BARRY J. MULDREY, PH.D.

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Curriculum Vitae

APPOINTMENTS

University of Mississippi
Assistant Professor of Electrical and Computer Engineering *Fall 2020 to present*

RESEARCH SUMMARY

On-the-Fly Post-Silicon Validation of RF Systems (with application to hardware-trojan detection) Algorithms which use fabricated AMS hardware as the basis for generating its own validation tests. The approaches are novel in that no assumptions were made about classes of design anomalies present in the DUT; but rather, stimuli were generated using the DUT itself.

Multivariate Soft-Fault Detection Threshold Optimization in Analog Circuits Methodologies for algorithmic generation of test signals for detecting short and open-circuit defects in analog circuits. These techniques optimize test stimuli to be simultaneously and maximally sensitive to detection of the *weakest possible* manifestations of short and open faults in analog circuits.

Automated Diagnosis in Mixed-Signal Systems Algorithmic foundations for autonomous circuit diagnosis predictions which don't require any assumptions about the nature of design errors. Other approaches require prior knowledge about the kinds of likely design errors typically encountered; these methods employ iterative and alternate on-the-fly hypothesis synthesis , experimentation, and fitting of embedded low-order nonlinear filters to produce best-guess estimates of root cause.

Reinforcement Learning and Active Learning in Mixed-Signal Test Design Automation A first in the testing community, reinforcement-learning methods are integrated with circuit simulation tools to provide a globally convergent test stimulus optimization, a means of "storing" the valuable information created during stimulus generation, and low-cost iterated generation. Active learning components seek to automate the process of search space exploration in order to reduce the number of required simulations.

Public-key Authentication with Analog PUFs The use of process-sensitive nonlinear analog circuit structures to provide sufficient uniqueness for forming the basis of cryptographically secure identity authentication.

Power-Aware BIST and Tuning in RF Devices Pursuit of dynamic and power aware optimization architectures for coding and modulation selection in RF handsets in the presence of channel noise, multipath, interferers, ISI, etc.

High-rate Sampling with Low-Cost Hardware Award-winning research on techniques for robust and stable characterization of high-speed signals using asynchronous sub-Nyquist sampling on low-cost hardware.

PERSONAL SUMMARY

Barry grew up in New Orleans where he attended Jesuit High School. There he received a college preparatory education including five years of study in Latin and Homeric Greek. Barry performed music often; a banjo adaptation of "The Devil Went Down to Georgia" can likely be credited with his election as student council vice-president.

In 2003, Barry began attending the University of Southern California on a scholarship almost certainly granted for his *academic* achievements; he nevertheless pursued the study of jazz- and studio guitar performance. Returning to New Orleans after a year to work under Mark Bingham and John Fischbach at Piety Street Recording studios, a closet of broken electronics piqued his interest, and he began tinkering.

Hurricane Katrina threw the city into disarray and prompted Barry's reentry to academics in 2006 when he enrolled in the University of New Orleans' electrical engineering program. There he was fortunate to conduct research in neural networks and participate in team robotics under the guidance of Drs. Edit Bourgeois and Dimitrios Charalampidis.

After attempting a startup in recording studio technology, Barry joined Georgia Tech and shortly thereafter began his pursuit of the Ph.D. Supervised by Dr. Abhijit Chatterjee, he conducted research in circuit model validation, debugging, and machine learning for testing analog and mixed-signal systems, receiving his doctorate in the summer of 2019.

It was during the summer of 2013, while Barry was in Santa Clara, CA conducting research for the Intel Corporation, that he was very lucky to meet his wife, Ashley King, in neighboring Oakland where she was beginning her transition from school teacher to psychiatric healthcare provider. Together they live in a turn-of-the-century home which provides *seemingly infinite* opportunity for Barry's other hobbies: structural analysis, repair, and woodcraft.

