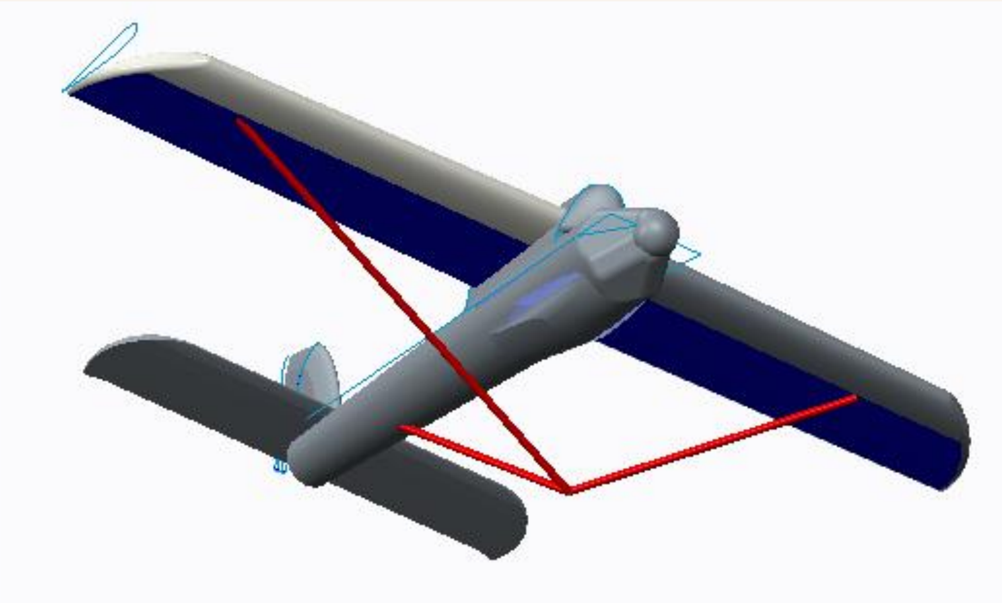
Base Station Design

Electrical Controls





Adjustable Bridle



Components

The base station consists of a reel and power transmission system, motor, electrical controls and base structural supports.

An adjustable bridle was designed to hold the necessary bank angle required for the circular flight path.

The glider tether wraps around an aluminum drum. The dimensions of the drum were designed to match expected glider speed and torque requirements. An AndyMark 9015 DC motor was selected to reel in the glider when needed.

Controls for the motor are driven by an MSP430 microcontroller. An H-Bridge controls the direction of the motor while a potentiometer controls the motor's speed.

The whole assembly is held together on a wooden board with aluminum columns and a ring plate to guide the flight path. Attached are also stabilizers and anchors on the underside to ensure the base station can remain leveled and grounded against lift forces.

Conclusion

Upon design, the feasibility of net power generation became too difficult. The main objective became making a base and glider that behaves as the foundational theory predicted.

During flight trials, we found the proposed flight path was feasible, though difficult to control and maintain.

The flight path of the glider did not end up being perfectly horizontal but instead flew in an ellipse shape tilted at about 20 degrees from the horizontal.

Flight Results

Date	# Flights	Total Time (h:m:s)	Wind Speed (mph)	Flight goals	Significant findings and observations
10.06.15	4	0:12:25	1.7	Practice controlling glider	Plane worked well Slight transmitter issues when flying near power lines
10.28.15	3	0:03:12	8.0	Practice controlling glider	Encountered RC motor issues
11.15.15	3	0:08:02	11.0	Practice controlling glider	Plane has issues fighting strong winds
3.29.16	5	0:04:55	9.3	Practice tether flight	Bridle causes unwanted yaw Tether was difficult to keep taut
3.30.16	9	0:04:00	3.2	Conduct experimental trials	A lot of stress on the far wing created as the glider fights the tether tension
4.13.16	4	0:03:44	8.9	Test glider repairs	Nothing significant. Just general flight practice
4.14.16	5	0:02:20	7.6	Conduct experimental trials	Plane does not have the mass or motor strength to fight winds and tether
4.18.16	5	0:01:30	7.6	Conduct experimental trials	Foam wings likely need reinforcement
4.27.16	6	0:01:45	5.8	Conduct experimental trials	It helps to have the tether reeled out significantly (>50ft) at the start of launch The flight path is likely possible but with a heavier plane and maybe stronger plane motor
4.30.16	3	0:02:15	8.4	Conduct experimental trials	Glider needs more height to increase recovery time
Total	**47**	**0:44:08**	**6.6**		

A 3 point bridle was selected over a 2 point bridle system to create the horizontal flight path. As a trade off, the pilot was tasked with stabilizing the plane. Using the 3 point bridle, the tether connection was offset towards the point of rotation as well as below and behind the wing to orient the glider to fly into the wind.

The glider and bridle system were subjected to a number of trials. The glider experienced a handful of crashes that caused some body damage.

Through testing and adjusting the bridle and with pilot practice, preliminary findings indicate that the proposed flight path is feasible. More testing is required to gain conclusive results.

Moving Forward

For future teams, it is recommended to operate a heavier aircraft as the current plane tends to act like a kite at wind speeds above 10mph, leaving it stationary. A heavier craft would be able to generate more thrust, and better withstand the forces generated onto it by the wind and bridle.

If continued, later teams will test the feasibility and optimizing power gain from this system.

http://goo.gl/52cuvd

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