Aftab Hussain

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Research Interests

My research interests are in the areas of programming languages, systems, and security. I enjoy the design of interface description languages that can generate secure code for inter-module interactions of large code systems like Linux. I also enjoy developing scalable systems that can support static analysis applications, such as bug detection, on very large codebases. Currently, I am working in a project on light-weight capability domains in Linux at the MARS Systems Research Group with my advisor, Professor Anton Burtsev.

Education

2015 - present — PhD Candidate in Computer Science,
University of California, Irvine (UCI), United States
Focus: "Programming Languages and Systems" | Advisor: Prof. Anton Burtsev
GPA: 3.83/4

2013 - 2015 — M.Sc. in Software Engineering,
University of California, Irvine, United States
GPA: 3.74/4

2010 - 2012 — M.Sc. Engg. in Computer Science and Engineering,
Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh
Thesis: "Software Restructuring using Hierarchical Clustering"
Advisor: Prof. Md. Saidur Rahman
GPA: 3.83/4

2005 - 2009 — B.Tech. in Computer Science and Engineering,
Institute of Engineering and Management (IEM), Kolkata, India
Thesis: "Steganography" | Advisor: Prof. Himadri Nath Saha
GPA: 8.01/10

Experience

Research

Graduate Researcher at Department of Computer Science, University of California, Irvine — Mar 2015 to *present*
Areas: Scalable static program analysis, graph processing, cyber security
Labs: Mars Systems Research Group, PLSys Group

Graduate Researcher at Department of Informatics, University of California, Irvine — Sep 2013 to Mar *2015*
Areas: Big data analytics, software repository mining
Lab: Big Data Mondego Lab

Research Associate at Department of Computer Science, Bangladesh University of Engineering and Technology — Dec 2012 to Aug 2013
Areas: Graph clustering, software visualization
Labs: Graph Drawing and Info Visualization Lab, Samsung Innovation Lab

Research Assistant at Department of Computer Science, Bangladesh University of Engineering and Technology — Sep 2010 to Jun 2011
Areas: Planar graph drawing, wireless sensor networks
Lab: Graph Drawing and Info Visualization Lab

Teaching	**Teaching Assistant** at Bren School of Information and Computer Sciences, University of California, Irvine	Jan 2014 to *present*
	Reader at Bren School of Information and Computer Sciences, University of California, Irvine	Sep 2013 to Dec 2013
Industry	**Software Engineering Intern** at NextTel Communication, Dhaka, Bangladesh *Project:* GUI design of pharmaceutical mobile application	Mar 2010 to Apr 2010
	Software Engineering Trainee at CMC Kolkata, (A TATA Enterprise), Kolkata, India *Project:* Design of hospital database management system	Jul 2008

Publications

Conference Publications

C.5. V. Narayanan, A. Balasubramanian, C. Jacobsen, S. Spall, S. Bauer, M. Quigley, A. Hussain, A. Younis, J. Shen, M. Bhattacharyya, and A. Burtsev. LXDs: Towards isolation of kernel subsystems. In *2019 USENIX Annual Technical Conference (USENIX ATC 19)*, Renton, Washington, US, 2019

C.4. K. Wang, A. Hussain, Z. Zuo, G. Xu, and A. A. Sani. Graspan: A single-machine disk-based graph system for interprocedural static analyses of large-scale systems code. In *22nd ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS '17)*, Xi'an, China, 2017 (paper)

C.3. D. Yang, A. Hussain, and C. V. Lopes. From query to usable code: An analysis of stack overflow code snippets. In *13th International Conference on Mining Software Repositories (MSR '16, Co-located with ICSE '16)*, Austin, Texas, US, 2016 (paper)

C.2. I. Hossain, S. Sultana, A. Hussain, N. N. Moon, and M. S. Rahman. L-shaped drawings of series-parallel graphs. In *International Mathematics Conference*, Dhaka, Bangladesh, 2013 (paper)

C.1. A. Hussain and M. S. Rahman. A new hierarchical clustering technique for restructuring software at the function level. In *6th India Software Engineering Conference (ISEC '13)*, New Delhi, India, 2013 (paper)

