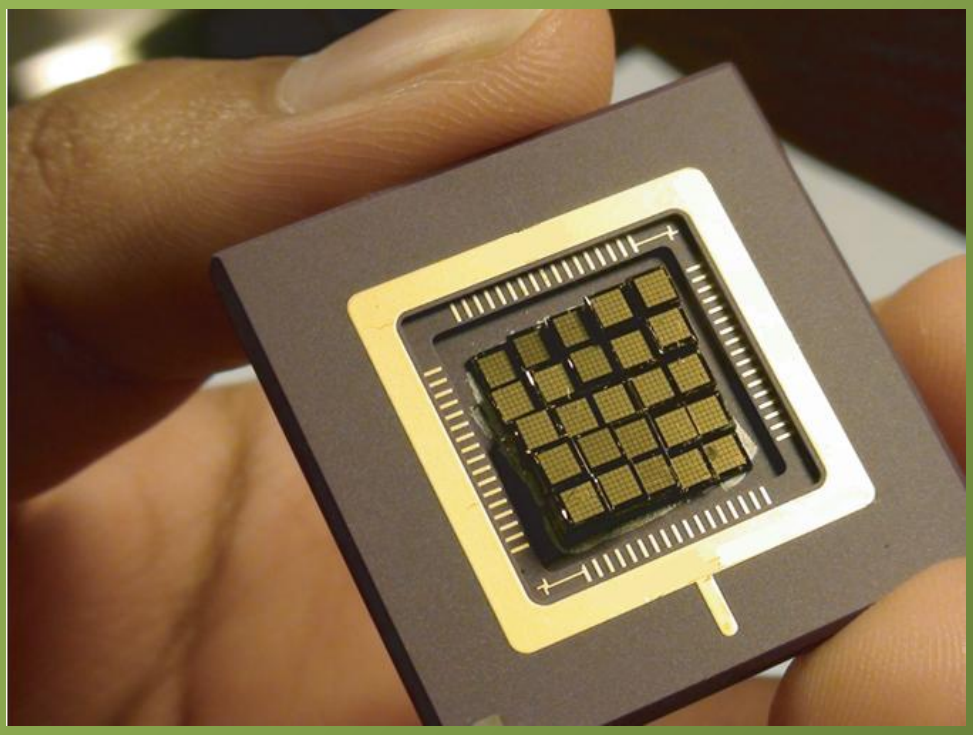
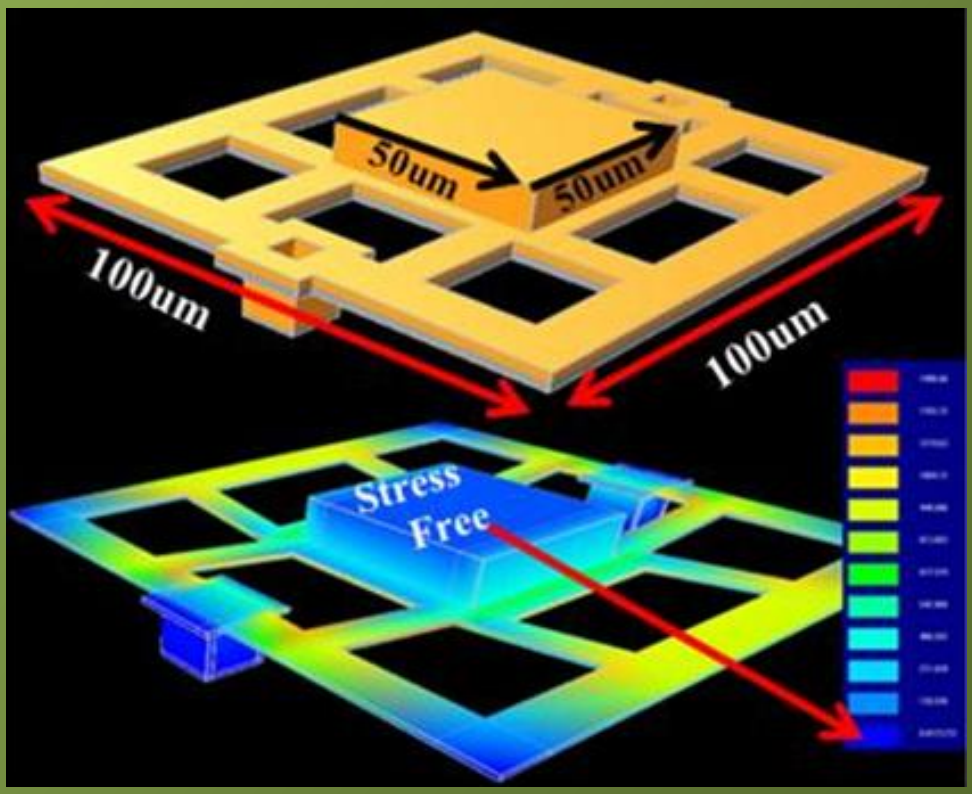
RESEARCH CENTRE FOR INTEGRATED MICROSYSTEMS (RCIM) REPORT

January 1, 2010 – December 31, 2010

Department of Electrical & Computer Engineering
University of Windsor





Director's Report for 2010

I am delighted to present the 2010 annual report of the Research Centre for Integrated Microsystems (RCIM), at the Department of Electrical and Computer Engineering, University of Windsor. RCIM was established in January 2000 with an extensive financial support and encouragements from the former President, Ross Paul, and the former Provost and Vice President Academic, Professor Neil Gold and Dr. Graham Reader, former Dean of Engineering to conduct leading edge research, develop collaborative partnerships and train highly qualified graduate students in various areas of integrated Microsystems with applications in the field of digital signal processing, communication, automotive electronics few to mention. RCIM currently has 11 faculty members, 17 PhD students and 22 MASc students who are actively pursuing research in this facility.

In 2010 RCIM faculty members graduated 10 MA.Sc. and 3 Ph.D. students. During the same year, our members received more than **$1,600,000** in grants and contracts and the results from their research works generated 36 papers published in premier Refereed Journals and top tier Refereed Conferences as well as filing two US patents. Also, RCIM members delivered 22 research seminars during 2010 and our members were active in organizing various international conferences including: ISSCS, IEEE-ICECS, and IEEE-MWSCAS few to mention. They have also served on the editorial board of various journals.

On behalf of the RCIM faculty and student members I would like to express our sincere thanks for the continued support we have been receiving from the President, Dr. Alan Wildeman, Vice-President Research, Dr. Ranjana Bird, and the Acting Dean of Engineering, Dr. Robert Gaspar of the University of Windsor. The support and encouragement received from Dr. Sid-Ahmed, Head of the Department of Electrical and Computer Engineering is also very much appreciated. Finally, we are especially thankful to CMC Microsystems for providing RCIM with multi-million dollar state-of-the-art facilities allowing us to design advanced integrated Microsystems and for subsidizing our IC fabrication costs.

Majid Ahmadi, PhD, C.Eng., FIET, FIEEE
Director of RCIM
University Professor

RCIM Areas of Specialization

The Research Center for Integrated Microsystems within the Department of Electrical and Computer Engineering in the Faculty of Engineering at the University of Windsor is carrying out leading edge research, in the following areas:

1. **MICROELECTRONIC,** including:

    - High Speed DSP System
    - Computer Arithmetic
    - Encryption
    - Radio Frequency Identification (RFID)
    - Testing of Mixed Signal Integrated Circuits
    - Field Programmable Chips and Systems
    - CMOS and Nanoelectronic circuits design

2. **MICROELECTROMECHANICAL SYSTEMS (MEMS),** including:

    - Sensors and Filters
    - Capacitive Microphones and 3-D Acoustical Sensing
    - Electromagnetic Microactuators
    - Acousto-Magnetic Transducers
    - Optical Switching MEMS
    - Automotive Sensors
    - Customs MEMS Sockets
    - Micro power Generators
    - Atomic Force Microscopy
    - MEMS RADAR

3. **DIGITAL SIGNAL PROCESSING AND COMMUNICATION,** including:

    - Algorithms
    - Massively Parallel Arrays and Special Architects
    - Computer Vision and Image Processing
    - Pattern Recognition and Document Analysis
    - Network Security Management
    - Network Management

These projects vary from fundamental pre-competitive research to mission-oriented research, technology transfer and prototype development. We are particularly interested in areas requiring advanced signal processing systems embedded in complex integrated Microsystems.

