Chapter 1

Intrabody Communications (IBC) as an Alternative Proposal for Biomedical Wearable Systems

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ABSTRACT

Many times, medical monitoring requires the use of wires that connect patients with monitoring devices and reduce their mobility and comfort at the same time that hamper the work of doctors and medical staff. The development of transmissions technologies based on wireless communications standards, like Bluetooth or Zigbee, does not conform optimal solutions to develop the communication links in the biomedical wearable systems because of the situation of overexploitation and saturation of the Industrial, Scientific and Medical (ISM) frequency bands, and also due to the consumption of their transceivers. This chapter presents both theoretical and application aspects of Intrabody Communications Technology (IBC) as an optimum solution for wireless communications in the wearable biomedical monitoring domain, which overcomes the previous inconveniences. The chapter is addressed by referencing dense scientific literature of the IBC technologies evolution till nowadays.

INTRODUCTION

The problem of aging is emphasizing the need for efficient health care systems. According to UN, in 2050 Spain will be the most aged country in the world: 44.1% of the population will be older than 60 years (United, 2001). This group of people needs specialized assistance, not only medical but also surveillance associated with the risk of

DOI: 10.4018/978-1-61520-670-4.ch001

falls (Prado, 2006)-(Prado, 2002), malnutrition (Gonzalo, 2004) or managing medical doses for patients with chronic diseases (Fulmer, 1999). In fact, about 20% of people aged more than 85 years are not prepared to live alone (Eriksson, 1995). This matter increases the cost of medical services and also reduces the quality of life for people who look after them.

Progress in the context of information and communications technology (ICT) has become a key ally in the development of systems for elderly patient monitoring, all together with the search for minimally invasive sensors to gather physiological variables of clinical interest (Lymberis, 2005). One of the areas where these new technologies emerge is the patient's home (Estudillo, 2007), where the so called wearable systems and sensor networks are main characters (Tröster, 2005). The goal is to fill the gap in the classic systems of care at home and the storage of clinical data.

The position of the sensors is a key design aspect to dispose physiological signals of good quality (Lukowic, 2002). Many of them have to be situated on a specific emplacement, often in skin contact or even implanted (Tröster, 2005). Thanks to the development of nanobiotechnology and micro-electromechanical systems (MEMS), current research trends show that sensors can be really small and integrated naturally into the patient habits of life, with action capacities at cellular level (Park, 2005). Another fundamental point of view in the patient monitoring technologies is the communications. If it is intended that the system is truly wearable, transmission of information has to happen, inevitably, by the use of wireless technologies (Dohler, 2008), which avoids the problems of wiring between biosensors and improve the ease of use (Kirsch, 2007).

The evolution of WSN (Wireless Sensor Network) technologies and WPAN (Wireless Personal Area Network) is marked by user's needs, a fact that is accentuated in the monitoring and continuing care field. The patient demands lightweight devices, with a reduced data-processing capacity and embedded alarms, and which must also maintain a connection with the health centre 24 hours a day (Lymberis, 2005). The immunity to interference, coverage, or transmission rate are other aspects to be taken into account (Dohler, 2008). From the review of the transmission needs and design limitations, different architectures and WPAN standards appear, promoted at industrial level by the establishment of strategic alliances between companies. Bluetooth is a paradigmatic example (Winston, 2008; Bluetooth, 2008a), which provides an efficient wireless transmission medium with high data rate capacity (Bluetooth, 2008b)-(Prado, 2007b). The price to pay is the high consumption (Wexler, 2005), which is revealed as a key aspect of design in wearable systems. The strategy of ZigBee Alliance (Zigbee, 2008) is to reduce the coverage and transmission rate, allowing the user not to be worried about renewing the battery from the device for years (Dagtas, 2007).

The enormous development of ZigBee at the low consumption level has encouraged the emergence of new alternatives in full development nowadays. The clearest option is the proposal from Ultra Low Power Bluetooth (BT ULP) (Bluetooth, 2008c; Schoo, 2007). The first commercial product, Wibree (Wibree, 2008), increases the transmission rate (1 Mbit/s), despite offering a smaller range (up to 15 meters). These features can provide extra capacity at the communication levels where other architectures are not appropriate. The ULP BT Working Group is developing some full specifications for wireless devices with restrictions on consumption, which would be brought out by the end of 2008, although they are being already used in the context of Biomedical Engineering (CSR, 2008; Prado, 2007a). ULP is an appropriate option in wearable systems where Bluetooth has already been used thanks to their compatibility. By means of a software upgrade the integration of the new very low consumption structure within the developed system will be allowed.

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