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J.F. Silva Gomes, Shaker A. Meguid
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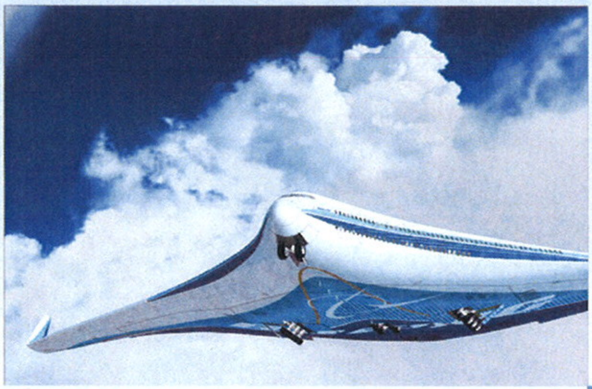

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IMPLEMENTATION OF A HYDRIC ENERGY HARVESTING SYSTEM FOR WIRELESS SENSOR NETWORKS

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ABSTRACT

In the context of the wireless sensor networks (WSN), there are almost no systems using hydric energy harvesting. The purpose of this work is to show a small-scale hydro generator for energy harvesting and the necessary electronics to power WSN nodes. A system based on the Pelton turbine were constructed and tested in different watercourses, in order to evaluate two modes of operation: continuous and intermittent generation. It was found that with a small flow rate it is possible to power WSN nodes without the need for batteries.

Keywords: hydric, energy harvesting, wireless sensor networks, water flow.

INTRODUCTION

The wireless sensor networks (WSN) allow to monitor various parameters of the physical environment. These networks, with the last decade technological developments, are comprised of small size and low cost sensor nodes, which include sensors, processor, a small radio and a power source (Raghunathan, 2006). Although the RF communication offers flexibility in data transmission on a distributed system, power continues to be supplied mainly by batteries or directly connected to the mains (Woias, 2005). The batteries make possible applications of sensors in remote or difficult to access areas with operation periods of several days to several months, but hardly offer longer operating time (Kulkarni, 2008). One solution is to harvest energy from the surrounding environment (Raghunathan, 2006). The energy harvesting systems must be compact and provide power to the sensor nodes, requiring between one milliwatt to one hundred milliwatts.

In recent years, several options have been considered for energy harvesting from the environment. Most works have used solar PV to power the sensor nodes in WSN (Raghunathan, 2005). Several studies also consider vibration and some have considered wind energy harvesting (Penella, 2007). The flow of water available in some environments offers a high potential for harvesting energy. But while the great potential of this energy source on a large scale is already well known, in the context of WSN there are few systems that use this energy source.The water flow may be constant or variable over time. To fill the energy gaps within these variations it is necessary to have an efficient management of energy by the sensor node and to use some type of energy storage (e.g. rechargeable batteries). Super-capacitors may be used instead of batteries, solving issues such as battery memory or load control very thin.

The purpose of this work is to implement a small hydro generator and the circuit needed to power sensor nodes efficiently without the use of batteries. This involves controlling the energy extraction from water flow in continuous or intermittent conditions and feeding the sensor node directly or through a super-capacitor.

RESULTS AND CONCLUSIONS

Two modes of operation were tested. In the continuous mode the small Pelton turbine was placed in a small waterfall. The goal was to produce enough energy to power an XBee node that is always on and consuming about 135 mW. The required power was obtained for a head of H=3 m and a flow rate of Q=2.2 L/min. In this case no battery was used, demonstrating the advantage of hydro systems. Figure 1 a) shows the generator output voltage that varies with the turbulence of water flow and the voltage after the rectification circuit.

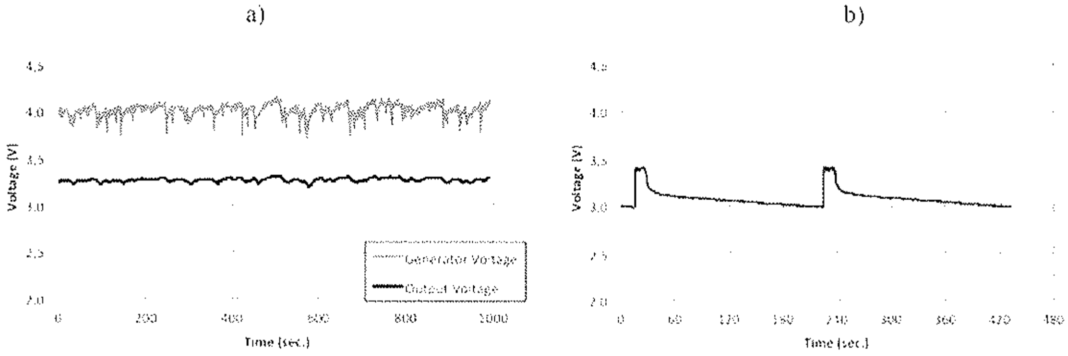

Fig. 1 - Voltages registered: a) Continuous operation; b) Intermittent operation

In the intermittent mode, the hydro generator only works during the active state intervals, being controlled by an electro valve. A capacitor is charged in the same interval to power the microcontroller during the sleep time and the system start-up of the next cycle. Figure 1 b) shows the voltage across the capacitor that supplies power to the circuit during about two periods. The capacitor value and the active time to charge are dependent of the sleep time defined by the WSN application.

REFERENCES

[1]-Kulkarni Purushottam Sudevalayam Sujesha, "Energy Harvesting Sensor Nodes: Survey and Aplications," December 2008.

[2]-Penella, M. T. and Gasulla, M., "A Review of Commercial Energy Harvesters for Autonomous Sensors", IEEE Instrumentation and Measurement Technology Conference, 1 - 5, May 2007.

[3]-P. Woias, Manoli Y., and Nann Stetten, "Energy Harvesting for Autonomous Microsystems", 2005, pp. 42-45.

[4]-Raghunathan, V., Ganeriwal, S., and Srivastava, M., "Emerging Techniques for Long Lived Wireless Sensor Networks", IEEE Communications Magazine, Apr. 2006, Vol. 44, Nº 4, pp. 108-114.

[5]-Raghunathan, V., Kansal, A., Hsu, J., Friedman, J., and Srivastava, M.B., "Design considerations for solar energy harvesting wireless embedded systems", Proceedings of the 4th Information Processing in Sensor Networks, April 24-27, IEEE Press, Piscataway, USA, Apr. 2005, pp. 457-462.