Proceedings of the 2012 Winter Simulation Conference
C. Laroque, J. Himmelspach, R. Pasupathy, O. Rose, and A.M. Uhrmacher, eds

GPU-BASED SIMULATION OF WIRELESS BODY SENSOR NETWORKS

Dion Paul and Hongmei Chi

Florida A&M University
Department of Computer and Information Sciences
Tallahassee, FL 32307, USA

ABSTRACT

Recent technology-driven innovations, such as the body sensor network (BSN), provide an example of a medical device that assists in maintaining and improving the health status of a single user, or even multiple patients in a hospital ward. It is useful to simulate a BSN before manufacture and deployment to address usability, power consumption, communication channel, bandwidth limitations, and interference issues. The purpose of this project is to use high performance computing hardware to investigate energy consumption and communication channel issues for the BSN model. The graphics processing unit (GPU) is adopted to simulate the operation of the BSN model, which is comprised of MATLAB, Simulink, and CUDA code. This poster describes the development and evaluation of a body sensor network model, for acquiring and reporting the vital sign data for a single user in a simulated health monitoring scenario.

1 INTRODUCTION

The increasing use of wireless networks and the constant miniaturization of electrical devices have empowered the development of wireless body sensor networks. In these networks various sensors are attached on clothing or on the body or even implanted under the skin [2]. The wireless nature of the network and the wide variety of sensors offer numerous new, practical and innovative applications to improve health care and the quality of life. The sensors of a BSN measure for example the heartbeat, the body temperature or record a prolonged electrocardiogram [1]. Using a BSN, the patient experiences a greater physical mobility and is no longer compelled to stay in the hospital.

Simulation has always been very popular among network-related research. However, BSNs present additional challenges, since they are energy constrained, resource constrained and ideally, size constrained and are affected by physical stimulus of the human body. Energy concerns bring communication challenges, since the majority of energy consumption in a node comes from wireless communication. This study targets these concerns by investigating the requisite parameters for developing a body sensor network which proposes to maintain and improve the health status of its users. The result of this research work is intended for use as a foundation for the implementation of *iSox* – a BSN with the capability to remotely monitor a user's pulse, temperature and blood pressure.

The system components of iSox are: (1) a customizable, wearable pair of socks, (2) embedded sensor network system, and (3) a mobile application. The mobile application will be used to monitor biological data received from the pair of socks, while worn on patient's feet. This device is considered as medical apparatus for private use by patient. Similar medical devices are: costly, available primarily at medical institutions, and lack mobile interface and other technology. Our intended audiences are general patients, but specific use targeted to diabetic type 2, cardiac and post-surgical patients with compromised

978-1-4673-4781-5/12/$31.00 ©2012 IEEE

systems, as well as medical practitioners and researchers. The purpose of our system is to enable patients to learn acceptable vital sign ranges based on their age and condition. It will also enable regular monitoring and recording of patient data, with capability to send this data to their primary care provider (PCP) and/or medical practitioner.

Figure 1 – iSox sensor layout and architecture

As illustrated in Figure 1, *iSox* consists of a wearable sock made of comfortable material, with special design considerations to minimize static electricity and optimize communication with mobile application. The sensor system is embedded to reduce user intrusion, synchronous operation and data transmission of blood pressure and pulse monitoring, temperature sensor, radio transmitter and power supply. Once the i*Sox* is on your feet it will automatically transmit data to your mobile device or transmitted to your physician. *iSox* will be less dependent on the user and will already have the data available without any effort from the user. The *iSox* has to be manually put on your feet and once it is on your feet you have to turn on your mobile to device to activate its operation. Once *iSox* is on your feet and activated, the user no longer has to do anything else.

2 SIMULATION

This project applies this concept of a GPU in a health monitoring scenario using a BSN model developed in Simulink, MATLAB and CUDA code. The BSN model is developed in a manner such that the vital sign readings acquired from the sensing module are dependent on stochastic fluctuations between two stable states of the system. This is due to the static nature of the BSN model, which is operable without the use of dynamically changing data structures. The integrated environment of MATLAB, Simulink and CUDA code present a suitable tool for this stochastic method. This environment is also useful because MATLAB and Simulink could be easily extended via MEX files to take advantage of the computational power offered by the latest NVIDIA graphics processor unit (GPU). MATLAB executable (MEX) files are dynamically-linked subroutines that the MATLAB interpreter is able to load and execute.

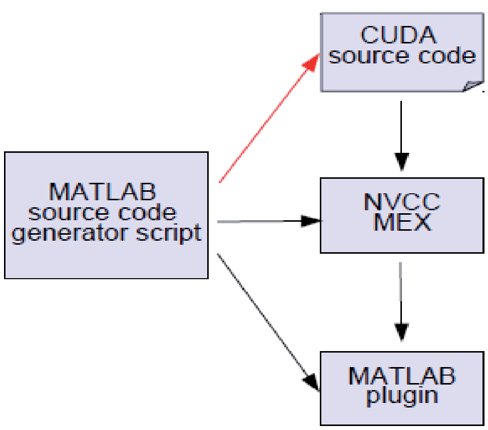

Figure 2 – Source code generation method for the BSN using GPU-based simulation

Figure 2 illustrates the method of source code generation method for the BSN using GPU-based simulation.
The MATLAB plug-in for CUDA provides an acceleration of standard MATLAB two dimensional (2D) fast Fourier transforms (FFT) and CUDA/MEX files. This poster investigates a methodology for simulating wireless body sensor networks (BSN). An integrated environment of MATLAB, Simulink and CUDA was used to build the simulation environment for our proposed BSN

REFERENCES

[1] Luca Mottola and Gian Pietro Picco. 2011. Programming wireless sensor networks: Fundamental concepts and state of the art. ACM Comput. Surv. 43, 3, Article 19 (April 2011), 51 pages

[2]Benoît Latré, Bart Braem, Ingrid Moerman, Chris Blondia, and Piet Demeester. 2011. A survey on wireless body area networks. Wirel. Netw. 17, 1 (January 2011), 1-18.