AWARDS, HONORS, AND DISTINCTIONS

Best Paper Award, 2015 JETTA-TTTC, "Low Cost Sparse Multiband Signal Characterization Using Asynchronous Multi-Rate Sampling: Algorithms and Hardware."
Georgia Tech ECE FOCUS Ambassador, 2016
IEEE New Orleans Chapter student member of the year, 2008 and 2009
IEEE Region V Robotics Competition, 2009
IEEE Region V Circuit Design Competition, 2008,2009

INSTRUCTION

Testing of Computing Systems(UM:Cmp E 432)
Instructor 2020
Defects in digital systems; fault modeling; fault collapsing; test pattern synthesis; fault simulation; course project: code an ATPG tool and fault simulator.

Senior Design Project(UM:El E 461/462)
Instructor 2020
Teach fundamentals of independent pursuit of electronics design projects: Project planning; project management; system requirements and specifications; design process documentation; business memoranda; PCB design; BOM management; system assembly.

Fundamentals of Digital System Design (GT:ECE2020)
Periodic instruction, exam administration, and grading 2013-2018
Computer system and digital design principles. Switch and gate design, Boolean algebra, number systems, arithmetic, storage elements. Datapath, memory organization. Instruction set architecture, assembly language.

Digital Systems Testing (GT:ECE6130)
Periodic instruction, exam administration, and grading 2016-2018
Introduction to the basic concepts in digital systems testing. Advanced topics in fault modeling and simulation, test pattern generation, and design for testability.

Advanced Digital Systems Testing (GT:ECE7141)
Project evaluation 2017, 2018
Design and test techniques for high-speed digital systems operating at rates above 100 MHz with a practical emphasis via substantial projects.

EDUCATION

Georgia Institute of Technology
Ph.D., Electrical Engineering *August 2019*
Management of Technology *Jan 2015*
M.S. Electrical Engineering *May 2014*
University of New Orleans
B.S. in Electrical Engineering *May 2009*
University of Southern California
Undergraduate Study in Music *2003,2004*

ORGANIZATIONS

Georgia Tech College of Engineering Student Advisory Council
ECE Representative *2016*
Institute of Electrical and Electronics Engineers
Member *2007-present*
Tau Beta Pi
Louisiana Epsilon Chapter Vice President *2008,2009*
Member *2007-present*

OPEN-SOURCE CONTRIBUTIONS

Xanity
A Python-, Bash-, and Anaconda-based framework which promotes portability, reproducibility, documentation, and data-management hygiene in scientific computing. Xanity is available on Pypi (`pip install xanity`).

Circuitgym
An OpenAI-Gym compatible API for electrical circuit simulations to interface modern reinforcement learning libraries. Circuitgym is available on Pypi (`pip install circuitgym`).

Pyspectre
An easy-to-use and parallelizable Python interface to the Spectre circuit simulator from Cadence. Pyspectre is available on Pypi (`pip install pyspectre`).

LibPSF
A C library and Python binding for reading the native ".psf" binary output format of Cadence simulation software. Libpsf is available on Pypi (`pip install circuitgym`).
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PRESENTATIONS

Design Validation and Debugging Under Limited Observation and Control, IEEE International Test Conference, Ft. Worth, TX, 2016
Post-Silicon Validation of Mixed Signal Systems...,VLSI Test Symposium, Berkeley, CA, 2013
Mixed Signal Design Validation Using Reinforcement Learning, Techcon, Austin, TX, 2018
Mixed Signal Design Validation Using Reinforcement Learning, VLSI Test Symposium, Monterey, CA, 2019

TECHNICAL INDUSTRY EXPERIENCE

Kickr Design, Atlanta, GA

Electronics Project Manager *2017-2018*

Acted as liaison through early process development phase of silicon wafer based lab-on-a-chip project featuring ZnO and AlN solidly-mounted resonators. Managed electronics design and integration for therapeutic aerosol salt atomizer.

Intel Corporation, Santa Clara, CA

Graduate Intern *2013*

Contributed to development of internal fault-injection and simulation tool chain (C++). Also led exploratory research into automated test generation and fault-signature clustering tool (Matlab).

