CESCA Newsletter

Center for Embedded Systems for Critical Applications

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From the Director's Desk

A new academic year is upon us, and we are at full steam through the fall 2010 semester. Soon the picturesque yellow, red, green foliage will show up on the mountains around Blacksburg. As I was pondering what to write in my very first column as the new CESCA director, such matters descended upon my mind. Since its very inception in 2003, Prof. Dong Ha bravely, valiantly, and judiciously led CESCA as the director, and more recently made strong efforts to reinvigorate CESCA into a cohesive but diversified portfolio of expertise in research. His efforts to inculcate a sense of community among the CESCA members – faculty and students alike - has made CESCA a great place to work, and a great source of support for its members, in terms of various resources. Prof. Ha, not only impregnated the CESCA vision with community based striving for excellence, but also financially supported CESCA through its various ups and downs. Today, I can proudly say that I have taken the torch from his hand to take it to higher grounds, and I hope to accomplish it with the support of you – all the CESCA faculty and students. When we founded CESCA in 2003, we did not have the mature integrative vision that we have today. So I ask you all to join me in thanking Prof. Dong Ha for his contributions, and his insistence to make CESCA what it is today, and his vision for even better tomorrow. Prof. Ha will remain in charge of the corporate affiliate program, the website and publicity of CESCA, while I will struggle with other mundane issues of directorship.

As you know, we have decided to publish three Newsletters every year – one each for fall, spring and summer semesters. This particular issue of the newsletter is to declare our accomplishments during the summer semester of 2010, and understand the scopes of future improvements. CESCA faculty and students have been busy through the summer publishing, bringing in research funding, participating in various conferences, and workshops, and traveling around to give invited talks. All these are important for the enhancement of CESCA's the reputation inside and outside Virginia Tech, and for the betterment of the quality of our research, recruiting, and eventually our contributions to the society at large. Also, our students have graduated and found productive positions in the industry as is the case during any other semester. Some of you have also been to various industries to experience the real world outside academics. Hopefully, you will keep in touch with the alumni who have graduated, for networking, and knowledge sharing purposes. I also hope that those who have gained experiences through co-operative and internship opportunities in the industry will share it with your fellow students. The continual exchange of the academic research and the industry is how we can achieve technology transfer. In a related news, thanks to Prof. Ha, CESCA got its first industrial affiliate member this summer. Altogether, I reckon this as a successful summer, but we want to succeed beyond success, and hence I count on your hard work, and enthusiasm – faculty and student alike.

In the fall semester, we want to continue doing good work, and as a director, I want to figure out new ways to extend CESCA's effectiveness in industrial knowledge transfer, by expanding our corporate affiliate program. This will be a major emphasis during the next two semesters. The corporate affiliates will gain early access to technology, and intellectual properties developed by CESCA members, and also are able to hire interns, co-ops, and full time employees from CESCA through more organized channels. The existence of corporate members will also help the faculty and students to gain better understanding of the industrial needs in research and development and will allow us to help the companies to build their research portfolio.

Prof. Patrick Schaumont is the new deputy director of CESCA who will help me run CESCA with his ideas, and his great experience with IMEC in Belgium. In addition Prof. Schaumont is in charge of weekly seminars this year. He is initiating a new format, and modus operandi for CESCA seminars to enhance the academic values of these seminars. I request all CESCA faculty and student to help him accomplish this by regularly attending CESCA seminars and taking active part in discussions. Prof. Jungmin Park remains in charge of CESCA finances. Prof. Yaling Yang is the new editor of CESCA newsletter. Prof. Leyla Nazhandali is in charge of CESCA meetings, and gatherings. Prof. Lynn Abbott and Prof. Michael Hsiao will organize the next big CESCA event – CESCA day of 2011. As mentioned before Prof. Dong Ha is taking care of website, publicity, and together with Prof. Park, the affiliate program. Without them, and our administrative expert Ms. Yumi Lim, running a center of this size (as of the latest count, CESCA has 54 graduate students, multiple undergraduate researchers, and 8 faculty members) would be impossible. My sincere thanks and gratitude goes to all of them.

