10th International Conference on Radiation Effects on Semiconductor Materials, Detectors and Devices

Contribution ID: **14** Type: **not specified**

Wireless ultra-wide band transmission of bio signals

Friday, 10 October 2014 12:10 (20 minutes)

The main objective of this proposal is to design a system for transmission and reception of signals and biological parameters through dedicated radio circuits using a purely digital approach (asynchronous events). Each source of biomedical parameters will be translated into temporal events that can be transmitted and received without further processing. The system, in fact, thanks to its intrinsic use of events, allows controlling in an extremely efficient release of energy for the transmission of information, and therefore exploit an approach completely on-demand to minimize the consumption of power. The events are generated occurrence of particular patterns in the input signal (and then it is extracted the information content of the signal of interest) and efficiently (with respect to energy consumption, complexity, integration and flexibility) synthesized via a digital system asynchronously. The information is transmitted only when required, allowing for a longer battery life than traditional wireless processes. From the technological point of view it will be exploited the wireless transmission techniques that employs the Impulse Radio Ultra-Wide-Band, localized around 3-5 GHz, for transmitting and receiving signals by very reduced temporal pulses, resulting in very wide spectral occupation. As a consequence of that, we gain limited power consumption at the transmitter side.
This wireless system can find various applications in the field of medicine, allowing accurate measurements of various biological parameters detected from time to time by a single receiver (collector). The latter will have the task of reworking the received signals to identify the correct sequence and the source of information.

Summary

The device must have reduced final dimensions to be integrated on a single microchip, which, after having amplified and processed the information of external sensors, must be able to transmit it at distances of the order of meters, possibly using an integrated antenna. The miniaturization of the system to use more sensors, perfectly compatible with low-consumption electronics, can meet the needs of medical applications such as the remote control of biological parameters or the construction of robotic equipment (exoskeletons). The proposed mechanism will be developed in a prototype phase to discrete components in order to validate an initial feasibility study, and will then be integrated microchip in a final stage.
We have been able to mount in a preliminary data acquisition chain an amplifier for instrumentation, which we use to interface and read out the bio signals, a voltage controlled oscillator (VCO) to digitize the information and a wireless transmitter.
The transmission tests were carried out exploiting a specific digital modulation, namely Synchronized On/Off Keying (S-OOK) digital modulation. Moreover, for these tests the carrier was used nominally at 3.5 GHz. The S-OOK modulation is devoted to "translate"bit transmission requests into transmission trigger events for the following UWB transmitter. Standard OOK maps each 1 into an impulse trigger, and each 0 into a "space"that is a no impulse trigger, or just a delay. S-OOK adds a synchronizing impulse "S"before the data bit "D", thus allowing the receiver to know whenever a data bit is being effectively transmitted and hence not requiring to recover any timing information regarding the data stream. Despite using a synchronizing impulse, this solution allows to design a fully asynchronous event-based receiver, more robust with respect to undesired delays due to the transmission channel. Here we have used an external S-OOK modulator together with the on-chip transmitter. Indeed, this S-OOK modulation was easily implemented in one prototype ASIC. In

more detail, any digital series of 0s and 1s, i.e. the modulation sequence of bits, enables or disables the RF transmitter. Hence, the effective transmitted bits were formed by a series of RF bursts centered at a carrier frequency of 3.5 GHz.

The proposed approach using standard CMOS process suggests the use of this technology for monolithic implementations of generic sensors along with microelectronic readout circuits. In addition, the prototype that we have described allows an Ultra-Wide-Band, low-power digital modulation. The range of transmission via the integrated antenna is of the order of 1 m and the total power consumption was measured as low as a few hundreds of μW. Future improvements of the microelectronic design are oriented to include an additional on-chip remote powering system, using state-of-the-art deep submicron architectures. In this way the chip will be able to work without any in-system battery and this also fits medical applications.

Primary author: GABRIELLI, Alessandro (Universita e INFN (IT))

Presenter: GABRIELLI, Alessandro (Universita e INFN (IT))

Session Classification: Bio-Medical Applications