

# Aaron Reed Young

Email: [ayoung48@vols.utk.edu](mailto:ayoung48@vols.utk.edu)

Website: <https://web.eecs.utk.edu/~ayoung48/>

---

## *Computer Engineering Doctoral Candidate, Late Stage*

### Work Experience

---

#### University of Tennessee, Knoxville

- January 2016–Present: Research with the TENNLab Neuromorphic Computing Research Group. See Research section for more information.
- August 2016–August 2017: Graduate teaching assistant for Dr. Plank. Led lab sections, graded labs, and helped students for Data Structures and Algorithms II, Systems Programming, and Advanced Programming and Algorithms.

#### Garmin International, Inc., Olathe, KS

- Summer 2015: On the Aviation Software-Navigation Library Team. Improved the Navigation Library by revising requirements, making changes to the code base, and creating new test cases.

#### Oak Ridge National Laboratory, Manufacturing Demonstration Facility, Knoxville, TN

- Summer 2014: Programmed slicing engine for use with ORNL's two large-scale additive manufacturing machines using C++ and C#. Software was used to print the world's first 3D printed car.

#### Siemens Medical Systems, Knoxville, TN

- Summer 2013: Implemented embedded system control software using MQX RTOS on an ARM9 processor. Development included interfacing with GPIO, I<sup>2</sup>C, SPI, CANopen, RS-323, and Ethernet. Embedded software supported interfacing to LEDs, LCD, FPGA, Temperature and Humidity sensors, EEPROM, DACs, SFP+, and a Power Controller. Designed a C# testing interface to communicate with the processor over TCP/IP.
- Summer 2012: Designed a system using an Altera Stratix IV FPGA development board to read data from two TI 1 GHz ADCs. Developed a NIOS II FPGA soft-core running  $\mu$ C/OS-II using Quartus II. Designed a C# application to interface with the development board using UDP/IP.
- Summer 2011: Used C# and ASP.NET to develop a database-driven website to keep track of employee's tasks. Learned and utilized LINQ to access the SQL database records.

## Education

---

- University of Tennessee, Knoxville, Ph.D. in Computer Engineering Fall 2017–Present, GPA: 4.0. Will complete Ph.D. Degree May 2020.
- University of Tennessee, Knoxville, Master’s Degree in Computer Engineering, Fall 2016–Summer 2017, GPA: 4.0.
- University of Tennessee, Knoxville, Bachelor’s Degree in Computer Engineering, Chancellor’s Honors Program, EECS Honors. Fall 2012–Spring 2016, GPA: 4.0.
- Engineering in London Study Abroad Program: Spent five weeks in London earning six University of Tennessee engineering credit hours, June 2013.
- Hardin Valley Academy, Knoxville, Tennessee, High School Diploma, May 2012. GPA: 4.38 / 4.0. Received college credit for AP classes.

## Awards

---

- Bodenheimer Fellowship Recipient, August 2016–Present.
- Top Collegiate Scholar, College of Engineering, The University of Tennessee, May 2016.
- Outstanding Computer Engineering Senior, Department of Electrical Engineering and Computer Science at the University of Tennessee, December 2015.
- Outstanding Computer Engineering Senior, Department of Electrical Engineering and Computer Science at the University of Tennessee, December 2014.
- Outstanding Computer Engineering Junior, Department of Electrical Engineering and Computer Science at the University of Tennessee, December 2013.
- Min H. Kao Electrical and Computer Engineering Scholarship Recipient, 2013–2015.
- Alcoa—College of Engineering Study Abroad Fellowship, 2013.
- Tau Beta Pi, The Engineering Honor Society, 2013.

## Publications

---

### Ph.D. Dissertation

#### **SNACC: The Scaled-up Neuromorphic Array Communications Controller**

This work builds on my previous work redesigning the communications between the host and the neuromorphic system, by adding error detection and correction to the communication protocol to ensure error free, robust communication. This work describes how the DANNA2 element core is tiled into a grid array and placed on an FPGA. Additionally, this work uses the neuromorphic array communication controller to build a large-scale neuromorphic system called SNACC through the use of multiple neuromorphic processors arranged in a two-dimensional array and with scalable, local, high-speed, error-free connections.

## Master's Thesis

### Scalable High-Speed Communications for Neuromorphic Systems

To alleviate communication limitations and to expand scalability, a new communications solution is presented which takes advantage of the GTX/GTH high-speed serial transceivers found on Xilinx FPGAs. A Xilinx VC707 evaluation kit is used to prototype a new neuromorphic array communication controller for use as a communication solution for neuromorphic systems. The high-speed transceivers are used to communicate to the host computer via PCIe and to communicate to the DANNA arrays with the link layer protocol Aurora. The new communications system is able to outperform the FX3, reducing the latency in the communication and increasing the throughput of data. This new communications setup will be used to further DANNA research by allowing the DANNA arrays to scale to larger sizes and for multiple DANNA arrays to be connected to a single communication board.

