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Statement of Research Interests

1. Introduction

I believe successful research in the field of Computer Science and Engineering should focus not only on the ideas, but also on economics and practicality. My experiences at a start-up company, Myricom, Inc. and four universities, UC Berkeley, UT Austin, UCLA, and Washington University in St. Louis has prepared me have a balanced view of research to formulate and publish high impact novel ideas that also led to successful implementations of operational system.

After receiving Ph.D. from UCLA in 2005, I accepted a visiting assistant professor position in Applied Research Laboratory at Washington University to conduct research in a large DoD funded project with a well respected colleague, John W. Lockwood. In fact, I declined a tenure-track position offer from Iowa State University so that I can see my research work become a deployable state-of-the-art system. Through this intense experience, I have gained much more hands-on-experience in embedded, networked, and distributed high-performance system [1-10].

After successful completion of the project at Washington University, my growing interest in wireless, low-power, and reconfigurable systems research led me to come back to UCLA to work with Deborah Estrin and Mani Srivastava at the Center for Embedded Networked Sensing (CENS). At UCLA, my expertise in a slightly different aspect of computer sciences led to a number of novel contributions in wireless sensor network nodes and distributed systems [11-14].

2. Purpose

There are two very different groups of scientists and engineers working in the field of distributed computing systems. One group belongs to high performance computing community where the innovations for higher computation per unit time are sought. Other group belongs to sensor network community that focuses on computing efficiencies, often under extreme resource constraints. Traditionally, these goals were not very compatible due to types of processors and applications that these communities were interested. However, over the past few years, the high performance computing community has started to take a serious look into the issues of efficiency, especially in terms of power, while the wireless sensor network community started to classify higher-end system as sensor nodes.

The recent progresses in high performance computing and wireless sensor networks point toward the future where both technology can converge and co-exist. I believe the technology convergence will result in distributed cyber-physical systems that will leverage innovations in dynamic system reconfiguration [15-18] and context aware adaptive computing [1,5,6,9].

My expertise in both converging technologies gives me the advantage in pursuing novel and high impact research in distributed and networked cyber-physical systems. Since context aware systems reacts to the, often unpredictable, environment, I believe field experiments are necessary to validate the success of the claims. My hands-on experience in system design and implementation will enable the research to progress quickly.

3. Research Goals

My immediate research responsibilities at USC-Information Science Institute include being the principal investigator in three low-power sensor network systems projects.

The research goal associated with the work on Satellite Sensornet Gateway (SSG) is to use in-situ environmental monitoring sensor network and satellites to build an efficient reactive system that can dynamically reconfigure the sensor nodes to optimize the data collection and analysis. In addition to novel research plans, we are refining our current system to be user-friendly such that the deployment rate of our system will increase.

Another research endeavor is with the underwater wireless sensor network. The major reason that new research is needed is due to the fact that radio communication is not practical to use underwater. Therefore, new innovations that will enable high throughput, low-power underwater communication is necessary before making further progress. The current goal of the project is to develop low-power acoustic modem that can be used with mote-class sensor network nodes. As a parallel effort, we are making progress to address other basic problems such as localization and network protocols that are more suitable for underwater deployment.

I am also initiating research in monitoring sensor network system for steam flooding of oil recovery sites. The goal of the research is to develop innovative technology that will allow inexpensive and redundant sensor network to not only increase the efficiency but the functionality of the monitoring system.

Above research works involve wireless sensor network deployed in distinctively different environments and purposes. Therefore, one implementation differs drastically from another. However, my future research will attempt to tie them all together by introducing the concept of cyber-physical system to each project. As described in the previous section, research in distribute cyber-physical system will integrate the concept of dynamic system reconfiguration and context aware adaptive computing.

