Queen's Graduate Computing Society Conference

The Fourth Annual
Queen's Graduate Computing Society Conference
(QGCSC 2013)

Queen's University
Kingston, ON

May 8 – 9, 2013

Conference Summary

Wednesday May 8th, 2013

2:30 p.m. – 3:00 p.m.	**Opening Remarks**	Biosciences Room 1103
3:00 p.m. – 4:00 p.m.	**Opening Keynote** *Dr. Igor Jurisica*	Biosciences Room 1103
4:00 p.m. – 7:30 p.m.	**Carnival Event**	Biosciences Atrium

Thursday May 9th, 2013

9:00 a.m. – 9:30 a.m.	**Arrival, Set Up, Registration & Refreshments**		Biosciences Atrium
9:30 a.m. – 10:30 a.m.	**Morning Keynote** *Dr. Hossam Hassanein*		Biosciences Room 1103
10:30 a.m. – 11:45 a.m.	**Track I – Student Talks** BioSci 1102	**Track II – Student Talks** BioSci 1103	
11:45 a.m. – 12:30 p.m.	**Poster Session**		Biosciences Atrium
12:30 p.m. – 1:30 p.m.	**Lunch Break**		Biosciences Atrium
1:30 p.m. – 2:30 p.m.	**Panel Discussion** *Topic: Careers in Computer Science*		Biosciences Atrium
2:30 p.m. – 3:30 p.m.	**Track I – Student Talks** BioSci 1102	**Track II – Student Talks** BioSci 1103	
3:30 p.m. – 4:30 p.m.	**Final Keynote** *Dr. Monty Newborn*		Biosciences Room 1103
4:30 p.m. – 5:00 p.m.	**Closing Remarks & Awards**		Biosciences Atrium

Keynote Speakers

Dr. Igor Jurisica
Departments of Medical Biophysics and Computer Science,
University of Toronto

Biography:
Igor Jurisica, Tier I CRC in Integrative Cancer Informatics, is a Senior Scientist at OCI, Professor at the U Toronto and Visiting Scientists at IBM.s CAS. He is also an Adjunct Professor at the School of Computing Queen.s U and Computer Science at York U. His research focuses on integrative computational biology and the representation, analysis and visualization of high-dimensional data to identify prognostic/predictive signatures, drug mechanism of action and in silico re-positioning of drugs. Interests include comparative analysis for mining different integrated data sets (e.g., protein-protein interactions, high-dimensional cancer data, and high-throughput screens for protein crystallization).

Abstract:
"High-performance computing and "big data" in integrative cancer informatics. Challenges and opportunities in intelligent molecular medicine."

Personalized medicine requires better identification of patient subgroups and novel treatment options. Since most cancer treatments only work for subsets of patients we need alternative treatment options. Single drugs are rarely sufficient; thus, we need to identify drug combinations, and new drugs.
Data on thousands of cancer patient profiles from diverse technology platforms provide essential resources for molecular medicine. However, effectively integrating, annotating, and analyzing these high-dimensional, heterogeneous and distributed data with aim to create intelligent hypotheses and realistic models of human disease is not trivial. Systematic computational analysis has the potential to unravel mechanism of action for therapeutics, re-position existing drugs for novel, use and prioritize multiple candidates to best treat an individual patient. We need to integrate algorithms and systems from machine learning, databases, image and text analysis, ontologies, human-computer interaction, graph theory and visualization to tackle these diverse problems.
Scale changes everything, and size does matter. Integrating intelligent heuristics with novel computing environments, such as grid and GPU computing, provides scalable platform for these big data challenges.

Dr. Hossam Hassanein
School of Computing,
Queen's University

Biography:
Hossam Hassanein is leading research in the areas of broadband, wireless and mobile networks architecture, protocols, control and performance evaluation. His record spans more than 500 publications in journals, conferences and book chapters, in addition to numerous keynotes and plenary talks in flagship venues. Dr. Hassanein has received several recognition and best papers awards at top international conferences. He is also the founder and director of the Telecommunications Research (TR) Lab at Queen's University School of Computing, with extensive international academic and industrial collaborations. Dr. Hassanein is a senior member of the IEEE, and is the former chair of the IEEE Communication Society Technical Committee on Ad hoc and Sensor Networks (TC AHSN). Dr. Hassanein is an IEEE Communications Society Distinguished Speaker (Distinguished Lecturer 2008-2010).

Abstract:

"Global Resource Utilization in the Internet of Things"

The Internet of Things (IoT) is envisioned as a paradigm shift, with a plethora of applications, on the premise of well-established enabling technologies; prominently Wireless Sensor Networks (WSNs) and RFIDs. The former has evolved to improve energy efficiency and resilient operation, yet, true scalability has only been recently probed and quite sparsely advancing. Moreover, the traditional approach whereby most WSN platforms are tailored for a single-application to meet a given efficiency metric, imposes significant rigidity in re-utilizing devised platforms for new applications, and limitations on re-using previously deployed ones. In remedy, we present a novel paradigm in WSNs to efficiently utilize network resources, and extend it to a platform for multiple applications to cross utilize resources over multiple WSNs. This paradigm presents a leap in scalability, not only in a WSN, but across multiple ones, with dynamicity to accommodate for varying resources being introduced and removed; in addition to utilizing transient resources in their vicinity. To this end, we present a global architecture to efficiently adopt WSNs in IoT with changing demands and scale. Our approach is further explained and demonstrated via a detailed use case depicting the premise of IoT application.

Dr. Monty Newborn
School of Computer Science,
McGill University

Biography:

Monty Newborn received his Ph. D. in Electrical Engineering from The Ohio State University in 1967. He was an assistant professor and then associate professor at Columbia University in the Department of Electrical Engineering and Computer Science from 1967-1975. In 1975, he joined the School of Computer Science at McGill University and has been with the School since then, serving as its director from 1976-1983. He has been an ACM Fellow since 1994 and a member of the Canadian Chess Hall of Fame since 2001.

His research has focused on search problems in artificial intelligence where two areas are of particular interest: chess-playing programs and automated theorem-proving programs. He has published seven books on these subjects and a number of research papers as well. He served as chairman of the ACM Computer Chess Committee from 1981 until 1997. In that capacity he organized the first Kasparov versus Deep Blue match (known as the ACM Chess Challenge) in 1996. The following year he served as head of the officials at the second Kasparov versus Deep Blue match won by Deep Blue. Through the 1970s and 1980s, his chess program Ostrich competed in five world championships, coming close to winning in 1974.

