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CLEAN ENERGY MANAGEMENT

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Introduction

Renewable resources such as wind and solar provide clean power to our society. Because wind resource is ubiquitous and strong offshore, our project focuses on harvesting wind energy to continuously charge an underwater remotely operated vehicle (ROV), which collects geographic information of the ocean floor. Continuous wind power supply will extend the battery life of the ROV, increasing the productivity and decreasing the operation cost. This project determines the power requirements of the ROV, and outlines a system for power generation, regulation and transmission.

Project Overview

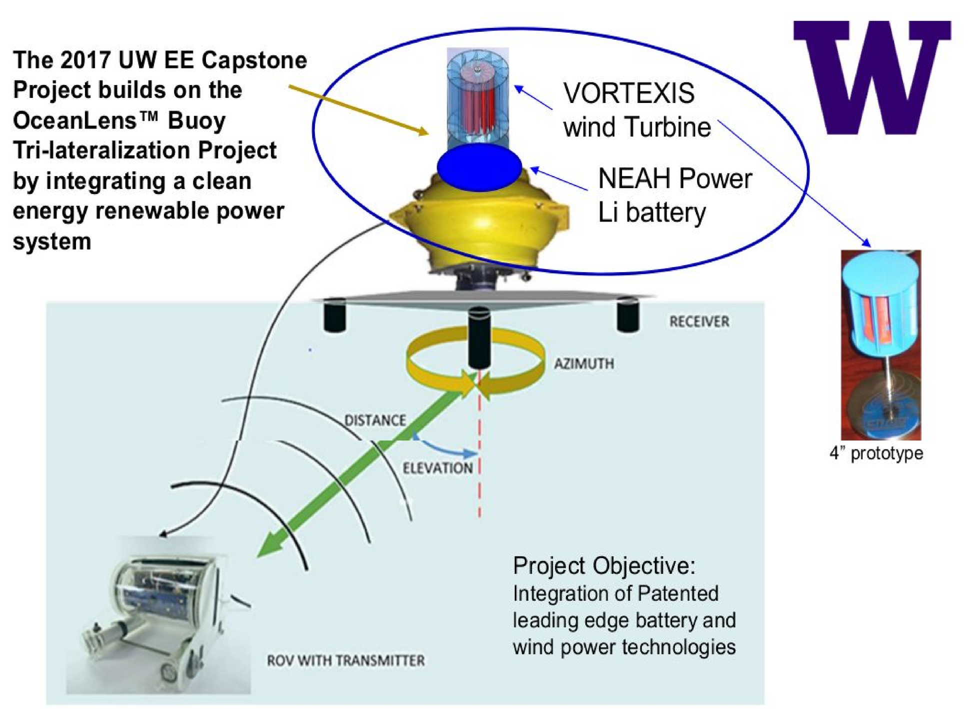

Figure 1: Project Concept

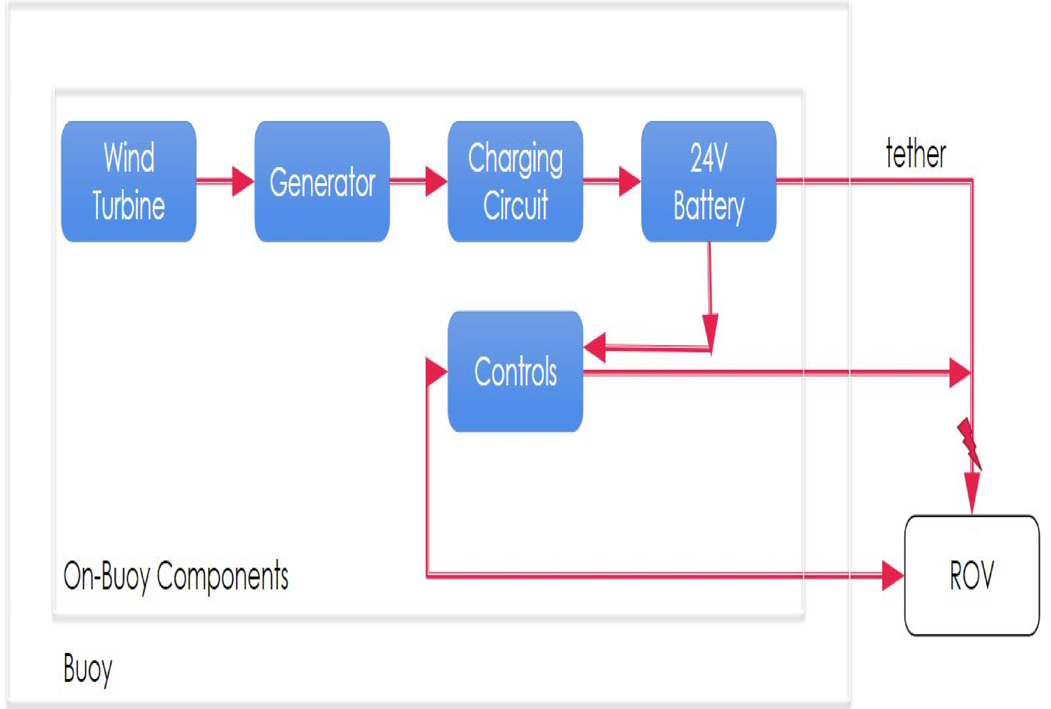

Figure 2: System Block Diagram

Power Consumption

We ran a feasibility study to better understand the power needs of the ROV and its associated systems. Based on these results, we chose a generator, and selected a charge controller to prevent the battery from discharging through the turbine, or from overcharging.

Component Name	Voltage(V)	Current(A)	Power(W)
ROV	18	5	90
BeagleBone	5	1.8	9
Acoustic Receivers	12	1	12
Networking Equipment	24	1	24
