Soonho Kong

Senior Research Scientist
Toyota Research Institute
Building 100, Suite 1-201
One Kendall Square, Cambridge, MA 02139

Email: soonho.kong@tri.global
Web: https://soonhokong.github.io
Github: https://github.com/soonho-tri

Research Interests

Automated reasoning and its applications toward robust CPS (Cyber-Physical Systems).

Work Experience

Toyota Research Institute (2016 – present):

- Design and implement dReal, an SMT solver for nonlinear theories over the Reals.
- Design and implement the symbolic engine in Drake which enable symbolic analyses and syntheses in the framework.
- Design and implement a code-generator which emits an MPC controller highly-optimized for a custom solver.

Education

Carnegie Mellon University Aug 2010 – Jun 2016
Ph.D. in Computer Science Department (*All But Dissertation*)
Advisor: Prof. Edmund M. Clarke

Seoul National University Mar 2007 – Aug 2009
Master of Science in Computer Science and Engineering
Advisor: Prof. Kwangkeun Yi

Seoul National University Mar 2000 – Feb 2007
Bachelor of Science in Computer Science and Engineering

Software

dReal: SMT solver for nonlinear theories over the Reals (Lead developer, since 2013)
Drake: Model-based design and verification for robotics (Platform-reviewer, since 2016)
Lean: Lean theorem prover (Contributor, 2013 – 2016)

Publications

[1] Nikos Arechiga, Jonathan DeCastro, Soonho Kong, and Karen Leung. "Better AI through Logical Scaffolding". In: *FoMLAS 2019: 2nd Workshop on Formal Methods for ML-Enabled Autonomous Systems*. 2019.

[2] Sicun Gao, James Kapinski, Jyotirmoy Deshmukh, Nima Roohi, Armando Solar-Lezama, Nikos Arechiga, and Soonho Kong. "Numerically-Robust Inductive Proof Rules for Continuous Dynamical Systems". In: *Computer Aided Verification*. Ed. by Isil Dillig and Serdar Tasiran. Cham: Springer International Publishing, 2019, pp. 137–154.

[3] Calvin Huang, Soonho Kong, Sicun Gao, and Damien Zufferey. "Evaluating Branching Heuristics in Interval Constraint Propagation for Satisfiability". In: *Numerical Software Verification*. Ed. by Majid Zamani and Damien Zufferey. Cham: Springer International Publishing, 2019, pp. 85–100.

[4] Daniel Jackson, Jonathan DeCastro, Soonho Kong, Dimitrios Koutentakis, Angela Feng Ping Leong, Armando Solar-Lezama, Mike Wang, and Xin Zhang. "Certified Control for Self-Driving Cars". In: *DARS 2019: 4th Workshop On The Design And Analysis Of Robust Systems*. 2019.

[5] Soonho Kong, Armando Solar-Lezama, and Sicun Gao. "Delta-Decision Procedures for Exists-Forall Problems over the Reals". In: *Computer Aided Verification*. Ed. by Hana Chockler and Georg Weissenbacher. CAV'18. Cham: Springer International Publishing, 2018, pp. 219–235.

[6] Kyungmin Bae, Peter Csaba Ölveczky, Soonho Kong, Sicun Gao, and Edmund M. Clarke. "SMT-Based Analysis of Virtually Synchronous Distributed Hybrid Systems". In: *Hybrid Systems: Computation and Control*. HSCC'16. Vienna, Austria: ACM, 2016, pp. 145–154.

[7] Md. Ariful Islam, Greg Byrne, Soonho Kong, Edmund M. Clarke, Rance Cleaveland, Flavio H. Fenton, Radu Grosu, Paul L. Jones, and Scott A. Smolka. "Bifurcation Analysis of Cardiac Alternans Using delta-Decidability". In: *Computational Methods in Systems Biology*. Ed. by Ezio Bartocci, Pietro Lio, and Nicola Paoletti. CMSB'16. Cham: Springer International Publishing, 2016, pp. 132–146.

[8] Seunghak Lee, Soonho Kong, and Eric P. Xing. "A network-driven approach for genome-wide association mapping". In: *Bioinformatics* 32.12 (2016), pp. i164–i173.

[9] Yungbum Jung, Soonho Kong, Cristina David, Bow-Yaw Wang, and Kwangkeun Yi. "Automatically inferring loop invariants via algorithmic learning". In: *Mathematical Structures in Computer Science* 25.4 (2015), pp. 892–915.

[10] Soonho Kong, Sicun Gao, Wei Chen, and Edmund Clarke. "dReach: Delta-Reachability Analysis for Hybrid Systems". In: *Tools and Algorithms for the Construction and Analysis of Systems*. TACAS'15. New York, NY, USA: Springer-Verlag New York, Inc., 2015, pp. 200–205.

[11] Bing Liu, Soonho Kong, Sicun Gao, Paolo Zuliani, and Edmund M. Clarke. "Towards Personalized Prostate Cancer Therapy Using Delta-reachability Analysis". In: *Hybrid Systems: Computation and Control*. HSCC'15. Seattle, Washington: ACM, 2015, pp. 227–232.

[12] Leonardo de Moura, Soonho Kong, Jeremy Avigad, Floris van Doorn, and Jakob von Raumer. "The Lean Theorem Prover (System Description)". In: *Automated Deduction*. Ed. by Amy P. Felty and Aart Middeldorp. CADE'15. Cham: Springer International Publishing, 2015, pp. 378–388.