Finally, I wish all of you great success through the fall semester, and we will touch base again in the spring semester when we publish the next newsletter. Till then, good work, and good luck!

Sandeep Shukla

CESCA Officially Launches Industry Affiliate Program

July 2010. The primary purpose of the CESCA Industry Affiliate Program (IAP) is to establish close cooperation as well as technology transfer between CESCA and its Industry Affiliate partners that are interested in supporting research and education activities of CESCA. Becoming a member of the CESCA IAP is an excellent way to get broad access to CESCA's research and intellectual property (IP); receive support in recruiting efforts; and setting the foundation for research collaboration opportunities. Currently, the IAP offers two types of membership levels: Associate Member and Principal Member. The Associate Member level entails an annual fee of $10,000 and the Principal Member level entails an annual fee of $40,000. Associate Members receive a non-exclusive, royalty-free, non-transferable license to non-commercially use of the CESCA IPs generated during their membership period, and have an option to negotiate a commercial license to IP rights, provided no Principal Member has exercised its six month option rights to such CESCA IP. Principal Members receive all of the benefits of Associate Members plus a few additional benefits, including the opportunity to support a graduate student fellowship. The student awarded with the fellowship will explore a research area that is of interest to the sponsoring Principal Member, consistent with CESCA's strategic plans. In addition, Principal Members have the option to negotiate an exclusive royalty bearing license. For more information on the CESCA IAP, please contact Drs. Dong Ha (ha@vt.edu) and Jerry Park (jungmin@vt.edu), CESCA IAP liaisons.

IFOS becomes the first CESCA's industry affiliate member

July 2010. IFOS® (Intelligent Fiber Optic Systems) based in Santa Clara, California, has joined CESCA Industry Affiliate Program (IAP) as a principal member. IFOS designs and manufactures innovative optical sensing systems, photonic

modules, fiber optic sensors, and environment monitoring subsystems. Since the company's inception in 1996, IFOS has worked towards creating fully flexible optical sensing networks that can monitor a wide variety of data over a dynamic fiber network. Dong Ha has collaborated with IFOS closely in high data rate sensing for jet engines in the past two years, and IFOS will further strengthen its collaboration with CESCA through IAP. Welcome IFOS to Industry Affiliate Program of CESCA!

New Research Projects

Software for safety critical application development.

FERMAT Lab directed by Sandeep Shukla received a 498K USD funding for 2 years from the Office of Secretary of Defense (OSD) to work with the Air Force Labs in Rome on correct by construction composition of software components for safety critical application development.
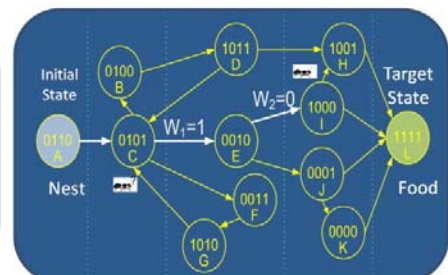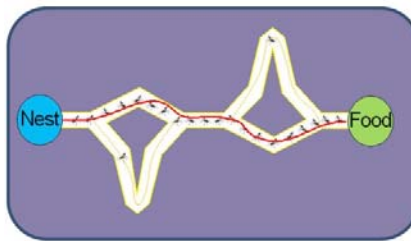
Structural Health Monitoring for Wind Blades

Dong Ha and Daniel Inman (Mechanical Engineering, Virginia Tech) received an SBIR project from Department of Energy through Extreme Diagnosis, Inc. Incipient flaws of a wind blade such as micro-cracks and early composite material failure have minimal influence on the system's global response, so typical acceleration based structural health monitoring (SHM) systems fail to identify initial damage. To address the problem, they proposed to develop a wireless embedded sensor to detect and localize damage based on the impedance-based method. Ha and Inman collaborated on numerous government and industry projects in SHM in the past five years and are regarded as world experts in SHM research.

