Dr. Amer Tahat

Research Assistant Professor

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Pragmatic and results-oriented researcher and academic with a dynamic background in developing practical and rigorous security verification tools for critical technological components in order to increase the trust in the safety of binary code. Innovative problem solver with an analytical approach from a robust history of cross-disciplinary research and teaching experiences in high-assurance programming and formal analysis.

Education

Doctor of Philosophy in Computational Science and Engineering
Michigan Technological University, MI

Dissertation: "On the Applications of Interactive Theorem Proving on Computational Sciences and Engineering"

- Dissertation research used by NASA Langley Critical Systems unit in the design of their navigation control system
- Dissertation has been downloaded 790+ times since 2016

Master of Science in Mathematics
Michigan Technological University, MI

Visiting

- Stanford Research International (SRI) visitor, 28 Aug 2017 to 12 Sept 2017. Silicon Valley, CA, USA.

Awards

- ONR Award, Marine Corps Science and Technology, 2018–2022
- GRA/GTA, National Science Foundation and CS Department Michigan Technological University, 2013–2016
- Travel grants for Stanford Research International (SRI) Summer School of Formal Techniques, National Science Foundation (NSF), 2014–2013
- Study Abroad Scholarship (SAS), Tafila Tech University, 2009–2012

Affiliations

- Society of Industrial and Applied Mathematics (SIAM), member, 2012–2019
- American Mathematical Society (AMS), Member, 2010–2019

Technical Proficiencies

Software and Hardware Skills:	Python, Interactive Theorem Proving PVS7, ARMv8 Machine Code Formal Analysis, ASL-ARM CPU Machine Instruction Specification Language and Validation Interpreter (ASLi), Radare2 (reverse engineering analysis tool), Unicorn (CPU emulator), JSON, XML.
Project Management:	Git-Hub, Bit-Bucket, Slack

Career Experience

The Pennsylvania State University, State College, PA — **2021 – present**
Assistant Research Professor

Pursue research interests and develop research proposals to obtain funding. Write publications conferences, and workshops and present papers at events.

- Conducts independent research on building tools for ARMv8 binary transformations, instrumentations, reassembly, and formal verification.

Virginia Tech, Blacksburg, VA

- **(Promoted) Assistant Research Professor** — **2020 – 2021**
- **Postdoctoral Research Associate** — **2016 – 2020**

Developed research proposal that obtained **$681K** in funding from the Department of Defense. Applied statistical, computational, and scientific expertise to the design, implementation, data analysis, interpretation, and reporting of original research studies on formal binary verification. Taught graduate and undergraduate courses.

- Conducts independent research on the verification of binary code using ARMv8 hardware security mechanisms
- Mentored 3 graduate students, guiding and directing their research.
- Designed and taught the graduate class High Assurance Software Development that included certifying a real small size NAVAL code using lightweight formal verification of PVS7 for JAVA code programs.
- Conducted Naval high assurance programming training sessions.

Michigan Technological University, Houghton, MI — **2013 – 2016**

Conducted research and supported teaching and grading of undergraduate classes and guided students on the subject matter while pursuing my doctorate.

- TA in computer science courses: Discrete Structures, Algorithm, Model Driven Software, Computer Graphics, and JAVA (Lab Instructor).
- PhD research results have been cited/reused by researchers from the National Institute of Aeronautics, NASA LaRC, Stanford Research International

Professional Events and Activities

- Isaac Newton Institute Virtual Workshop on "Verified Software: From Theory to Practice", 10th to 14th May 2021, University of Cambridge, UK (Attendee).
- 12th NASA Formal Methods Symposium. May 2020, NASA Ames, CA, USA (Presenter).
- Office of Naval Research TPCP Technical Meeting, Seattle, WA, May 2018 (Presenter).
- SRI-Summer School in Formal Techniques at Menlo College, Menlo Park, CA, 2014 –2018, and 2020 in collaboration with Prof. Natrajan Shankar from SRI (I have been student presentation sessions coordinator).
- Invited Talk on Renee Tool-Chain at Stanford Research International (SRI), Hosted by Prof. Natrajan Shankar, Menlo Park, CA, Sept 2017 (Presenter).
- Naval high assurance programing training sessions using PVS at Virginia Tech University, Blacksburg, VA, Spring, Summer, Fall 2017 (Organizer).
- First and second PVS Tutorial at Michigan Tech University, Houghton, MI, Nov 2014 and Dec 2015 (Organizer).
- Fifth NASA Formal Methods Symposium (NFM), NASA Ames, Moffett Field, CA, May 2013 (Attendee).
- NASA Langley/National Institute of Aeronautics PVS Class, Hampton, VA, October 9–12, 2012 (Attendee).