CDI (startup), New Orleans, LA

Founder *2008-2010*

Designed, prototyped, provisionally-patented, and marketed an ARM7 and 8051-based automation system for legacy professional audio equipment.

Keystone Engineering, Mandeville, LA

Control Systems Intern *2008-2009*

Designed electrical and control systems for unmanned oil and gas wells and associated apparatus in the inshore Gulf of Mexico. Additional focus on solar and battery backup system designs.

Cryopen, Covington, LA

Analog Design Engineer *2009*

Designed analog front end for ultra-low temperature (appx. -100C) thermocouple measurement subsystem for dermatological cryotherapy device.

Audubon Aquarium of the Americas, New Orleans, LA

Design and Exhibitry Technician *2004-2006*

Worked under technical director David Mancuso. Supervised operation of technical portions of interactive exhibits. Responsible for operation, maintenance, and repair of electronic exhibitry systems.

NONTECHNICAL EXPERIENCE

Piccadilly Housing, LLC, Atlanta, GA

Owner/Operator *2013-present*

Major structural repair and refurbishment of historic (1920) craftsman bungalow in Grant Park, Atlanta. Scope has included shoring and foundation replacement under existing building, substantial frame replacement and repair, upgrades to mechanical, electrical, and plumbing subsystems, and complete replacement of exterior siding and trim.

Piety Street Recording, Bywater, LA

Recording Engineer *2004-2007*

Worked under Chief Engineer Mark Bingham. Prepared studio for recording sessions, repaired various recording equipment, assisted in control room during recording sessions, recorded songs for self and others during unbooked hours.

Gem Printing, Metairie, LA

Printer *2003-2005*

Performed hot foil-transfer stamping of pencils and matchbooks. Prepared, exposed, and developed screens for silk-screen printing and produced custom-printed handkerchiefs. Also responsible for menial shop-cleanup tasks.

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Publications

PATENTS

Analog Push Pull Amplifier-Based Physically Unclonable Function for Hardware Security,U.S. pat. 20170126415A1. Georgia Tech Research Corp. 2017.

PEER-REVIEWED JOURNAL ARTICLES

Muldrey,B., Chatterjee, A., "Automated Extraction and Verification of Numerical Behavioral Models", *IEEE Transactions on Design Automation of Electronic Systems* *

Banerjee, Debashis et al. "Self-Learning RF Receiver Systems: Process-Aware Real-Time Adaptation to Channel Conditions for Low Power Operation." In: *IEEE Transactions on Circuits and Systems I: Fundamental Theory and Applications* (2016).

Charalampidis, Dimitrios and Barry Muldrey. "Clustering Using Multilayer Perceptrons." In: *Nonlinear Analysis* 71.12 (2009), e2807–e2813.

Tzou, Nicholas et al. "Low Cost Sparse Multiband Signal Characterization Using Asynchronous Multi-Rate Sampling: Algorithms and Hardware." In: *Journal of Electronic Testing* 31.1 (2015), pp. 85–98.

Tzou, Nicholas L. et al. "Concurrent Multi-Channel Crosstalk Jitter Characterization Using Coprime Period Channel Stimulus." In: *Circuits and Systems I: Regular Papers, IEEE Transactions on* 63.6 (2016), pp. 859–870.

PROFESSIONAL LITERATURE

Muldrey, B., "The Efficiency the Public Wants and the Efficiency it Gets", *IEEE Technology and Society Magazine* *

PEER-REVIEWED CONFERENCE ARTICLES

Muldrey,B., "A Computing-Energy Consumption Model for Consumer Applications Supported by Network Systems", *IEEE Conference on Technologies for Sustainability* *

Banerjee, D. et al. "Self-Learning MIMO-RF Receiver Systems: Process Resilient Real-Time Adaptation to Channel Conditions for Low Power Operation." In: *2014 IEEE/ACM International Conference on Computer-Aided Design (ICCAD)*. 2014 IEEE/ACM International Conference on Computer-Aided Design (ICCAD). 2014, pp. 710–717.

