

Carthik A. Sharma

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Technical Interests

Digital systems and computer architecture with emphasis on reconfigurable computing, and evolutionary algorithms for autonomous reconfiguration.

Education

- **Doctor of Philosophy – Computer Engineering**
University of Central Florida – August 2008
Dissertation: *Sustainable Fault-Handling of Reconfigurable Logic using Throughput-Driven Assessment*
- **Master of Science – Computer Engineering**
University of Central Florida – May 2004
Emphasis: Computer Architecture
- **Bachelor of Technology – Electrical and Electronics Engineering**
National Institute of Technology, Warangal, India – May 2001

Professional Experience

July 2008 – present: Systems Programmer, Department of Physics, University of Central Florida, Orlando, Florida

- Developed and maintained programming and computing infrastructure for Dr. Joseph Harrington's Planetary Sciences research group. Assembled, installed, and maintained high-performance computing clusters, content management systems, and software development infrastructure on Ubuntu Linux OS-based 8-way machines and high-performance computing clusters. Deployed content management systems, and software development infrastructure including custom software stacks for development in Python and IDL. Managed email, web, LDAP, and DNS servers running Debian Linux, and research computing facilities for the Department of Physics.

January 2008 – August 2008: Graduate Assistant, University of Central Florida, Orlando, Florida

- Organized information for preparing the departmental self-study report of the undergraduate degree program for ABET accreditation.

2007: Teaching Associate, University of Central Florida – Valencia Community College Satellite Campus

- Instructor of record for *EEL 3123: Networks and Systems*. Taught lecture and laboratory sections, developed homework and exams, and assigned course grades.

2004 – 2007: Research Assistant, NASA-Sponsored Project, University of Central Florida – Orlando, Florida

- Conducted research in autonomous Field Programmable Gate Array (FPGA) fault tolerance strategies and Group Testing techniques. Developed evolutionary computation techniques using Genetic Algorithms to regain lost functionality due to stuck-at faults and other permanent failures in Xilinx FPGA platforms
- Developed and maintained laboratory website and network hardware infrastructure

2004 – 2005: Teaching Associate, University of Central Florida – Orlando, Florida

- Instructor of record for the following courses:
 - EEL 4767: Computer System Design – I
 - EEL 3801: Introduction to Computer Engineering
- Developed course materials, website, and evaluated student performance

2002 – 2003: Teaching Assistant, University of Central Florida – Orlando, Florida

- Assisted the instructor in evaluating student performance and conducting laboratory sessions for the following courses:
 - EEL 3342: Introduction to Digital Circuits and Systems
 - EEL 3801: Introduction to Computer Engineering
 - EEL 4767: Computer System Design – I
 - EEL 4768: Computer System Design – II
 - EEL 5722: Field-Programmable Gate Array (FPGA) Design
 - EEL 4781: Computer Communication Networks

2001 – 2002: Ad-hoc Lecturer, National Institute of Technology – Warangal, India

- Instructor of Record for the following courses:
 - Introduction to Computer Programming
 - Network Analysis

- Switching Theory and Logic Design
- Microprocessors
- Basic Electrical Science
- Power Systems - I
- Electrical Measurements and Instrumentation
- Electrical Machines
- Electrical Machine Design

Honors and Awards

- Graduate Research Fellowship, University of Central Florida, Summer 2006
- Graduate Achievers Award, University of Central Florida, 2006
- Featured graduate student in International Graduate Student Handbook of the International Services Center, University of Central Florida, 2006
- Graduate Fellowship, University of Central Florida, 2002 – 2004

Teaching Activities

A. Courses Taught

Taught courses in lecture, recitation, and laboratory formats at the Undergraduate (EEL 3xxx/4xxx) levels at the University of Central Florida:

1. **EEL 3123: Electrical Network Analysis** *with Laboratory*

The course was offered at the Valencia Community College campus as part of the pilot bridge program for graduates of the community college seeking to continue their education at the University of Central Florida. Developed course materials, laboratory experiments, and examinations. Lectured and conducted laboratory sessions, and evaluated student performance. Significant topics covered included Laplace transforms, Fourier transforms, Frequency-domain analysis techniques, and Two-port Networks

2. **EEL 4767: Computer System Design I** *with Laboratory*[40]

Significant topics covered include Computer Organization, and Motorola 6811 Assembly Language Programming.

3. **EEL 3801: Introduction to Computer Engineering** *with Laboratory*[60]

Significant topics covered include computer programming fundamentals, Object Oriented Programming, Intel 8086 Assembly Programming, Programming in C and C++.

