Net-Centric & Cloud Software & Systems I/UCRC

Semi-Annual Highlights of Industry/Academic Cooperative Research Projects

http://netcentric.unt.edu

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Multi-University Collaboration on Machine Learning

A longstanding tenet of the I/UCRC concept is multi-university collaboration on a single project for the benefit of corporate sponsors. Historically this has been a difficult vision to realize as universities often work individually to engage new members. Research projects sometimes become siloed in a relationship based on a single faculty investigator and a single sponsor. Another complicating issue is finding one unifying project that can leverage the technical capabilities of all the university members. Many I/UCRCs struggle to achieve this synergy, but at least one process is proving to be useful for identifying unified projects.

Our I/UCRC holds semi-annual meetings of its Industry Advisory Board (IAB) where all corporate project sponsors and university researchers come together to hear about new project proposals, status existing projects, and network with other like-minded colleagues. A portion of the IAB meeting is dedicated to the discussion of "wicked problems", i.e., formidable technical issues that present significant challenges to sponsors' research and development goals. Sponsors are given an opportunity to present their most significant research problems to an audience of faculty members and graduate students from all the universities in the center, giving them an opportunity to hear first-hand about technical problems that could form the basis of a multi-university collaboration. The most recent project of this kind to be proposed by NCSS to its sponsors is on the topic of implementing efficient machine learning algorithms for embedded sensor systems used for mobile and cloud-based Internet of Things (IoT) applications.

The project is a collaborative effort among investigators from the University of North Texas, the University of Texas at Dallas, and Arizona State University. The research goal is to identify and compare machine learning algorithms for sensors and IoT applications by studying and profiling algorithms in terms of performance and computational complexity. Research will also consider overlapping big data and clustering based learning, and will consider low power issues with various machine learning algorithms.

This is a unique multi-site project that brings together talents in engineering and computer science to study machine learning algorithms for sensor and IoT applications. Prior results in embedding and training machine learning algorithms on sensor boards can be leveraged from all three universities. The project is also multi-disciplinary and uses advanced signal processing and cloud computing tools. Several technical recommendations to member companies will be made on machine learning algorithms in a comprehensive report.

The benefits to industry sponsors are far-reaching. IoT and machine learning have been identified as areas of common interest. Integration of sensors and machine learning for embedded and cloud computing is a pervasive industry problem. The capabilities developed for this project will enable testing and evaluation of novel architectures for machine learning, providing insights not only to execution performance, but to energy saving opportunities as well. ■

Lockheed Martin Joins Center

Lockheed Martin has engaged with NCSS several times over the Center's 8-year history and most recently their Missiles and Fire Control (MFC) group has joined forces with UNT. MFC is a recognized designer, developer and manufacturer of precision engagement aerospace and defense systems for the U.S. and allied militaries. They develop, manufacture and support advanced combat, missile, rocket, manned and unmanned systems for military customers that include the U.S. Army, Navy, Air Force, Marine Corps, NASA and dozens of foreign allies. MFC also offers a wide range of products and services for the global civil nuclear power industry and the military's green power initiatives. MFC pursues business in more than 50 countries with more than 50 product and service lines. We look forward to working with them to meet their net-centric R&D goals during the coming months.

Ref: http://www.lockheedmartin.com/us/ml

LOCKHEED MARTIN

Installation of Networking Infrastructure to Support Wide Area Mobile IoT Systems

A team of engineers from NWave and UTD has been working hard over the past several weeks to install an advanced wide area infrastructure for actually deploying and evaluating case study scenarios for the NSF NCSS I/UCRC multi-site collaborative project on "Implementation of Efficient Machine Learning Algorithms for Embedded Sensor Systems, Mobile, and Cloud IoT Application." This includes various communication units as well as sensors and actuators. One application that is being designed is a "smart campus" parking system where information will be continuously collected from all the sensors and used to provide real-time guidance to drivers to safely and quickly navigate through the campus to the best available parking spots for their destination. These devices will be enhanced to deal with various operational situations, including accidents, special events, and environmental conditions such as rain, snow, ice, floods, etc. One challenge is that the navigation guidance system has to take into consideration that different vehicles may have to navigate along different routes under different environmental conditions and it is not possible to pre-program the system to identify the optimal routes under all the possible situations. Machine learning and cloud computing based big data analysis capabilities will be incorporated into the mobile IoT guidance system to ensure that each vehicle can optimally navigate to its destination.