[13] Qinsi Wang, Paolo Zuliani, Soonho Kong, Sicun Gao, and Edmund M. Clarke. "SReach: A Probabilistic Bounded Delta-Reachability Analyzer for Stochastic Hybrid Systems". In: *Computational Methods in Systems Biology*. Ed. by Olivier Roux and Jérémie Bourdon. CMSB'15. Cham: Springer International Publishing, 2015, pp. 15–27.

[14] Sicun Gao, Soonho Kong, and Edmund M. Clarke. "Proof Generation from Delta-Decisions". In: *Symbolic and Numeric Algorithms for Scientific Computing*. SYNASC'14. Sept. 2014, pp. 156–163.

[15] Bing Liu, Soonho Kong, Sicun Gao, Paolo Zuliani, and Edmund M. Clarke. "Parameter Synthesis for Cardiac Cell Hybrid Models Using δ-Decisions". In: *Computational Methods in Systems Biology*. Ed. by Pedro Mendes, Joseph O. Dada, and Kieran Smallbone. CMSB'14. Cham: Springer International Publishing, 2014, pp. 99–113.

[16] Sagar Chaki, Arie Gurfinkel, Soonho Kong, and Ofer Strichman. "Compositional Sequentialization of Periodic Programs". In: *Verification, Model Checking, and Abstract Interpretation*. VMCAI'13. Rome, Italy: Springer-Verlag New York, Inc., 2013, pp. 536–554.

[17] Sicun Gao, Soonho Kong, and Edmund M. Clarke. "dReal: An SMT Solver for Nonlinear Theories over the Reals". In: *Automated Deduction*. CADE'13. Lake Placid, NY: Springer-Verlag, 2013, pp. 208–214.

[18] Sicun Gao, Soonho Kong, and Edmund M. Clarke. "Satisfiability modulo ODEs". In: *Formal Methods in Computer-Aided Design*. FMCAD'13. 2013, pp. 105–112.

[19] Yungbum Jung, Soonho Kong, Bow-Yaw Wang, and Kwangkeun Yi. "Deriving Invariants by Algorithmic Learning, Decision Procedures, and Predicate Abstraction". In: *Verification, Model Checking, and Abstract Interpretation*. VMCAI'10. Madrid, Spain: Springer-Verlag, 2010, pp. 180–196.

[20] Soonho Kong, Yungbum Jung, Cristina David, Bow-Yaw Wang, and Kwangkeun Yi. "Automatically Inferring Quantified Loop Invariants by Algorithmic Learning from Simple Templates". In: *Asian Conference on Programming Languages and Systems*. APLAS'10. Shanghai, China: Springer-Verlag, 2010, pp. 328–343.

[21] Soonho Kong, Wontae Choi, and Kwangkeun Yi. "Abstract Parsing for Two-staged Languages with Concatenation". In: *Generative Programming and Component Engineering*. GPCE'09. Denver, Colorado, USA: ACM, 2009, pp. 109–116.

[22] Soonho Kong, Wontae Choi, and Kwangkeun Yi. "PCC Framework for Program-Generators". In: *Workshop on Proof-Carrying Code and Software Certification*. 2009.

[23] Soonho Kong, Nikolai Tillmann, and Jonathan de Halleux. "Automated Testing of Environment-Dependent Programs - A Case Study of Modeling the File System for Pex". In: *Information Technology: New Generations*. ITNG'09. Apr. 2009, pp. 758–762.

Patents

[1] "Systems and methods for improving situational awareness of a user". Jonathan Decastro, Frank Permenter, Soon Kong, Nikos Arechiga. US Patent 10,621,858.

[2] "System and method for detecting errors and improving reliability of perception systems using logical scaffolds". Nikos Arechiga, Soonho Kong, Jonathan DeCastro, Sagar Behere, Dennis Park. US Patent App. 16/745,560

[3] "Certified control for self-driving cars". Daniel Jackson, Jonathan DeCastro, Soon Ho Kong, Nikos Arechiga Gonzalez, Dimitrios Koutentakis, Feng Ping Angela Leong, Mike Meichang Wang, Xin Zhang. US Patent App. 16/745,560.

[4] "Simulation-based technique to synthesize controllers that satisfy signal temporal logic specifications". Nikos Arechiga, Karen Leung, Soon Ho Kong, Jonathan DeCastro, Frank Permenter US Patent App. 16/425,723.

[5] "Personalized Notification System For Mobility as a Service". Soonho Kong, Jonathan Decastro, Nikos Arechiga, Frank Permenter. US Patent App. 16/413,218.

[6] "Actively adapting to driving environments based on human interactions". Soonho Kong, Jonathan DeCastro, Nikos Arechiga, Frank Permenter. US Patent App. 16/279,857.

Professional Activities

Program Committee Member:
ADHS 2021, HSCC 2021, MEMOCODE 2021, MT-CPS 2021, HSCC 2020, MEMOCODE 2020, DARS 2019, HSCC 2019, MEMOCODE 2019, NSV 2019, DARS 2018, WSC 2018

External Reviewer:
IEEE-IV 2021, IEEE-IV 2020, POPL 2020, ATVA 2015, ASE 2014, FoSSaCS 2013, POPL 2013, APLAS 2012, SAS 2012, GPCE 2010, SPLASH 2010, CAV 2010, VMCAI 2010, SAS 2009, DEFECTS 2009, APLAS 2007

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