Abstract:

"Beyond Deep Blue: Chess in the Stratospher"

Deep Blue made history in 1997 when it defeated Garry Kasparov, who was then the world chess champion. Fifteen years have passed since then, and the current crop of chess programs is an even tougher bunch! This talk will survey Deep Blue's story and developments in the world of chess and computers since then. The talk will generally follow the material presented in "Beyond Deep Blue: Chess in the Stratosphere," published by Springer-Verlag in 2011.

Panel Discussion: *"Careers in Computer Science"*

The panel will be giving their opinions on the career options in Computer Science, ranging from industry, to academia, to a mix of both, and even options within these branches. After each of the panelists presents their views, the audience will be given the chance to ask questions that may help them make some very important decisions in the near future.

Panelists

Dr. Monty Newborn
School of Computer Science ,
McGill University

Biography:
Monty Newborn received his Ph. D. in Electrical Engineering from The Ohio State University in 1967. He was an assistant professor and then associate professor at Columbia University in the Department of Electrical Engineering and Computer Science from 1967-1975. In 1975, he joined the School of Computer Science at McGill University and has been with the School since then, serving as its director from 1976-1983. He has been an ACM Fellow since 1994 and a member of the Canadian Chess Hall of Fame since 2001.

Dr. Komminist Weldemariam
School of Computing,
Queen's University

Biography:
Komminist is a researcher and Adjunct Assistant Professor at the School of Computing, Queen's University, Canada. Prior to joining the Queen's Reliable Software Technology (QRST) group, he was a tenure-track researcher at the Fondazione Bruno Kessler (FBK), Trento Italy (2011 – 2012). He was also a postdoctoral researcher at FBK (2010 – 2011). He completed his PhD in the Information Engineering and Computer Science Department at the University of Trento, Italy. He also received a BSc. degree in Computer Science from Addis Ababa University, Ethiopia in 2003 and a Master's of Technology in Computer Science and Engineering from Indian Institute of Technology, Bombay, India in 2006. He has visited the Security Laboratory (Seclab) at the University of California, Santa Barbara CA USA.

Dr. Bob Crawford
School of Computing,
Queen's University

Biography:
Dr. Bob Crawford did his undergraduate degree in Engineering Science at Penn State, followed by doctoral studies in the newly emerging field of Computer Science at Cornell University. He came to the Department of Computing and Information Science at Queen's in 1971. His keen interest in and love for students have been demonstrated in his advising, teaching and administrative roles. In 1985 he began ten years as Associate Dean (Studies) in the Faculty of Arts & Science. He spent the summer of 1995 as Interim Director of Queen's International Study Centre at Herstmonceux Castle in England. In 1995 he was appointed to the newly created position of Dean of Student Affairs and was in that role for ten years. He is currently a professor in the School of Computing.

Dr. Scott Grant
School of Computing, Queen's University

Biography:

Scott is an NSERC CREATE Post-Doctoral Fellow at the School of Computing. Prior to his doctoral studies, he worked as a Software Engineer at Electronic Arts and as a Web Applications Engineer at Google. He is founder and president of the Queen's Game Developers Club.

Dr. Sarah-Jane Whittaker
Co-founder
GoSaBe Development and Design

Biography:
Sarah completed her PhD in Computer Science at Queen's University in 2011, Masters in Computer Science at Queen's University in 2005, and Bachelor's degree in Computer Science (Software) at Carleton University in 2003. During her time as an undergraduate, Sarah was employed as a co-op student and contract programmer for Entrust, ObjecTime, Rational, and IBM. Since the completion of her PhD, Sarah co-founded GoSaBe Development and Design, a software and web development business here in Kingston. She will also return to teaching at Queen's University next year.

Panel Moderator

Eric Rapos
School of Computing, Queen's University

Biography:
Eric Rapos is a PhD candidate in the School of Computing at Queen's University, under the supervision of Dr. James Cordy. Eric obtained both his Masters and Bachelor's degrees from Queen's University as well, also within the School of Computing. His area of research for his PhD is currently in development, but with a focus in model-driven development, software evolution and test case generation.

Student Talks

Session 1

Track I – BioSci 1102	Track II – BioSci 1103
Designing Action-based Exergames for Children with Cerebral Palsy Hamilton Hernandez	**Localization in Large-Scale Wireless Sensor Networks (LS-WSNs)** Yaser Al Mtawa
Ontology Alignment using Best-Match Clone-Detection Paul Geesaman	**Using Tracked Ultrasound to Guide Percutaneous Spinal Interventions** Simrin Nagpal
FlexView: An Evaluation of Depth Navigation On Deformable Mobile Devices Jesse Burstyn	**Advancing the Architecture of Mobile Web Services** Khalid Elgazzar
Supporting Model Driven Development of Reactive Systems with Analysis and Abstraction Karolina Zurowska	**Accuracy of Electromagnetic Tracking in an Operating-Room Setting** Elodie Lugez
When Paper Meets Multi-Touch: A Study of Multi-Modal Interactions in Air Traffic Control Cheryl Savery	**Democratic Wireless Sensor Networks** Sharief Oteafy

Session 2

Track I – BioSci 1102	Track II – BioSci 1103
Identifying User Complaints of iOS Apps Hammad Khalid	**Effect of Multi-hop localization in WSN** Walid Ibrahim
Studying the Relationship between Build Technology and Build Maintenance Shane McIntosh	**Quantifying Nondeterminism in Finite Automata** Alexandros Palioudakis
Inter-Cell Interference Coordination for Highly Mobile Users in LTE-Advanced Systems Shadi Khalifa	**SimITK: Model Driven Engineering for Medical Imaging** Melissa Trezise
The Computation of Sensor Activation Decisions in Discrete-Event Systems David Sears	**Clinical Decision Support Software for Prediction of Postoperative Atrial Fibrillation Following Bypass Surgery** Geoffrey Seaborn

Student Posters

Row I	Row II
Executing data-intensive workload in a cloud with minimal dollar-cost Riwan Mian	**Action Prediction and Player Modeling in Online Games** Max Graham
Open Source Ultrasound Simulation Using Surface Meshes Laura Bartha	**Clinical Ultrasound Data Collection of the Spine from an Imaging Perspective** Simrin Nagpal
Unconventional Cryptography Eslam AbdAllah	**Bringing Action to Exergames for Children with Cerebral Palsy** Hamilton Hernandez
MOBILE IMAGE OVERLAY SYSTEM FOR IMAGE GUIDED INTERVENTIONS Manjunath Anand	**Identifying User Complaints of iOS Apps** Hammad Khalid
MFW: Mobile Femtocells utilizing WiFi Mahmoud H. Qutqut	**SimITK: Visual Programming for ITK** Melissa Trezise