Exploring Swarm Intelligence for Design Validation

A 3-year NSF grant has been awarded to Michael Hsiao, entitled, "Exploring Swarm Intelligence for Design Validation", $363,439. The likelihood of hidden, subtle bugs increases with growing design sizes, and reaching corner cases in large designs and systems in order to expose such subtle bugs has become a daunting task. Verifying the correctness of the design is now a tremendous bottleneck. Critical to the effectiveness of stimuli generation is the quality of guidance and feedback provided during the search. The objective of this research is to elicit the swarming power to solve this very difficult problem, which has not been done in the past. Individual knowledge acquired during the search is extracted to benefit collective effort. This is enabled via cultivation of knowledge exchange, accumulation, and utilization. The intelligent partitioning and grouping of the state variables allows for the construction of many effective abstract navigation tracks in large designs, benefiting the swarm platform. The development of new theories and algorithms will allow for deeper understanding of semi-formal verification and state space exploration.

Real-world Oriented Design for Dynamic Spectrum Access Systems

Yaling Yang (CESCA), George Morgan (Finance, VT), Dilip Shome (Finance, VT), Tamal Bose (ECE, VT) received 108k from Institute of Critical Technology and Applied Science (ICTAS) to investigate the design of dynamic spectrum systems. The proliferation of wireless services and the inefficiency of the current spectrum allocation schemes have caused severe contention for available wireless spectrum. Recently, wireless industry proposed Dynamic Spectrum Access (DSA) concept to address the issue. In DSA, underutilized licensed spectrum bands are allowed to be opportunistically used by secondary users under the condition that the service qualities to the owners of the spectrum bands are not significantly degraded. While there are many design options for realizing this new technology, it is not clear which design options will prevail in a real market, where a technology's success depends on a delicate balance between its performance and its design complexity and operation cost. Hence, identifying the correct trade-off point between design complexity and performance-based economical gain is of critical importance for DSA technologies. The purpose of this project is to provide an intensive study on the design trade-off of DSA networks between its complexity and its economical viability.
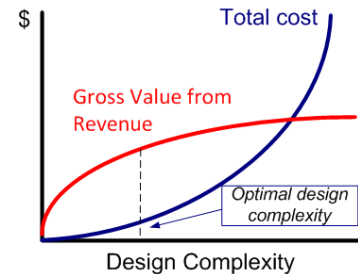
Undergraduate research of formal design methods

FERMAT Lab directed by Sandeep Shukla received a 12K REU funding from NSF for supporting undergraduate research assistants in the lab to work on various aspects of formal methods based design of systems.

Enhancing Access to the Radio Spectrum (EARS) Workshop

Jennifer T. Bernhard (PI, ECE, UIUC), Jeff Reed (PI, ECE, VT) and Jerry Park (co-PI, CESCA) received a $96k funding from NSF to organizing a workshop for enhancing access to the radio spectrum. Enhancing Access to the Radio Spectrum (EARS) is a multi-disciplinary activity whose goal is to improve the efficiency with which the radio spectrum is utilized and to improve access to the radio spectrum in support of current and new technologies. Achieving these goals will, among other impacts, improve the availability of wireless broadband to Americans presently without broadband access, as called for in the American Recovery and Reinvestment Act. Because the radio spectrum is a valuable but finite natural resource improvements in in spectrum efficiency will have significant economic impact to the nation and the world. This award funds the first step, which is an invitational workshop that will bring together some of the key researchers and policy makers involved in radio spectrum access. All relevant fields will be represented, including science, engineering, economics, and policy. The output of the workshop will include a vision for the future of radio spectrum access and use, and a prioritized list of research areas can of radio spectrum access and use, and a prioritized list of research areas that can help achieve that vision.
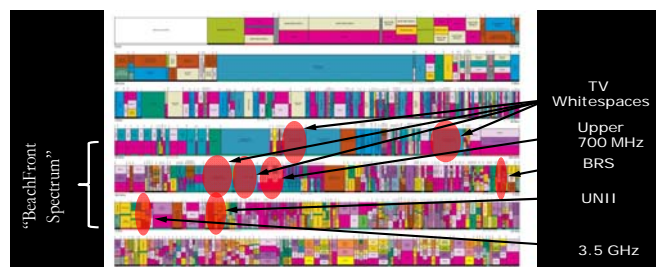
Highlights