Chatterjee, A., S. Deyati, B. Muldrey, et al. "Validation Signature Testing: A Methodology for Post-Silicon Validation of Analog/Mixed-Signal Circuits." In: in collab. with undefined. International Conference on Computer Aided Design. ACM, 2012, pp. 553–556.

Chatterjee, A., S. Deyati, and B. J. Muldrey. "Post Silicon Validation of Analog/Mixed Signal/RF Circuits and Systems: Recent Advances." In: *2016 IEEE 21st International Mixed-Signal Testing Workshop (IMSTW)*. 2016 IEEE 21st International Mixed-Signal Testing Workshop (IMSTW). 2016, pp. 1–6.

Deyati, S., A. Banerjee, et al. "VAST: Post-Silicon VAlidation and Diagnosis of RF/Mixed-Signal Circuits Using Signature Tests." In: *2013 26th International Conference on VLSI Design and 2013 12th International Conference on Embedded Systems*. 2013 26th International Conference on VLSI Design and 2013 12th International Conference on Embedded Systems. 2013, pp. 314–319.

Deyati, S., B. J. Muldrey, A. Banerjee, et al. "Atomic Model Learning: A Machine Learning Paradigm for Post Silicon Debug of RF/Analog Circuits." In: *2014 IEEE 32nd VLSI Test Symposium (VTS)*. 2014 IEEE 32nd VLSI Test Symposium (VTS). 2014, pp. 1–6.

Deyati, S., B. J. Muldrey, and A. Chatterjee. "Adaptive Testing of Analog/RF Circuits Using Hardware Extracted FSM Models." In: *2016 IEEE 34th VLSI Test Symposium (VTS)*. 2016 IEEE 34th VLSI Test Symposium (VTS). 2016, pp. 1–6.

Deyati, S., B. J. Muldrey, and A. Chatterjee. "Targeting Hardware Trojans in Mixed-Signal Circuits for Security." In: *2016 IEEE 21st International Mixed-Signal Testing Workshop (IMSTW)*. 2016 IEEE 21st International Mixed-Signal Testing Workshop (IMSTW). 2016, pp. 1–4.

Deyati, S., B. J. Muldrey, and A. Chatterjee. "TRAP: Test Generation Driven Classification of Analog/RF ICs Using Adaptive Probabilistic Clustering Algorithm." In: *2016 29th International Conference on VLSI Design and 2016 15th International Conference on Embedded Systems (VLSID)*. 2016 29th International Conference on VLSI Design and 2016 15th International Conference on Embedded Systems (VLSID). 2016, pp. 463–468.

Deyati, S., B. J. Muldrey, and A. Chatterjee. "Trojan Detection in Digital Systems Using Current Sensing of Pulse Propagation in Logic Gates." In: *2016 17th International Symposium on Quality Electronic Design (ISQED)*. 2016 17th International Symposium on Quality Electronic Design (ISQED). 2016, pp. 350–355.

Deyati, S., B. J. Muldrey, A. D. Singh, et al. "Challenge Engineering and Design of Analog Push Pull Amplifier Based Physically Unclonable Function for Hardware Security." In: *2015 IEEE 24th Asian Test Symposium (ATS)*. 2015 IEEE 24th Asian Test Symposium (ATS). 2015, pp. 127–132.

Deyati, Sabyasachi, Barry Muldrey, and Abhijit Chatterjee. "BISCC: Efficient Pre through Post Silicon Validation of Mixed-Signal/RF Systems Using b Uilt Ins Tate c Onsistency c Hecking." In: *Proceedings of the Conference on Design, Automation & Test in Europe*. European Design and Automation Association, 2017, pp. 274–277.