I. RCIM MEMBERS

(A) Faculty Members:

Eleven professors in Electrical and Computer Engineering carry out research and supervise graduate students as members of the RCIM. The day-to-day operation of the Center is administered by the coordinator of the RCIM, who provides training for new graduate students on how to use the facilities, as well as maintaining the hardware and CAD tools used by the RCIM members.

1. Dr. Majid Ahmadi, Professor (Director, RCIM)
2. Dr. Shervin Erfani, Professor
3. Dr. Chunhong Chen, Professor
4. Dr. Esam Abdel-Raheem, Associate Professor
5. Dr. Sazzadur Chowdhury, Associate Professor
6. Dr. Roberto Muscedere, Associate Professor
7. Dr. Mohammed Khalid, Associate Professor
8. Dr. Huapeng Wu, Associate Professor
9. Dr. Mitra Mirhassani, Assistant Professor
10. Dr. Rashid Rashidzadeh (Adjunct Professor and RCIM Coordinator)
11. Dr. William C. Miller (RCIM Director Emeritus)

(B) Student Members:

RCIM has a strong track record of training outstanding graduate students. Our students have been very competitive in the private sector and in admission to PhD programs at major universities.

❖ RCIM Students Graduated in 2010

First name	Surname	Program	Thesis
Bashier	Elkarami	MASc	An Efficient Design of 2-D digital filter by singular Value Decomposition and Genetic algorithm with CSD Coefficients
Mohammed Jahirul	Islam	PhD	Artificial Neural Network and Its Application in Quality process Control document Recognition and Biomedical Imaging
Sundeep	LAL	MASc	A 77 GHz MEMs Radar Signal Processing System For Automotive Collision Avoidance
Jianjun	Li	PhD	Algorithms & Implementation of Advanced video Coding Standards
Matthew	Murawski	MASc	NoC Prototyping on FPGAs: Component Design, Architecture Implementation and Comparison
Christopher	Rennick	MASc	TCP/IP Control Server For A Multi-Drop Test Bench Network
Shu-Yi (Jack)	Wong	MASc	Low Power CMOS Rectifier and Chien Search Design for RFID Tags
Kwasi	Afrifa	MASc	FPGA Implementation of a Frame Delay
Carl	Chute	MASc	Digital Control in Tube Power Amplifiers
Suzana	Farzeen	MASc	A Nano-Power Voltage-Controlled oscillator Design for RFID Applications
Ahmad	Sinjari	PhD	A MEMs Based Radar Sensor For Automotive Collision Avoidance
Iman	Khodadadzadeh	MASc	Recognition of Handwritten Arabic-Persian Characters
Al-Laith	Taha	MASc	FPGA Implementation of Blind Source Separation Using FastICA

❖ Current RCIM Students

First name	Surname	Program	Supervisor	Thesis
Iftekhar	Ibne Basith	MASc	Dr. M. Ahmadi & Dr. R. Rashidzadeh	A built-in Self-test solution for CMOS-MEMs Sensors
Abbas	Elazhari	MASc	Dr. M. Ahmadi	2-D Digital Filter Design
Suhas	Sreehari	MASc	Dr. M. Ahmadi & Dr. H. Wu	Eliptic Curve Cryptography
Shruti	Kubatur	MASc	Dr. M. Ahmadi & Dr. Sid-Ahmed	Handwritten Word Recognition
Ayesa	Parvin	MASc	Dr. M. Ahmadi & Dr. R. Muscedere	High Performance DSP Architecture
Farhad	Hajali-Asghari	PhD	Dr. M. Ahmadi & Dr. J.Wu	Power Management and Leakage Power Reduction Methods in Deep Sub-Micron Nodes
Amir Hossein	Nabatchian	PhD	Dr. M. Ahmadi & Dr. Abdel-Raheem	Human Face Recognition Artificial Neural Network and Its Applications in Quality Process Control, Document Recognition and Biomedical Imaging
Golnar	Khodabandehloo	PhD	Dr. M. Ahmadi & Dr. Mirhassani	A Prototype CVNS Distributed Neural Network
Mahzad	Azarmehr	PhD	Dr. M. Ahmadi & Dr. Jullien	Arithmetic with Two-Dimensional Logarithmic Number System (2DLNS)
Karl	LeBeouf	PhD	Dr. M. Ahmadi & Dr. Muscedere	Design and Implementation of Digital Neural Network
Iman	Makaremi	PhD	Dr. M. Ahmadi	Face Recognition with Degraded Images
Soodeh	Nikan	PhD	Dr. M. Ahmadi	Human Face Recognition
Shoaleh	Hashemi-Namin	PhD	Dr. M. Ahmadi & Dr. H.Wu	Low-Power Arithmetic over Finite Field
Nabeeh	Khandalf	PhD	Dr. M. Ahmadi & Dr. R. Rashidzadeh	MEMS Interface Board
Muhammad	Supon	MASc	Dr. M. Ahmadi & Dr. R. Rashidzadeh	A PLL Based Readout and BIST for MEMS Sensors
Mahnaz	Shafii	PhD	Dr. M. Ahmadi & Dr. Sid-Ahmed	On Persian Word Recognition
Ismail	Hamieh	MASc	Dr. S. Chowdhury	A Reconfigurable MEMS based Microstrip Antenna

Amar	Sawadi	MASc	Dr. S. Erfani & Dr. R. Rashidzadeh	A High Gain Scanning Patch Antenna for RFID
Krishnamohan	Thangrajah	PhD	Dr. S. Erfani & Dr. R. Rashidzadeh	Indoor Location Positioning using WLAN networks
Soke	Onyemelukwe	MASc	Dr. S. Erfani	Authentication and Confidentiality in Ad Hoc Network Environment
Diana	Nano	MASc	Dr. S. Erfani	Security Issues in WiFi Network and their Resolutions
Tugrul	Zure	MASc	Dr. S. Chowdhury	Characterization of a Non-Planar CMUT Array
Mohan	Thangarajah	MASc	Dr. M. Kahlid	A New Simplified Algorithm Suitable for Implementation on FPGA for Turbo Codes
Guoqing	Deng	PhD	Dr. C. Chen	Hybrid SET-MOS Arithmetic Circuits Design
Mario	Mendizal	MASc	Dr. C. Chen	Low Power Demodulator Design for RFID Applications
Chia-Chin	Liu	MASc	Dr. C. Chen	SET-Based Boltzmann Machines for Neural Networks
Naila	Syed	MASc	Dr. C. Chen	Low Power Static MemoryCell Design Using Single-Electron Devices
Ajit	Muhury	MASc	Dr. C. Chen	TBA
Olakunle	Esuruoso	M.ASc	Dr. H. Wu	Efficient Implementation of Hash Functions in FPGA
Walid Mustafa	Mahmoud	Ph.D	Dr. H. Wu	Efficient Inversion in GF(2^m)
Salem	Abdullah	Ph.D	Dr. H. Wu	TBA
Yiruo	He	M.Sc	Dr. H. Wu	Efficient Modular Exponentiation with resistance to Side Channel Attacks
Babak	Zamanloo	PhD	Dr. Mirhanssani	A prototype CVNS neural network
Amit Kumar	Patel	PhD	Dr. Mirhanssani	Nano and micro implementations of on-line neuronal network for real time signal processing
Ashley	Novak	MASc	Dr. Mirhanssani	Insect-based vision chip for car collision avoidance
Farinoush	Saffar	MASc	Dr. Mirhanssani& Dr. Ahmadi	High accuracy low-power Multiplying-Digital-to-Analog-Converters
Soheil	Servati	PhD	Dr. R. Muscedere	Hardware Acceleration of Text Display
Leila	Sepahi	MASc	Dr. R. Muscedere	MDLNS addition/subtraction using co-transformation
Daniel	MacDonald	MASc	Dr. R. Muscedere	A hardware based image file decoder

Graduate Student Summary

Currently, RCIM faculty members are supervising 22 MASc students and 17 Doctoral candidates. Over 50% of RCIM graduate students were recipients of various scholarships from NSERC, OGS, and the University of Windsor.

IV. PROFESSIONAL ACTIVITIES of RCIM FACULTY MEMBERS

Dr. M. Ahmadi:

- Member of IEEE-CAS Society Neural Network Committee
- Regional Editor, Journal of Circuits, Systems and Computer
- Associate Editor for Pattern Recognition Journal
- Member of the Steering Committee for the IEEE Midwest Symposium on Circuits and Systems
- Technical Program Chair for 2011 International Symposium on Signals, Circuits and Systems, June 2011 Iasi, Romania
- Member of Technical Program Committee for 2011 IEEE Midwest Symposium on Circuits and Systems, August 2011, Seoul, Korea.

