Embedded Systems Laboratory
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Embedded electrocardiogram processing for Wireless Body Sensor Network (WBSN) applications

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Project Description

In the last few years, wireless body sensor networks (WBSN) have emerged as a key enabling technology for future personal health monitoring systems. They hold the promise of providing ambulatory, continuous and real-time monitoring of an individual's vital signs. Typically, a WBSN is composed of a number of sensor nodes dedicated to sensing electrocardiogram (ECG), electromyogram (EMG), body temperature, blood pressure and so on. Each sensor node is composed of a limited number of components including: an analog readout front-end, a microprocessor, a radio transmitter/receiver and a power supply circuit together with batteries. These sensor nodes then transmit their data continuously through a wireless connection to a master node, typically a PDA or a PC, which collects, visualizes and analyzes the data. The current challenge in WBSN is the minimization of power consumption to reduce the dependency on batteries and allow miniaturization of the nodes. Reduction of power consumption can be done at the level of each component composing the sensor node, and the trade-off between local Digital Signal Processing (DSP) and radio transmission turns out to be very important. It has been shown that, with off-the-shelf radios (such as ZigBee), it is always more attractive to process the data locally on the node, therefore reducing the amount of data to be transmitted, before sending it out through the radio link for reception by the master node. At ESL, we have recently demonstrated the feasibility of supporting advanced ECG signal processing algorithm on a commercial WBSN platform, namely Shimmer™ [1], without compromising the diagnosis quality.

Within the scope of an ESL-CSEM collaboration, this project proposes to implement two of our ECG signal processing algorithms on CSEM's IcyCOM platform [2]. IcyCOM is an RF system-on-chip (SoC) integrating an 868/915 MHz low-power RF transceiver and a 32-bit 120µA/MHz DSP RISC core (icyflex1) with 96 kbytes of SRAM. The initial C-codes corresponding to the two algorithms will be provided. The tasks of the student in this project will include the understanding of those codes at an algorithmic level, optimization for real-time and embedded implementation and the actual implementation on IcyCOM. Finally, sensor nodes will be provided such that the ported algorithms by the students could be tested with real ECG signals. The results of the student in this project should enable will serve to benchmark the IcyCOM platform with respect to the commercial Shimmer platform.

Tasks of the student

For each of the two algorithms, the student will:

1. Get familiar with the C-code and understand the corresponding algorithm.
2. Modify and optimize the code for real-time implementation.
3. Optimize and port the code for embedded implementation on the icyflex1.
4. Test their implementation on the IcyCOM platform.
5. Measure the power consumption of the two implementations.

Requirements

1. Advanced programming experience in C. Familiarity with GNU development tools and the gcc compiler.
2. Good theoretical knowledge of embedded software requirements.
3. Basic practical experience with embedded software.
4. Interest in biomedical applications and practical work on wireless sensor nodes.

References

[1] Shimmer WBSN Platform, Intel Research, http://shimmer-research.com
[2] CSEM's Icycom Platform, http://www.csem.ch/docs/Show.aspx?id=12228