Eunsuk Kang

CONTACT INFORMATION

Software and Societal Systems Department
School of Computer Science
Carnegie Mellon University
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Pittsburgh, PA 15213-2890 USA

+1-412-268-3761
eskang@cmu.edu
https://eskang.github.io

RESEARCH INTERESTS

Software engineering, formal methods, system safety, security, cyber-physical systems.

APPOINTMENTS

Assistant Professor (08/2018 - present)
Software and Societal Systems Department (S3D)
School of Computer Science (SCS)
Carnegie Mellon University

EDUCATION

Ph.D. in Electrical Engineering and Computer Science, February 2016.
Massachusetts Institute of Technology, Cambridge, MA
- Thesis: *Multi-Representational Security Modeling and Analysis*.
- Supervisor: Daniel Jackson

S.M. in Electrical Engineering and Computer Science, February 2010.
Massachusetts Institute of Technology, Cambridge, MA
- Thesis: *A Framework for Dependability Analysis of Software with Trusted Bases*.
- Supervisor: Daniel Jackson

Bachelor of Software Engineering, June 2007.
University of Waterloo, Waterloo, ON Canada

AWARDS AND HONORS

NSF CAREER Award, 2022.
Distinguished Reviewer Award. IEEE/ACM International Conference on Automated Software Engineering (ASE), 2022.
ACM SIGSOFT Distinguished Paper Award. Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering (ESEC/FSE), 2021.
Best Paper Award. ACM/IEEE Conference on Internet-of-Things Design and Implementation (IoTDI), 2017.
ACM SIGSOFT Distinguished Paper Award. International Symposium on the Foundations of Software Engineering (FSE), 2016.
ACM SIGSOFT Distinguished Paper Award. International Conference on Software Engineering (ICSE), 2015.

JOURNAL PUBLICATIONS

Matthew L. Bolton, Xi Zheng, and Eunsuk Kang. A Formal Method for Including the Probability of Erroneous Human Task Behavior in System Analyses. *Reliability Engineering and System Safety*, 213: 107764, 2021.

Romulo Meira-Goes, Eunsuk Kang, Raymond H. Kwong, and Stephane Lafortune. Synthesis of sensor deception attacks at the supervisory layer of Cyber-Physical Systems. *Automatica*, 121: 109172, 2020.

Hokeun Kim, Eunsuk Kang, David Broman, Edward A. Lee: Resilient Authentication and Authorization for the Internet of Things (IoT) Using Edge Computing. *ACM Trans. Internet Things*, 1(1): 4:1-4:27, 2020.

Hamid Bagheri, Eunsuk Kang, Sam Malek, and Daniel Jackson .A formal approach for detection of security flaws in the android permission system. *Formal Aspects of Computing (FAC)*, 30 (5), 525-544, 2018.

Jianye Hao, Eunsuk Kang, Jun Sun, Zan Wang, Zhaopeng Meng, Xiaohong Li, and Zhong Ming. An Adaptive Markov Strategy for Defending Smart Grid False Data Injection from Malicious Attackers. *IEEE Transactions on Smart Grid (TSG)*, 2018.

Aleksandar Milicevic, Joseph P. Near, Eunsuk Kang, and Daniel Jackson. Alloy*: A Higher-Order Relational Constraint Solver. *Formal Methods in System Design (FMSD)*, 2016.

Eunsuk Kang and Daniel Jackson. Designing and Analyzing a Flash File System with Alloy. *International Journal of Software and Informatics (IJSI)*, Vol. 3 No. 2, 2009.

CONFERENCE PUBLICATIONS

Tzu-Han Hsu, Borzoo Bonakdarpour, Eunsuk Kang, and Stavros Tripakis. Mapping Synthesis for Hyperproperties. *IEEE International Symposium on Computer Security Foundations (CSF 22)*.

Changjian Zhang, Ryan Wagner, Pedro Orvalho, David Garlan, Vasco Manquinho, Ruben Martins, and Eunsuk Kang. AlloyMax: Bringing Maximum Satisfaction to Relational Specifications. *ACM Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering (ESEC/FSE)*, 2021. **ACM SIGSOFT Distinguished Paper Award**.