Student Talks
Abstracts

Designing Action-based Exergames for Children with Cerebral Palsy
Hamilton Hernandez

"Cerebral Palsy is a neurological disorder characterized by deficits in gross motor control and manual ability. Children with cerebral palsy often have difficulty engaging in casual exercise such as going for a bike ride or kicking around a ball with their friends. This can contribute to loss of mobility as the children grow.
Exergames, video games with an exercise component, represent a promising approach to helping children with CP to be more physically active. We have found that children with CP want to play fast-paced action video games similar to those played by their friends without motor disabilities. This is particularly true of exergames, whose physical activity matches the fast-pace of action games. However, disabilities associated with CP can make it difficult to play action games.
Existing guidelines for developing games for people with motor disabilities can lead to slow-paced games that are accessible, but may lack the fun of fast-paced action games.
Through a year-long participatory design process with children with CP, we have discovered that it is in fact possible to develop action exergames for children with CP at level III on the Gross Motor Function Classification Scale.
We have developed and tested six fast-paced action exergames for children with CP. We have produced a revised set of design guidelines for games for children with CP, which retain the core principles of existing guidelines, while being compatible with fast-paced action.
The results of a follow up 8-week home trial showed high overall enjoyment and adherence. Players' interest held up so strongly that more minutes were played in the final week than the first."

Localization in Large-Scale Wireless Sensor Networks (LS-WSNs)
Yaser Al Mtawa

Localization in Wireless Sensor Networks (WSNs) has attracted much research recently. The interest in this field is expected to proliferate since localization in WSNs is the corner stone of many applications in areas such as: smart buildings, smart vehicles, wildlife and environmental monitoring, military, health care, and merchandise tracking. The rapid growth of the number of sensors that have heterogeneous wireless technologies deployed over huge areas poses many challenges to localization systems: robustness, scalability, accuracy, energy consumption, and interoperability. In this talk, an overview of the advantages and the limitations of various localization techniques will be provided. The localization systems can be classified into either range-based or range-free techniques. The main focus of this talk is to overview the localization aspects in large-scale WSNs; then to analyze and evaluate qualitatively samples of the existing schemes against the following metrics: accuracy, energy efficiency, scalability, resilience, and cost efficiency.

Ontology Alignment using Best-Match Clone-Detection
Paul Geesaman

"Ontologies are a key component of the Semantic Web, providing a common basis for representing and exchanging domain meaning in web documents and resources. Ontology alignment is the problem of relating the elements of two formal ontologies for a semantic domain, in order to identify common concepts and relationships represented using different terminology or language, and thus allow meaningful communication and exchange of documents and resources represented using different

ontologies for the same domain. Many algorithms have been proposed for ontology alignment, each with their own strengths and weaknesses. The problem is in many ways similar to near-miss clone detection: while much of the description of concepts in two ontologies may be similar, there can be differences in structure or vocabulary that make similarity detection challenging.
Based on our previous work extending clone detection to modelling languages such as WSDL using contextualization, in this work we apply near-miss clone detection to the problem of ontology alignment, and use the new notion of ”best-match” clone detection to achieve results similar to many existing ontology alignment algorithms when applied to standard benchmarks."

Using Tracked Ultrasound to Guide Percutaneous Spinal Interventions
Simrin Nagpal

"Using Tracked Ultrasound to Guide Percutaneous Spinal Interventions
BACKGROUND: The use of ultrasound (US) to guide needle injections to the spine, in particular into facet joints, has been previously reported in the literature. However, US has not been adopted as the image modality of choice for guiding these injections despite US's accessibility, low cost and lack of ionizing radiation. This is due to the fact that interpretation of US images is difficult, especially in bony structures or deep targets; it also requires the operator to coordinate the needle and US transducer simultaneously.
METHODS: We propose a technique to improve the success of facet joint injections. The technique uses an electromagnetically tracked US transducer to locate the facet joint. Once the joint is visualized in the US slice, the slice is saved and displayed. At this point, the operator no longer needs to manipulate the US transducer. A target point and entry point are added to the slice and now the operator is free to navigate the needle using only the saved slice. Validation of the needle placement into the facet joint of interest is done using two orthogonal X-ray images.
RESULTS: Using a lamb cadaveric model, five orthopedic surgery residents achieved a success rate of 93.3% using tracked US slice guidance, a significant increase from 44.4% using freehand US ($p < 0.05$). There was a significant decrease in needle insertion time from 47.9 ± 34.2 s to 36.1 ± 28.7 s (mean ± SD). In a synthetic human spine model, tracked US slice guidance led to a success rate of 96.7%. The targeting accuracy of the system in the synthetic model was 1.03 ± 0.48 mm, which is clinically sufficient for facet joint injections.
CONCLUSION: The tracked US slice needle guidance system improved the success rate and needle insertion time for facet joint injections. This approach is applicable to other spinal needle procedures."

FlexView: An Evaluation of Depth Navigation On Deformable Mobile Devices
Jesse Burstyn

"Mobile devices are frequently used to view rich content while on the go. However, they have a tradeoff between increased screen size and portability; mobile devices, by definition, are constrained to a fraction of a desktop computer's display area. This constraint means a user has to frequently navigate to content that lies outside the display.
We present FlexView, a prototype system and set of interaction techniques, which allows users to navigate through depth-arranged large information spaces using display curvature as an additional input channel. FlexView augments the planar (X-Y) navigation currently performed by touch input with two forms of bend input to navigate through depth (Z). With leafing, the user holds one side of display and bends the opposite side. Squeezing involves gripping the display in one hand and applying pressure on both sides to create concave or convex curvatures, and supports concurrent interaction with touch input.
We performed two evaluations to investigate the performance of FlexView's interaction techniques. In Experiment 1, we measured the efficiency of participants when searching through pages of a document, and compared touch input to squeezing and leafing used in isolation. Experiment 2

introduced X-Y navigation in a pan-and-zoom pointing task where multi-touch pinch gestures were compared against squeezing and leafing for zoom operations. Panning, across all conditions, was performed with touch input using the index finger.
Our experiments demonstrated that touch and bend interactions are comparable for navigation through depth-arranged content, and squeezing to zoom recorded the fastest times in the pan-and-zoom pointing task. Overall, FlexView allows users to easily browse depth-arranged information spaces without sacrificing traditional touch interactions."