Workshop Publications

W.2 A. Hussain. Graspan: A single-machine disk-based graph system for interprocedural static analyses of large-scale systems code. In *17th Southern California Workshop on Programming Languages and Systems (SoCal PLS '16)*, Irvine, California, US, 2016

W.1 A. Hussain and M. S. Rahman. A new clustering technique using (k,w)-core decomposition for restructuring software functions. In *Workshop on Graph Drawing and Graph Algorithms (GDGA '13)*, Dhaka, Bangladesh, 2013

Posters

P.3 K. Wang, A. Hussain, Z. Zuo, G. Xu, and A. A. Sani. Graspan: A single-machine disk-based graph system for interprocedural static analyses of large-scale systems code. In *22nd ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS '17)*, Xi'an, China, 2017 (poster)

P.2 A. Hussain. Graspan: A single-machine disk-based graph system for interprocedural static analyses of large-scale systems code. In *Student Research Competition, 37th ACM SIGPLAN conference on Programming Language Design and Implementation (PLDI '16)*, Santa Barbara, California, US, 2016

P.1 A. Hussain. Graspan: A single-machine disk-based graph system for interprocedural static analyses of large-scale systems code. In *Computer Science Research Showcase, University of California, Irvine*, Irvine, California, US, 2016

Technical Reports

T.6 A. Hussain, V. Narayanan, and A. Burtsev. An implementation overview of an idl generation framework based on dsa. Technical report, Department of Computer Science, University of California, Irvine, 2018

T.5 H. Xu, Z. Zuo, K. Wang, A. Hussain, and K. Nguyen. Systemized program analyses: A big data perspective on scaling large-scale code analyses. Technical report, Department of Computer Science, University of California, Irvine, 2017 (report)

T.4 A. Hussain and I. Scherson. A study on memory consistency approaches in distributed shared memory systems. Technical report, Department of Computer Science, University of California, Irvine, 2016

T.3 A. Hussain and G. Xu. GraphDTC: A graph processing system for scalable and precise program analysis. Technical report, Department of Computer Science, University of California, Irvine, 2015 (report)

T.2 A. Hussain, O. Asadi, and D. Richardson. A holistic look at requirements engineering practices in the gaming industry. Technical report, Department of Informatics, University of California, Irvine, 2015 (report)

T.1 D. Yang, A. Hussain, and C. V. Lopes. Effect of follow and watch relationships in pull requests (in github). Technical report, Department of Informatics, University of California, Irvine, 2014 (report)

Under Preparation

U.1 A. Hussain and A. Burtsev. Common vulnerabilities and exposures in the cloud (under preparation). Technical report, Department of Computer Science, University of California, Irvine, 2018

Selected Projects

IDL Compilation for generating Glue Code for isolating Linux Drivers

2018-*present*

Design and compilation of an interface definition language to generate glue code that helps to isolate Linux drivers.

› Resources: Source code, IDL compiler documentation

IDL Generation for Linux Kernel Security

2017-*present*

Static analysis of Linux kernel to automatically generate interface definition language (IDL) code for isolating kernel modules for enhancing security.

› Resources: Source code

Graspan: Parallel Graphs System for Big Code Analysis

2015-2017

We built a disk-based parallel graph system, Graspan, that uses a novel edge-pair centric computation model to compute dynamic transitive closures on very large program graphs. We implement context-sensitive pointer/alias and dataflow analyses on Graspan. An evaluation of these analyses on program graphs of large codebases such as Linux shows that their Graspan implementations scale to millions of lines of code. (**Computations in Graspan took 2 to less than 12 hrs, and the largest graph generated had 1.1 billion edges**).

Graspan implementations are also much simpler to implement than their original implementations. After augmenting existing checkers with these analyses, the checkers **uncovered 132 new NULL pointer bugs and 1308 unnecessary NULL tests in Linux 4.4.0-rc5, PostgreSQL 8.3.9, and Apache httpd 2.2.18**.

› Accepted in ASPLOS '17, Xi'an, China.

› Featured in the tutorial, Systemized Program Analyses at ASPLOS '17.

› Invited for presentation at SoCal PLS '16.

› Invited for poster presentation at PLDI SRC '16.