B. Curriculum Enhancement Efforts

- Assisted the College of Electrical Engineering and Computer Science (CECS) at the University of Central Florida in compiling data and organizing information to prepare the self study report for accreditation by ABET Inc.
- Assisted in re-designing laboratory experiments in the course entitled *EEL 4767: Computer System Design – I* to use LabView infrastructure
- Developed and provided programming assistance for creating five new laboratory experiments for the course entitled *EEL 5722: Field-Programmable Gate Array (FPGA) Design* using Altera FPGA design tools

C. Teaching Evaluations

Averages for Course Evaluations During the 2003-2004 Academic Year

Course Evaluation Question	C. A. Sharma	ECE Dept.*	College*
Feedback on performance	3.77	2.76	2.88
Interest in student learning	4.32	3.15	3.14
Use of class time	3.92	3.10	2.98
Course organization	3.92	3.07	3.02
Continuity between lectures	4.17	3.15	3.08
Pace of course	3.46	2.75	2.79
Assessment of progress	3.90	2.76	2.81
Text and related materials used	3.76	2.43	2.53
Description of course objectives	3.79	2.83	2.87
Communication of ideas	3.89	2.91	2.92
Expectations for performance	3.88	2.90	2.88
Availability to assist students	4.24	3.21	3.01
Respect and concern	4.36	3.28	3.24
Stimulation of interest	3.85	2.96	2.95
Facilitation of learning	3.85	2.89	2.87
<i>Overall assessment</i>	4.07	3.16	3.11

Scale: “Excellent”=5, “Very Good”=4, “Good”=3, “Fair”=2, “Poor”=1

*4-year average available for the ECE Department and College

Student Feedback from the Free Response Section of course evaluation forms:

- “Professor is a great asset for the class (and for UCF).”
- “Mr. Sharma is the only professor I have ever had that inspires me so much to be an engineer.”
- “The instructor enjoyed teaching the material and made it easier to learn.”
- “Carthik gave the course perspective, making it less stressful...made even the most obscure topics and concepts conceivable.”
- “Amazing teacher – has a gift for making the difficult easy.”
- “[I liked most about this course]...takes a personal interest in seeing that you learn the material.”

Research Activities

A. Dissertation Summary

A sustainable Evolvable Hardware (EH) system is developed on SRAM-based reconfigurable Field Programmable Gate Arrays (FPGAs) using outlier detection and group testing-based assessment principles. The fault diagnosis methods leverage throughput-driven, relative fitness assessment to maintain resource viability information autonomously. Group testing-based techniques are developed for adaptive real-time input-driven fault isolation in FPGAs, without the need for exhaustive testing or coding-based evaluation. All these techniques maintain the device operational, and continue to generate validated outputs throughout the repair, or fault isolation process. Adaptive fault isolation methods based on discrepancy-enabled pair-wise comparisons are developed for reconfigurable logic devices. By observing the discrepancy characteristics of multiple Concurrent Error Detection (CED) configurations, fault isolation is realized without requiring additional test vectors or data encoding schemes. The results from the analytical FPGA model are demonstrated via a self-healing, self-organizing evolvable hardware system. Reconfigurability of the SRAM-based FPGA is leveraged to identify logic resource faults which are successively excluded by group testing using alternate device configurations. This simplifies the system architect's role to definition of functionality using a high-level Hardware Description Language (HDL) and system-level performance versus availability operating point. System availability, throughput, and mean time to isolate faults are monitored and maintained using an Observer-Controller model. Results are demonstrated using a Data Encryption Standard (DES) core that occupies approximately 305 FPGA slices on a Xilinx Virtex-II Pro FPGA. With a single simulated stuck-at-fault, the system identifies a completely validated replacement configuration within three to five positive tests. The approach demonstrates a readily-implemented yet robust organic hardware application framework featuring a high degree of autonomous self-control.

B. Graduate Research Projects

Co-architected the Competitive Runtime Reconfiguration framework for autonomous fault tolerance in reconfigurable architectures for the *Adaptive Device Fault Occlusion through Competitive Runtime Reconfiguration* project, one of four research projects accepted by NASA from over 400 applications. Executed the following tasks on schedule for the project:

- Prototyped and implemented *Fault Injection and Analysis Toolkit (FIAT)*, an FPGA fault simulator using the C Programming Language, Python, and VHDL that injects stuck-at-faults and re-designs Field Programmable Logic Array configurations within constraints imposed by Xilinx design tools
- Developed Combinatorial Group Testing-based algorithms that isolate fault-affected FPGA logic resources using normal dataflow inputs
- Designed Genetic Algorithms for Consensus-Based Evaluation and Regeneration of Reconfigurable Hardware

- Realized an Self-monitoring, Self-diagnosing Organic System on Xilinx Virtex-II Pro FPGAs
- Created and maintained laboratory website and research hardware infrastructure