Advancing the Architecture of Mobile Web Services
Khalid Elgazzar

While mobile devices, with the recent revolution in their capabilities, are currently recognized as active data participants and service providers, the reliability and availability of their services remain challenging. Although many basic principles of the standard Web service approach continue to apply, the inherent constraints of mobile devices and limitations of broadband wireless access make the deployment of standard architectures and Web services mechanisms in mobile environments inefficient. To tackle these concerns, our research approaches these problems from two different perspectives, 1) Augmenting the capabilities of mobile devices to overcome their inherent limitations using emerging technologies (such as cloud computing), and 2) Taking advantage of the ability of mobile devices to access a wide range of context information to offer "personal services".

Supporting Model Driven Development of Reactive Systems with Analysis and Abstraction
Karolina Zurowska

"Formal analysis of models is an important aspect of the Model Driven Development (MDD) paradigm. Although there are many methods to analyze models, for instance with model checking, the direct analysis of large models that are hierarchically built from communicating modules and which contain complex state machines with action code is less researched. Such models are often encountered in MDD modeling tools, e.g., in IBM Rational Software Architect Real Time Edition (IBM RSA RTE). The research direction presented here aims to introduce methods to analyze MDD models and to investigate the use of abstractions to improve the scalability of verification.
Based on a formal representation that preserves the structure of MDD models, we will define abstractions, which target data (using symbolic execution), structure (using removal of internal parts of hierarchies) and descriptions of behavior of models."

Accuracy of Electromagnetic Tracking in an Operating-Room Setting
Elodie Lugez

"Purpose
As an integral part of computer-assisted surgery, tracking requires a careful characterization for use in orthopedic applications and multi-sensor fusion. This is particularly essential, for electromagnetic (EM) measurement systems which have recently gained popularity due to their small sensor size and the absence of line-of-sight restriction. The static errors caused by field distortion due to the presence of unmoving metallic and electrical objects, as well as the inherent error in the tracking system, have been widely studied. A shortcoming of previous work is that there has been little study of how orientation by EM tracking behaves in an operating-room setting, and only a few studies have decoupled the 3D position and orientation error of an EM sensor in a tracked volume. Moreover, a principal limitation has been the additional undesired EM distortions introduced by external manipulators employed for positioning EM sensors within a workspace. This paper presents a method for characterizing decoupled static EM errors in position and orientation measurements without external interference. The concept was to use 3D plastic scaffolds “printed” using additive manufacturing, to

provide a large number of static trajectories. This allowed many orientations to be tested, to high repeatability, without an external manipulator.

Methods

The 5-DOF (degrees of freedom) EM measurements were taken using an Aurora system (Northern Digital, Waterloo, Canada) with a planar field generator providing a global coordinate frame. To decouple the position and orientation readings, two repeatability scaffold devices were designed and manufactured in order to be interchangeable in a fixed measurement base. The position scaffold contained 49 parallel paths to evaluate position and orientation measurement uncertainties as a function of position. The paths were regularly distributed in a 7x7 grid, with various insertion depths, that were sized to accept the 5-DOF sensor in a noninterfering fit. The orientation scaffold contained 65 converging paths to evaluate the position and orientation measurement uncertainties as a function of orientation. The paths were formed on 4 rings of 16 hexagonal holes, plus a central hole, which were sized to accept a custom plastic inserter in a noninterfering fit. The inserter had several clips to firmly hold the 5-DOF sensor. Experiments were conducted in a clinical environment. The experimental setup was placed on a carbon-fiber operating table, located midway between an X-ray fluoroscope and a CT scanner. The fluoroscope and scanner were fully powered but not emitting X-rays during the entire process of data collection, simulating a surgical-navigation setting. Each scaffold was centered 300 mm away from the EM field generator in a custom fixture. An EM sensor was introduced in each path of each scaffold in turn, and a 10-second data stream of approximately 400 samples was recorded. The path positions were registered to the ground truth positions using a least-squares method, from which the position accuracy was computed using the Euclidean distance. The orientation accuracy was computed using the difference of orientation between both the direct angle of 2 successive measured paths, and the ground truth. Data were assembled into four classes: position accuracy as the sensor was translated within the position scaffold; orientation accuracy during translation; orientation accuracy as the sensor was rotated in the orientation scaffold; and position accuracy during rotation. The mean and maximum accuracies were found. The 95% confidence interval (CI) was also computed.

Results

Position error, when translating the sensor within the positioning scaffold, had a mean of 1.4mm and had a 95% CI of 2.2mm. Orientation error, when rotating the sensor within the orientation scaffold, had a mean of 1.0deg and had a 95% CI of 1.6deg. These errors would have been reported, by previous groups, as the translation and rotation errors of EM tracking. We also found the "cross-displacement" errors. Orientation error, when translating the sensor within the positioning scaffold, had a mean of 1.2deg and had a 95% CI of 2.0deg. Position error, when rotating the sensor within the orientation scaffold, had a mean of 1.2mm and had a 95% CI of 1.1mm. The most accurate position and orientation measurements were measured when the insertion paths were aligned to the Aurora global XY plane.

Conclusion

In a surgical setting, the experiments successfully decoupled and evaluated uncertainties in position and orientation measurements without introducing external interference. In this workspace, the EM errors were comparable to those of popular optical localization systems (e.g., Polaris). The results suggest that a carbon-fiber operating table and nearby X-ray imaging equipment do not deleteriously affect the EM tracking system tested here. Further experiments are needed prior to EM use in high-accuracy orthopedic navigation. The study was limited in not testing the X-ray equipment during use, when high electric potentials and ionizing radiation are present. The study also did not systematically introduce surgical instruments or implants into the EM field. Nonetheless, these data suggest that EM sensors are more promising for demanding applications than the conservative recommendations of the manufacturers may imply."

When Paper Meets Multi-Touch: A Study of Multi-Modal Interactions in Air Traffic Control
Cheryl Savery

When multiple modes of interaction are available, it is not obvious whether combining these technologies necessarily leads to a better user experience. It can be difficult to determine which modes are most appropriate for each interaction. However, complex activities such as air traffic control require multiple interaction techniques and modalities. As a result, in this paper, we study the technical challenges of adding finger detection to an augmented flight strip board used by air traffic controllers. We use our augmented strip board to evaluate interactions based on touch, digital pen and physical paper objects. From our user study, we find that users are able to quickly adapt to an interface that offers such a wide range of modalities. The availability of different modalities did not overburden the users and they did not find it difficult to determine the appropriate modality to use for each interaction.

