Nikhil Vijay Naik

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RESEARCH INTERESTS

Formal Methods, System Design Robustness,Cyber-Physical Systems, Electronic Design Automation, Artificial Intelligence

EDUCATION

University of Southern California **Los Angeles, CA, USA**
Ph.D. Student, Ming Hsieh Department of Electrical and Computer Engineering *August 2018 - ongoing*
GPA : 3.81/4.0

Indian Institute of Technology **Kharagpur, West Bengal, India**
Bachelor of Technology in Instrumentation Engineering *July 2014 - July 2018*
Cumulative GPA : 8.8/10

PROJECTS

Design of Reliable, Safe and AI-enabled Cyber-Physical Systems *Aug 2018 - Present*
- *Mentor: Prof. Pierluigi Nuzzo, Ming Hsieh Department of Electrical and Computer Engineering, University of Southern California*
- Currently working on techniques to combine formal methods with probabilistic learning models in order to enforce safety guarantees on the operation of autonomous systems
- Developed contract-based formalisms for expressing and verifying properties of AI-enabled systems, including perception systems and closed-loop neural network-based control systems. Results published in the conference 'MEMOCODE-2020' and won the best paper award
- Extension of contract based models to system safety and reliability is being investigated, with further application to hierarchical contract networks applied to assurance cases in avionics and autonomous vehicles

Computer Vision System for End-to-End Autonomous Driving *July 2017 – April 2018*
- *Mentor: Prof. Debdoot Sheet, Dept. of Electrical Engineering, IIT-Kharagpur*
- Undergraduate thesis work at IIT-Kharagpur – worked on developing a reliable real-time computer vision system for 360° panoramic field of view with minimal hardware and software requirement

A New Algorithm for Wideband Multi-Term Imaging for Radio Astronomy *May – July 2017*
- *Mentor: Dr. Urvashi Rao Venkata, National Radio Astronomy Observatory, Socorro, New Mexico, USA*
- Worked extensively on development of a new joint deconvolution algorithm, for the combination of wideband data from single-dish radio telescopes and interferometers for multi-term imaging
- Signal and image processing algorithms were utilized to create high-bandwidth and fine-resolution images of the sky
- Project was the first significant attempt at solving *problem of short spacing* encountered in image processing for radio astronomy

INTERNSHIPS

Research Internship in Formal Methods for High-Assurance Software *May 2020 - September 2020*

- *Mentor: Dr. Zamira Daw Perez, Staff Engineer/Scientist - Model-based design, Raytheon Technologies Research Center, Berkeley, California, USA*
- Worked on developing confidence models for design of high-assurance aerospace software
- Combined concepts of platform-based design, contract-based design and Bayesian inference to reason about confidence in hierarchical, real-time safety-critical software.
- Developed and benchmarked a DO-178 standard based case study against the developed confidence model.

PROGRAMMING AND HARDWARE SKILLS

- **Programming Languages:** C, C++, CUDA C, and Python
- **Software for Engineering Applications:** OrCAD capture, MATLAB/Simulink, Proteus
- **Embedded Hardware:** Arduino, ATMEL studio and Raspberry Pi
- **Software for Formal Methods and Model Checking:** NuSMV, Z3 (by Microsoft), IBM ILOG CPLEX, Gurobi (convex optimization)
- **Operating Systems:** Windows, Linux
- **Miscellaneous Skills**: Design experience in autonomous systems, verification and design of correct-by-construction machine learning components, contract-based and platform based design methods (graduate level coursework experience as well as acted as assistant reviewer for 10+ publications in the area) Experienced in convex optimization, mixed integer linear programming (MILP) and constraint solving (both Boolean satisfiability - SAT solving as well as in the continuous domain)

ACADEMIC COURSES

Graduate Courses **University of Southern California, Los Angeles, CA**

- *Mathematics:* Probability for Electrical and Computer Engineers, Linear Algebra for Engineering, Random Processes in Engineering
- *Computer Science:* Foundations of Artificial Intelligence, Deep Learning, C++ Programming for Electrical Engineers
- *Electrical Engineering:* Stochastic Systems and Reinforcement Learning, Mathematical foundations of System Design, Digital Signal Processing