Yutong Wu, Renzhi Tang, Eunsuk Kang, and Zhihao Jiang. Model-based Clinical Assist System for Cardiac Ablation. *ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS)*, 2021.

Cole Vick, Eunsuk Kang, and Stavros Tripakis. Counterexample Classification. *International Conference on Software Engineering and Formal Methods (SEFM)*, 2021.

Nianyu Li, Mingyue Zhang, Eunsuk Kang, and David Garlan. Engineering Secure Self-Adaptive Systems with Bayesian Games. *Fundamental Approaches to Software Engineering (FASE)*, 2021.

Changjian Zhang, David Garlan, and Eunsuk Kang. A Behavioral Notion of Robustness for Software Systems. *ACM Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering (ESEC/FSE)*, 2020.

Benjamin Gafford, Tobias Dürschmid, Gabriel A. Moreno, and Eunsuk Kang. Synthesis-Based Resolution of Feature Interactions in Cyber-Physical Systems. *IEEE/ACM International Conference on Automated Software Engineering (ASE)*, 2020.

Nianyu Li, Sridhar Adepu, Eunsuk Kang, and David Garlan. Explanation for Human-on-the-loop: A Probabilistic Model Checking Approach. *International Symposium on Software Engineering for Adaptive and Self-Managing Systems (SEAMS)*, 2020.

Weichao Zhou, Ruihan Gao, BaekGyu Kim, Eunsuk Kang, and Wenchao Li. Runtime-Safety-Guided Policy Repair. *International Conference on Runtime Verification (RV)*, 2020.

Shih-Lun Wu, Ching-Yuan Bai, Kai-Chieh Chang, Yi-Ting Hsieh, Chao Huang, Chung-Wei Lin, Eunsuk Kang, and Qi Zhu. Efficient System Verification with Multiple Weakly-Hard Constraints for Runtime Monitoring. *International Conference on Runtime Verification (RV)*, 2020.

Hamid Bagheri, Eunsuk Kang, and Niloofar Mansoor. Synthesis of Assurance Cases for Software Certification. *International Conference on Software Engineering, New Ideas and Emerging Results (ICSE-NIER)*, 2020.

Christian Kästner and Eunsuk Kang. Teaching Software Engineering for AI-Enabled Systems. *International Conference on Software Engineering, New Ideas and Emerging Results (ICSE-SEET)*, 2020.

Eunsuk Kang, Stéphane Lafortune, and Stavros Tripakis. Automated Synthesis of Secure Platform Mappings. *International Conference on Computer-Aided Verification (CAV)*, 2019.

Tobias Dürschmid, Eunsuk Kang, and David Garlan. Trade-off-Oriented Development - Making Quality Attribute Trade-offs First-Class. *International Conference on Software Engineering, New Ideas and Emerging Results (ICSE-NIER)*, 2019.

Chanwook Oh, Eunsuk Kang, Shinichi Shiraishi, and Pierluigi Nuzzo. Optimizing Assume-Guarantee Contracts for the Design of Cyber-Physical Systems. *Design, Automation, and Test in Europe (DATE)*, 2019.

Santhana Gopalan Raghavan, Kosuke Watanabe, Eunsuk Kang, Chung-Wei Lin, Zhihao Jiang, and Shinichi Shiraishi. Property-Driven Runtime Resolution of Feature Interactions. *International Conference on Runtime Verification (RV)*, 2018.

Inigo Incer Romeo, Alberto L. Sangiovanni-Vincentelli, Chung-Wei Lin, and Eunsuk Kang. Quotient for Assume-Guarantee Contracts. *International Conference on Formal Methods and Models for System Design (MEMOCODE)*, 2018.

Hengyi Liang, Matthew Jagielski, Bowen Zheng, Chung-Wei Lin, Eunsuk Kang, Shinichi Shiraishi, Cristina Nita-Rotaru, and Qi Zhu. Network and System Level Security in Connected Vehicle Applications. *International Conference on Computer-Aided Design (ICCAD)*, 2018.

Ximing Chen, Zhihao Jiang, Eunsuk Kang, Shinichi Shiraishi, and Victor M. Preciado. Digital Behavioral Twins for Safe Connected Cars. *International Conference on Model Driven Engineering Languages and Systems (MODELS)*, 2018.