Research Interests

- Cyber Security and Scalable High Assurance Programming:
  - Scalable formal translation and validation techniques of critical system software ARMv8 binaries such as Google Zircon, Linux.
  - Scalable formal model of ARMv8 machines using interactive theorem provers and practical validation tools based on CPU emulation using unicorn-CPU emulator, and ARM Specification Language-interpreter (ASLi).
  - Pointer integrity certification for ARMv8.3a binary code using ARM's cryptographic pointer authentication hardware mechanism.
  - Memory safety certification for proving the absence of memory violations such as use-after-free and buffer-overflow using Interactive theorem proving and scalable hardware mechanisms such as ARMv8.5 binary and ARMv8.5a's MTE (Memory Tagging Extension).
- Fault Tolerance: Verifying parameterized fault-tolerant and self-stabilized distributed systems.

- Autonomous vehicles trajectories determination: Designing ultra-reliable mathematical numerical algorithms and automatic proof strategies (used by NASA formal assurance group for aircraft control systems).

Publications

1. Amer Tahat, Sarang Joshi, Pronnoy Gawsami, Binoy Ravindran. Scalable Translation Validation of Unverified Legacy OS Code. FMCAD2019, Formal Methods in Computer-Aided Design, Oct 22 - 25, 2019, San Jose, California, USA." Paper artifacts: (https://github.com/ssrg-vt/renee-artifacts/tree/master/).
2. Xioaxin Ann, Amer Tahat, Binoy Ravindran. A Validation Methodology for Translating from OCaml to PVS,NFM 2020: 12th NASA Formal Methods Symposium. May 2020, NASA Ames, CA, USA.
3. Amer Tahat, Riemann Integral, in NASA PVS Lib, reviewed and published software under GNU General Public License, May 2016. (https://github.com/nasa/pvslib/tree/master/Riemann)
4. Amer Tahat and Ali Ebnenasir,2014, A Hybrid Method for the Verification and Synthesis of Parameterized Self-Stabilizing Protocols, 24th International Conference on Logic-Based Program Synthesis and Transformation (LOPSTR14), Canterbury, UK 2014.
5. Ali Ebnensair and Amer Tahat, A computational Implementation of Avicenna Argument of the Existence of a Necessary Existent and its Unity, 6th International Conference on Fundamentals of Software Engineering (FSEN15), refereed poster-paper, April 2014, IR.
6. Amer Tahat, On the Applications of Interactive Theorem Proving in Computational Sciences and Engineering," Open Access Dissertation, Michigan Technological University, Sept 2016. (http://digitalcommons.mtu.edu/etdr/210)

Papers in Preparation

7. Amer Tahat, PAVeri: Toward Formally Verifying Pointer Integrity of Unmodified Pointer Authenticated ARM Binaries - to be submitted (https://github.com/PAVE-artifacts).
8. Amer Tahat. Formally Verifying C-like Memory Safety Using ARM's Memory Tagging Mechanism. In preparation.

Research Projects

Renee: A Formal Methodology and Toolchain for Scalable Verification of Binary Code Using Dependent Type Theory
https://ssrg-vt.github.io/Renee/

The goal of this project is to develop a methodology and toolchain for verifying systems software binaries, such as Linux and Google Zircon, using the PVS theorem prover tool.

- Funded by a $681K+ grant from the DOD Office of Naval Research (ONR), Award number N00014-18-1-2665.
- Served as CO-PI (Co-Principal Investigator).

Applications of Mechanical Verification of Parameterized Self-Stabilizing Protocols Using Theorem Proving
http://asd.cs.mtu.edu/projects/mechVerif/index.htm

Research assistant to Ali Ebnenasir in this project that advanced a new approach to correct-by-construction protocol synthesis for an unlimited number of processes (i.e., arbitrarily significant) and substantial domains (i.e., possibly infinite).

- Partially funded by the National Science Foundation, Award number CCF-1116546.

Applications of Mechanical Verification of Reimann Integration Using Theorem Proving
http://asd.cs.mtu.edu/projects/mechVerif/index.htm

Research assistant to Dr. Ali Ebnenasir. This project advanced a new approach to developing a rigorous and automatic verification framework for Riemann Integrals calculations that arise in UV trajectory determinations.

- Partially funded by the National Science Foundation, Award number CCF-1116546.

Teaching Preferences

- Object-Oriented Programming
- Data Structures
- Discrete Structures
- Algorithms
- Computer Security
- Digital Logic and Formal Verification
- Computer architectures (ARMv8 CPU)