› Resources: Source code, paper, poster, tutorial

Analysis of Usability of Stack Overflow Code Snippets

2013-2014

Besides being useful for software developers, annotated Stack Overflow snippets can potentially serve as the basis for automated tools that provide working code solutions to specific natural language queries. Towards this goal, we investigated the compilability of Stack Overflow code snippets. **A total of 3 million code snippets were analyzed across four languages**: C#, Java, JavaScript, and Python. Python and JavaScript proved to be the languages for which the most code snippets are usable. Conversely, Java and C# proved to be the languages with the lowest usability rate.

› Accepted in MSR '16.

› Resources: Paper

Software Restructuring using Hierarchical Clustering

2011-2013

Software restructuring techniques based on hierarchical agglomerative clustering (HAC) algorithms have been widely used to restructure large modules with low cohesion into smaller modules with high cohesion, without changing the overall behaviour of the software. These techniques generate clustering trees, of modules, that are sliced at different cut-points to obtain desired restructurings. Choosing appropriate cut-points has always been a difficult problem in clustering. Previous HAC techniques generate clustering trees that have large number of cut-points. Moreover, many of those cut-points return clusters of which only a few lead to a meaningful restructuring of the software.

In this work, we develop a new hierarchical clustering technique for restructuring software that **improves refactoring visualization by at least 30% over 3 widely popular clustering algorithms, is 60% faster, and yields the same code quality improvements on Java functions extracted from real-life industrial programs.**

› Accepted in ISEC '13.

› Invited for presentation in GDGA (Graph Drawing and Graph Algorithms) '13.

› Resources: Paper, thesis

Presentations

P.5 Graspan: A Single-machine Disk-based Graph System for Interprocedural Static Analyses of Large-scale Systems Code, SoCalPLS, November 2016, Irvine, California, US

P.4 Graspan: A Single-machine Disk-based Graph System for Interprocedural Static Analyses of Large-scale Systems Code, PLDI SRC, (poster), June 2016, Santa Barbara, California, US

P.3 Graspan: A Single-machine Disk-based Graph System for Interprocedural Static Analyses of Large-scale Systems Code, UCI CS Research Showcase, (poster), June 2016, Irvine, California, US

P.2 A New Hierarchical Clustering Technique for Restructuring Software at the Function level, ISEC, February 2013, New Delhi, India

P.1 A New Clustering Technique using (k,w)-Core Decomposition for Restructuring Software Functions, GDGA, January 2013, Dhaka, Bangladesh

Teaching

Courses

Served as Teaching Assistant (TA), University of California, Irvine:

Operating Systems (CS 238P), graduate level	Spring 2019
Computer Systems Architecture (CS 250P), graduate level	Winter 2019
Operating Systems (CS 238P), graduate level	Fall 2018
Concepts in Programming Languages (CS 141), undergraduate level	Summer 2018
Principles of System Design (ICS 53), undergraduate level	Spring 2018
Compilers and Interpreters (CS 142), undergraduate level	Winter 2018
Concepts in Programming Languages (CS 141), undergraduate level	Fall 2017
Compilers and Interpreters (CS 142), undergraduate level	Winter 2017
Introduction to Programming (ICS 31), undergraduate level	Winter 2014
Requirements Analysis and Engineering (INF 113), undergraduate level	Winter 2014

Served as Reader, University of California, Irvine:

Introduction to Software Engineering (INF 43), undergraduate level	Fall 2013

Selected Lectures

Operating Systems (CS 238P):

Basic UNIX shell commands, VIM	Fall 2018
C basics, arrays, pointers (code)	Fall 2018
C string manipulation, structures, function pointers (code)	Fall 2018
C bitfields, xv6 setup, GDB (video)	Fall 2018
xv6 booting: Transitioning from 16 to 32 bit mode (video)	Fall 2018
ELF header, real mode segmentation, paging (video)	Fall 2018
Threads, locks (video, code)	Fall 2018
xv6 review, system call chain (video)	Fall 2018

Compilers and Interpreters (CS 142):

Bottom-up parsing (LR(0), LR(1))	Winter 2018
Top-down parsing (LL(1)), handles	Winter 2018
Global optimization	Winter 2017