BaekGyu Kim, Chung-Wei Lin, Eunsuk Kang, Nobuyuki Tomatsu, and Shinichi Shiraishi. Platform-Independent QoS Parameters and Primitive APIs for Automotive Software. *IEEE International Conference on Intelligent Transportation Systems (ITSC)*, 2018.

Kosuke Watanabe, Eunsuk Kang, Chung-Wei Lin, and Shinichi Shiraishi. Runtime monitoring for safety of intelligent vehicles. *Design Automation Conference (DAC)*, 2018 (invited paper).

Thomas Chowdhury, Eric Lesiuta, Kerianne Rikley, Chung-Wei Lin, Eunsuk Kang, BaekGyu Kim, Shinichi Shiraishi, Mark Lawford, and Alan Wassyng. Safe and Secure Automotive Over-The-Air Updates. *International Conference on Computer Safety, Reliability, and Security (SAFECOMP)*, 2018.

Romulo Meira Goes, Eunsuk Kang, Raymond Kwong, and Stéphane Lafortune. Stealthy deception attacks for cyber-physical systems. *IEEE Conference on Decision and Control (CDC)*, 2017.

Hokeun Kim, Eunsuk Kang, Edward Lee, and David Broman. A Toolkit for Construction of Authorization Service Infrastructure for the Internet of Things. *ACM/IEEE Conference on Internet-of-Things Design and Implementation (IoTDI)*, 2017. **Best Paper Award**.

Eunsuk Kang, Aleksandar Milicevic, and Daniel Jackson. Multi-Representational Security Analysis. *Symposium on the Foundations of Software Engineering (FSE)*, 2016. **ACM SIGSOFT Distinguished Paper Award**.

Jianye Hao, Eunsuk Kang, Jun Sun and Daniel Jackson. Designing Minimal Effective Normative Systems with the Help of Lightweight Formal Methods. *Symposium on the Foundations of Software Engineering (FSE)*, 2016.

Eunsuk Kang. Design Space Exploration for Security. *IEEE Conference on Cybersecurity Development (SecDev)*, 2016.

Aleksandar Milicevic, Joseph P. Near, Eunsuk Kang, and Daniel Jackson. Alloy*: A Higher-Order Relational Constraint Solver. *International Conference on Software Engineering (ICSE)*, 2015. **ACM SIGSOFT Distinguished Paper Award**.

Hamid Bagheri, Eunsuk Kang, Sam Malek, and Daniel Jackson. Detection of Design Flaws in the Android Permission Protocol through Bounded Verification. *International Symposium on Formal Methods (FM)*, 2015.

Joseph P. Near, Aleksandar Milicevic, Eunsuk Kang, and Daniel Jackson. A Lightweight Approach to Construction and Evaluation of a Dependability Case. *International Conference on Software Engineering (ICSE)*, 2011.

Eunsuk Kang and Daniel Jackson. Dependability Arguments with Trusted Bases. *International Conference on Requirements Engineering (RE)*, 2010.

Ethan Jackson, Eunsuk Kang, Dirk Seifert, Markus Dahlweid, and Thomas Santen. Components, Platforms, and Possibilities: Towards Generic Automation for MDA. *International Conference on Embedded Software (EMSOFT)*, 2010.

Eunsuk Kang and Daniel Jackson. Formal Modeling and Analysis of a Flash Filesystem. *International Conference on ASM, B, and Z (ABZ)*, 2008.

Eunsuk Kang and Mark Aagaard. Improving the Usability of HOL through Controlled Automation Tactics. *International Conference on Theorem Proving in Higher-Order Logics (TPHOLs)*, 2007.

Workshops and Book Chapters

Eunsuk Kang. The Role of Environmental Deviations in Engineering Robust Systems. *RE'21 Workshop on Environment-Driven Requirements Engineering (EnviRE)*, 2021.

Eunsuk Kang. Robustness Analysis for Secure Software Design. *International Workshop on Software Security from Design to Deployment (SEAD)*, co-located with ASE, 2020.

Sridhar Adepu, Eunsuk Kang, and Aditya P. Mathur. Challenges in Secure Engineering of Critical Infrastructure Systems. *International Workshop on Software Security from Design to Deployment (SEAD)*, co-located with ASE, 2019.