Tether Loss (300 feet)			25
Total			160

Figure 3A: Power Consumption of System Components

Figure 3B: Wind Turbine Connected to Generator through a coupling

In real time, the ROV requires 165 W to operate. A generator is used to convert wind's mechanical energy into electrical energy. A regulator keeps the generator output voltage stable and a charge controller prevents battery from overcharging and sudden gusts of wind power.

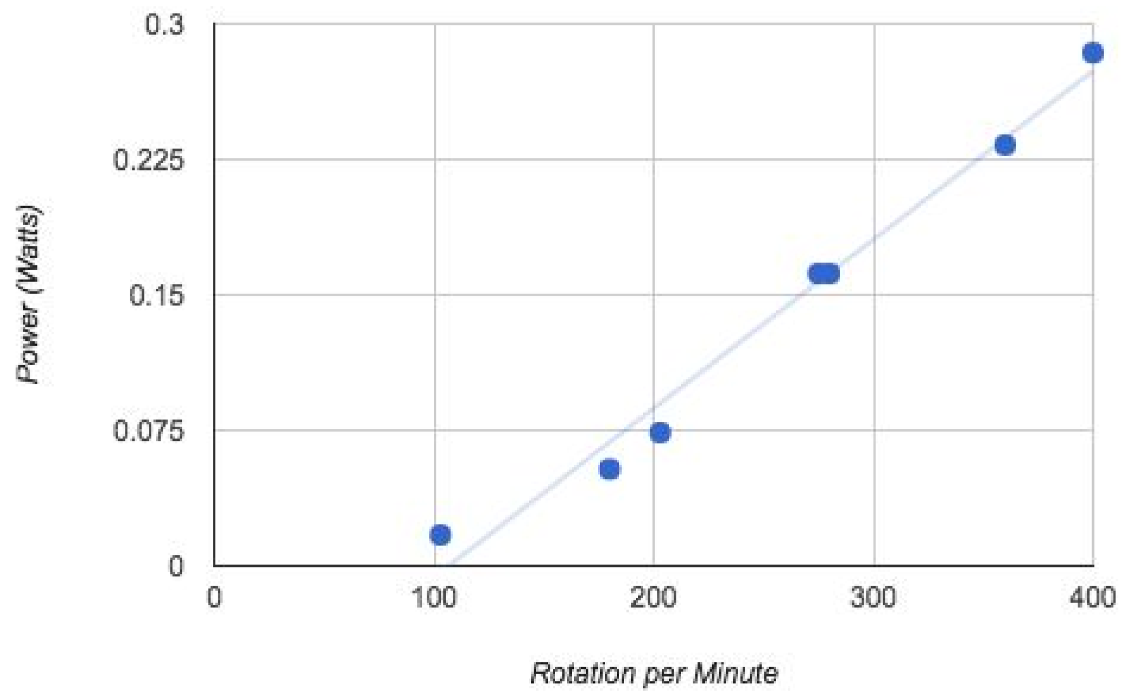

Figure 3C: Turbine RPM v.s.Power Output

Power Regulation

Providing Power to Multiple Devices

Electricity generated via the wind turbine is used to charge on-buoy batteries. From there, the on-buoy batteries go on to supply the following systems, in descending order of power consumption; ROV(125W at 24V), buoy computing (a BeagleBone at 2W, 5V), and on-buoy sensors (2W, at 3.3V and 9V). Since the 9V sensors require extremely low noise these regulators will be separated from the main circuitry, with each sensor getting its own regulator off the 12V line. Networking equipment will be powered off a buck-boost regulator on the 24V line, and the ROV will be powered off the unregulated 24V line. Short protection, control, and logging of each output line is done using high-side switches integrated into the circuit board.