Dr. M. Khalid:

- Reviewer for ACM Transactions on Reconfigurable Technology and Systems
- Reviewer for IEEE Trans. on CAD, IEEE Trans. on VLSI and several IEEE sponsored conferences
- Reviewer for Journal of Circuits, Systems and Computers, published by World Scientific
- Reviewer for Canada Foundation for Innovation (CFI)
- Reviewer for Natural Sciences and Engineering Research Council (NSERC)
- Reviewer for Research Grants Council of Hong Kong

Dr. E. Abdel-Raheem:

- Editorial Board Member, IET (formerly IEE) Signal Processing,
- Associate Editor, Canadian J. Elec. & Comp. Eng. (CJECE)

Dr. S. Chowdhury :

- Reviewer, Elsevier, Communications in Nonlinear Science and Numerical Simulations
- Reviewer, IEEE Sensors Journal
- Reviewer, IEEE Transactions on Circuits and Systems I
- Reviewer, Journal of Nanotechnology, Institute of Physics Publishing, Dirac House, Temple Back, Bristol, UK
- Reviewer, Journal of Physics D: Applied Physics, Institute of Physics Publishing, Dirac House, Temple Back, Bristol, UK
- Reviewer, Journal of Micromechanics and Microengineering, Institute of Physics Publishing, Dirac House, Temple Back, Bristol, UK

Dr. S. Erfani:

- Member of Steering Committee, IEEE Midwest Symposium on Circuits and Systems
- Technical Advisory Board member, Journal of Network and Systems Management

Dr. R. Rashidzadeh:

- Reviewer for IEEE International Conference on Electronics, Circuits, and Systems 2010.
- Reviewer for IEEE transaction on Instrumentation and Measurement
- Reviewer for Journal of Analog Integrated Circuits and Signal Processing

I. SCHOLARY ACTIVITIES AND PUBLICATIONS

(a) Refereed Journal Publications

1. Jianjun Li and Esam Abdel-Raheem, "Efficient Rate Control for H.264/AVC Intra Frame", IEEE Trans. On Consumer Electronics, pp. 1043-1048, May, 2010.

2. Jianjun Li and Esam Abdel-Raheem, , Modeling DV/DVCPRO Standards on Reconfigurable Video Coding Framework, Journal of Elec. & Comp. Eng., Hindawi, Volume 2010 (2010), Article ID 509394, 7 pages.

3. Jianjun Li and Esam Abdel-Raheem, Fast Implementation of H.264 4x4 Intra Prediction, IEICE Electronics Express (ELEX), Vol. 7, No. 5 (2010), pp. 332-338, Mar. 2010.

4. Iman Makaremi, M.Ahmadi "A Novel Representation in Wavelet Domain" Pattern Recognition Journal , Vol.43, No.12, December 2010,pp3950-3957.

5. N. Chang, R. Rashidzadeh, M. Ahmadi "Robust Indoor Positioning Using Differential WI-FI Access Points" IEEE Transactions on Consumer Electronics,Vol.56, No.3, August 2010,pp1860-1867.

6. M.J. Islam, M.Ahmadi, M.A. Sid-Ahmed, Y.M. Alginahi " Optimal Parameter Selection Technique for a Neural Network Based Local Thresholding Method" Journal of Pattern Recognition, 2010, pp 69-94.

7. M.Azarmehr, M. Ahmadi, G.A. Jullien, and R. Muscedere, : `High-Speed and Low-Power Reconfigurable Architectures of 2-digit 2DLNS-based Recursive Multipliers', IET Journal on circuits, Devices & Systems Volume: 4 , Issue: 5, 2010, pp. 374 - 381.

8. M. Azarmehr, and R. Muscedere,.: `A RISC Architecture for 2DLNS-based Signal Processing', International Journal of High Performance Systems Architecture (IJHPSA), 2010, In press.

9. A. Hosseinzadeh Namin, H.Wu, M.Ahmadi "High –Speed Architectures for Multiplication Using Reordered Normal Basis" Accepted for publication in IEEE Transactions on Computers, Date of acceptance August 20, 2010.

10. A. Hosseinzadeh Namin, H. Wu, M.Ahmadi "A word-Level Finite Field Multiplier Using Normal Basis" in press in IEEE Trans. On Computers, Vol. 60, 890 - 895, 2011.

11. A. Nabatchian, E. Abdel-Raheem, M.Ahmadi " Illumination Invariant Feature Extraction and Mutual-Information Based Local Matching for Face Recognition Under Illumination Variation and Occlusion" Accepted for publication in Pattern Recognition Journal. Date of acceptance March 14, 2011. 26 Manuscript pages.

12. A. Hosseinzadeh Namin, K. Leboeuf, R. Muscedere, H. Wu, and M. Ahmadi, "High Speed Hardware Implementation of a Serial-In Parallel-Out Finite Field Multiplier Using Reordered Normal Basis", IET Circuits, Devices & Systems, 4(2), 168-179, March 2010.

13. M.J. Islam, M. Ahmadi, M.A. Sid-Ahmed " An efficient Automatic Mass Classification Method in Digitized Mammograms Using Artificial Neural Network" International Journal of Artificial Intelligence & Applications (IJAIA), Vol. 1, No. 3, pp. 1-13, 2010.

14. M.J. Islam, Q.M.J. Wu, M.Ahmadi, M.A. Sid-Ahmed " Investigating the Performance of Naïve Bayes Classifiers and K-Nearest Neighbor Classifier" Journal of Convergence Information Technology (JCIT), Vol. 5, No. 2, pp 133-137, 2010.

15. G. Khodabandehloo, M. Mirhassani, M. Ahmadi; "Resistive-Type CVNS Distributed Neural Networks With Improved Noise to Signal Ratio", IEEE Transactions on Circuits and Systems II, Vol. 57, No. 10, pp. 793-797, 2010

16. G. Khodabandehloo, M. Mirhassani, M. Ahmadi; "Analog Implementation of a Novel Resistive-Type Sigmoidal Neuron", IEEE Transactions on Very Large Scale Integration (VLSI) Systems, in Press, 2010

17. G. Khodabandehloo, M. Mirhassani, M. Ahmadi;"CVNS Based Storage and Refreshing Scheme for a Multi-Valued Dynamic Memory, IEEE Transactions on Very Large Scale Integration (VLSI) Systems", In Press, 2010

(b) Refereed Conference papers

1. M.Azarmehr, M.Ahmadi, G,.A. Jullien "Recursive Architecture for 2DLNS Multiplication" Proc. of 2010 IEEE-ISCAS, June 2010, Paris, France, pp3869-3872.

2. M.Azarmehr, R. Rashidzadeh, M.Ahmadi "High- Speed CMOS Track-and-Hold with an Offset Cancellation Replica Circuit" Proc. of 2010 IEEE-ISCAS, June 2010, Paris, France, pp 4297-4300.

3. I. Makaremi, M.Ahmadi "A Mutual Information Based Face Recognition Method" Proc. of 2009 International Conference on Neural Information Processing, Dec. 2009, Bangkok, Thailand, pp70-707.

4. A. Nabatchian, E. Abdel-Raheem, M.Ahmadi "An Efficient Method for Face Recognition Under Illumination Variation" Proc. of 2010 International Conference on High Performance Computing and Simulation, June 28- July2, 2010, Caen, France, pp 432-435.

5. Mosaddequr Rahman, Sazzadur Chowdhury, "A New Deflection Shape Function for Square Membrane CMUT Design", Proceedings of IEEE ISCAS2010, 2010, Paris, France, vol. 1, pp. 2019-2022

6. M. Rahman, S. Chowdhury, "Analysis of a MEMS-Based Ring–Disc Electrode System for Stabilization of Microbubbles in Aqueous Solution Using Dielectrophoretic Force", in Proc. of 3rd International Joint Conference on Advanced Materials and design,(ISDT2009), May 11-14, 2009, pp. 1-6.

7. A. Sinjari, S. Chowdhury, "A Single-Pole-Triple-Throw (SP3T)MEMS RF Switch for 24 GHz Short Range Radar", in Proc. of IEEE EIT2009, June 7-9, 2009, Windsor, ON, pp. 182-185.