Deyati, Sabyasachi, Barry Muldrey, Adit Singh, et al. "Design of Efficient Analog Physically Unclonable Functions Using Alternative Test Principles." In: *2017 International Mixed Signals Testing Workshop (IMSTW)*. IEEE, 2017, pp. 1–4.

Deyati, Sabyasachi, Barry J. Muldrey, et al. "Concurrent Built in Test and Tuning of Beamforming MIMO Systems Using Learning Assisted Performance Optimization." In: *2017 IEEE International Test Conference (ITC)*. IEEE, 2017, pp. 1–10.

Deyati, Sabyasachi, Barry John Muldrey, et al. "High Resolution Pulse Propagation Driven Trojan Detection in Digital Logic: Optimization Algorithms and Infrastructure." In: *Test Symposium (ATS), 2014 IEEE 23rd Asian*. IEEE, 2014, pp. 200–205.

Muldrey, B., S. Deyati, and A. Chatterjee. "Concurrent Stimulus and Defect Magnitude Optimization for Detection of Weakest Shorts and Opens in Analog Circuits." In: *2016 IEEE 25th Asian Test Symposium (ATS)*. 2016 IEEE 25th Asian Test Symposium (ATS). 2016, pp. 96–101.

Muldrey, B., S. Deyati, and A. Chatterjee. "DE-LOC: Design Validation and Debugging under Limited Observation and Control, Pre- and Post-Silicon for Mixed-Signal Systems." In: *2016 IEEE International Test Conference (ITC)*. 2016 IEEE International Test Conference (ITC). 2016, pp. 1–10.

Muldrey, B., S. Deyati, M. Giardino, et al. "RAVAGE: Post-Silicon Validation of Mixed Signal Systems Using Genetic Stimulus Evolution and Model Tuning." In: *VLSI Test Symposium (VTS), 2013 IEEE 31st*. VLSI Test Symposium (VTS), 2013 IEEE 31st. 2013, pp. 1–6.

Muldrey, Barry. "Mixed Signal Design Validation Using Reinforcement Learning Guided Stimulus Generation for Behavior Discovery." In: *Proceedings IEEE VLSI Test Symposium*. VLSI Test Symposium. Monterey, CA, USA: IEEE, 2019.

Muldrey, Barry, Sabyasachi Deyati, and Abhijit Chatterjee. "Post-Silicon Validation: Automatic Characterization of RF Device Nonidealities Via Iterative Learning Experiments on Hardware." In: VLSI Design Conference. Hyderabad, India, 2016.

MUSICAL PUBLICATIONS

Recording Engineer and Producer

United Talking Machine Symphony, *United Talking Machine Symphony*, 2006
The Gubernatorial Candidates, *The Gubernatorial Candidates* (EP), 2006
The Gubernatorial Candidates, *No Remainder* (single), 2008
Something Delicious, *Dialectability*, 2007

Assistant Recording Engineer

Voice of the Wetlands Allstars (Dr. John, The Neville Brothers, Anders Osborne, Tab Benoit, et al.), *Voice of the Wetlands*, 2005
All the King's Men, *Motion Picture Soundtrack*, 2006
The Interlopers, *You Make it Sound So Bad*, 2005
Dr. Dog, *Live at House of Blues*, 2006
The Morning 40 Federation, *Morning 40 Federation*, 2004
The Morning 40 Federation, *Ticonderoga*, 2006
The Morning 40 Federation, *Personal Hygiene Live*, 2011

Performances

Bass guitar, The Matthew Resignola Band, Carrolton Station, New Orleans, LA, 2005-2008
Bass guitar, organ, piano, vocals; "The Matthew Resignola Band," *Piety Street (EP)*, 2004
Bass guitar, duo w. Patrick Gaulin, Hi-Ho Lounge, New Orleans, LA, 2006
Bass guitar, duo w. Patrick Gaulin, Saturn Bar, New Orleans, LA, 2005
Drums, "The Gubernatorial Candidates", One-Eyed Jack's, New Orleans, LA, 2007

An asterisk (*) indicates an impending submission.