Hokeun Kim, Eunsuk Kang, David Broman, and Edward A. Lee. An Architectural Mechanism for Resilient IoT Services. *ACM Workshop on the Internet of Safe Things (SafeThings)*, 2017.

Eunsuk Kang, Sridhar Adepu, Daniel Jackson, and Aditya P. Mathur. Model-Based Security Analysis of a Water Treatment System. *Workshop on Smart Cyber-Physical Systems*, part of *International Conference on Software Engineering (ICSE)*, 2016.

Eunsuk Kang, Santiago Perez De Rosso, and Daniel Jackson. The Same-Origin Policy. A book chapter in *500 Lines or Less*, part of the *Architecture of Open Source Applications*, 2016.

Jianye Hao, Eunsuk Kang, Daniel Jackson, and Jun Sun. Adaptive Defending Strategy for Smart Grid Attacks. *Workshop on the Smart Energy Grid Security*, part of *ACM Conference on Computer and Communications Security (CCS)*, 2014.

Daniel Jackson and Eunsuk Kang. Separation of Concerns for Dependable Software Design. *Workshop on the Future of Software Engineering Research (FoSER)*, co-located with the *Symposium on the Foundations of Software Engineering (FSE)*, 2010.

Eunsuk Kang and Daniel Jackson. Patterns for Building Dependable Systems with Trusted Bases. *Pattern Languages of Programs Conference (PLOP)*, 2010.

Daniel Jackson and Eunsuk Kang. Property-Part Diagrams: A Dependence Notation for Software Systems. A book chapter in *Software Design and Requirements: The Work of Michael Jackson* (eds. Bashar Nuseibeh and Pamela Zave), Good Friends Publishing Company, New Jersey, 2010.

Eunsuk Kang, Ethan Jackson, and Wolfram Schulte. An Approach for Effective Design Space Exploration. *Monterey Workshop on Software Systems*, 2010.

RESEARCH FUNDING

NSF CAREER: *Towards a Rigorous Methodology for Engineering Robust Software Systems*.
Role: PI
Duration: 02/01/2022 - 01/31/2028
Amount: $506,052

DARPA V-SPELLS: *CODES: Compositional DSLs for Enhancing Software*.
Role: Co-PI
Duration: 04/01/2021 - 03/31/2025
With: Daniel Balasubramanian (Vanderbilt University)
Amount: $2,842,246 (CMU portion $1.19M)

NSF Formal Methods in the Field (FMitF): Collaborative Research: *Preventing Human Errors in Cyber-human Systems with Formal Approaches to Human Reliability Rating and Model Repair*.
Role: PI
Duration: 08/15/2019 - 07/31/2023
With: Matthew Bolton (SUNY-Buffalo)
Amount: $750,000 (CMU portion $375,000)

NSF SaTC Medium: *Bridging the Gap between Protocol Design and Implementation through Automated Mapping*.
Role: Senior Personnel
Duration: 09/15/2018 - 08/31/2021
With: Stavros Tripakis, Cristina Nita-Rotaru (Northeastern University)
Stéphane Lafortune (University of Michigan)
Daniel Jackson (MIT)
Amount: $1,200,000 (CMU portion $222,000)

Systematic Attack Generation for Industrial Control Systems.
CMU CyLab IoT Initiative award
Role: PI
Duration: 01/15/2020 - 01/14/2022
Amount: $105,000

Designing Safe and Robust Connected Systems with Contract Negotiation.
Gift from Toyota InfoTechnology Center
Role: PI
Duration: 08/28/2018 - 03/01/2022
Amount: $200,000

Teaching Activities

11-695/17-445/17-645: ML in Production, Co-Instructor (with Christian Kästner), CMU, Spring 2022, Spring 2021, Fall 2020, 2019.

17-314/324: Formal Methods, Co-Instructor (with David Garlan), CMU, Fall 2022, 2021.

17-651: Models of Software Systems, Co-Instructor (with David Garlan), CMU, Fall 2020, 2019, 2018.

6.170: Software Studio, Curriculum Development, MIT, 01/2013 - 04/2013.

6.088: Introduction to C/C++ Programming, Instructor, MIT, 01/2010.

6.00: Introduction to Computer Science and Programming, Teaching Assistant, MIT, 09/2009 - 12/2009.