8. M. Rahman, S. Chowdhury, “A Highly Accurate Method to Calculate Capacitance of MEMS Sensors with Circular Membranes”, in Proc. Of EIT2009, June 7-9, 2009, Windsor, ON, pp. 178-181.

9. A. Sinjari, S. Chowdhury, “High Performance 77 GHz Single Pole Triple Throw (SP3T) MEMS Switch”, in Proc. of IEEE NEWCAS-TAISA’09, June 28-July 1, 2009, Toulouse, France, pp-1-4.

10. M.Brugge, M. Khalid, “Design and Evaluation of a Parameterizable NoC Router for FPGAs”, 18th ACM/SIGDA International Symposium on FPGAs, FPGA 2010, Feb. 21-23, 2010, Monterey, California.

11. G. Deng and C. Chen, Towards Robust Design of Hybrid CMOS-SETs Using Feedback Architectures, in Proceedings of 2010 IEEE International Conference on Nanotechnology (IEEE-Nano'10), August 2010, Seoul, South Korea, pp.

12. V. Puthucode and C. Chen, Delay Models for Single-Electron-Tunneling Based Logic Circuits, in Proceedings of 2010 International Conference on Nanotechnology: Fundamentals and Applications, August 2010, Ottawa, Canada, pp. 241.1-241.8.

13. S. Farzeen, G. Ren, and C. Chen, An Ultra-Low Power Ring Oscillator for Passive UHF RFID Transponders, in Proceedings of 2010 IEEE Midwest Symposium on Circuits and Systems (MWSCAS'10), August 2010, Seattle, USA, pp. 558-561.

14. K.Leboeuf, A.H. Namin, H. Wu, R. Muscedere, M. Ahmadi, “Efficient VLSI implementation of a finite field multiplier using reordered normal basis “ 53rd IEEE International Midwest Symposium on Circuits and Systems (MWSCAS), 2010 Page(s): 1218 – 1221

15. M.J. Islam, M. Ahmadi, M.A. Sid-Ahmed “ Computer-Aided Detection and Classification of Masses in Digital Mammogram Using Artificial Neural Networks” Proceedings of ICSI 2010, LNCS, Springer Verlag Berlin- Heidelberg, Vol. 6146, pp 327-334, 2010.

16. Babak Zamanlooy, Mitra Mirhassani, "System-Level Design of Low Complexity CVNS Feedforward Neural Network", IEEE International Symposium on Circuits and Systems (ISCAS), pp. 2578 - 2581, 2010

17. Golnar Khodabandehloo, Mitra Mirhassani, Majid Ahmadi, "Resistive-Type CVNS Distributed Neural Networks With Improved Noise-to-Signal Ratio ", IEEE International Symposium on Circuits and Systems (ISCAS), 793 – 797, 2010

18. S. Erfani and N. Bayan, "Frequency analysis of linear time-varying systems," Proc. IEEE International Conference on Electronics, Circuits, and Systems (ICECS 2010), pp. 1116-1119, Athens, Greece, Dec. 12-15, 2010.

19. I. Basith, N. Kandalaft, R. Rashidzadeh, “Build-in self-test for capacitive MEMS using a charge control technique,” *IEEE 19th Asian Test Symposium(ATS2010)*, pp. 135–140, Shanghai, China, Dec. 01-04, 2010.

20. N. Kandalaft, I. Basith, R. Rashidzadeh, “A MEMS based device interface board,” *International Test Conference*, Austin, Texas, Oct. 31-Nov. 05 2010

Papers Presented at Special Workshops and Symposia

1. Sazzadur Chowdhury, APMA-Auto21 Conference, APMA, Auto21, Windsor, ON, A MEMS-Based Intelligent Active Safety System for Vehicles, 2010, June, Project leaders report on AUTO21 funded project "A MEMS-Based Intelligent Active Safety System for Vehicles ".
2. N. Kandalaft, R. Rashidzadeh, M. Ahmadi, "High-speed test channels for die level testing," CMC Annual Symposium, Ottawa, Canada, Oct. 04-05, 2010
3. I. Basith, N. Kandalaft, R. Rashidzadeh, M. Ahmadi, "A new BIST architecture for MEMS fault detection," CMC Annual Symposium, Ottawa, Canada, Oct. 04-05, 2010

(c) Patents Registered and Applied for

Dr. S. Chowdhury: **MEMS Radar for ranging and velocity measurement** (US provisional patent)
Dr. Rashidzadeh, Mr. Nabeeh Kandalaft and Dr. Ahmadi: **A MEMS Based Device Interface Module** (US provisional patent)

II. LIST OF SEMINARS HELD IN 2010

1) **Efficient VLSI Implementation of a Finite Field Multiplier Using Reordered Normal Basis & Domino Logic Design Flow**
Feb. 05, 2010
Presenter: Karl Leboeuf

2) **An Efficient Design of 2-D Digital Filters Using Singular Value Decomposition**
Feb. 12, 2010
Presenter: Bashier Elkarami

3) **Neural Network Applications in Quality Process Control, Document Recognition and Biomedical Imaging**
Feb. 19, 2010
Presenter: Mohammed Islam

4) **Leakage Control Techniques in High Performance Register Memory Arrays in Deep Sub-micron (DSM) Technologies**
Feb. 26, 2010
Presenter: Farhad Haj Ali Asgari

5) **Accurate and Low-cost Indoor Location Estimation in a Decorrelated Space**
Mar. 12, 2010
Presenter: Ning Chang

6) **Recursive Architectures for 2DLNS Multiplication**
Apr. 09, 2010

Presenter: Mahzad Azarmehr

7) **Artificial Neural Networks: Introduction, and Recent Developments**
Apr. 23, 2010
Presenter: Karl Leboeuf

8) **Leakage control techniques in high performance microprocessor registers**
Apr. 30, 2010
Presenter: Farhad Haj Ali Asgari

9) **Characterization of Variable Systems**
Jul. 23, 2010
Presenter: Dr. Shervin Erfani

10) **Efficient VLSI Implementation of a Finite Field Multiplier Using Reordered Normal Basis**
Jul. 30, 2010
Presenter: Karl Leboeuf

11) **Blur Invariants: A Novel Representation in the Wavelet Domain**
Aug. 06, 2010
Presenter: Iman Makaremi

12) **Resistive-Type CVNS Distributed Neural Networks**
Aug. 13, 2010
Presenter: Golnar Khodabandeloo

13) **Register Files in High-Performance Microprocessors: Leakage Current and Reliability**
Aug. 27, 2010
Presenter: Farhad Haj Ali Asgari

14) **Design digital filters by genetic algorithm**
Aug. 27, 2010
Presenter: Bashir Elkarami

15) **MEMS Based Device Interface Board for High-Speed Automatic Testers**
Sept. 10, 2010
Presenter: Nabeeh Kandalaft

16) **A 2DLNS-based Finite Impulse Response (FIR) Filter Design**
Sept. 17, 2010
Presenter: Mahzad Azarmehr

17) **An Overview of Finite Multipliers**
Oct. 01, 2010
Presenter: Shoaleh Hashemi Namin

18) **Towards Robust Design of Hybrid CMOS-SETs Using Feedback Architectures**
Oct. 15, 2010
Presenter: Guoqing Deng

19) **Directional Antenna for Radio Frequency Identification (RFID) Passive Transponders**
Oct. 22, 2010
Presenter: Amar Swadi

20) **A Built-in Self-Test for Capacitive MEMS Sensors**
Oct. 29, 2010
Presenter: Iftekhar Ibne Basith

21) **GPU Acceleration of Elliptic Curve Cryptography**
Nov. 19, 2010
Presenter: Karl Leboeuf

22) **A Low Power Static Memory Design Using Single Electron Devices**
Dec. 03, 2010
Presenter: Naila Syed

AWARDS AND HONOURS

Dr. M. Ahmadi received University of Windsor Award for Excellence in Scholarship, Research and Creativity, Feb. 2010.