Study Material

Operating Systems (CS 238P):

Memory layout after booting xv6	Fall 2018
Counting semaphores	Fall 2018

Concepts in Programming Languages (CS 141):

Memory layout of struct and union in C	Fall 2017

Tools

Compilers and Interpreters (CS 142):

Crux Compiler Project Autograder	Winter 2018

Training Undertaken

Advanced TA Training (ICS 398B) by Prof. David G. Kay, graduate level	Winter 2018
TA Training (ICS 398A) by Prof. David G. Kay, graduate level	Fall 2013

Mentoring

Projects

University of California, Irvine:

4.	Efficient Software Infrastructure for Non-Uniform Memory Machines	Aug 2018 - Jan 2019
3.	Graspan Migration from Java to C++	Jun 2016 - Dec 2016
2.	Automatic Comment Generator for Java Code	Sep 2015 - Dec 2015

Bangladesh University of Engineering and Technology:

1.	Improving Code Testing Environments	Dec 2012 - Aug 2013

Students

I-Surf Fellows at University of California, Irvine:	[Project #]
Jeonghoon Lee, Undergraduate, Hanyang University, Seoul	4
Jiwon Jeon, Undergraduate, Ajou University, Suwon	4
Minjun Cha, Undergraduate, Kookmin University, Seoul	4
Yealynn Kim, Undergraduate, Kookmin University, Seoul	4
Sungsoo Son, Undergraduate, Kookmin University, Seoul	3
Hansem Jeon, Undergraduate, Kookmin University, Seoul	3
Soyeong Park, Undergraduate, Kookmin University, Seoul	2
John Vincent Thorpe, Undergraduate, UCI	3
Md. Khaled Hussain, Graduate, BUET	1

Service

ISSTA 2018 Amsterdam, Netherlands	Artifact Evaluation Committee Member International Symposium on Software Testing and Analysis
ISSTA 2017 Santa Barbara, California, US	Artifact Evaluation Committee Member International Symposium on Software Testing and Analysis
WADM 2013 Dhaka, Bangladesh	Reviewer Workshop on Advances in Data Management
BWTCSE 2013 Dhaka, Bangladesh	Organizing Committee Member Brain Storming Workshop on Theoretical Computer Science and Engineering
GDGA 2013 Dhaka, Bangladesh	Organizing Committee Member Workshop on Graph Drawing and Graph Algorithms
WALCOM 2012 Dhaka, Bangladesh	Organizing Committee Member and Reviewer Workshop on Algorithms and Computation

Honors

Grants

Mar 2017 ACM Professional Activities Grant
For paper presentation in 22nd ACM International Conference on Architectural Support for Programming Languages and Operating Systems, (ASPLOS '17).

May 2016 ACM Travel Award
For poster presentation in Student Research Competition at Programming Languages Design and Implementation Conference (PLDI '16)

Feb 2013 Chair's Award
Department of Informatics, University of California, Irvine

Dec 2012 CodeCrafters-Investor Tools Research Grant
For paper presentation in ACM Indian Software Engineering Conference (ISEC '12)

Sep 2010 Research Assistantship Grant
Committee of Advanced Studies and Research,
Bangladesh University of Engineering and Technology

Offers

Mar 2017 Invited to present tutorial on "Systemized Program Analyses - A Big Data Perspective on Static Analysis Scalability" at ASPLOS '17

Apr 2013 Graduate Admission Offer
Department of Computer Science, University of California, Davis

Feb 2013 PhD Admission Offer with Full Scholarship
School of Computing, Queen's University, Canada

Jul 2009 Associate System Engineer Position Offer
IBM-India

Certifications

May 2008 DELF A2 Diploma in French Language
Alliance Française, Ministrè de l'Éducation Nationale, Republique Française

Nov 2007 DELF A1 Diploma in French Language
Alliance Française, Ministrè de l'Éducation Nationale, Republique Française

Others

Feb 2010 Selection in National ICT Internship Program
Bangladesh Computer Council,
Ministry of Science and ICT, Dhaka, Bangladesh

Oct 2009 Top 22 of 152 test takers
Master's Program Admission Test, Bangladesh University of Engineering and Technology