6.005: Elements of Software Construction, Teaching Assistant, MIT, 09/2008 - 12/2008.

Industrial Employment

Toyota InfoTechnology Center, U.S.A., Inc., Mountain View, CA
Researcher 09/2017 - 08/2018

NASA Jet Propulsion Laboratory, Pasadena, CA
Research Intern 06/2011 - 08/2011

Microsoft Research, Redmond, WA
Research Intern 06/2009 - 09/2009

Intel Corporation, Vancouver, BC Canada
Software Engineering Intern 01/2006 - 04/2006

Student Supervision

Parv Kapoor. Formal methods for AI Safety, PhD Student, CMU ISR, 08/2021 - present.

Simon Chu. Feature interactions in software systems. PhD Student, CMU ISR, 08/2020 - present (co-advised with David Garlan).

Benjamin Gafford. Testing for safe cyber-physical systems. PhD Student, CMU ISR, 08/2020 - present (co-advised with Rohan Padhye).

Changjian Zhang. Robustness in software systems. PhD Student, CMU ISR, 08/2019 - present (co-advised with David Garlan).

Tobias Dürschmid. Trade-off-oriented software development. PhD Student, CMU ISR, 08/2018 - 08/2021 (co-advised with David Garlan).

Sridhar Adepu. Security of Industrial Control Systems. Visiting PhD Student, Singapore University of Technology and Design, 08/2019 - 01/2020.

Tarang Saluja. Automated design robustification. REU Student, Swarthmore College, Summer 2021.

Emma Shedden. Feature interaction resolution through requirements weakening. REU Student, University of Michigan, Summer 2021.

Katherine Braught. Automated error generation for human-machine interfaces. REU Student, Iowa State University, Summer 2020.

Sangheon Choi, Consolidation as an approach for reducing errors in human-machine interactions. REU Student, Rose-Hulman Institute of Technology, Summer 2020.

Vivek Gupta. Formal analysis of business rules for microservices. MSE Student, CMU ISR, 2020.

Ajay Nair. Formal analysis of file system specifications. MSE Student, CMU ISR, 2020.

Benjamin Gaffords. Synthesis-based feature interactions resolution. REU Student, Grinnel College, Summer 2019.

Jeanie Chen. Trade-off-Oriented Software Development. REU Student, University of Oregon, Summer 2019.

Joseph Worku. Trade-off-Oriented Software Development. REU Student, University of California, San Diego, Summer 2019.

Sakshi Roongta. Simulation framework for connected vehicles. Undergraduate Researcher, CMU, Summer 2019.

Audrey Tzeng. Simulation framework for connected vehicles. Undergraduate Researcher, CMU, Summer 2019.

Dayoung Kwon. Automated threat modeling tool. Undergraduate Researcher, CMU, 09/2018-05/2019.

Chanwook Oh. Adaptive contracts for safe automotive design. Research intern, Toyota InfoTechnology Center, 05/2018-08/2018.

Santhana Gopalan Raghavan. Runtime resolution of feature interactions. Research intern, Toyota InfoTechnology Center, 01/2018-04/2018.

Xavier Gillard. Web-based visualization framework for Alloy. Master's student, Université catholique de Louvain, 06/2015-08/2015.

Asa Oines. Model-based testing of Git using Alloy. Undergraduate research assistant, MIT, 02/2014 - 05/2014.

Jose Pinheiro and Tiago Guimaraes. Model-based testing of Git using Alloy. Master's students, MIT & University of Minho, 02/2013 - 06/2013.

Christopher Dessonville. Automating diagnosis of CCS errors. Undergraduate research assistant, MIT, 02/2013 - 05/2013.

Renato Neves and Claudio Lourenco. Modeling of Git in Alloy. Master's students, MIT & University of Minho, 02/2012 - 06/2012.

Justin Holmgren. Analysis of Facebook privacy settings. Undergraduate research assistant, MIT, 02/2012 - 05/2012.

Formal Presentations

Towards Secure and Resilient Critical Infrastructure by Design. Invited talk, Computer Science and Information Engineering (CSIE) Seminar, National Taiwan University (NTU), Jan 2020.