## Journal and Conference Papers

- A Review of Spiking Neuromorphic Hardware Communication Systems, A. R. Young, M. E. Dean, J. S. Plank and G. S. Rose, in *IEEE Access*, vol. 7, pp. 135606-135620, 2019.
- Understanding Selection and Diversity for Evolution of Spiking Recurrent Neural Networks, Catherine D. Schuman, Grant Bruer, Aaron R. Young, Mark Dean and James S. Plank, *IJCNN: The International Joint Conference on Neural Networks*, 2018.
- Neuromorphic Array Communications Controller to Support Large-Scale Neural Networks, Aaron R. Young, Mark E. Dean, James S. Plank, Garrett S. Rose and Catherine D. Schuman, *IJCNN: The International Joint Conference on Neural Networks*, 2018.
- DANNA: A Neuromorphic Software Ecosystem, Adam Disney, John Reynolds, Catherine D. Schuman, Aleksander Klibisz, Aaron Young, and James S. Plank, *Biologically Inspired Cognitive Architectures, Volume 9*, 2016.

## Posters

- Poster: Neuromorphic Array Communications Controller, Aaron R. Young and Mark E. Dean, *JDRD Symposium*, 2019.
- Poster: DANNA Neuromorphic Application Development Kit Demo, Mark Dean, Aaron Young, Parker Mitchell, Patricia Eckhart, John Reynolds, Grant Bruer, Adam Disney, James Plank, and Catherine Schuman. *5th Neuro Inspired Computational Elements Workshop (NICE 2017)*, 2017.

## Research

I am part of the TENNLab—Neuromorphic Architectures, Learning, Applications research group. We research a new paradigm of computing, inspired by the human brain. Our research encompasses nearly every facet of the area, including current and emergent hardware implementations, theoretical models, programming techniques and applications. Specifically, I have worked on framework development, the DANNA and DANNA2 digital neuromorphic processors, and neuromorphic application development. My Focus has been on communication between traditional computers and neuromorphic processors. I have developed the NACC (Neuromorphic Array Communications Controller) to support high-speed, low-latency communication between the host PC and neuromorphic system. I have also designed and built SNACC

(Scaled-up Neuromorphic Array Communications Controller) which uses a NACC to connect multiple neuromorphic processors together to build larger unified neuromorphic systems to run large neural networks. This system also supports real-time communication with the Host PC.

## Projects

---

### **ECE 599—BOB**

This project involved the design and construction of a high-performance cluster composed of 68 quad-core ARMv8 64-bit Raspberry Pi 3s. The primary intent of the project was to establish the operating environment, communication structure, application frameworks, application development tools, and libraries necessary to support the effective operation of a high performance computer model for the students and faculty in the Electrical Engineering and Computer Science Department of the University of Tennessee to utilize. As a foundation, the system borrowed heavily from the Tiny Titan system constructed by the Oak Ridge National Laboratory, which was a similar but smaller-scale project consisting of 9 first generation Raspberry Pis. Beyond the primary target of delivering a functional system, efforts were focused on application development, performance benchmarking, and delivery of a comprehensive build/usage guide to aid those who wish to build upon the efforts of this project.

### **CS 594—Alice**

This project was an expansion of The University of Tennessee's Big Orange Bramble (BOB) project from Summer 2016. The success of the BOB project led to a proposal for a secondary cluster, which was intended to be combined with BOB to form a larger, heterogeneous cluster. This secondary cluster was created from 32 64-bit Pine64s and 12 Nvidia TX1 GPUs. It was also a requirement to perform benchmarking on each subset of architecture and provide a performance comparison to BOB. Additionally, several more applications were developed for BOB, including a facial recognition application, a weather forecasting, and a Gillespie algorithm application. An installation and usage guide was also developed for these applications for anyone wishing to utilize them.

### **ECE 651—TRASHCAN on a Chip**

The Tiny RISC Architecture System with Homogeneous Communication Across a Network on a chip (TRASHCAN) project aimed to design and implement a multi-core RISC-V processor with cores communicating through an embedded network-on-chip (NoC). The NoC follows a basic two-dimensional mesh topology for simplicity, and the processor cores are 5 stage, in order RISC-V cores. By scaling out with more cores and a simple mesh interconnect, we hope to see the potential for large many-core systems beyond today's offerings. Much of the project draws from three open source hardware projects: RISC-V, OpenSoC, and Parallela. Through the project, we look to extend and incorporate the Rocket Chip generator for RISC-V with the network-on-chip generator from OpenSoC to build a processor inspired by the principles of the Adapteva Parallela.