C. Research with Undergraduate Students

- Co-developed the *Genetic Algorithm Learning Module* for the NSF-sponsored *Combined Research and Curriculum Development (CRCD)* project in Machine Learning at the University of Central Florida. The module has been taught to 243 students in 8 undergraduate classes, and it motivates students to take senior-level course sequence entitled *Machine Learning I and II*
- Mentored and co-authored a conference publication with an undergraduate student, as part of the UCF CRCD project
- Co-authored an article submitted to the *IEEE Transactions on Education* describing the experiences and outcomes of the UCF CRCD project in Machine Learning

D. Journal Articles

1. M. Georgiopoulos, R. F. DeMara, A. J. Gonzalez, A. S. Wu, M. Mollaghasemi, E. Gelenbe, M. Kysilka, J. Secretan, C. A. Sharma, and A. J. Alnsour, "A Sustainable Model for Integrating Current Topics in Machine Learning Research into the Undergraduate Curriculum," accepted to *IEEE Transactions on Education*.
2. R. F. DeMara, K. Zhang, and C. A. Sharma "Autonomic Fault-Handling and Refurbishment Using Throughput-Driven Assessment," accepted with revision to *Applied Soft Computing*.

E. Conference Proceedings

1. A. Sarvi, C. A. Sharma, R. F. DeMara, "BIST-Based Group Testing For Diagnosis of Embedded FPGA Cores," in *Proceedings of the International Conference on Embedded Systems and Applications (ESA'08)*, Las Vegas, Nevada, U.S.A., July 14 – 17, 2008.
2. R. N. Al-Haddad, C. A. Sharma, R. F. DeMara, "Performance Evaluation of Two Allocation Schemes for Combinatorial Group Testing Fault Isolation," in *Proceedings of the International Conference on Engineering of Reconfigurable Systems and Algorithms (ERSA '07)*, Las Vegas, Nevada, U.S.A., June 25 – 28, 2007.
3. R. S. Oreifej, C. A. Sharma, R. F. DeMara, "Expediting GA-Based Evolution Using Group Testing Techniques for Reconfigurable Hardware," in *Proceedings of the IEEE International Conference on Reconfigurable Computing and FPGAs (Reconfig '06)*, San Luis Potosi, Mexico, September 20-22, 2006, pp 106-113.
4. C. A. Sharma, R. F. DeMara, "A Combinatorial Group Testing Method for FPGA Fault Location," in *Proceedings of the International Conference on Advances in*

- Computer Science and Technology (ACST '06)*, Puerto Vallarta, Mexico, January 23 - 35, 2006.
5. C. J. Milliord, C. A. Sharma, R. F. DeMara, "Dynamic Voting Schemes to Enhance Evolutionary Repair in Reconfigurable Logic Devices," in *Proceedings of the International Conference on Reconfigurable Computing and FPGAs (Reconfig '05)*, pp. 8.1.1 - 8.1.6, Puebla City, Mexico, September 28 - 30, 2005.
 6. K. Zhang, R. F. DeMara, C. A. Sharma, "Consensus-based Evaluation for Fault Isolation and On-line Evolutionary Regeneration," in *Proceedings of the International Conference in Evolvable Systems (ICES '05)*, pp. 12 -24, Barcelona, Spain, September 12 - 14, 2005.
 7. R. F. DeMara and C. A. Sharma, "Self-Checking Fault Detection using Discrepancy Mirrors," in *Proceedings of the International Conference on Parallel and Distributed Processing Techniques and Applications (PDPTA '05)*, pp. 311-317, Las Vegas, Nevada, U.S.A, June 27 – 30, 2005.

F. Articles Undergoing Review

1. R. F. DeMara, K. Zhang, C. A. Sharma, "Consensus-Based Evolvable Hardware for Sustainable Fault Handling," revision pending to *IEEE Transactions on Evolutionary Computation*.
2. C. A. Sharma, A. Sarvi, R.F. DeMara, "Automated BIST-Based Diagnostics and Group Testing Algorithms for Rapid Localization of Faults in FPGAs," in preparation for submission to the *Journal of Electronic Testing*.
3. C. A. Sharma, R. F. DeMara, A. Sarvi, "Group Testing-Based Self-Healing Reconfigurable Logic," in preparation for submission to *ACM Transactions on Autonomous and Adaptive Systems*.

Professional Affiliations and Service

- Student Member, IEEE, 2002-present
- Technical reviewer for the following journals/conferences:
 - *IEEE Transactions on VLSI Systems*
 - *International Conference on Engineering of Reconfigurable Systems and Algorithms (ERSA)*

Extra-Curricular Activities

- One of 300+ Community council-approved members of the Ubuntu Linux Distribution
- Technical reviewer of "Ubuntu for Non-Geeks: A Pain-Free, Project-Based, Get-Things-Done Guidebook," by Rickford Grant, No Starch Press, 2006