In order to engage this research, my near-term goal is to build a low-power field programmable gate array based sensor network. I intend to design and build the initial prototype by leveraging my prior experiences in building and using two-level multicomputer nodes [15] and UC Berkeley mote-class sensor network nodes [12-14]. Each node will consist of a memory, a microcontroller which will act as the first level computer, and low-power FPGA as its second level computer as shown in figure 1. First level computer will mainly handle functions such as network communication, second level computer reconfiguration, and other high level management. The second level computer will handle more application specific functions and lower-level functions as deterministic interrupt handlers, power management, and time stamping.

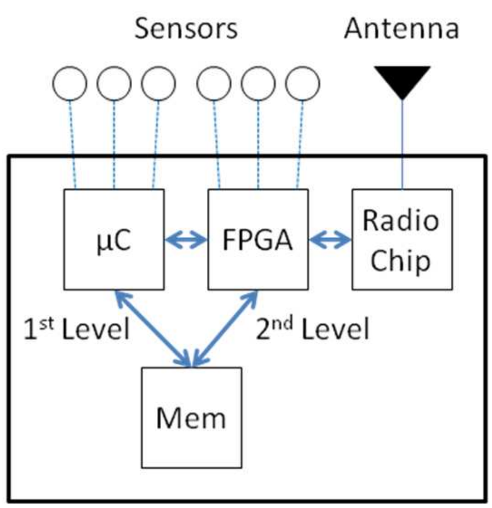

Figure 1: Low-power, Reconfigurable, Two-level Multi-computing Wireless Sensor Network Node

The cyber-physical platform will have the means to sense its physical environment, communicate, and dynamically reconfigure. The low-power FPGA will enable highest computation density in terms of power with highly parallel circuit design. The initial set of new applications for the platform includes extended version of the low-power smart timing unit [12], algorithm for adaptive time calibration on distributed wireless nodes, and context aware data logger.

The key advantage of such system is that it can be completely and dynamically reconfigured at several different levels (i.e. external network configuration as well as modular configuration within FPGAs.) Thus, the entire network of nodes can be seen as one reconfigurable system. By incrementally develop modular system, I envision building a adaptive cyber-physical system that tunes itself to the given environment and application to obtain optimal result.

Ultimately, the cyber-physical system mimics the biological system in that it uses its sensed data to constantly change and adapts itself. An example of such a system would be a organic brain. A model described by Walter J. Freeman at UC Berkeley suggests that each neuron can be represented as a chaotic function with a feedback loop [19]. There have been a few research publications which attempt to make use of the model to mimic how brain works. However, the experimental platforms do not consider the structure of the network itself. I believe the network of reconfigurable nodes presents an architecture that is closer to the structure of the biological brain, thus providing a better simulation environment than other existing environments.

4. References

[1] Phillip H. Jones, James Moscola, Young H. Cho, and John W. Lockwood, "Adaptive Thermoregulation for Applications on Reconfigurable Devices." 17th IEEE International Conference on Field Programmable Logic and Applications (FPL), Amsterdam, Netherlands, August 27-29, 2007.

[2] Moshe Looks, Ronald P. Loui, John W. Lockwood, Adam Covington, Andrew Levine, Young H. Cho, "Streaming Hierarchical Clustering for Text Mining." IEEE Aerospace Conference, Big Sky, MT, March 3-10, 2007.

[3] Andrew Levine, Ronald P. Loui, John W. Lockwood, Young H. Cho, "Sensitivity Analysis of Gigabit Concept Mining System." IEEE Aerospace Conference, Big Sky, MT, March 3-10, 2007.

[4] James Moscola, Young H. Cho, and John W. Lockwood, "Hardware-Accelerated Parser for Extraction of Metadata In Semantic Network Content." IEEE Aerospace Conference, Big Sky, MT, March 3-10, 2007.

[5] Phillip H. Jones, Young H. Cho, and John W. Lockwood, "Dynamically Optimizing FPGA Applications by Monitoring Temperature and Workloads." 20th IEEE/ACM International Conference on VLSI Design, Bangalore, India, January 6-10, 2007.