III. GRANTS AND CONTRACTS RECEIVED BY THE RCIM MEMBERS

1. Dr. M. Ahmadi, NSERC Discovery Grant, $58,471.
2. Dr. C. Chen, NSERC Discovery Grant $20,000
3. Dr. C. Chen, AUTO21, $17,000
4. Dr. R. Muscedere, NSERC Discovery Grant $20,000
5. Dr. M. Khalid, NSERC Discovery Grant $20,000
6. Dr. M. Mirhassani, NSERC Discovery Grant $19,000
7. Dr. S. Chowdhury, NSERC Discovery Grant $20,000
8. Dr. S. Chowdhury, Ontario Centres of Excellence, 4. A MEMS 77 GHz Radar Sensor grant, $97,000 /year
9. Dr. S. Chowdhury, MEMS-Based Intelligent Active Safety Systems, Auto21, $70,700/year
10. Dr. Huapeng Wu, NSERC Discovery Grant $20,000
11. ECE internal research grant for RCIM faculty members $140,000
12. In-Kind support of $210,030 per year from IntellliSense Software Inc. towards the license of their MEMS CAD tools

13. CMC Microsystems contributions to RCIM totaled **$975,975.25** for 2010. The breakdown of the funding is as follows:

Support, Design Kits, Training Material, Tutorials and Fabrication	**$232,090.90**
Microsystems CAD Tools	**$743,884.35**
Total	**$975,975.25**

Total Grants received by RCIM members in 2010: $1,688,176.25

IV. GRADUATE COURSES TAUGHT BY RCIM MEMBERS

1. Dr. S. Erfani — 06-88-557: Network Security
2. Dr. S. Erfani — 06-88-523: System Theory
3. Dr. M. Ahmadi — 06-88-521 Digital Signal Processing
4. Dr. M. Ahmadi — 06-88-590 Motion Estimation
5. Dr. E. Abdel-Raheem — 06-88-551: Advanced Digital Signal Processing
6. Dr. E. Abdel-Raheem — 88-562: VLSI Implementation of DSP Systems
7. Dr. M. Khalid — 06-88-560: Reconfigurable Computing
8. Dr. M. Khalid — 06-88-590: Physical Design Automation for VLSI and FPGAs
9. Dr. R. Muscedere — 06-88-531: VLSI Design
10. Dr. C. Chen — 06-88-541: Low Power CMOS Design
11. Dr. C. Chen — 06-88-590-43: Introduction to Nanoelectronic Design
12. Dr. H. Wu — 06-88-555: Computer Arithmetic
13. Dr. H. Wu — 06-88-529: Discrete Transforms & Number Theoretical
14. Dr. S. Chowdhury — 06-88-552: Advanced Topics in MEMS
15. Dr. Rashidzadeh — 06-88-590-37: Advanced Analog Circuit Design
16. Dr. Rashidzadeh — 06-88-590-74: RF Integrated Circuit Design
17. Dr. M. Ahmadi — 06-88-525: 2-Dimensional Digital Signal Processing
18. Dr. M. Mirhassani — 06-88-590-47: Analog IC mask design

V. COLLABORATIVE RESEARCH WITH THE PRIVATE SECTOR

Gennum Corporation , 970 Fraser Drive, Burlington, Ontario L7L 5P5

***Principal Investigator*:** Dr. G.A. Jullien/ Dr. M. Ahmadi,

Project: Integrated Systems for High Performance Signal Processing. NSERC-CRD with industrial support from Gennum

Pharmaphil , 3190 Devon Rd , Windsor, Ontario N8X 4L2

Principal Investigator: Dr. M. Ahmadi, Co-PIs, Dr. R. Muscedere, Dr. W. Abul-Kader

Project: A Computer Vision-Based Quality Process Controller for Pharmaceutical Products OCE project with support from MMO, NSERC and Pharmaphil of Windsor, Ontario

IntellliSense Software Inc. 600 West Cummings Park, Suite 2000, Woburn, MA,

Project: Collaborative research partnership. In-Kind support of $210,030 per annum

Principal Investigator: Dr. S. Chowdhury

Dr. Chowhury's OCE and Auto21 Auto21 initiated several technology transfer meetings during 2010 and 2011 to transfer the developed technology to OEMs, Tier 1 automotive suppliers, and microelectronic companies including: **Toyota North America**, **Fujitsu Tan**, **Magna Electronics**, **Invotronics, Escort Manufacturing**.

CMC Microsystems Corporation, 210A Carruthers Hall, Kingston, Ontario, Canada K7L 3N6

Principal Investigators: M.Ahmadi, C. Chen, W.C. Miller, .S. Chowdhury, . R. Muscedere, M. Khalid, Mitra Mirhassani, R. Rashidzadeh

Project: System-on-Chip (SoC) Design Methodology, Authoring IP Cores

Jean Monnet University, France

Dr. Ahmadi and Dr. Rashidzadeh were involved in co-supervision of (Briand Yoann) who spent 6 months of internship at RCIM.

Benha University, Egypt

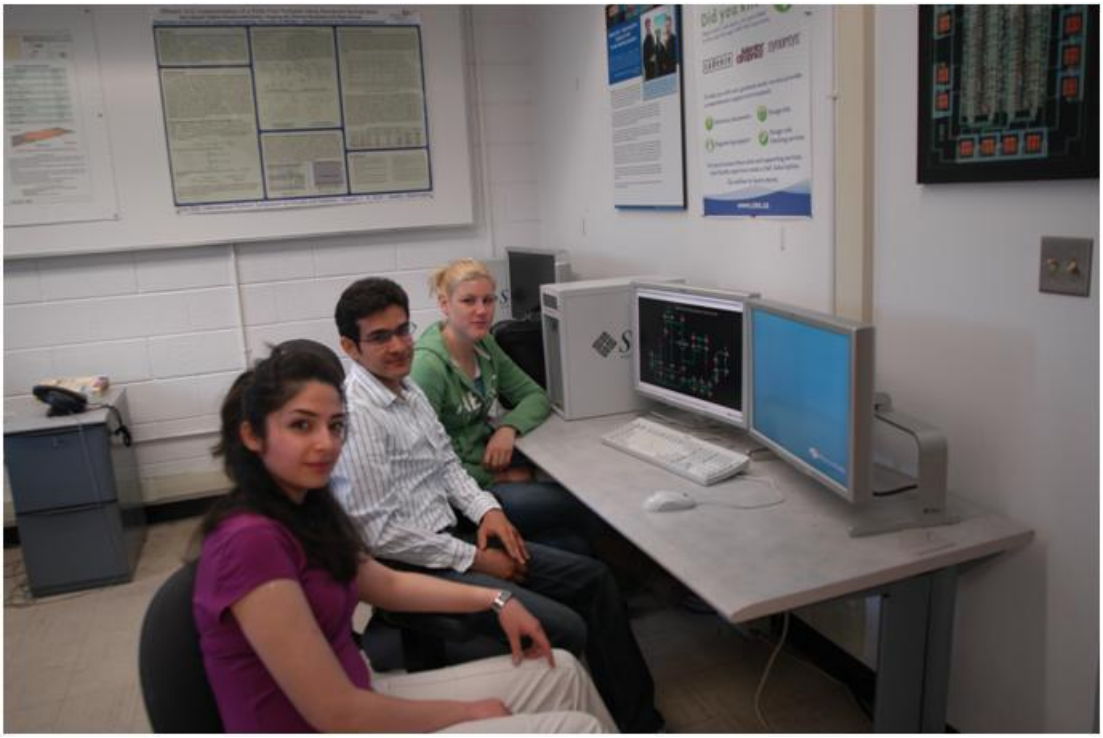
Dr. Abdel Raheem was involved in supervision of a Ph.D. student (Doaa Ashmawy) who conducted her research for two years in the RCIM Lab.

VI. PHOTOGRAPHS

RCIM Director, Dr. M. Ahmadi, presenting the results of his research at National University of Defense Technology (NUDT) in China

RCIM Director, Dr. M. Ahmadi, presenting the results of his research in (NUDT) China

RCIM students and faculty members



RCIM graduate students (from right to left) Ashley Novak, Babak Zamanlooy and Farinoush Saffar Montasheri working on hardware implementation of artificial neural networks.

