UNIVERSITY OF CENTRAL FLORIDA

Buoy Array for Ocean Wave Power Generation

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Description: The objective of this project is to develop a novel design that can extract ocean wave energy for commercial consumption. The design detailed herein is unique in that it is a wave point energy harvester that is small in size and contains all of the mechanical components directly within the buoy. The project focuses mainly on the mechanical system within the buoy as well as methods to control the electrical load on the system. Different mechanical systems have been developed and tested on a motion platform to simulate a vertical wave motion—these systems have been analyzed and compared in order to provide an ever-increasingly effective design. The Harris Corp. have acted as new collaborators with the project since October 1st 2010, funding four UCF senior design teams in the development of a buoy for wave power generation.

Budget: $150,000
Universities: UCF

Progress Summary

In collaboration with Dr. Zhihua Qu's wave energy research the Harris Corp. funded the work of four UCF senior design teams. The four teams were directed by Carlos Velez, Dr. Qu's graduate researcher in wave energy, to design, construct and optimize four components of an innovative wave energy application. The four teams were split in half with two teams working on creating a wave-energy converter mechanical system and buoy. The other two teams worked on an automated abandoned oil well monitoring system which would be powered by the surface buoy. A small project description and accomplishments for each team are described below.

Ocean Oil Well Monitoring System Team

The team designed a large cap that when placed on top of a pre-existing or newly abandoned ocean oil well can detect any oil leakage from the abandoned well. If oil is detected a wired signal is transmitted to the surface buoy which then sends a wireless transmission of the detection data. The team constructed two prototypes and tested the performance of the sensor system in a ten foot deep water tank. The experiment simulated oil flow emanating from the bottom of the tank for various different scenarios. The performance of the sensor system was very successful in detecting a variety of leaks. The sensor data was collected and will be used to improve upon the prototypes design. Shown below in figure 1 is the oil well monitoring system.

Figure 1. Illustration of oil well monitoring system

Electrical Systems Team

This team designed an electrical system which converts the electricity produced by the wave energy buoy into a usable and consistent power source for the oil well monitoring system. The team's goal was to efficiently convert the AC electricity created by the generator, which runs at a variable RPM, due to the inconsistent nature of the ocean waves. This fluctuating output was properly rectified to a DC signal and then stored in a battery for use by the oil well monitoring system. Additionally, the teams created an automated load control board which varies the generator load to minimize the range of the generator RPM. This

benefits both the energy conversion and the overall efficiency of the wave energy system. The conversion system is soon to be tested with the current PMG generator available.

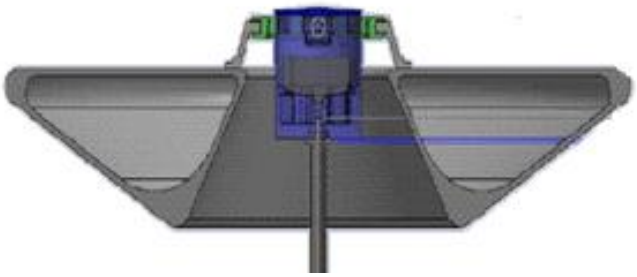

Figure 2 - Illustration ocean buoy

Wave Energy – Turbine Team

This team designed, constructed and tested two different wave energy mechanisms. The design consists of a novel bi-directional turbine which allows a generator to be spun in a single direction regardless of the direction of the wave motion. This allows for power generation on the up and down stroke of the wave and provides a more continuous force input. The Harris Corp. built the turbine design and two different converging diverging shells for the team. The prototypes were tested with the use of Dr. Qu's motion platform to simulate the oscillating motion of the buoy. Data was collected on the performance of the system and a mathematical model was created which agrees with the experimental results. The data and model will be used to improve upon the design and predict the performance of a full scale model.

Figure 3 – Prototype turbine and channel system

Wave Energy- Buoy Team

The buoy team designed, built and tested a 1/3 scale buoy which would drive the turbine when the buoy rises or falls with the ocean waves. This buoy also houses the electrical equipment created by the electrical team and sensor team. The team used CFD simulations to design the optimal buoy shape for large power generation and stability. The buoy was tested at the UCF pool and the results agreed with those found in the simulation.

Aside from directing the senior design projects the graduate student has developed various high quality CFD simulations which analyze the performance of this bi-directional turbine in various unexplored transient scenarios. His thesis is based on this turbine design and from his results he has published two conference papers for this year's ASME OMAE offshore structures conference. Currently, the work from the senior design teams is being collected to be published in a multi-disciplinary journal this summer.

Funds leveraged

The Harris Corp. funded $10,000 for the four senior design teams. Three thousand was given to each wave energy team and the remaining four thousand was used jointly by the electrical and sensor teams. The funds were used to construct prototypes and purchase the sensors and equipment required for each team to perform experiments to test and document the performance of each prototype. An account has yet to be established from the 5K awarded to Dr. Qu's research by the FESC Energy Tech Commercialization Program, so none of the funds have been used as of yet.