Towards Secure and Resilient Critical Infrastructure by Design. Invited keynote at Cybersecurity Camp part of the Singapore Cybersecurity Symposium, Dec 2019.

Automated Synthesis of Secure Platform Mappings. Conference presentation at CAV, July 2019.

Property-Driven Runtime Resolution of Feature Interactions. Conference presentation at RV, November 2018.

Runtime Monitoring for Safety of Intelligent Vehicles. Invited talk at DAC, 2018.

Designing Safe and Secure Systems in an Adversarial World.
Carnegie Mellon University, April 2017.
University of Toronto, April 2017.
University of Texas, Austin, April 2017.
Ptolemy Group Meeting, UC Berkeley, March 2017.

Designing Minimal Effective Normative Systems with the Help of Lightweight Formal Methods. Conference presentation at FSE, November 2016.

Multi-Representational Security Analysis.
Conference presentation at FSE, November 2016.
Systems Seminar, University of Michigan, March 2016.
BAE Systems, May 2015.
ExCAPE Seminar, Apri 2015.
Institute for Software Integrated Systems, Vanderbilt University, April 2015.

Design Space Exploration for Security. Conference presentation at SecDev, Nov 2016.

Architectural and Design Analysis for Secure Cyber-Physical Systems. Invited talk at the Secure Cyber-Physical Systems Week, Singapore, July 2016.

Detection of Design Flaws in the Android Permission Protocol through Bounded Verification. Conference presentation at FM, June 2015.

High-Level Languages for Configuration Modeling and Analysis. Dagstuhl Seminar on Product and Software Configuration, April 2014.

Automating End User Security Tasks. Invited talk at MIT CSAIL Security Seminar, November 2012.

Alloy: A Language for Modeling and Analyzing Software Systems. Invited talk at the 14th Real-Time Linux Workshop (RTLWS), Chapel Hill, North Carolina, October 2012.

Dependability Arguments with Trusted Bases. Conference presentation at RE, October, 2010.

An Advanced Introduction to Alloy. Tutorial at the ABZ conference, February 2010.

Counter Example Detection, Core Extraction, and Simulation: Three Analyses Applied to a Flash File System Model. Invited talk at the Workshop on the Verified Software Repositories (VSR-net), co-located with ABZ, September 2008.

SERVICES

Program Committee Member

- Intl. Conf. on Automated Software Engineering (ASE), 2020, 2021, 2022.
- Intl. Conf. on Formal Methods and Models for System Design (MEMOCODE), 2021, 2022.
- Intl. Conf. on Formal Methods in Software Engineering (FormaliSE), 2019, 2020.
- ACM Cyber-Physical System Security Workshop (CPSS), 2020.
- IEEE Workshop on Electrical and Autonomous Vehicle Software (EVAS), 2020.
- Spring Simulation Conference (SpringSim), 2020.
- Intl. Conf. on the Art, Science, and Engineering of Programming, 2019.
- Intl. Symp. on High Assurance Systems Engineering (HASE), 2017, 2019.
- Artifact Evaluation, Intl. Conf. on Tools and Algorithms for the Construction and Analysis of Systems (TACAS), 2018.

Travel Grants Chair, ICSE, 2019, 2022.

Publicity Chair, Int. Symp. on Formal Methods (FM), 2021.

Program Chair, Workshop on the Future of Alloy, 2018.

Journal Reviewer

- ACM Transactions on Software Engineering (TOSEM), 2020, 2021, 2022.
- IEEE Transactions on Software Engineering (TSE), 2020, 2022.
- Journal of Information Security, 2019.

- Journal of Security and Communication Networks, 2011.
- Journal of Systems and Software, 2010.

External Reviewer
- ACM Intl. Conf. on Hybrid Systems (HSCC), 2021.
- Design Automation Conference (DAC), 2018.
- TACAS, 2017, 2018.
- IEEE Conf. on Decision and Control (CDC), 2017.
- IEEE Conf. on Control Technology and Applications (CCTA), 2017.
- Intl. Conf. on Model Checking of Software (SPIN), 2017.
- Replication Packages, FSE, 2015.
- Satisfiability Modulo Theories (SMT) Workshop, 2011.
- Pervasive Computing (PERVASIVE), 2011.

Co-organizer, CSAIL Student Research Workshop, MIT, 2009.