

Final Report for Period: 08/2009 - 07/2010**Submitted on:** 10/14/2010**Principal Investigator:** Wolf, Marilyn C.**Award ID:** 0720536**Organization:** GA Tech Res Corp - GIT**Submitted By:**

Wolf, Marilyn - Principal Investigator

Title:

Collaborative Research: CSR---EHS: Foundations for Design and Implementation of Software Radio Platforms

Project Participants**Senior Personnel****Name:** Wolf, Wayne**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Mukhopadhyay, Saibal**Worked for more than 160 Hours:** No**Contribution to Project:**

Collaborated with Wolf and Kim on low-power arithmetic and image processing.

Post-doc**Graduate Student****Name:** Lee, Chiahan**Worked for more than 160 Hours:** No**Contribution to Project:**

Graduate student who just received his Ph.D.

Name: Kim, Sehun**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Lee, Dongwon**Worked for more than 160 Hours:** Yes**Contribution to Project:**

New PhD student with experience in cell phone design.

Name: Desai, Manali**Worked for more than 160 Hours:** No**Contribution to Project:**

M.S. student

Undergraduate Student**Technician, Programmer****Other Participant****Research Experience for Undergraduates**

Organizational Partners

Other Collaborators or Contacts

Trevor Mudge, University of Michigan.

Keren Bergman, Columbia University.

Hyesoon Kim, Georgia Tech College of Computing.

Activities and Findings

Research and Education Activities:

We developed new methods for the design of memory controllers for systems-on-chips that can be used for software radio. (We are in the process of extending that work to analyze the performance of optical interconnect for memory systems.)

We developed a new model for errors in low-voltage adders and their relationship to errors in image compression.

We developed new techniques for performing turbo coding (an important error correction algorithm) on graphics processing units (GPUs).

We added material on embedded computing and software radio to ECE 6161, Parallel and Distributed Computing

Findings:

We have developed a novel methodology for the design of memory controllers for digital signal processing systems such as software radios [Lee09]. We developed a novel buffer mapping policy that maps from a synchronous dataflow (SDF) representation of the algorithm onto memory requests, based on bank concurrency in DRAMs.

With Prof. Saibal Mukhopadhyay, we developed new results for error-tolerant low-power image processing systems. We developed a new model for the determination of error probabilities in adders when they are operated at low voltages. We used this model to analyze the perceptual errors in images that have been compressed using low-voltage adders. Because cell phones are the most common platform for digital still cameras, these results can substantially improve the battery life of cell phones.

With Prof. Hyesoon Kim of Georgia Tech College of Computing, we have developed new methods for speeding up turbo coding on GPUs. Experimental results show that the radix-4 algorithm with the SM-centric mapping method shows the best performance at four sub-frames per thread block. We found two important factors: the occupancy and shared memory bank conflicts. We optimized the kernel operation (max*) and applying the MAX-Log-Maximum A Posteriori (MAP) algorithm.

[Lee09] Dongwon Lee, Shuvra S. Bhattacharyya, and Wayne Wolf, "High-performance buffer mapping to exploit DRAM concurrency in multiprocessor DSP systems," submitted to RSP '09.

[Kim09] Seun Kim, Saibal Mukhopadhyay, and Wayne Wolf, "Error properties of low-voltage adders in image processing," submitted to ISLPED '09.

Training and Development:

Dongwon Lee and Sehun Kim are being trained in embedded computing and software radio.

Outreach Activities:

Wolf participates in a number of cyber-physical systems committees. Under a separate grant, Wolf co-hosted Cyber-Physical Systems Summer Schools in 2009 and 2010.

Journal Publications**Books or Other One-time Publications**

Chia-Han Lee and Wayne Wolf, "Design methodology of software radio system", (2007). Book, Published
Collection: Embedded Computer Systems: Architectures, Modeling, and Simulation
Bibliography: LNCS vol. 4599, July 2007

Chia-Han Lee and Wayne Wolf, "Multiple access-inspired cooperative spectrum sensing for cognitive radio", (2007). Book, Published
Collection: Proceedings of the IEEE Military Communications Conference
Bibliography: IEEE

Chia-Han Lee and Wayne Wolf, "Energy-efficient techniques for cooperative spectrum sensing in cognitive radios", (2008). Book, Published
Collection: Proceedings, 2nd IEEE Workshop on Cognitive Radio Networks
Bibliography: IEEE

Chia-Han Lee and Wayne Wolf, "Evaluation of functional architectures for cognitive radio systems", (2008). Book, Published
Collection: Proceedings, 2008 International Conference on Acoustics, Speech, and Signal Processing
Bibliography: IEEE

Chia-Han Lee, "Power-Efficient Integrated Cognitive and Software Radio System", (2008). Thesis, Published
Bibliography: Ph.D dissertation, Princeton University

D. Lee, S. S. Bhattacharyya, and W. Wolf, "High-performance buffer mapping to exploit DRAM concurrency in multiprocessor DSP systems", (2009). proceedings, Published
Editor(s): IEEE
Collection: Proceedings of the International Symposium on Rapid System Prototyping
Bibliography: Juen 2009

Dongwon Lee, Marilyn Wolf, and Hyesoon Kim, "Design space exploration of the turbo decoding algorithm on GPUs", (2010). Book, Accepted
Editor(s): CASES 2010
Collection: Proceedings, Embedded Systems Week 2010
Bibliography: IEEE

Web/Internet Site**Other Specific Products**

Product Type:**doctoral dissertation****Product Description:**

Chia-Han Lee, "Power-Efficient Integrated Cognitive and Software Radio System", (2008).

Thesis, Published

Bibliography: Ph.D dissertation, Princeton University

Sharing Information:

Library collection, University Microfilms, derived publications.

Contributions**Contributions within Discipline:**

We (Chia-han Lee) developed new cognitive radio algorithms that use adaptive control. These algorithms have low complexity and rely on low-complexity architectures. We have also shown that they require relatively little power.

We are performing some post-grant work to complete a collaboration with Keren Bergman's group (Columbia U.) to apply our experimental methodology on memory system performance for software radio to Bergman's optical memory interconnect system.

Pending publication:

Dongwon Lee, Marilyn Wolf, and Hyesoon Kim, 'Design Space Exploration of the Turbo Decoding Algorithm on GPUs,' CASES, Oct. 2010.

Submitted, not yet accepted:

Dongwon Lee, Hyesoon Kim, and Marilyn Wolf, 'GPU architecture enhancements for the Turbo decoding algorithm,' Submitted to DATE'2011.

D. Lee, S. S. Bhattacharyya, and W. Wolf, 'High-performance and low-energy buffer mapping method for multiprocessor DSP systems,' Submitted to TECS (Under the second review).

Contributions to Other Disciplines:

Some of these results may be of interest to the computer architecture community as well as the communications community.

Contributions to Human Resource Development:

Chia-Han Lee received his Ph.D. from Princeton University.

Contributions to Resources for Research and Education:

We added material on embedded computing and software radio to ECE 6101, Parallel and Distributed Computing. That course has previously concentrated on scientific parallel computing.

Contributions Beyond Science and Engineering:

Our embedded computer vision system, commercialized by Verificon Corporation, is now in operation at Tokyo Station. Verificon has operated 48 channels of real-time computer vision at Tokyo Station since July 2008.

Conference Proceedings**Categories for which nothing is reported:**

Organizational Partners

Any Journal

Any Web/Internet Site

Any Conference