Tugrul Zure an M.A.Sc student testing an implemented Capacitive Micromachined Ultrasonic Transducer (CMUT)

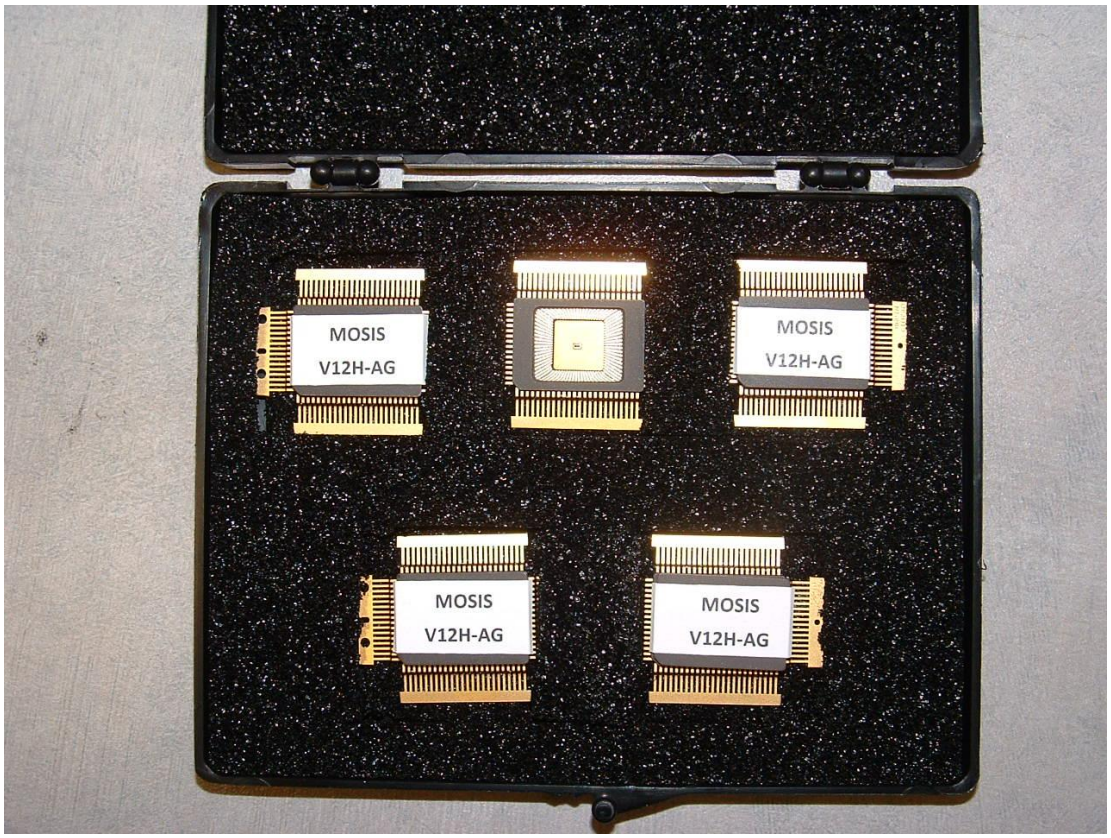
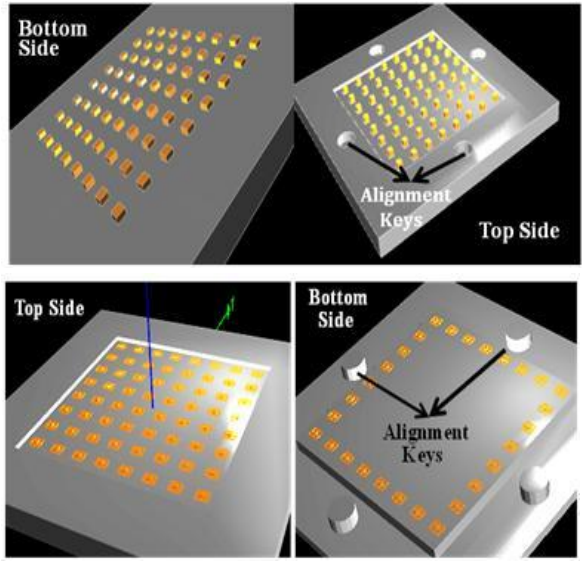
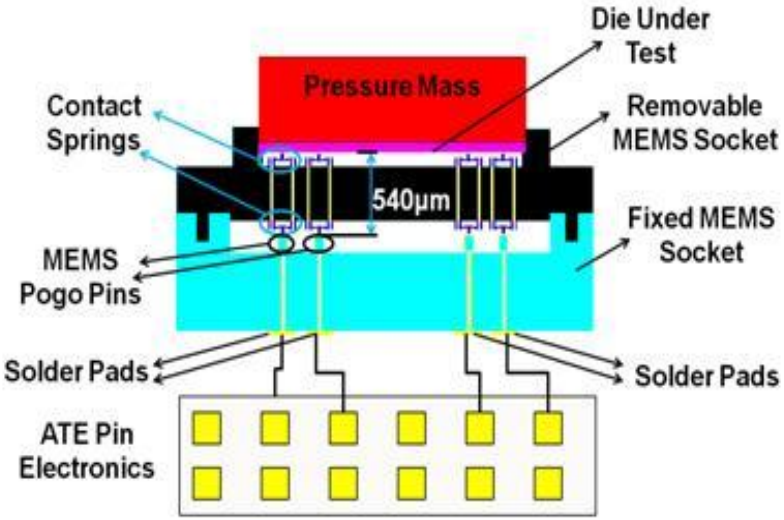


Photo of MEMS readout circuits designed by RCIM graduate students using TSMC CMOS 65nm technology

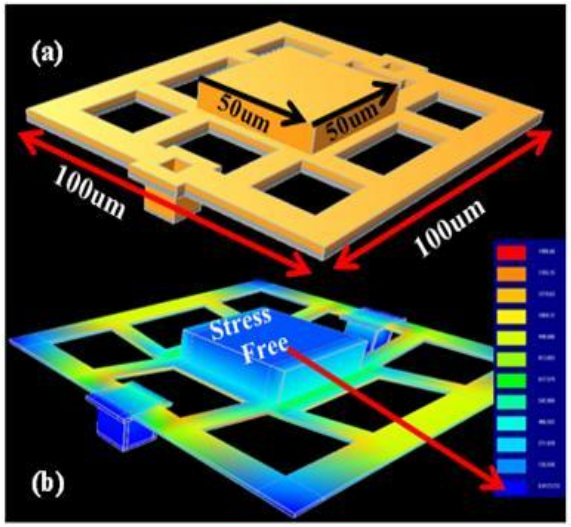
A MEMS Based Device Interface Module

Nabeeh Kandalaft, Ph.D. Candidate
Supervisors: Dr. R. Rashidzadeh and Dr. M. Ahmadi





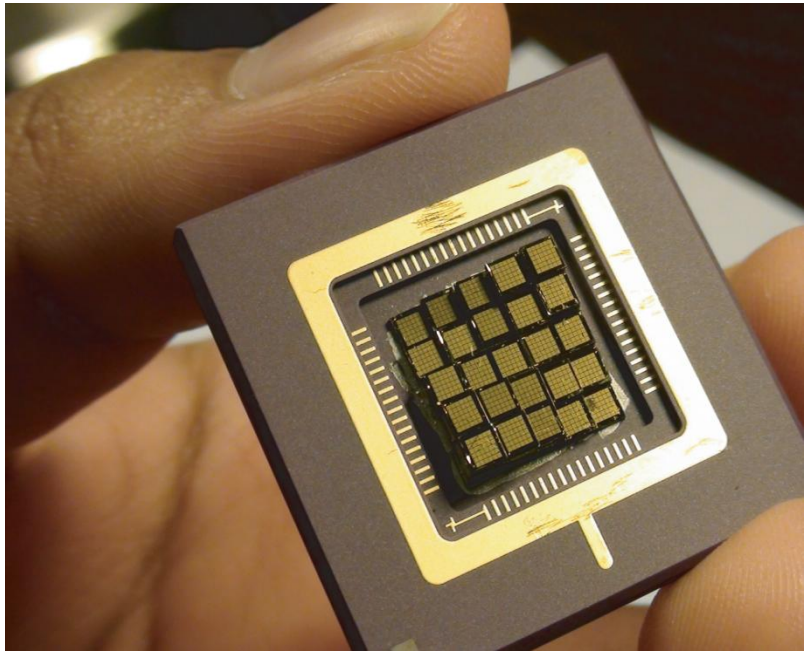
At gigahertz frequency range, performance degradation of the device interface board increases the yield loss and the cost of manufacturing. In this work a MEMS based solution is proposed to design a Device Interface Board (DIB) supporting high-speed connectivity between the device under test and the tester. Simulation results indicate that the proposed scheme can operate up to 50 GHz without considerable signal integrity degradation



Characterization of a Non-Planar CMUT Array

Tugrul Zure, M.A.Sc. Student
Supervisor: Dr. S. Chowdhury

Capacitive Micromachined Ultrasound Transducers (CMUT) are considered the next generation of ultrasound transducers. They operate in a variety of environments with less coupling loss, less temperature dependence, higher bandwidth and higher sensitivity comparing to piezoelectric transducers. Their broadband frequency range makes them suitable for medical imaging and non-destructive testing. This work includes a read-out circuit and FPGA implementation of a novel air-coupled non-planar CMUT array for blind spot detection and park assist applications.