Democratic Wireless Sensor Networks
Sharief Oteafy

In telecommunications, Wireless Sensor Networks (WSNs) are growing both in research and real-world deployments. As a network of small devices that communicate wirelessly, energy efficiency has long been the core concern for WSN protocols and architectures. Much has been researched and tested in the realm of WSNs, especially in routing data back to base stations, and contention over the wireless medium when these devices communicate. In this talk we contend a domain seldom approached in WSN research: efficient sensing and selection mechanisms. When an event occurs, all sensors which detect it often report it. This results in significant traffic overhead as many reports traverse the network back to the collecting base station. A common practice is aggregating data up the routing tree, or designating controllers to dictate who reports. Both approaches incur overhead in operation and energy loss. We present a dynamic paradigm for electing the most fit sensing node to report an event; in a decentralized manner. Our approach optimizes detection rates while reducing network traffic. It is also optimized to adapt to varying traffic rates and nodal densities, network scaling and failures.

Identifying User Complaints of iOS Apps
Hammad Khalid

"In the past few years, the number of smartphone apps has grown at a tremendous rate. To compete in this market, both independent developers and large companies seek to improve the ratings of their apps. For many businesses, the star ratings that their apps receive are directly tied to their revenues. Therefore it is crucial for developers to understand how they can avoid bad ratings. Therefore, understanding the user's perspective of mobile apps is extremely important. In this study, we examine the user's perspective of iOS apps by qualitatively analyzing app reviews.
We implement a web crawler to crawl each page containing reviews of 20 iOS apps. We then manually tag a statistical sample of these reviews using an iterative process. In total, we manually tag 6,390 reviews for 20 iOS apps. We find that there are 12 types of user complaints.
Having manually tagged the iOS reviews, we answer our research problem: What do iOS users complain about? We find that 'Functional Error', 'Feature Request' and 'App Crashing' are the most frequently reported complaints, accounting for more than 50% of the user complaints. In addition, we find that complaints about device compatibility, responsiveness and resource heavy apps are not reported as often. We also find that iOS apps have their own unique complaints such as 'Hidden cost' and 'Privacy and ethical issues'. This study is the first to provide a listing of these complaints with empirical evidence. Interestingly,we find that there is no statistically significant difference in complaints between above and below average apps. In addition to these findings, we discovered that 11% of the complaints reported an update hindering the app. This highlights the importance of regression testing when updating mobile apps.It is crucial for developers to understand the type of complaints that their

apps receive from users. To aid developers,our paper contributes a listing of the most frequent complaints about iOS apps. From our study, researchers are made aware of the reasons that can affect the ratings of apps. Hence, future research efforts can focus on solving those problems."

Effect of Multi-hop localization in WSN
Walid Ibrahim

Estimating the location of sensor nodes in wireless sensor networks is a fundamental problem, as sensor node locations play a critical role in a variety of applications. In many cases the area covered is very large so that it is impossible to localize all sensor nodes using single-hop localization techniques. A solution to this problem is to use a multi-hop localization technique to estimate sensor node positions. Multi-hop localization techniques are classified into two categories: range-based and range-free. Despite the numerous existing localization techniques, the fundamental behavior of multi-hop localization is yet to be fully examined.

Studying the Relationship between Build Technology and Build Maintenance
Shane McIntosh

Build systems specify how source code is translated into deliverables. They require continual maintenance as the system they build evolves. This build maintenance can become so burdensome that projects switch to different technologies, rewriting potentially thousands of lines of build code. We aim to understand the relationship between build technology and build maintenance activities by analyzing version histories in a corpus of more than 840,000 repositories spread across four software forges, three software ecosystems, and four large-scale projects. We study low-level, abstraction-based, and framework-driven build technologies as well as dependency management tools that automatically resolve third-party API dependencies. We find the modern, framework-driven technologies to be associated with a higher churn rate and a tighter coupling with source code than low-level and abstraction-based ones. Technology migrations tend to reduce source-build coupling and the percentage of developers that need to change the build system, shifting build maintenance activity to specialized build maintainers. We expect that our findings will help build maintainers in build technology selection and in planning build migration projects. Our findings raise important questions for research and practice (e.g., why are modern build technologies associated with more maintenance activities?) and provide an approach that we expect to help answer them.

Quantifying Nondeterminism in Finite Automata
Alexandros Palioudakis

Our study is in the area of finite automata, which is a simplification of the more powerful model of computation know as Turing machines. These models can be defined either in a deterministic way or in a nondeterministic way. Although deterministic and nondeterministic models effectively have the same computational power, i.e. they accept the same set of languages, the nondeterministic version can possibly be faster and more economical. Comparing deterministic and nondeterministic computational models have led to some very important problems in computer science and mathematics. To address these problems, our approach is to study them in the simpler model of finite automata. For finite automata the question of time complexity has no meaning. However, we know that nondeterministic finite automata (NFA) can be exponentially more efficient in terms of space complexity than deterministic finite automata (DFA). More specifically, we count the space complexity of finite automata in terms of the number of states of the machine. In the literature this is called state complexity.
In order to better understand the trade-off nondeterminism against state complexity, it seems appropriate to treat nondeterminism as just one more resource by quantifying it. The quantification of

nondeterminism varies among authors. Some of these approaches measure the number of leaves of a computation trees on inputs, some take the product of the amount of nondeterminism that appears in a computation. Others simply count the number of nondeterministic steps that occur in a computation, or they count the number of accepting leaves in the computation tree of the automaton on a given input.
More specifically we study the measures, so called, tree width and trace. We study the efficiency in terms of state complexity between DFA and NFA with finite nondeterminism. We also study the interrelationships between various measures of nondeterminism for finite automata. The tree width of an NFA is a function that associates a positive integer n to the maximum number of leaves in any computation tree of A on an input of length n. The trace of an NFA is defined in terms of the maximum product of the degrees of nondeterministic choices in computation on inputs of given length. We establish upper and lower bounds for the trace function of an NFA in terms of its tree width. Additionally, we have found that the unbounded trace of an NFA has exponential growth.

