Live Demonstration: Sea Wave Energy Harvester for Environmental Monitoring Buoys

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***Abstract*—An energy harvester based on the electromagnetic induction effect exploiting the pitch oscillation of a sensor buoy is presented. An experimental prototype has been tested to extract the main parameters of the system.**

***Index Terms*—Energy Harvester, Wave Energy Converter**

I. Introduction

Networks of small sensorized buoys are becoming increasingly widespread for a variety of applications such as monitoring marine species, protecting coastal and offshore ecosystems, analyzing water pollution, weather forecasting, navigation aids, support for search and rescue operations, and so on [1]. One of the most challenging issues in sensor buoy design is the supply of sensors and communication transceivers. Since batteries have high maintenance costs, limited reliability and high environmental impact, the alternative solution is represented by energy harvesters which convert otherwise wasted energy available in the surrounding environment into electrical energy. An energy harvester that converts the pitching oscillation energy of the buoy via electromagnetic induction is analyzed here. This solution is simple, has a light structure, and low cost.

II. Demonstration Setup

The analyzed sea wave energy harvester consists of a magnetic cylinder that rolls on a track located inside the buoy, as illustrated in Fig. 1. For a given position on the track, two coils are placed on their sides. They can pick up the changes in the magnetic field caused by the movement of the cylinder induced by the pitching motion of the buoy. Since the north and south poles of the magnet are at the bases of the cylinder, the magnetic field generated is orthogonal to the track. A voltage is induced at their terminals when the cylinder rolls close to the coils. If these terminals are connected to an electrical load, a current flows through the circuit, and power is supplied to the load.

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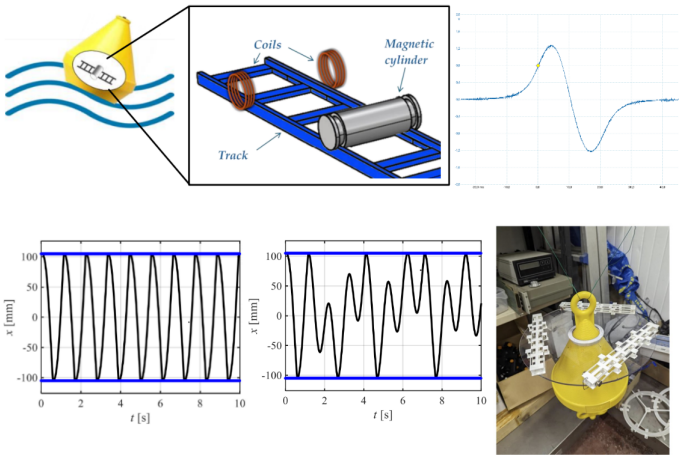

Fig. 1. Demo set-up showing the structure of the harvester, the main signal coming from the coils, trajectories of the magnet in different regimes of oscillation, and a prototype of the harvester.

The energy extracted by the harvester is a function of the oscillation period of the buoy which in turn depends on marine conditions. When the frequency is too high (low period), the cylinder does not have sufficient time to increase its speed before changing direction, as illustrated in Fig. 1. Low speed implies low power. On the other hand, when the frequency is too low (high period), the cylinder reaches the opposite end and remains stationary in that position until the inclination changes. The stationary position implies no power. Therefore, an optimal oscillation period at which the energy extraction will be the maximum can be found.

III. Visitors Experience

This demo will allow visitors to see the prototype of the sea wave energy harvester in action on an oscillating plane simulating marine conditions. Different regimes will be explored to show the behavior of the harvester in different conditions.

References

[1] O. Aiello, C. Boragno, D. D. Caviglia, A. Lo Schiavo, F. Nicora, "Analysis of a Sea Wave Energy Harvester for Environmental Monitoring Buoys," Proc. of ICECS2024, Nov. 2024.