Monitoring and Controlling Power Distribution

We use four high-side switches to control the four output rails of our power distribution system: computers and low voltage sensors, ROV, networking, and unregulated 12V. These switches also have integrated short protection and current sensing which allows us to report current power usage, remaining time, and similar statistics to other devices on the buoy's network such as the driver station and ROV. A major advantage of this design is the protection of the BeagleBone. Even if the system enters a fault state, the BeagleBone will continue to run of battery power, which allows for a complete log.

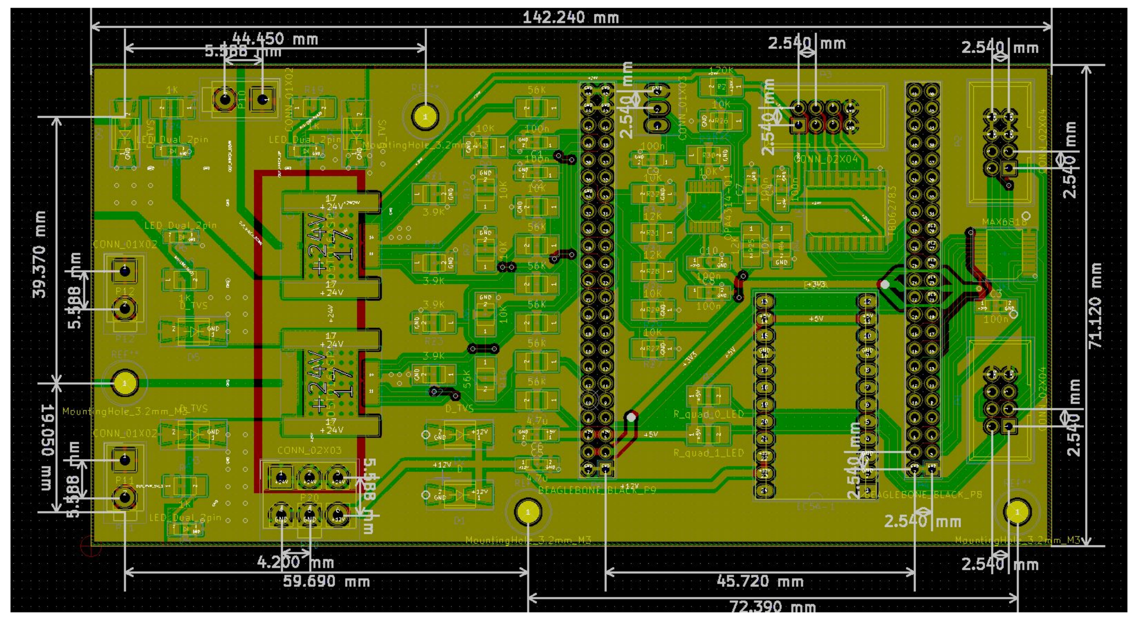

Figure 4 Printed Circuit Board for Sensors

Power, Data Transmission

In order to provide the ROV with power and data over a 100m distance, a tether and networking system was designed to minimize losses and noise.

For power, we chose a stranded, 12 AWG wire at 24V. With this method we lose 25% of the power we put into it at worst, however it is much simpler to implement and has the benefit of allowing a future group to reuse the same cable. A cat-5 cable would have been lighter, but at only a 100W rating, this would have left no room for future expansion.

For data transfer, it was agreed with the ROV team that an ssh system would be simplest for communication. This allows the ROV to open an ssh session with the buoy BeagleBone at a static IP, and control systems (tether reeling, power, etc) as necessary.

Results & Future Plans

Results, Conclusions

- Data of wind speed, turbine rotations, and generator power output
    - The wind turbine alone will likely be unable to, or take an unreasonable amount of time to charge the on-buoy batteries.
- Printed Circuit Board for power distribution
    - Our header pins were misplaced, these will be fixed for the next iteration
- Networking software package
    - ssh found to be most convenient for work with ROV

Future Plans

- Add a gearbox between the turbine and the generator
- Supplement energy input with solar panels - develop buoy rotation system to maximize wind, solar inputs
- Prototype with actual buoy and ROV
- Development of tether reeling system

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