Inter-Cell Interference Coordination for Highly Mobile Users in LTE-Advanced Systems
Shadi Khalifa

How good is the performance of the existing Inter-Cell Interference Coordination (ICIC) schemes when dealing with users moving at high speeds? In this paper, we evaluate a number of existing schemes under high user mobility conditions. Then, we propose a dynamic decentralized ICIC scheme that requires no apriori frequency planning. The proposed scheme minimizes the amount of data needs to be exchanged among base stations. The scheme uses the Harmony Search (HS) algorithm in order to rapidly generate a more accurate User-to-Channel allocation matrix to cope with high user mobility. We also propose power control and channel restriction strategies to minimize the power consumption and inter-cell interference. A key advantage in the proposed scheme is that its computations are independent of the number of users and cells in the network. Accordingly, it can be deployed in large networks with large number of users. Extensive simulations demonstrate that, with a slight degradation in fairness, the proposed scheme provides 18% throughput improvements to edge users without penalizing other users. In addition, the use of the power control and restriction strategies has led to a 22% reduction in power consumption**.**

SimITK: Model Driven Engineering for Medical Imaging
Melissa Trezise

The Integrated Segmentation and Registration Toolkit (ITK) which is a C++ toolkit can potentially have a steep learning curve for users with little C++ experience or those without a programming background. ITK is of particular importance to the medical imaging community because of its widespread use for registration, segmentation, and analysis of medical images. A model driven engineering approach to programming in ITK is presented where written code is replaced by an equivalent model representation in Simulink within Matlab. This previously released open-source software, SimITK, allows the user to connect blocks in a workflow to perform common medical imaging tasks including registration. Work has focused on usability improvements for the registration pipeline along with modifications to the system for ITK version 4. This talk will briefly touch on use cases for SimITK, usability improvements, and the process of moving to ITK version 4.

The Computation of Sensor Activation Decisions in Discrete-Event Systems
David Sears

This talk considers partially-observed discrete-event systems where sensors are associated with events observable to an agent monitoring the system. The agent is capable of turning the sensors for events on and off dynamically, depending on the trajectory of the system. Reading data from the sensors

may be costly so it is imperative that their use be reduced for reasons such as energy, bandwidth or security. When a sensor for an event is on / active any occurrence of the event is detected by the agent and is not detected otherwise. The agent may employ different sensor activation policies, depending on the task at hand. Sensor activation policies are defined over the transitions of a state-transition representation of the system. From sensor activation policies a map from observed event sequences to sensor activation decisions can be computed which the agent can use to determine which sensors to turn on / off and when. In this talk, we consider three subclasses of sensor activation policies of increasing generality. For each subclass, we will summarize ways to compute maps from observed event sequences to sensor activation decisions in polynomial time. However, for the last subclass considered, we demonstrate that verifying if an arbitrary sensor activation policy belongs to this class is PSPACE-complete.

Clinical Decision Support Software for Prediction of Postoperative Atrial Fibrillation Following Bypass Surgery
Geoffrey Seaborn

"Every year, approximately 11,000 Ontarians undergo coronary artery bypass grafting (CABG), which is an invasive surgical procedure designed to treat coronary artery disease (CAD), the leading cause of cardiovascular deaths in Canada. Following this critical procedure, survival in patients at high risk is greatly increased. However, 20%-40% CABG recipients develop sustained atrial fibrillation (AF), the most frequent basis for hospitalizations due to heart rhythm disturbances, and the primary cause of stroke. Postoperative AF is a tremendous burden for patients in terms of morbidity and mortality, as well as for the healthcare system in terms of additional costs incurred. Despite investigators reporting numerous independent predictors for postoperative AF, its etiology continues to be unclear, and its prevention and management remain suboptimal. Efforts to reduce the incidence of postoperative AF would achieve significant health benefits for patients, and substantial cost savings for the Canadian healthcare system.
The problem of accurately predicting the onset of sustained postoperative AF in patients undergoing CABG remains open. Investigators have reported many clinical indices currently associated with postoperative AF following CABG. Contemporary machine learning techniques are well-suited to recognizing underlying trends in 'training' data consisting of several labeled examples, and to using the results to classify new unlabeled data with remarkable sensitivity and specificity. We are currently developing an advanced clinical decision support software capable of automatically gathering and analyzing relevant clinical data from patients undergoing CABG in order to provide physicians with objective and non-invasive insights into the likelihood of sustained postoperative AF so that patient morbidity and mortality, as well as healthcare costs, can be significantly reduced by targeting appropriate preventative therapies."

Student Posters
Abstracts

Executing data-intensive workload in a cloud with minimal dollar-cost
Riwan Mian

Cloud computing appears as a promising paradigm for deploying applications due to its large resource offerings on a pay-as-you-go basis. In this paper, we examine the problem of determining the most cost-effective deployment of a data-intensive application in a public cloud. We formulate the problem of resource provisioning and workload execution, and then define a framework to solve it. Our framework uses an existing cost model to predict the cost of executing a workload on a resource configuration and standard heuristics for selecting configurations. The heuristic based algorithms balance resource costs and penalties from SLAs, or provide non-violating configurations if required. The specific resource demands and frequencies are accounted for by an existing performance model of the Virtual Machines (VMs), which is used to predict performance. We validate our approach experimentally using workloads based on standard TPC benchmarks on Amazon EC2.

Action Prediction and Player Modeling in Online Games
Max Graham

Network latency is a major hindrance for highly interactive multiplayer online video games. Delays in the transmission of information may cause players to make decisions based on an out-of-date game state, which can lead to confusion and frustration from the players' point of view. We hope to show that by modeling a player's actions, we can predict which action, if any, the remote player has performed since the last update was received over the network. This will allow us to perform the action in real time on both machines, rather than displaying a lagged action after the update has arrived.

Open Source Ultrasound Simulation Using Surface Meshes
Laura Bartha

"Purpose: Ultrasound (US) is frequently used for image guided therapy (IGT) as it is a safe, relatively cheap, and portable modality. However, this popular approach is difficult to develop algorithmically, and difficult to master. A part of the problem is the accessibility and quality of the images. US machines as well as patients or phantoms are necessary to acquire the images, and are often expensive. Even once acquired, real US images are hardly reproducible and have uncontrollable parameters. A solution to these problems is simulation. It provides the controllable environment needed for verification and better facilitates learning. Current physically accurate simulators require significant processing power and time, making them poorly suited for IGT. Commercial systems are not only expensive, but are lacking in versatility, often being limited to only one application, and open source simulators were not found in a search of the literature.
Method: The objects to appear in the simulated US image are defined geometrically. Anatomical data is acquired from segmentations of CT or MRI data converted into surface meshes. Other objects, such as surgical tools, are also represented using surface meshes, allowing for the preservation of model details. The pose of the objects is represented using linear transforms, which could be specified either as constants, in a configuration file, or coming from a tracker. Transducer parameters, such as radius, imaging depth, number of elements and shape (curvilinear vs. linear) are also defined, as was the material properties associated with each model. Next, the points of intersection between the surface meshes and the scan lines of the US image are determined.
For time efficiency binary space partitioning (BSP) tree is used. The intersection points divide the scan line into segments, which are then filled with a grey value; the result of an intensity calculation based on the material properties defined earlier. The scan lines are finally converted to a regular brightness-

mode US image. All the above steps were implemented in C++, as part of the open-source PLUS (Public software Library for Ultrasound) toolkit.
Results: The simulator was tested in an US-guided spinal injection training scenarios. The anatomical objects (spine), tools (US transducer, needle), and simulated US image were visualized in 3D Slicer. An electromagnetic tracker was connected to the computer and provided position information. The spine mesh consisted of over 97,000 points in 195,000 cells. The US images were generated at a speed of 50 frames per second, and a resolution of 820 x 616 pixels on a PC with a 3.4 GHz processor.
Conclusion: A basic US simulator has been implemented and integrated into the open-source PLUS toolkit, to aid teaching US-guided procedures and for producing test data for various US image processing and analysis algorithms, such as volume reconstruction and spatial and temporal calibration. Presently, only bone contour is generated. Blending speckle and trace of the surgical tools is in progress."

