Mobile Solenoid Power Generator Designed For Simple and Rapid Deployment

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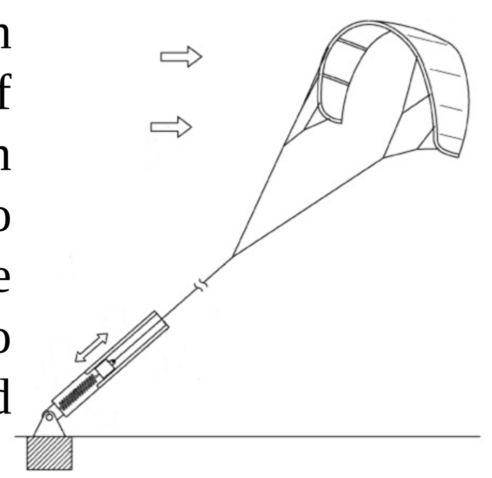
Background

Most modern clean energy methods are too costly to appeal towards major electrical companies today. Wind power is notorious for its massive blades, turbines and the towers required to support them. A glider system could reduce material and construction cost without sacrificing any potential power output by removing the necessity of building supporting towers and maximizing efficiencies. However, such technology has such little research behind it that many different power generation methods should be investigate.

Objective

The project was focused on studying the mechanics of converting mechanical kite motion into electrical power, while also investigating the feasibility of the current patent design in order to properly assess its feasibility and marketability.



Design

Design of the solenoid began with an aerodynamic analysis of how the kite performed in windy conditions. The team discovered a useful wind velocity dataset (Meteo-France) that could approximate the resultant force and displacement of the kite. The displacement of the kite dictated the displacement of the magnet which determined the size of the solenoid. Different wire diameters and their interaction with the magnet (emf) were simulated through matlab shown in the table. The solenoid was wrapped with AWG 18 magnet wire for its ease of fabrication and availability.

Wire Diameter	1.016 mm
Voltage	33.48 V
Current	1.04 A
Resistance	32.2 mΩ
Wrappings per layer	244
Layers	6
Total Wrappings	1,464
Projected Power Output	35 Watts

Up To Glider System

Simulation Motor

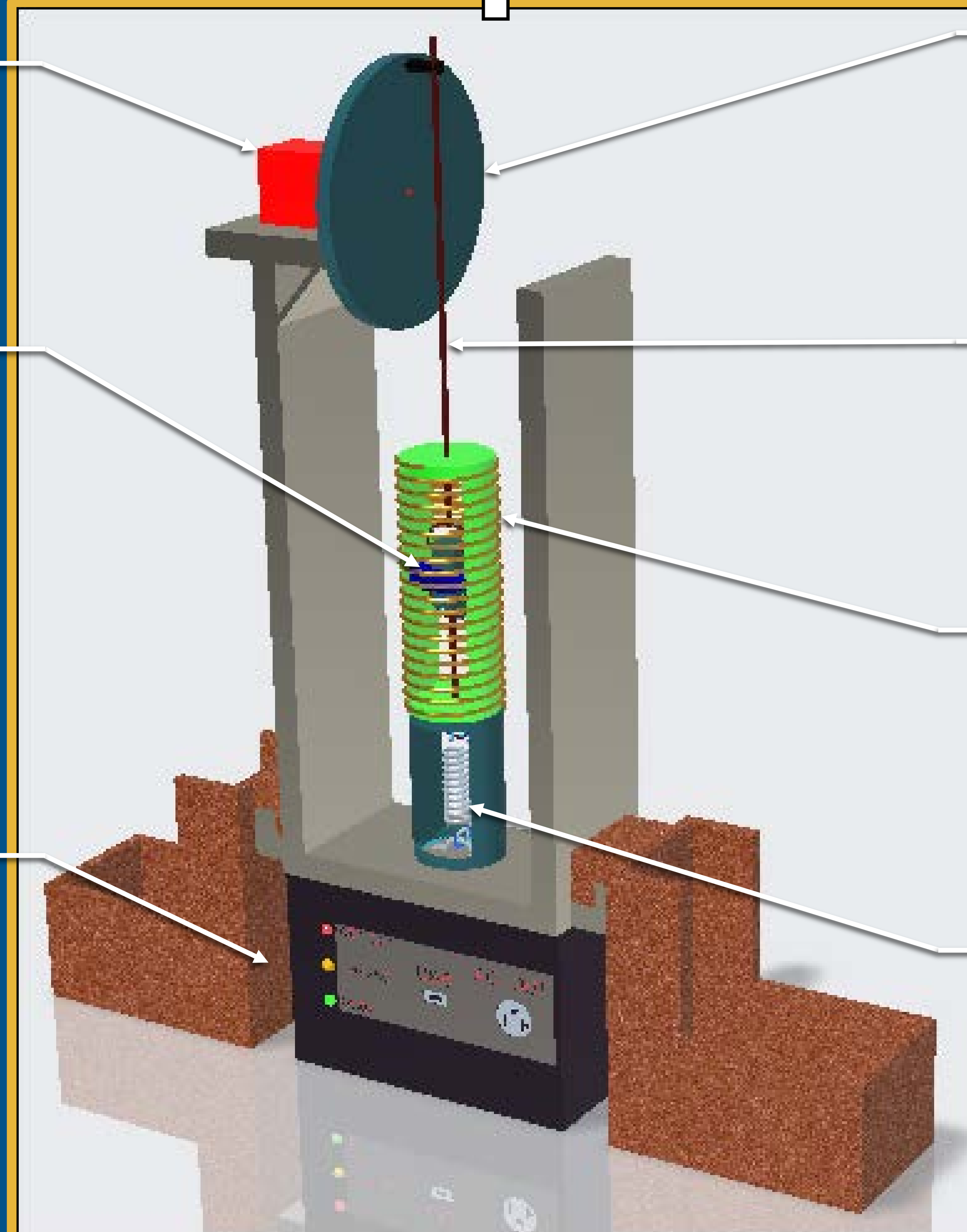
Utilized in place of a kite in order to focus on solenoid power generation

