ID18- PIEZOELECTRIC ENERGY HARVESTING SYSTEM FOR VOLCANIC SEISMIC ACQUISITION EQUIPMENT

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Abstract –In this paper it is presented a volcanic seismic acquisition equipment that has been developed together with an energy harvesting system, based on piezoelectrics elements, in order to work in autonomous conditions. The energy harvesting system it has been developed to convert the wind or marine currents energy into electrical energy through a new method based on piezoelectrics. For the deployment of the volcanic seismic acquisition equipment in marine environments, this power generator produces energy obtained from harnessing of the kinetic energy of marine currents. The first results have shown that the system it is capable to provide a small amount of energy that can be used to extend the deployment time of the volcanic seismic acquisition equipment.

Keywords - acquisition, volcanic, low power, energy-harvesting, piezoelectric.

I. INTRODUCTION

In volcanic monitoring, in order to obtain a good localization and characterization of the volcanic activity, it is necessary to install seismic acquisition stations in the volcano environment [1]. There are commercial devices that allow such monitoring, however these present problems of environmental impact, vandalism problems and high energy consumption and cost.

The autonomous volcanic seismic acquisition equipment are usually constructed using a battery for power, and in some cases accompanied by energy harvesting (EH) systems, typical there are use solar panels. The biggest problem in the use of these systems is the high volume of them and the need to be installed in places with no natural camouflage, which can lead to increased vandalism towards these systems [2].

II. ACQUISITION SYSTEM

The volcanic seismic acquisition system that has been designed, consists of low-power components to extend the life of the equipment without human intervention. At the same time, the equipment has been designed as a compact system placed in a sealed container in order to obtain greater resistance to the adverse effects of the environment in which there are going to be installed.

The system is divided into four modules: power, control, peripherals and sensors. The power module is formed by a li-ion battery and a voltage regulator system. The control module is composed by a management microprocessor system, an SD memory card for data storage, and three analog to digital converters. In the peripherals module there are included the devices for remote communication of acquired data, and the time synchronization system based on GPS. Finally, the sensor module is composed of the three geophones and a signal matching circuit [3].

Figure 1 Volcanic seismic acquisition equipment

The components are arranged within the sealed casing, as illustrated in Figure 1, in order to improve the distribution of the center of mass, and facilitate the installation. At the bottom there are the batteries and sensors, corresponding to the heavier elements of the system. On top there are the different electronic boards, the power switch and light indicator of activity. Finally, on the side, there are four connectors for external connection to different elements: antenna for data communication, GPS antenna, external sensors and external power supply such as the energy harvester.

III. ENERGY HARVESTING

It has been designed and developed a prototype of a turbine comprising a vertical turbine and two piezoelectric transducers, in order to generate electrical energy from mechanical energy produced by the wind turbine. The energy harvester has been developed to increase the energy supply to the volcanic seismic monitoring system.

For the EH design it has been considered that the seismic station is located in areas with an average wind speed between 4.67 to 6.05 m/s. Based on this, the design goals are to ensure the stability of the turbine, to ensure the necessary energy for the seismic station and the ability to pass unnoticed to prevent vandalism.