The project is currently in the phase of setting up a wide area infrastructure for deploying applications and using these to evaluate the techniques. Once the wide area mobile IoT platform is deployed, it will be used to implement and deploy the system and continuously improve the system and the supporting infrastructure based on the evaluation results. This infrastructure for supporting wide area mobile IoT systems will also be very helpful to students participating in this research since it provides them with access to actual real-world emerging IoT systems which will offer them invaluable learning experience and hands-on training. Once the infrastructure is deployed and operational, it will also be used to support class projects related to mobile IoT systems, especially in the area of smart parking systems.

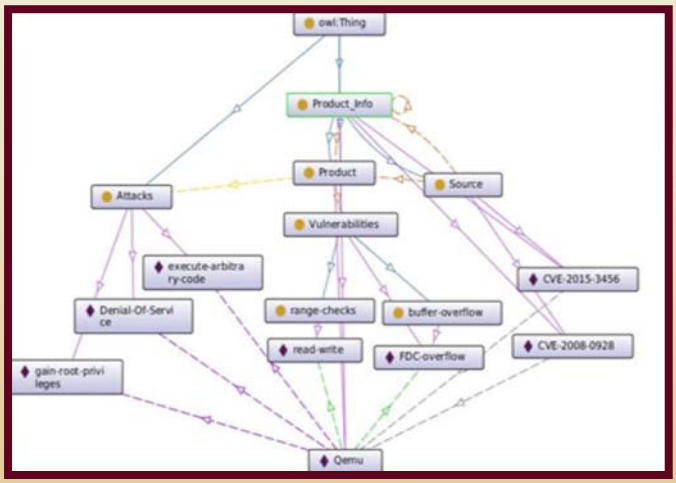
One challenge in deploying the infrastructure is that the wide area communication infrastructure needs antennas that have to be installed on high-level roof tops to make sure that the signals are available at a high level of quality across the campus. The team that has been working on installing the antenna includes Paul Peck who is the CFO and COO of NWave and Pete Poorman who is the Director of Corporate Relations at UTD. It also includes several engineers from the UTD Office of Information Technology (OIT), including Frank Feagans (Associate VP of Enterprise Application Services and Director of Research Computing), Tim Harrison (Network Engineer), Casey Horn (Manager of Network Services and Telecommunications), Kishore Thakur (Associate Director of Systems and Operations Infrastructure), as well as Gi Vania (Director of Enterprise Architecture). Paul Peck (pictured at left), Pete Poorman, and the engineers have climbed the roof tops several times to determine the best places for installing the antennas, to acquire the necessary equipment, and to actually build and deploy the infrastructure. ■

Analyzing Vulnerabilities for Possible Attacks Using Ontologies

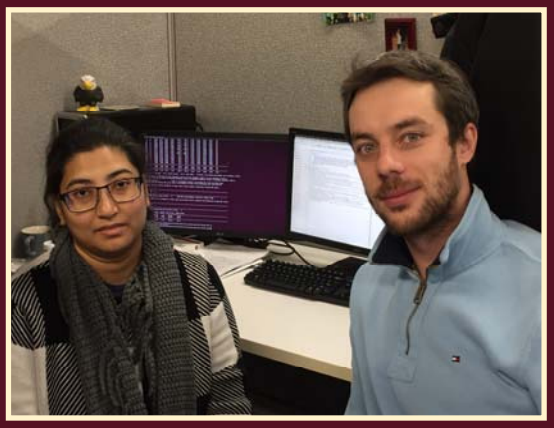
Most computer users are unaware that many application programs are subject to different types of vulnerabilities. Attackers can exploit these weaknesses to gain access to crucial user information or commit other malicious acts. Most of these vulnerabilities can be avoided by keeping current on patches released to the public by application vendors, but not all users realize that they have access to this information or understand how to apply it. One way that Zacharia Poycattle at UNT is approaching this issue is by using ontologies.