Sandeep Shukla was a keynote speaker at the International Conference on Novel Technologies for Distributed Systems (NOTERE'10) at Tozeur, Tunisia in June 2010. More information on this at http://notere2010.redcad.org/eng/KeynotesSpeakers.html. The title of the keynote talk was "Model Driven Embedded Software Generation: A Generative Approach to Safety". More information on the talk is at http://notere2010.redcad.org/eng/KeynotesSpeakers.html#abstractShukla

Sandeep Shukla also gave 2 ACM distinguished lectures throughout Tunisia during May 28-June2 at the University of Sfax, and at the University of Tunis. Sandeep Shukla has been an ACM Distinguished speaker for the last three years. The talks were on "Formal Model Driven Software Synthesis".

Sandeep Shukla also toured from west coast to the east coast of Canada, delivering 4 IEEE Computer Society Distinguished Lectures at University of British Columbia, University of Calgary, University of Regina, and Waterloo University between Aug 2 and Aug 10, 2010. Sandeep Shukla has been an IEEE Computer Society Distinguished Visitor for the last two years. The topic of the talks were "Formal Model Driven Software Synthesis".

Sandeep Shukla was also an invited speaker at the Cyber Physical Systems symposium at the US-Korea Conference (UKC'10) at Seattle, 2010, August.

Lynn Abbott participated in a panel discussion at the annual conference of the National Institute of Justice in Arlington on June 14. The event was "NIJ Panel on Impression Evidence: Strengthening the Disciplines of Fingerprints, Firearms, Footwear, and other Pattern and Impression Sciences through Research."

Lynn Abbott also gave a presentation at the 95th International Educational Conference of the International Association for Identification in Spokane, WA, in July. The title of the talk was "Toward a Quantitative Basis for Sufficiency of Friction Ridge Pattern Detail." Student participants in this research include CESCA members Nathan Short and Supratik Misra, as well as Nadia Kozievitch and Sung Hee Park from Computer Science. Co-Principal Investigators for this project are CESCA member Michael Hsiao, Ed Fox (Computer Science), Randy Murch (Associate Director for Research Program Development, Northern Capital Region), and Bruce Budowle (University of North Texas).

Dong Ha gave two talks at Samsung Electro-Mechanics and University of Pennsylvania about energy harvesting and structural health monitoring, respectively.

- Dong Ha "Small Scale Energy Harvesting – Principles, Practices, and Future," Samsung Electro-Mechanics, Suwon, Korea, July 9, 2010.

- Dong Ha "Low-Power Active Wireless Sensor Node for Structural Health Monitoring," University of Pennsylvania, Philadelphia, June 25, 2010.

Student News

Who graduated

Name	Degree	Where they will go
Avinash Lakshminarayana,	M.S.	Intel
Jason Pribble	B.S.	Thales
Sumit Ahuja	Ph.D.	CISCO

Michael Gora	CPE M.S.	Northrop Gruman
Sergey Morozov	CPE M.S.	Intel
Vignesh Vivekraja	M.S.	Intel
Amol Deshpande	M.S.	
Swati Kanaujia	M.S.	Microsoft Redmond
Jatin Thakkar	M.S.	Deutsche Bank
Neha Goel	M.S.	Intel
Saparya Krishnamoorthy	M.S.	Intel

Internship stories

- **Summer Internship at Qualcomm: a Good Learning Experience for a CESCA Ph.D. Student**

  During the summer of 2010, Shaver Deyerle interned at Qualcomm Inc. in San Diego, CA. He was recruited to perform circuit board design, but used his time to develop skills in many different areas. His primary task was developing a circuit board for verification of high speed interconnects on test equipment under development. The primary portion of the internship was devoted to signal integrity issues which must be taken into account in designing high speed serial links. In addition to working on board design, He also spent time working on VHDL code targeting Altera Stratix IV FPGAs, as well as verification of a power supply card.