Permanent Earth Magnet

3” Neodymium magnet (1.32 Tesla) oscillating inside the solenoid to induce an electromagnetic field (EMF)

Electronics Housing

Used to convert from DC to AC, to be either used immediately or stored in batteries



Flywheel

Connected to the motor, used to control the magnet motion

Tether

Connected to both the flywheel and the magnet

Solenoid

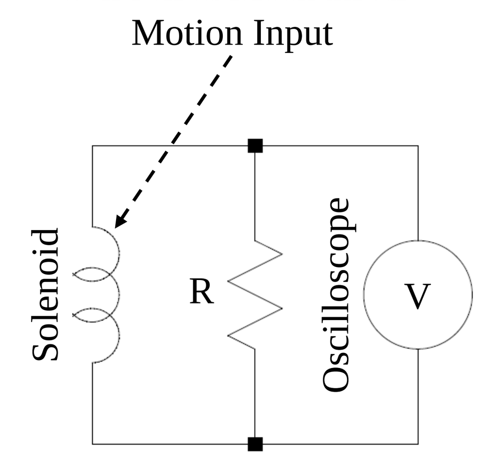
Insulated AWG 18 copper magnet wire wrapped around a PVC pipe

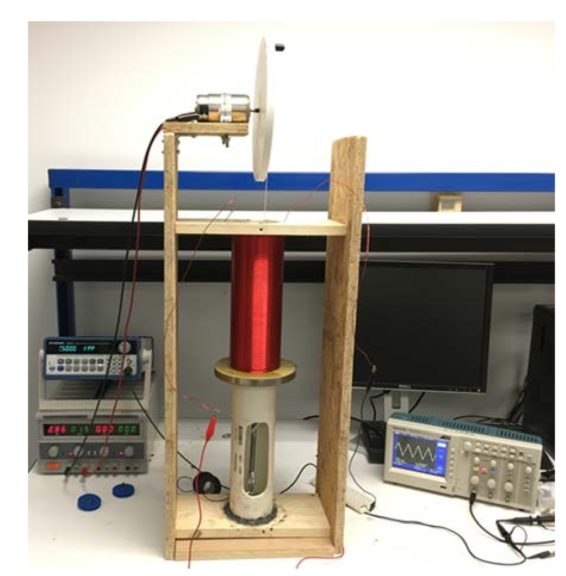
Spring

Designed for eventual integration of kite subsystem

Experiment and Data

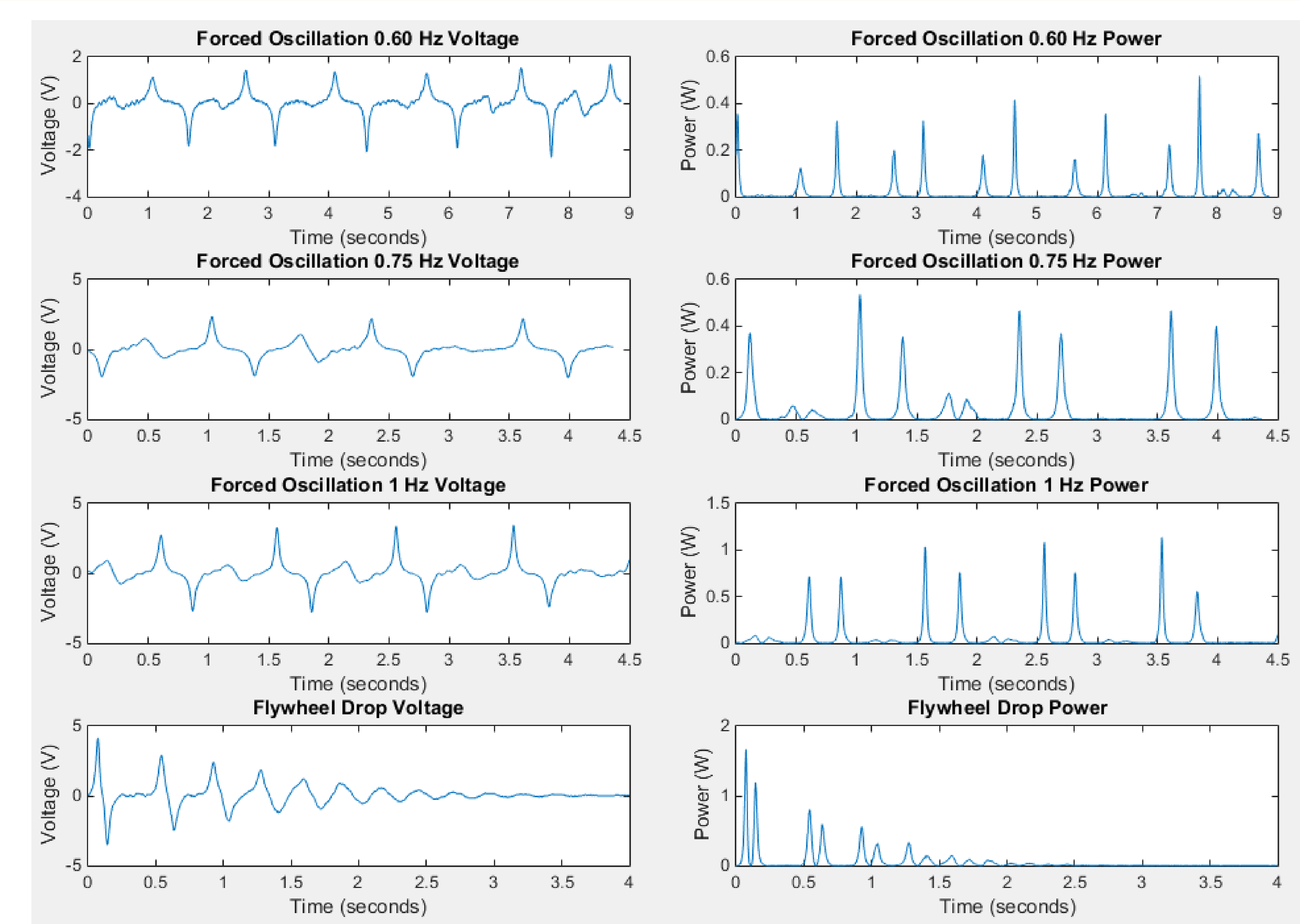
Two experiments were performed to determine what efficiencies the solenoid could produce: 1) a magnet was oscillated through a flywheel pendulum and 2) forced oscillation by manual input at different rates. The flywheel pendulum began with the magnet connected to the flywheel held at the topmost position and subsequently released to begin its motion. The magnet oscillated and displayed an exponential decay of motion. For the other experiment, a metronome acted as a timer for the frequency of oscillations for the experimenter moving the magnet. Both of these experiments were measured via an oscilloscope as seen in the diagram to the right. The motor stalling forced a change in experimental design and increased the margin of possible error. It should also be noted that the magnet used in these experiments was at roughly half its original size due to an accident during construction of the prototype. Nonetheless, the experiment produced valid results shown in the tables and plots to the right.





-Speed → +Speed

Parameters	0.60 Hz	0.75 Hz	1 Hz	Drop
Energy Produced (J)	0.218	0.204	0.329	0.173
Energy Expected (J)	3.418	1.897	2.932	0.570
Efficiency	6.37%	10.77%	11.21%	30.35%
Max Pk to Pk Voltage (V)	4.00	5.16	6.28	7.76



Concluding Results

The prototype completed in this project highly resembles the original design idea from the sponsor’s patent. Paired with the experimental results, the patent’s overall validity can be confirmed. However, the low efficiency ratings make the current system unmarketable. The experiment shows a constant trend of increasing efficiency at higher magnet speeds. This suggests that a mechanical system designed to ramp up the magnets speeds could potentially increase the efficiency despite the losses introduced by the mechanics. It should be noted that any kite system’s flight path will have an extremely low frequency, so the products performance may be highly reliant on mechanically gearing to higher speeds.

Future Work

- Continue experimentation with new, intact magnet
- Scale Solenoid Kite Generator for 10 kW Gas Generator and 600 kW Makani Power Station
- Integrate electrical components to store charge
- Link magnet motion to kite motion

Acknowledgments

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