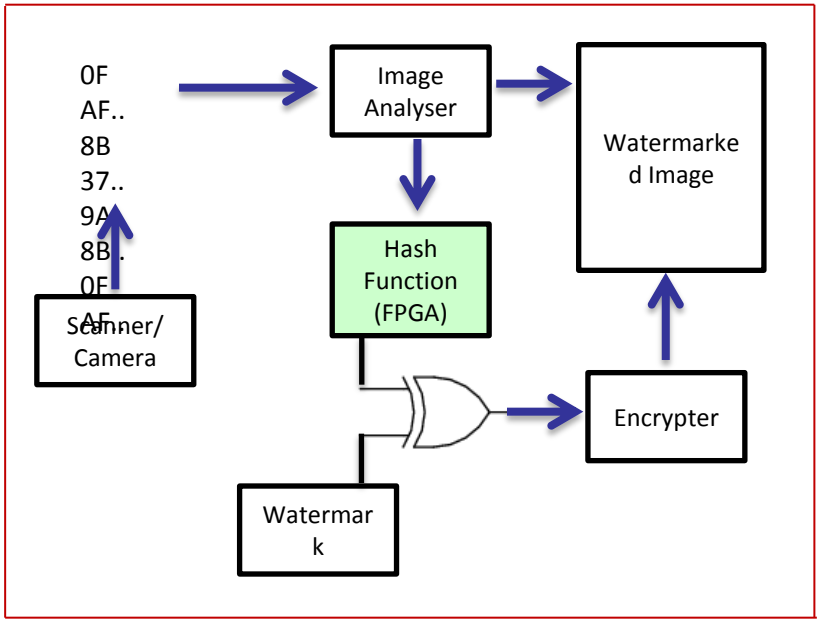


CMUT Array

High Speed FPGA Implementation of Cryptographic Hash Functions using Dynamic Programming

Olakunle Esuruoso, M.A.Sc. Student
Supervisor: Dr. H. Wu

Hashing a message or set of messages can give rise to overlapping sub-problems (repeated computations). A new hash function architecture which incorporates dynamic programming to effectively combat overlapping sub-problems and improve the speed of the hash function is designed. FPGA implementation is chosen for its re-configurability and rapid prototyping capability. The newly designed hash function is applied in Wong's algorithm for digital image watermarking



Digital Image Watermarking

Face Recognition with Degraded Images

Iman Makaremi, PhD Candidate
Supervisor: Professor Majid Ahmadi

Facial images which are acquired by surveillance cameras are not always perfect. They are usually degraded by different levels of blur, which could be caused by the movement of the subject, an unfocused camera, to name a few.

Since in a face recognition task, the goal is mostly to identify the individuals, the focus is on developing and utilizing descriptors that are blur invariant.

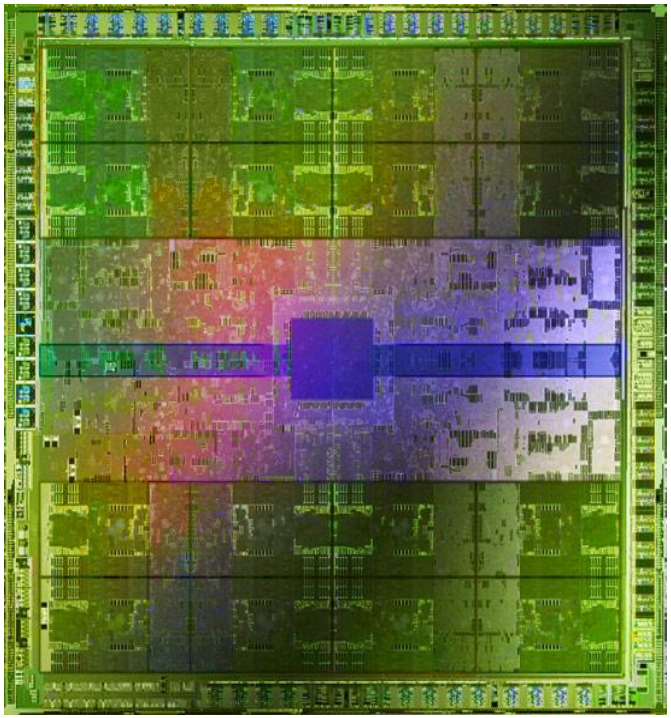
We have proposed blur invariant descriptors in the wavelet domain for the first time. The advantages of these descriptors are inherited from the domain that they are developed in. We are currently utilizing and evaluating the performance of these descriptors by applying them on different face databases.

GPU Implementation of Finite Field Arithmetic for Elliptic Curve Cryptography

Karl Leboeuf, Ph. D. Student
Supervisors: Dr. R. Muscedere, Dr. M. Ahmadi

On a daily basis, nearly everyone exchanges important or personal information over the vast collection of public networks that make up the internet. As end-users become more aware of how easy it is for their data to be stolen over these public networks, demand will increase for strong encryption protocols, which translates into a greater computational burden for web servers.

This project examines the use of inexpensive graphics processing units (GPUs) for carrying out the computationally expensive math operations that make up common cryptography operations.



An NVidia GPU die featuring 512 streaming multiprocessors

Low Power Hardware Acceleration of Text Placement

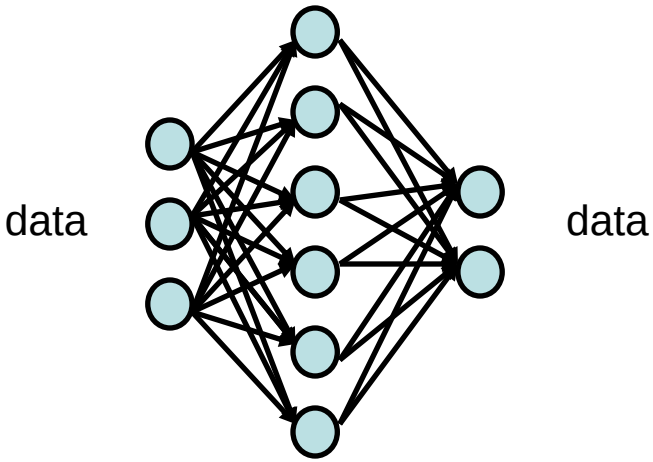
Soheil Servati Beiragh, PhD Student
Supervisor: Dr. R. Muscedere

Computing power of handheld devices are limited by the amount of battery power they consume and the limited area. Most of the context shown on display of such devices is text. According to several different tests, the process of text layout is the most time consuming one for CPU. In our proposed method this task will be done in a small hardware component which consumes much less power than CPU and also applies kerning to text for better readability. This will make the process faster and consumes less power.

Design and Implementation of CVNS Based Artificial Neural Networks with On-Chip Learning

Babak Zamanloo, Ph.D. Candidate
Supervisor: Dr. Mitra Mirhassani

Neural networks have a better performance comparing to Von Neuman computers in the applications that are ill defined and need enormous amount of processing. An example is pattern recognition. Hardware implementation of neural networks is interesting when cost, speed and fault tolerance is considered. Achieving low Noise-to-Signal-Ratio (NSR) is one of the major concerns when implementing hardware-based neural networks. To improve the NSR, alternative arithmetic can be employed. The Continuous Valued Number System (CVNS) is a candidate for such application. A CVNS-based neural network with on-chip learning capability is going to be implemented. Circuit simulation and verification is done using Cadence Framework simulator and the fabrication will be done through CMC corporation.