  In addition to work, Deyerle spent several days taking courses from experts in several fields. He took a class on Low-Power Digital IC design from Dr. Kaushik Roy, a well-respected researcher in this field form Purdue. In addition, he took classes on Signal Integrity from Dr. Eric Bogatin, one of the most well known authors in the field.

  Deyerle is a Ph.D. student and conducts research in power line communication at integrated circuits (ICs) under the supervision of Prof. Ha. He is currently a student representative for Qualcomm at Virginia Tech.

- CESCA Ph.D student, Michael Henry, spent his summer in McLean, Virginia working for The Nanosystems Group within The MITRE Corporation, a non-profit research lab working with the Department of Defense.Michael's project focused on graphene transistors, which are made from a flat single-atom-thick layer of carbon and are receiving a large amount of attention as a potential silicon replacement due to their incredible speeds. During the summer he developed the first known closed-form compact model of a graphene transistor, a necessary element for simulations of large graphene circuits.

- Yi Tang worked as software engineering intern in summer of 2010 at Logik Systems, an INC500 fast-growing company. He designed and developed new features for the company's core eDiscovery data processing engine, using technology such as .NET and Database. These features significantly help simplify the data processing workflow

- Zhenhua Feng recently finished his summer internship with Gigabytes Switching Business Unit (GSBU) at Cisco, located in San Jose, California. The 3-month internship focused on software

development for Cisco's enterprise grade switching products and for internal tools. Zhenhua's work is to be shipped with the next generation Catalyst 4500/4900 switch series, which are the most widely deployed modular switching unit in industry with key innovative features in security, collaboration, resiliency, virtualization, and energy efficiency. Zhenhua is graduating this Fall and will return to Cisco as a senior software development engineer at GSBU.

- Mahesh Nanjundappahas been working at Intel at Parsippany, NJ as an Graduate Technical Intern from May 18th-Dec 31st. His team is Wall Street Lab, Financial Engineering Services. He is part of a software team working on Linux and Windows software for high performance financial computing. His responsibilities include research and development of new financial software that can be used as benchmarks and in turn that can help in providing key traces for architects.

- Mathew Anderson just finished his summer internship at Air Force Research Labs in Rome, NY and studied the feasibility of automatic test generation for synchronous languages during the intern period.

- Bijoy Jose has been working at the Software Services Group of Intel at Folsom as a Graduate Technical Intern from May 18th-Dec 31st. Heworked on multi-threaded enabling of media codecs, optimization of software applications using streaming SIMD instructions and power analysis of software applications.

- Zhimin Chen (PhD) was invited to attend the Trusted Infrastructure Workshop, an Advanced Summer School organized by organized by CyLab (CMU) with sponsoring from NSF, CMU, HP, IBM, Sun, and Fujitsu.

- Kaushik Mukunda (MS) is an intern with Rockwell Collins for summer and fall 2010.

- Mainak Banga spent his summer as intern at Intel

- Wei Hu spent his summer as intern at NAL Research

Publications (June – August 2010)

- Jens Brandt, Klaus Schneider, Sandeep Shukla, Sumit Ahuja, "The Model Checking View to Clock Gating and Operand Isolation", In Proceedings IEEE International Conference on Applications of Concurrency in System Design (ACSD'10), pp.181-190 Braga, Portugal, July 2010

- Bijoy A. Jose, Jason Pribble, Sandeep K. Shukla, "Faster Embedded Software Synthesis using Actor Elimination Techniques for Multi-rate Synchronous Formalism", In Proceedings IEEE International Conference on Applications of Concurrency in System Design (ACSD'10), pp147-157, Braga, Portugal, July 2010.