Clinical Ultrasound Data Collection of the Spine from an Imaging Perspective
Simrin Nagpal

BACKGROUND: Intraoperative ultrasound guidance for spine needle procedures is becoming more prevalent since ultrasound is a non-ionizing and more accessible image modality. An inherent challenge to ultrasound imaging of the spine is the acoustic shadows created by the bony structures of the vertebra limiting visibility. Since the success of ultrasound-guided spine navigation systems is highly dependent on the quality of the acquired ultrasound images, guidelines for ultrasound imaging parameters and the freehand data acquisition must be specified.
PURPOSE: The objective of this work is to create The Spine Lumbar Data Collection Protocol to help with the acquisition of ultrasound data for a CT to ultrasound registration problem. The protocol aims to eliminate variability in image quality.
METHODS: The data acquisition system consists of a Sonix Touch (Ultrasonix) ultrasound scanner with GPS extension (Ascension DriveBay electromagnetic tracker) and a C5-2 (Ultrasonix) curvilinear ultrasound transducer. A preset of ultrasound imaging parameters was first created alongside a sonographer based on ultrasound images of volunteers. Only minor manual adjustments to the imaging parameters for each individual are needed to reduce intraoperative time. The image depth was adjusted for each individual so that the spinal canal was visible at the bottom margin in a sagittal view. The sonographer landmarked the T12 vertebrae and sacrum for the length of the sweep and the ends of the L1 transverse processes for the width of the sweep. This ensures that the entire lumbar region of the spine is scanned. During the freehand data acquisition, an ultrasound sweep is completed in a minimum specified time to ensure the probe moved slowly and smoothly, while keeping complete contact with the ultrasound transducer (minimum of 20 seconds).
RESULTS: It was evident from the initial ultrasound scans of volunteers that the curvature of the spine varies between individuals. For this reason, three different sweep styles in both the transverse and sagittal directions were designed to ensure that at least one sweep provided good ultrasound images.
CONCLUSION: The Spine Lumbar Data Collection helps control the quality of the spine ultrasound images by setting guidelines for ultrasound machine imaging parameters and demonstrating various types of freehand ultrasound sweeps.

Unconventional Cryptography
Eslam AbdAllah

"This poster addresses three problems:
Problem 1: Standard cryptographic primitives make costly solutions for limited hardware devices like (RFID tags – smart cards – wireless sensor…), so lightweight cryptography is therefore a pressing need. Lightweight cryptography includes low requirements in (H.W. implementation – RAM – ROM – power).

Problem 2: The security of cryptographic techniques can be classified to unconditionally secure and computationally secure. An encryption scheme is unconditionally secure if the cipher text generated by this technique does not contain enough information to determine the corresponding plaintext, regardless how much cipher text is available. There is no unconditionally secure technique existing except the one time pad (OTP) algorithm. In OTP we need to use a random key that is as long as the message and there is no repetition in the key. Mathematical solutions can only generate pseudorandom numbers.

Problem 3: Security attacks can be classified to passive attacks and active attacks. A passive attack attempts to capture or make use of information from the system without affecting the system resources. Passive attacks are in the nature of eavesdropping on transmissions like release of message contents and traffic analysis. An active attack attempts to alter system resources or affect their operation like masquerade, modification of messages, replay and denial of service. We can prevent the passive attacks by using encryption and decryption techniques but there is no way to detect the existence of the eavesdropper using classical cryptography. We can detect the active attacks because it modifies the data using techniques like hashing and digital signatures but we cannot prevent these types of attacks.

By using the unconventional cryptography we can overcome these three problems: developing lightweight cryptography, true random number generation and eavesdropper detection.

Unconventional cryptography can provide more secure cryptographic solutions, process huge amount of data in parallel and break the complex mathematical properties of the standard classical techniques like DES, AES and RSA. Lightweight cryptography includes low requirements in (H.W. implementation – RAM – ROM – power) and can be used in the limited hardware devices. True Random numbers can be implemented using the unconventional techniques like DNA, transfinite. DNA hybridization and generally physical processes can be used to generate "True" random numbers where mathematical algorithms can generate pseudo-random. By using transfinite arithmetic there is no need to generate and transmit new random keys after some initial keys due to the bijection relation between the infinite sets. The existence of the eavesdropper can be detected using the quantum cryptography because of the nocloning feature in the quantum computing. Although nocloning considered being a disadvantage in quantum computing it is a great advantage in quantum security."

Bringing Action to Exergames for Children with Cerebral Palsy
Hamilton Hernandez

"Cerebral Palsy is a neurological disorder characterized by deficits in gross motor control and manual ability. Children with cerebral palsy often have difficulty engaging in casual exercise such as going for a bike ride or kicking around a ball with their friends. This can contribute to loss of mobility as the children grow.

Exergames, video games with an exercise component, represent a promising approach to helping children with CP to be more physically active. We have found that children with CP want to play fast-paced action video games similar to those played by their friends without motor disabilities. This is particularly true of exergames, whose physical activity matches the fast-pace of action games. However, disabilities associated with CP can make it difficult to play action games.

Existing guidelines for developing games for people with motor disabilities can lead to slow-paced games that are accessible, but may lack the fun of fast-paced action games.

Through a year-long participatory design process with children with CP, we have discovered that it is in fact possible to develop action exergames for children with CP at level III on the Gross Motor Function Classification Scale. We have developed and tested six fast-paced action exergames for children with CP.

We have produced a revised set of design guidelines for games for children with CP, which retain the core principles of existing guidelines, while being compatible with fast-paced action. The results of a

follow up 8-week home trial showed high overall enjoyment and adherence. Players' interest held up so strongly that more minutes were played in the final week than the first.".