An ontology can show the relationship between vulnerabilities and the attacks that can exploit them, making it easier for users to understand how their computer may be subject to specific attacks. The data needed to build such an ontology for a given software product is available from public sources such as the National Vulnerability Database (NVD). Researchers can analyze vulnerabilities in the product and incorporate information about them into a local classification system. Rules about each vulnerability are created using SWRL (Semantic Web Rule Language). If a similar vulnerability appears in the future, the ontology can place it in the proper class. The same is true for a previously unseen attacker attempting to exploit an already known vulnerability. This allows creation of rules for instances of complicated attacks.

For example, if a vulnerability requires root access to a product before it can be exploited, and there is another vulnerability that allows an attacker to gain root access to that system, rules can be created that enable the ontology to "learn" that such complicated attacks are possible. Since the ontology has no set size, it can continue to grow indefinitely. The ontology can then be queried using a Resource Description Framework (RDF) query language called SPARQL. This allows users to discover which attacks are possible on their computer based on information in the ontology. ■



UNT Students to Present Work at ARCS 2017



Two students in the Computer Systems Research Laboratory (CSRL), Mahzabeen Islam and Marko Scrbak, recently had papers published.

Mahzabeen Islam, a PhD student, had been working on a collaborative project with AMD Research and recently got the paper "HBM-Resident Prefetching for Heterogeneous Memory System" accepted at the 30th International Conference on Architecture of Computing Systems (ARCS 2017) to be held at the Vienna University of Technology, Vienna, Austria in April 2017. In this paper they have shown that memory-resident prefetching is an effective optimization technique for next generation heterogeneous memory systems involving emerging high-bandwidth memory (HBM) and non-volatile memory.

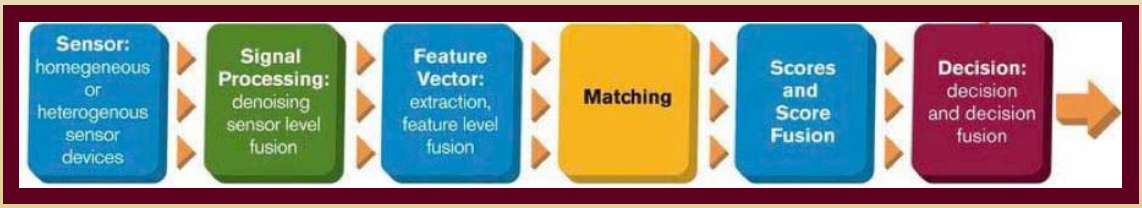
PhD student, **Marko Scrbak**, will also be presenting his work titled "DVFS Space Exploration in Power Constrained Processing-in-Memory Systems" at ARCS 2017. The work is the result of a nine month long internship at Advanced Micro Devices (AMD). During that time, Marko was closely involved in research on next generation heterogeneous computing systems and the development of computer system simulation and modelling tools. The Computer System Research Lab has been collaborating with Advanced Micro Devices (AMD) for over five years and has been closely involved in research on utilization of new emerging technologies and implementation of future heterogeneous computing systems. The collaboration will continue in the future as new members of the lab take over the responsibilities and broaden the research area in the field of computer system architecture. ■

ARCS 2017 will take place in Vienna, Austria.

Established REU Site on Sensors and IoT at ASU

PI: A. Spanias and J. Blain-Christen, ASU NCSS SenSIP Site

The program (2017-2010) will immerse students in grand challenge problems at the intersection of sensor circuits and signal processing. Sensor applications include internet-of-things (IoT), sustainability, and security. In addition to projects, the program will require students to take online modules prepared by faculty to build their theoretical knowledge in each research area and transdisciplinary training. The REU will address STEM-related projects and features multidisciplinary synergies across different research topics in labs that provide access to unique sensor and algorithm technology. Several of our industry partners will benefit from this program and will participate in student project presentations and assessments. ■



National Science Foundation
WHERE DISCOVERIES BEGIN

NSF Advancing the Science of Cybersecurity

Cyberattacks on corporations, agencies, national infrastructure and individuals have exposed the fragility and vulnerability of the internet and networked systems. Achieving truly secure cyberspace requires addressing both the technical vulnerabilities in systems, as well as those that arise from human behaviors and choices.