Undergraduate Courses **IIT-Kharagpur, India**

- *Mathematics:* Engineering Mathematics, Transform Calculus, Probability and Stochastic Processes, Symbolic Logic
- *Electrical Engineering:* Analog and Digital Electronics, Embedded Systems, Digital Signal Processing, Digital Image Processing
- *Control Systems:* Signals and Networks, Control Systems Engineering, Process Dynamics and Control
- *Instrumentation:* Measurement and Electronic Instruments, Instrumentation Devices, Instrumentation System Design
- *Computer Science:* Programming and Data Structures, Data Structure and Algorithms, Computer Architecture and Operating Systems

AWARDS AND ACHIEVEMENTS

- 'Best Paper Award' at the 18th ACM-IEEE International Conference on Formal Methods and Models, December 2020 (MEMOCODE-2020, held online)
- Annenberg fellowship, University of Southern California, August 2018
- Summer student assistantship of the National Radio Astronomy Observatory (NRAO), May 2017
- Visiting Student Research Program of the National Centre for Radio Astrophysics, May 2016 and 2017
- Selected as a grader for the 10th International Olympiad on Astronomy and Astrophysics (IOAA), Bhubaneswar, India, December 2016
- Silver medal in the Messier marathon at the 3^{rd} Inter-IIT tech meet, IIT-Kharagpur, February 2015
- Fellow of the National Initiative on Undergraduate Sciences (NIUS), Department of Science and Technology, Govt. of India, Dec. 2014
- Direct selection to the Chennai Mathematical Institute (CMI) for undergraduate studies (declined in favour of Electrical Engineering at IIT-Kharagpur), June 2014
- Fellowship of the Kishore Vaigyanik Protsahan Yojana (KVPY), Department of Science and Technology, Govt. of India, May 2013

PUBLICATIONS

, Scientific Papers:

- "Robustness Contracts for Scalable Verification of Neural Network-Enabled Cyber-Physical Systems", **Nikhil Naik**, Kevin Chang, Yifeng Xiao and Pierluigi Nuzzo, *in prep.*
- "Cyber-Physical System Design Assurance with Stochastic Contract Networks", Chanwook Oh, **Nikhil Naik** and Pierluigi Nuzzo, *submitted* to the 19th ACM-IEEE International Conference on Formal Methods and Models for System Design (MEMOCODE-21)
- "Designing Interpretable Approximations to Deep Reinforcement Learning with Soft Decision Trees", Nathan Dahlin, Rahul Jain, Chaitanya Kalagarla, **Nikhil Naik** and Pierluigi Nuzzo, *accepted for Reinforcement Learning for Real Life Workshop, International Conference on Machine Learning (ICML), 2021*
- "Robustness Contracts for Scalable Verification of Neural Network-Enabled Cyber-Physical Systems", **Nikhil Naik** and Pierluigi Nuzzo, *18th ACM-IEEE International Conference on Formal Methods and Models for System Design (MEMOCODE-2020)* (**Best Paper Award**)
- "A Joint Deconvolution Algorithm to Combine Single Dish And Interferometer Data For Wideband Multi-Term Imaging", U. Rau, **Nikhil Naik** and Timothy Braun, *The Astronomical Journal*, Vol. 158, No. 1 (June 2019)

OTHER PROFESSIONAL SERVICES

- Served as Teaching Assistant for the course "Mathematical Foundations for System Design: Modeling, Analysis and Synthesis"at USC (Fall 2020).
- *Student Welfare Group (SWG, IIT-Kharagpur):* Acted as a mentor to two juniors from electrical engineering under the SWG's mentorship programme
- Student member of the IEEE

CULTURAL INTERESTS AND ACTIVITIES

- **Languages Spoken**: English (Professional), Marathi, Hindi, Telugu (Bilingual), Sanskrit (Intermediate)
- **Hobbies**: Reading (*esp.* classical Sanskrit literature), cooking and listening to music