MOBILE IMAGE OVERLAY SYSTEM FOR IMAGE GUIDED INTERVENTIONS
Manjunath Anand

"Introduction: Previously, a static image overlay guidance system has been proposed for aiding needle placement interventions. In this technique, a 2D computer display image is reflected by a semi-transparent mirror, so that the virtual image appears floating inside the patient in correct 3D position. This system provides accurate transverse image guidance for musculoskeletal interventions of the shoulder, hip and spine. The previous static mounting of the system was either fixed to the CT/MR imaging system or on a floor-mounted frame over the patient table. This mounting required careful calibration before each procedure, and was prone to misalignments due to structural deformation or unintended physical contact with the device. Furthermore, the static mount limited the access to the patient and excluded clinically relevant ranges of motions of the tool and the physician. To overcome those limitations, we propose the Mobile Image Overlay System (MIOS). The potential applications of MIOS are musculoskeletal needle injections, parathyroidectomy, percutaneous nephrolithotomy and percutaneous access to blood vessel.
Method: MIOS consists of mirror-monitor configuration called as viewbox and attached to a floor mounted articulated counter-balanced system. It is equipped with optical markers on the monitor to measure the pose of the image overlay plane during the entire procedure. Another set of optical markers are fixed upon the patient for co-registration of scanned images and the MIOS. The system can be used for exploration of the image volume by a moving image slice overlaid on the patient. The software will display the correct image in real time corresponding to the position of the image overlay plane tracked by the MicronTracker (Claron Technology Inc, Canada) w.r.t the patient. After locating the target point in the image overlay plane inside the patient, the system is firmly locked in this position and the needle trajectory is drawn on the image slice in the software, which gets updated in the image overlay plane for needle guidance. The MIOS overcomes the practical difficulty of accurately positioning the static image overlay system by the motion tracking of the viewbox.
Results: The initial concept of MIOS was developed with CREO 2.0 software and the system specifications were developed. The first prototype developed successfully demonstrated the proof of concept. Phantom and cadaver studies need to be performed to evaluate the accuracy of direct calibration method and to refine the clinical workflow.
Conclusion: Based on successful pre-clinical testing of the static image overlay system, the mobile image overlay promises to become a useful tool for image-guided interventions, such as musculoskeletal needle injections, parathyroidectomy, percutaneous nephrolithotomy and percutaneous access to blood vessels."

Identifying User Complaints of iOS Apps
Hammad Khalid

"In the past few years, the number of smartphone apps has grown at a tremendous rate. To compete in this market, both independent developers and large companies seek to improve the ratings of their apps. For many businesses, the star ratings that their apps receive are directly tied to their revenues. Therefore it is crucial for developers to understand how they can avoid bad ratings. Therefore, understanding the user's perspective of mobile apps is extremely important. In this study, we examine the user's perspective of iOS apps by qualitatively analyzing app reviews.
We implement a web crawler to crawl each page containing reviews of 20 iOS apps. We then manually tag a statistical sample of these reviews using an iterative process. In total, we manually tag 6,390 reviews for 20 iOS apps. We find that there are 12 types of user complaints.

Having manually tagged the iOS reviews, we answer our research problem: What do iOS users complain about? We find that 'Functional Error', 'Feature Request' and 'App Crashing' are the most frequently reported complaints, accounting for more than 50% of the user complaints. In addition, we find that complaints about device compatibility, responsiveness and resource heavy apps are not reported as often. We also find that iOS apps have their own unique complaints such as 'Hidden cost' and 'Privacy and ethical issues'. This study is the first to provide a listing of these complaints with empirical evidence. Interestingly,we find that there is no statistically significant difference in complaints between above and below average apps. In addition to these findings, we discovered that 11% of the complaints reported an update hindering the app. This highlights the importance of regression testing when updating mobile apps.It is crucial for developers to understand the type of complaints that their apps receive from users. To aid developers,our paper contributes a listing of the most frequent complaints about iOS apps. From our study, researchers are made aware of the reasons that can affect the ratings of apps. Hence, future research efforts can focus on solving those problems."

MFW: Mobile Femtocells utilizing WiFi
Mahmoud H. Qutqut

"The ever growing data traffic generated by users in cellular networks is becoming more challenging and straining for cellular operators. Thus, developing efficient mechanisms that enable cellular operators to offload data traffic from their networks in a cost-effective manner is essential. To this end, we propose a generic framework (MFW) that exploits femtocells and WiFi networks. The framework allows cellular operators to offload part of the traffic load generated by mobile users in public transportation systems, viz.; buses, streetcars. Regular Femto Base Stations (FBSs) are installed in these vehicles to offer cellular coverage for mobile devices, called the mobile FBS (mobFBS). The mobFBS utilizes ubiquitous WiFi access points as a backhaul to route the traffic to the cellular operator's network through WiFi instead of the loaded macrocells. Mobile data users are categorized in our framework in different prioritized classes in order to efficiently allocate the mobFBS bandwidth to the maximum number of users. Efficiency is considered in terms of bandwidth utilization, enhancing capacity and managing grouped data traffic in vehicles. We elaborate on the performance of MFW via numerical experiments, emulating practical applications, viz. "Skype" and "YouTube", and demonstrate the efficiency of our framework in terms of data traffic offloading.".

SimITK: Visual Programming for ITK
Melissa Trezise

"Purpose: The Integrated Segmentation and Registration Toolkit (ITK) can potentially have a steep learning curve for users with little C++ experience or those without a programming background. The objective of our work is to improve the functionality of the previously released open-source software, SimITK, built in Matlab's Simulink environment. We focus on improvements to the image registration pipeline in order to provide greater flexibility for the user.
Methods: Previously, we presented an automatic approach for wrapping ITK classes as Simulink blocks [1]. This allowed the user to create workflows for imaging tasks such as registration and segmentation by dragging, dropping, and connecting these blocks without having to program in ITK. However, when creating a registration workflow the user had limited options and could not observe the progression of the registration similarity metric as the model was running. In order to allow for greater flexibility and usability we made changes to the individual virtual blocks and S-functions for the appropriate ITK classes. Our improvements allow the user to monitor the progress of the metric value in real time. As well, they can use the metric block independently to measure the similarity metric of two images. Functionality was also added to allow the user to specify the output image size when resampling the image.

Results: Currently, a useful subset of ITK functions are automatically wrapped in SimITK. We have focused on image registration and enabled the user to make modifications and observe registration as it proceeds. The current release, source code, and other information are available at www.simitkvtk.com

Conclusions: The proposed solution, SimITK allows users to quickly and easily create workflows for complex imaging tasks. This is particularly true for the registration pipeline whose added flexibility allows the user to monitor the registration process while it is executing.

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