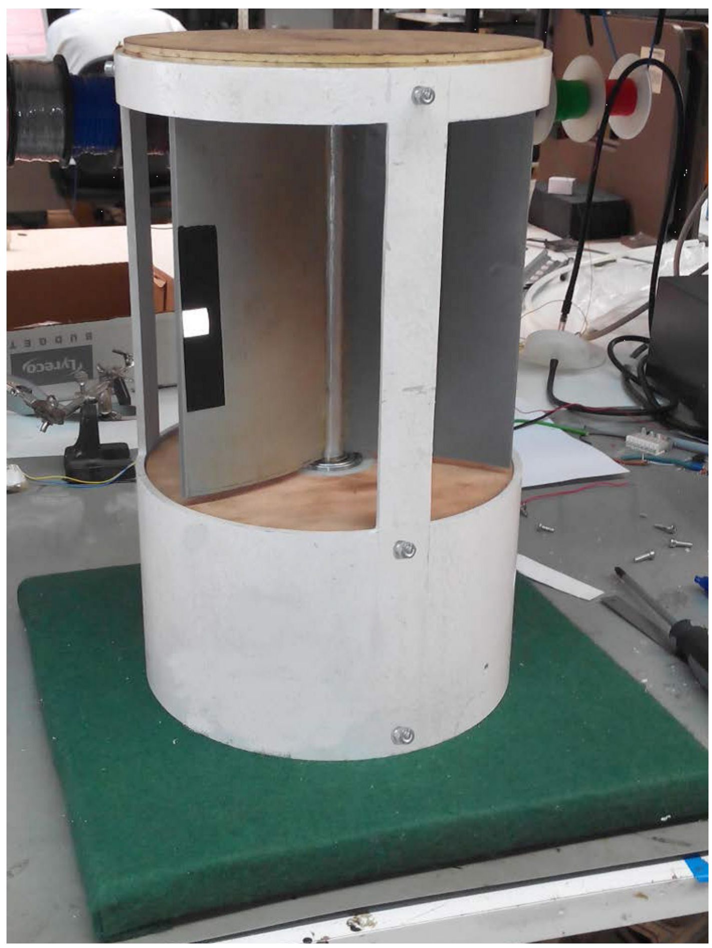
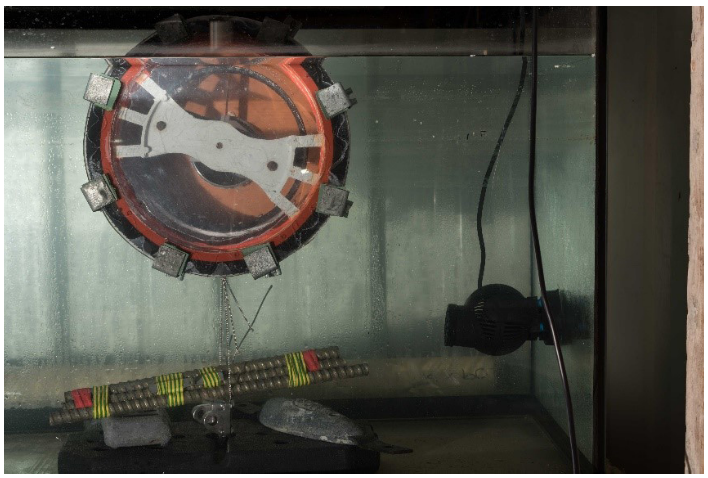


Figure 2 Energy Harvester prototype

The design of the vertical axis turbine shown in Figure 2 has been done based on a system of Savonius blades type [4], consisting of three blades with 40° angle and located at 120° around the axis of rotation of the turbine. Based on this design a prototype has been built and experimentally has been demonstrated the operation of this.

The wind energy for the projected turbine at an average wind speed of 4.67 m/s is 2.02W. Given this potential, corresponding experiments have been conducted to optimize energy production, using planked piezoelectric converter [5] based on impacts between the piezoelectrics and plectra's attached on the shaft of the turbine system.

To the energy produced by the sea motion in the bottom we start to develop a prototype based on a Bristol cylinder which can generate electrical voltage using vibration piezoelectric. These vibrations are generated by plectrums impacts, such as in the wind EH device, which create continuous free vibration in piezoelectric after impacting them [5].



Once manufactured the prototype illustrated in Figure 3, we begun the experiments based on waves and currents magnitudes usually found at OBSEA observatory. We will provide the result of the underwater EH device experiments, after we will finish them, in the final paper.

IV. RESULTS & CONCLUSIONS

From the different laboratory tests we have obtained that the seismic acquisition system consumes about 150 mW. This power consumption was obtained for continuously data recording in the SD memory without remote data transmission.

For the experiments regarding the power generation system, we use two piezoelectric (MEAS VOLTURE v21b) and four spikes (located at 90 ° around the axis of rotation). Then, simulating a constant wind speed of 7 m/s, the total power obtained by the EH to supply the seismometer was 0.868 mW. This means that if we have the system working for a period of 30 days at this constant speed, it would get a total of 0.625 Wh. Therefore, the prototype could allow an operation of four hours of the seismic acquisition system working in continuously data recording without remote data transmission.

The results of testing this novel power generating system have demonstrated the possibility to obtain energy from wind using piezoelectrics transducers, and can also be used for underwater currents. Although, the power generated by this first prototype is small, these tests provide a good basis for further work in this field.

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