## Neuro-Cluster

Using the skills gained from the BOB and Alice projects, I build a large, high-performance cluster from donated servers for the use of the TENNLab research group. This cluster consists of 8 Sun x2200s, 36 Dell PowerEdge C6145, and a Synology RS816 NAS with a Synology RX418 NAS Expansion unit. The cluster is setup with LDAP, Slurm, MPI, OpenMP, Ansible, Jenkins, MAAS, Infiniband, Firewall, Custom Monitoring GUI, and Git Server. The main compute partition has 1728 total cores and 3456 GB total RAM. In addition to setting up the system, I have also been the sole administrator of the system for 3 years, responsible for hardware maintenance, account management, and configuration maintenance. The system is being used by the TENNLab group as a valuable computing resource and results collected on the cluster have been published in multiple papers.

## Security Plan

As part of my computer system management duties, I help create the Galápagos Security Plan and Acceptable Use Policy. The Plan covers the Neuro-Cluster, BOB, and various benchtop workstations used by TENNLab. The security plan follows the National Standards and Guidance, NIST FIPS 199, Standards for Security Categorization of Federal Information and Information Systems (FIPS 199); National Standards and Guidance, NIST SP 800-53, Revision 4, Recommended Security Controls for Federal Information Systems and Systems (NIST 800-53); the Tennessee Code Annotated § 47-18-2107, 2010 S.B. 2793, Release of personal consumer information; University of Tennessee System Policy IT0110, Acceptable Use of Information Technology Resources; and University of Tennessee, Knoxville, Banner Data Standards Manual.

## Senior Design—Second Creak Monitoring

My senior design project was to build a Second Creak Monitoring database and website to help Dr. Hathaway, from the Department of Civil and Environmental Engineering, with his ongoing effort to collect high resolution data from Second Creek and a weather station located on the University of Tennessee-Knoxville campus. This project build a website which students and the general public can navigate to and see the conditions of the local environment and creek, thereby promoting water quality and watershed awareness. The website provides a user-friendly, aesthetically pleasing interface and better access to real time information about the local environment. The project also built an SQL database to collect information from the sensors and provide the information to the website. Another goal of this project was to ensure data security, since it is critical to minimize any data loss that could potentially affect the ongoing research.

## Relevant Coursework

---

ECE	692	Advanced Special Topics — Deep Learning	Final Grade: A
ECE	651	Computer-aided Design of VLSI Systems	Final Grade: A
COSC	594	Supercomputer Design & Analysis	Final Grade: A
COSC	594	Computer Graphics	Final Grade: A
ECE	593	Advanced Supercomputer Design & Analysis	Final Grade: A

COSC	565	Databases/Scripting Languages	Final Grade: A
COSC	560	Software Systems	Final Grade: A
ECE	555	Embedded Systems	Final Grade: A
ECE	551	Digital System Design I	Final Grade: A
COSC	530	Computer Systems Organization	Final Grade: A
COSC	528	Intro to Machine Learning	Final Grade: A
COSC	527	Biologically-Inspired Computation	Final Grade: A
COSC	494	Advanced Programming and Algorithms	Final Grade: A
COSC	462	Parallel Programming	Final Grade: A
ECE	457	Honors: Computer Systems Architecture	Final Grade: A
COSC	453	Introduction to Computer Networks	Final Grade: A
COSC	361	Operating Systems	Final Grade: A
COSC	360	Systems Programming	Final Grade: A
ECE	201/202	Circuits I & II	Final Grade: A/A
COSC	140/302	Data Structures & Algorithms I & II	Final Grade: A/A

## Relevant Skills

---

### Programming Languages

Bash, C, C#, C++, Chisel, CSS, HTML, Java, Javascript, MPI, OpenGL, OpenMP, Perl, PHP, Python, SQL, SystemVerilog, VHDL

### Frameworks

Django, Jekyll

### Libraries

GTK, Keras, NumPy, OpenGL, pandas, SciPy, TensorFlow

### Tools

Beamer, Blender, FreeCAD, GIMP, Git, Inkscape, Jenkins, L<sup>A</sup>T<sub>E</sub>X, Linux, Vivado

## Relevant Extracurriculars

---

### FIRST Robotics Participation

- Mentor for Hardin Valley Academy FIRST Robotics Team. Set-up source code version control. Assisted with teaching programming to students. Provided support at Regional Competition, 2012–2013.
- Computer Programmer for Hardin Valley Academy FIRST Robotics Team. Used C++ to design, simulate and implement the robot's control system and autonomous mode. Assisted with electrical set-up and mechanical manufacturing. Participated in regional and national competitions, 2011 & 2012.