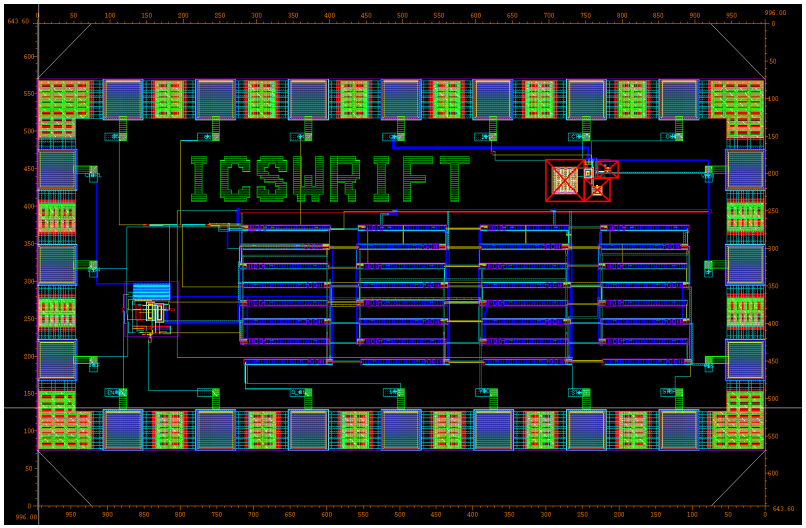


Madaline Architecture

A New Integrated Readout and Built-in Self-Test Method for Capacitive MEMS using a Charge Control Technique

Iftekhar Ibne Basith, M.A.Sc. Student
Supervisor: Dr. Rashid Rashidzadeh & Dr. Majid Ahmadi

A new readout circuit with integrated Built-in Self-Test (BIST) method for capacitive Micro-Electrical-Mechanical System (MEMS) devices using charge-control method is proposed.



Layout of the Chip

The input stimuli for the Device Under Test (DUT) is current source. A precision Time-to-Digital Converter (TDC) is used to measure the converted time domain signals from the output of the DUT. the proposed scheme is self-calibrated to reduce the need for external equipments and performs well under process, supply and temperature variations. A comb drive is designed for the simulation purpose and results indicate that the proposed method can successfully measure and detect minor structural defects altering the MEMS nominal capacitance.

Low Power Finite Field Arithmetic Units for Wireless Network Security

Shoaleh Hashemi Namin, PhD Student
Supervisor: Dr. M. Ahmadi
Co-Supervisor: Dr. H. Wu

The main computation involved in an elliptic curve cryptosystem is scalar multiplication, which can be broken down into finite field arithmetic operations, such as addition, multiplication, and inverse. Finite field addition is not a complex operation, so hardware implementation of addition operation is straightforward. Finite field inversion can be performed by using multiplications and squaring. Therefore, finite field multiplication is the most important operation in finite field arithmetic and EC cryptographic algorithms. As a result, a large number of architectures have been proposed for efficient implementation of finite field multipliers.

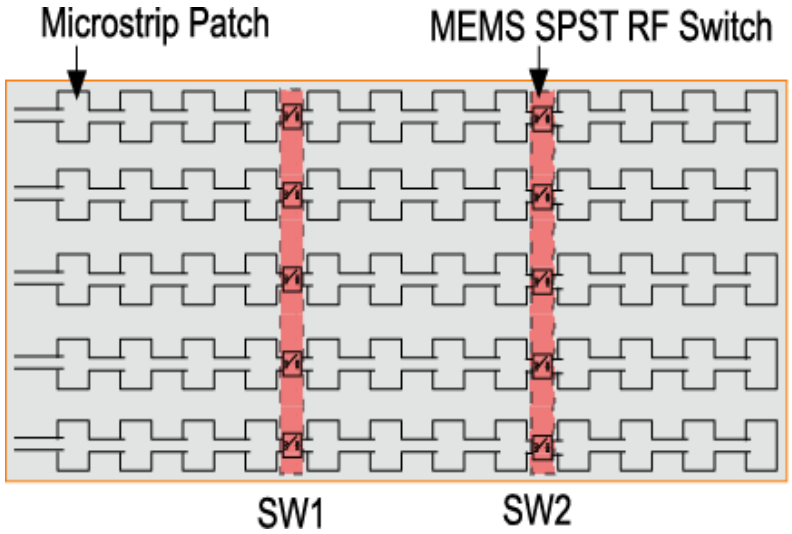
When the target are portable devices such as RFID tags, Wireless sensors and Contactless smart cards that are heavily constrained in terms of cost, size and power-consumption, low power design of finite field multipliers is useful.

A low power architecture is proposed for implementing finite field multiplication operation.

A 77 GHz Reconfigurable Micromachined Microstrip Antenna Array

Ismail Hamieh, M.A.Sc. Student
Supervisor: Dr. Sazzadur Chowdhury

This work presents a method to synthesize substrate in a silicon wafer. Micromachining techniques have been utilized to remove a portion of silicon material from underneath a specified cavity region resulting in two separate dielectric regions of air and silicon. The design of 77 GHz micromachined microstrip antenna array for multi-mode radar is presented along with the results.

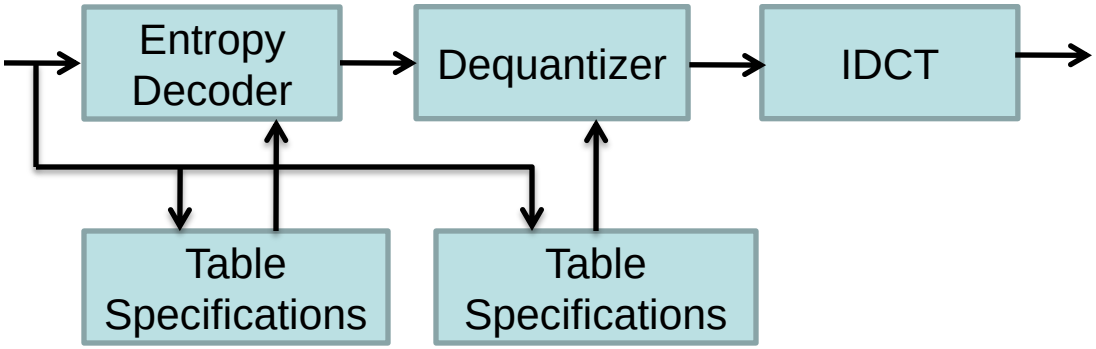


Micromachined Microstrip Antenna Array

Hardware JPEG Decompression

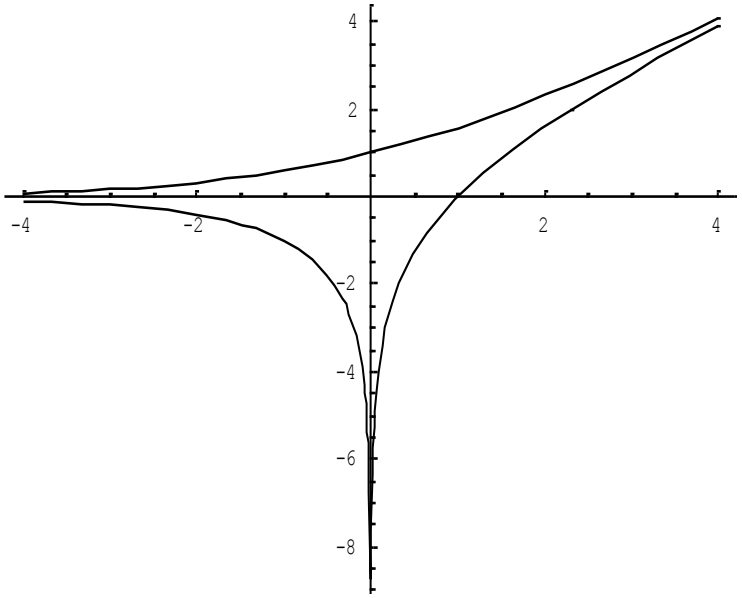
Dan MacDonald, M.A.Sc. Student
Supervisor: Dr. R. Muscedere

JPEG images are typically decoded in software. Delays are experienced when viewing large images, or collection of images. The computationally expensive operations, such as the inverse DCT, Huffman tree decoding, and dequantization can be implemented in hardware in a few clock cycles, greatly improving the timing bottleneck when decoding the image for viewing.



DCT Based JPEG Decoder

A Hardware Efficient Single-Digit Multi-Dimensional Logarithmic Number System Addition and Subtraction Circuit

Leila Sepahi, M.A.Sc. Student
Supervisor: Dr. R.Muscedere

The Multi-Dimensional Logarithmic Number System, which is a generalization of the classical Logarithmic Number System (LNS). Unlike the LNS, there is no monotonic relationship between standard linear representations and MDLNS representations. Traditionally lookup tables (LUTs) were used to perform addition and subtraction. However they can be unrealistic for hardware implementations when large exponent ranges are used. We try to apply Cotransformation to the MDLNS addition and subtraction tables to reduce the memory requirement.