This past November, the NSF announced $76 million in research grants through its Secure and Trustworthy Cyberspace (SaTC) program to study the scientific, engineering and socio-technical aspects of cybersecurity. The grants support 241 projects across 36 states and 129 institutions, and touch on all aspects of the field. These include hardware, software, network security, human incentives and behaviors, and the integration of computation with the physical world.

The program is inspired by and aligned with two new strategic plans that the administration released in 2016: the Federal Cybersecurity Research and Development Strategic Plan and the National Privacy Research Strategy. Both are dedicated to protecting and preserving the growing social and economic benefits of cyber systems while ensuring security and privacy.

The SaTC program takes an interdisciplinary, comprehensive approach to cybersecurity research, development and education, and encourages the transition of promising research ideas into practice. The program also emphasizes the need for sociotechnical approaches that consider human, social, organizational and economic factors involved in the creation, maintenance and operation of secure systems and infrastructure.

The awards are part of a portfolio of approximately $160 million invested in cybersecurity research across the agency in Fiscal Year 2016.

Ref: https://www.nsf.gov/news

Recent Publications on NCSS Related Research

V. Berisha, A. Wisler, A. Hero, A. Spanias, "Empirically Estimable Classification Bounds Based on a Nonparametric Divergence Measure," IEEE Transactions on Signal Processing,, vol. 64, no. 3, pp.580-591, Feb. 2016.

H. Braun, S. T. Buddha, V. Krishnan, C. Tepedelenlioglu, A. Spanias, M. Banavar, and D. Srinivansan, "Topology reconfiguration for optimization of photovoltaic array output," Elsevier Sustainable Energy, Grids and Networks (SEGAN), pp. 58-69, Vol. 6, June 2016.

G. Park, L. Chung, J. Hong, M. Noguera, "Problem-Aware Traceability in Goal-Oriented Requirements Engineering", International Conference on Software Engineering & Knowledge Engineering, July 2016.

M. Scrbak, M. Islam, K. Kavi, M. Ignatowski, N. Jayasena. "Exploring the processing in memory design space", Journal of Systems Architecture, Sept. 2016.

M. Islam, S. Banerjee, M. Meswani and K. Kavi. "Prefetching as a potentially effective technique for hybrid memory optimization", Proceedings of the International Symposium on Memory Systems (MEMSYS 16), October 3-6, 2016, Alexandria, VA.

Shuai Zhang, I-Ling Yen, Farokh Bastani, Hessam Moeini, Darnell Moore, "A semantic model for information sharing in autonomous vehicle systems," IEEE 2017 International Conference on Semantic Computing (ICSC 2017), Jan. 30-31, 2017.

G. Park, S. Park, L. Khan, L. Chung, "IRIS: A Goal-Oriented Big Data Analytics Framework on Spark for Better Business Decisions", IEEE International Conference on Big Data and Smart Computing, Feb. 2017.

G. Park, F. Fellir, J. Hong, J. Garrido, M. Noguera, L. Chung, "Deriving Use Cases from Business Processes: A Goal-Oriented Transformational Approach", ACM Symposium on Applied Computing, April 2017.

Upcoming Events

The semi-annual meeting of the NCSS Industrial Advisory Board will be held Wednesday and Thursday, April 26-27, 2017 at the University of Texas at Dallas.

For more information about the NCSS I/UCRC or how you can join our center, please contact:

Professor Krishna Kavi
Director of NCSS I/UCRC
Krishna.Kavi@unt.edu

or

Melanie Dewey
940-565-4764
Melanie.Dewey@unt.edu

University Membership

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