[6] Phillip H. Jones, Young H. Cho, and John W. Lockwood, "An Adaptive Frequency Control Method using Thermal Feedback for Reconfigurable Hardware Applications." IEEE International Conference on Field Programmable Technology (FPT), Bangkok, Thailand, December 13-15, 2006.

[7] James M. Moscola, Young H. Cho, and John W. Lockwood, "A Reconfigurable Architecture for Multi-gigabit-Speed Content-based Routing." 14th IEEE Hot Interconnects, Stanford, CA August 23-25, 2006.

[8] G. Adam Covington, Charles L.G. Comstock, Andrew A. Levine, John W. Lockwood, Young H. Cho, "High Speed Document Clustering in Reconfigurable Hardware." 16th IEEE International Conference on Field Programmable Logic and Applications (FPL), Madrid, Spain, August 2006.

[9] Phillip H. Jones, John W. Lockwood, and Young H. Cho, "A Thermal Management and Profiling Method for Reconfigurable Hardware Applications." 16th IEEE International Conference on Field Programmable Logic and Applications (FPL), Madrid, Spain, August 2006.

[10] Young H. Cho, James M. Moscola, and John W. Lockwood, "Context-Free Grammar based Token Tagger in Reconfigurable Devices." IEEE ICDE - International Workshop on Semantics enabled Networks and Services (ICDE SeNS), April 3-7, Atlanta, GA, 2006.

[11] Jonathan Friedman, Zainul M Charbiwala, Thomas Schmid, Young H Cho, Mani B Srivastava, "Angle-of-Arrival Assisted Radio Inteferometry (ARI) Target Localization," Proceedings of MILCOM 2008, November 2008.

[12] Thomas Schmid, Jonathan Friedman, Zainul M Charbiwala, Young H Cho, Mani B Srivastava, "Low-Power High-Accuracy Timing Systems for Efficient Duty Cycling," ISLPED 2008 , August 2008.

[13] Thomas Schmid, Zainul M Charbiwala, Jonathan Friedman, Young H Cho, Mani B Srivastava, "Exploiting Manufacturing Variations for Compensating Environment-induced Clock Drift in Time Synchronization," ACM Sigmetrics 2008 , June 2008.

[14] Thomas Schmid, Jonathan Friedman, Zainul M Charbiwala, Young H Cho, Mani B Srivastava, "XCXO: An Ultra-low Cost Ultra-high Accuracy Clock System for Wireless Sensor Networks in Harsh Remote Outdoor Environments," ISSCC/DAC 2008, (Unpublished Student Design Contest Entry, Award Winner) , February 2008.

[15] Young H. Cho, "Automatic Target Recognition Application using Field Programmable Gate Array," as part of Reconfigurable Computing: The Theory and Practice of FPGA-Based Computation by Scott Hauck and Andre Dehon, Morgan Kaufmann, Nov. 2007.

[16] James M. Moscola, Young H. Cho, and John W. Lockwood, "A Reconfigurable Architecture for Multi-gigabit-Speed Content-based Routing." 14th IEEE Hot Interconnects, Stanford, CA August 23-25, 2006.

[17] Young H. Cho and William H. Mangione-Smith, "Fast reconfiguring Deep Packet Filter for 1+ Gigabit Network." IEEE Symposium on Field-Programmable Custom Computing Machines (FCCM), Napa Valley, CA, April 2005. (~28% acceptance rate)

[18] Young H. Cho and William H. Mangione-Smith, "Programmable Hardware for Deep Packet Filtering on a Large Signature Set." First Watson Conference on Interaction between Architecture, Circuits, and Compilers(P=ac2), Yorktown, NY, Oct. 6-8, 2004.

[19] Walter J. Freeman, “Neurodynamics; An Exploration of Mesoscopic Brain Dynamics,” London, UK, Springer-Verlag, 2000.