ABSTRACT

Wireless sensor networks are a recent topic of research. They are formed by a set of nodes that perform a particular task. The nodes often are small electronic devices, autonomous, battery powered and they are able to communicate each with others wirelessly.

Due to the characteristics of size and battery powered, energy consumption is a key factor in the design. The need of optimizing power consumption originates new research topics as energy harvesting and consumption optimization. This thesis is content within these fields, studying, proposing and implementing solutions.

In the first part, the behavior, the most commonly used architectures devices and operating systems in the field of sensor networks are studied. The analysis will focus on the TinyOS, Contiki and MantisOS operating systems and the Tmote Sky and MICAz devices.

In the next part of the art of theoretical models for energy consumption in sensor networks will be studied from different perspectives: the transceiver, an entire node, a network, etc. Then, it is proposed a methodology to obtain models that improve knowledge on state of charge of a sensor node, taking into account factors such as temperature or battery wear. Applying this method, it will be proposed several models based on linear regressions and neural networks which can be executed by an end node. The results are validated with experimental measurements and compare with other hardware devices.

A power supply architecture based on solar energy harvesting will be proposed. Besides, this source will reduce wear on the rechargeable batteries by using supercapacitors. This power supply automatically switches between the two sources and it prioritizes the supercapacitor respect to the battery. The design will operate at a typical node exclusively from a supercapacitor for several days; the battery operation is only required when weather conditions prevent getting enough energy from the sun. After that, the possibility of using other sources of energy harvesting will be studied: energy from commercial radio waves. Several circuits will be studied, and their results will be compared. This method provides a little current, but it may be enough for a node with an extraordinarily low consumption, or to support other energy source , especially considering that it is always available and is not dependent on weather conditions.

In the last part of the thesis, several applications are implemented. Firstly, a wireless node will be implemented to control irrigation systems by using electrovalves. The node will have a power supply and trigger system combining capacitors and supercapacitors. Furthermore, a medium access protocol is implemented, this protocol maintains synchronism between adjacent nodes by a hardware system that reduces power consumption without losing the timing. The second application is a system that measures environmental parameters. This

system uses the solar power source designed previously. Besides the consumption of this node energy is very low, this consumption approaches to the energy that the radio energy harvesting system can provide. The environmental parameters can be accessed on Internet.