- Sumit Ahuja, Wei Zhang, Sandeep K. Shukla, "System level simulation guided approach to improve the efficacy of clock-gating", In Proceedings of IEEE International High Level Design Validation and Test Workshop (HLDVT), June, 2010, Anaheim, CA, pp 9-16.

- Bin Xue, Sandeep Shukla, S.S Ravi, "Minimizing Back Pressure for Latency Insensitive System Synthesis", In Proceedings of 8th ACM/IEEE International Conference on Formal Methods and Models for Co-Design (MEMOCODE'10), Grenoble, France, July 2010.

- Z. Chen, P. Schaumont, "Virtual Secure Circuit: Porting Dual-Rail Pre-charge Technique into Software on Multicore," IACR ePrint Archive 2010/272, April 2010.

- J. Fan, X. Guo, E. De Mulder, P. Schaumont, B. Preneel, and I. Verbauwhede, "State-of-the-art of secure ECC implementations: a survey on known side-channel attacks and countermeasures," IEEE International Symposium on Hardware-Oriented Security and Trust (HOST 2010), Anaheim, June 2010. Invited tutorial.

- Maiti, J. Casarona, L. McHale, P. Schaumont "A Large Scale Characterization of RO-PUF," IEEE International Symposium on Hardware-Oriented Security and Trust (HOST 2010), Anaheim, June 2010. Related article: http://www.ece.vt.edu/news/ar10/spartanboards.php

- X. Guo, S. Huang, L. Nazhandali, P. Schaumont, "Fair and Comprehensive Performance Evaluation of 14 Second Round SHA-3 ASIC Implementations", NIST 2nd SHA-3 Candidate Conference, Santa Barbara, CA, August 2010.

- Srivastava, H. Lam, M. S. Hsiao, D. Samuels, C. Finkielstein, "Identification of illegal states in a discrete transition model of apoptosis signaling," in Int'l Workshop on Bio-Design Automation (IWBDA), June 2010.

- M. Banga and M. S. Hsiao, "Trusted RTL: Trojan detection methodology in pre-silicon designs," in Proceedings of the IEEE Hardware-Oriented Security and Trust Symposium, June 2010.

- Chuan Han and Yaling Yang, "Optimal Cache-Based Route Repair for Real-Time Traffic", IEEE ICNP 2010

- Chuan Han and Yaling Yang, "The Information Propagation Speed Upper Bound in Cognitive Radio Networks", IEEE Globecom 2010

- Yongxiang Peng, Yaling Yang, Xianliang Lu, and Xuyang Ding, "Coding-Aware Routing for Unicast Sessions in Wireless Mesh Networks", IEEE Globecom 2010

- D. Zhou, D.S. Ha, and D.J. Inman, "Ultra Low-Power Active Wireless Sensor for Structural Health Monitoring," International Journal of Smart Structures and Systems, Vol.6, No.5-6, pp. 675-687, July/August, 2010.

Poster Presentation

- Shravan Garlapati, Hua Lin, Santhosh Sambamoorthy, Sandeep Shukla, Jim Thorp, "An Agent based supervision of Zone 3 relays to prevent hidden Failures in Power Systems", poster presentation at the IEEE Power Engineering Society General Conference, May 2010, Minneapolis, MN.

Books

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- Singh, Gaurav, Shukla, Sandeep K. Low Power Hardware Synthesis from Concurrent Action-Oriented Specifications, 1st Edition., 2010, 140 p. 100 illus., Hardcover, ISBN: 978-1-4419-6480-9, Springer, Boston, MA.

- Sandeep K. Shukla, Jean-Pierre Talpin "Synthesis of Embedded Software: Frameworks and Methodologies for Correctness by Construction", Springer, Aug 2010