Chapter 62
A Low Cost Wireless Sensors Network with Low-Complexity and Fast-Prototyping

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ABSTRACT

This chapter presents a low cost/fast prototyping wireless sensors network that was designed for a huge range of applications and making use of low cost commercial of the shelf components. Such applications includes industrial measurements, biomedical, domestic monitoring, remote sensing, among others. The concept of the wireless sensor network is presented and simultaneously, hot topics and their implementation are discussed. Such topics are valuable tools and can't be discarded when a wireless sensors network is planed. By the contrary, such tools must be taken in account to make the communications between the nodes and the base station the best possible reliable. The architecture, protocols and the reasons that were behind the selection of the components are also discussed. The chapter also presents performance metrics that are related to with the physical characteristics of sensors and with the radio specificity.

Microcontrollers with a RISC architecture are used by the network nodes to control the communication and the data acquisition and operate in the 433 MHz ISM band with ASK modulation. Also, in order to improve the communication and to minimize the loss of data, it is predicted to put the wireless nodes to handle line and source coding schemes.

This chapter cover the following topics: • the focus and application of the wireless sensor network; • the implications of the radio system; • the test bed implementation of the proposed low cost wireless sensors networks; • the wireless link power budget, coding and data recovering; • performance metrics of the wireless sensors networks; • cost analysis versus other technologies (wired and emerging wireless).

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INTRODUCTION

Wireless communication microsystems with high density of nodes and simple protocol are emerging for low-data-rate distributed sensor network applications such as those in home automation and industrial control (Choi *et al.*, 2003). It is available a huge range of solutions to implement wireless sensors networks (WSN). A few companies (Crossbow 2009; Dust 2009; Sensicast 2009) are offering products such as radios (motes) and sensor interfaces. The motes are battery-powered devices that run specific software. In addition to running the software networking stack, each mote can be easily customized and programmed, since it runs open-source operating systems which provides low-level event and task management. Mote Processor/Radio module families working at 2.4 GHz ISM band that support IEEE802.15.4 and ZigBee are available. However, to implement wireless buses for certain applications, it is required compact and miniaturized solutions. Also, the inclusion of chip-sizes antennas in the RF microsystem can be a crucial factor, as it is the case presented in (Enz *et al*., 2005) to target applications in wearables. However and despite their easiness, these solutions can revealed very expensive when it is desired to deploy a industrial network prototype. Thus, low-cost and ready-to-deploy solutions are more attractive for the Portuguese's small-and-medium industries (PMEs), as it is the case of restaurants and snack-bars, where it is mandatory to keep temperature logs in frizzing cameras with a periodicity less than an hour. If this regulation is not implemented and respected, the ASAE (*Autoridade de Segurança Alimentar e Económica*) organism acts in conformity and penalties starting from simple monetary dues to the close of the facilities are consequences to keep the activities working out of the law. Data acquisition systems require automated and efficient processes to do the records and logging. A wired infrastructure can be one possible solution. However, this can be a problem especially in older facilities, where holes must be made in the walls to pass the cables. The installation of wireless infrastructure is another way to install a communication connection. A wireless infrastructure allows the installation of multi-hop networks without doing severe changes in the facilities. Also, this kind of solution has the advantage to increase the number of network nodes with high flexibility. Behind that, other nodes with other type of functions can be installed. Also, since the prototyped solutions don't follows the mass production and thus the low-cost per unity, a new and prototypable solution must be found to meet these small-volume applications.

The wireless sensors network presented in this chapter meets a wide range of small-volume applications with a low-cost and in a ready to use fashion.

IMPLICATIONS OF THE RADIO-FREQUENCY SYSTEM

Normally, in the majority of the wireless sensors network applications, the total power consumption of a wireless node has a low or negligible contribution due to the electronics of control and processing, when compared with those from the radio-frequency (RF) system. The simple matter of fact that the available technologies present increased low-power features, it is not synonymous of a total power consumption relief. This is justified due to the fact the RF transceiver to be the bloc with the highest power consumption (Enz *et al*., 2005). The usage under low periods of time or low-duty cycles is a key to save power in wireless nodes. As depicted in Figure 1, the duty-cycle is defined by the ratio *duty-cycle* = T_u/T_f, where T_u [s] is the working time of the network for a total life time, T_f [s] and must be low. This paradigm is useful and it corresponds to what happens in a real wireless sensor network, where the nodes work in a peaked based transmission (Mateu *et al*., 2007).