

Narayanan Rengaswamy

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EDUCATION

Ph.D. in Electrical Engineering, Jan. 2016 – Present

Duke University, Durham, NC, USA

Research: Quantum Computing and Algorithms, Coding Theory, Inference Problems

Advisors: Prof. Henry D. Pfister and Prof. Robert Calderbank

Coursework: Compressed Sensing, Information Theory and Statistical Mechanics, Detection and Estimation Theory, Machine Learning, Basic Analysis, Convex Optimization

Cumulative GPA: 3.86 out of 4

M.S. in Electrical Engineering, Dec. 2015

Texas A&M University, College Station, TX, USA

Thesis: On Cyclic Polar Codes and the Burst Erasure Performance of Spatially-Coupled LDPC Codes

Advisors: Prof. Henry D. Pfister and Prof. Krishna R. Narayanan

Coursework: Channel Coding, Statistical Communication Theory, Information Theory, Advanced Channel Coding, Computer Communication and Networking, Wireless Communications

Cumulative GPA: 3.875 out of 4

B.Tech. in Electronics and Communication Engineering, May 2013

Amrita University, Coimbatore, Tamilnadu, India

Project: Wireless Electrocardiogram Monitoring for Cardiac Patients on Android Platform

Advisor: Prof. E.P. Sumesh

Advanced Coursework: OFDM for Broadband Wireless Communications, Agent Based Modeling, Pattern Recognition, Convex Optimization

Cumulative GPA: 9.70 out of 10 (3.88/4)

HONORS

Graduate Student Member of IEEE, since Nov. 2015

Top Rank in Undergraduate Studies, May 2013

Amrita University, Coimbatore, Tamilnadu, India

– Ranked 1st in the college, 3rd in the University (among 3 engineering campuses)

Ericsson Excel Certification in Telecommunications, 2012

Amrita University, Coimbatore, Tamilnadu, India

- Attended Ericsson leading researcher’s lectures, passed exam and completed internship

Amrita TIDE Best Innovation Award, 2011-12

Amrita University, Coimbatore, Tamilnadu, India

- As a team, developed an Integrated Village Development System
- Used Software Defined Radio (SDR) to demonstrate connectivity between places, with only partial dependence on the internet
- Created a web portal (using JSP language) for Job Classifieds System

RESEARCH

Research Assistant, Dr. Henry Pfister’s Group, Jan. 2016 – Present

Duke University, Durham, NC, USA

- Currently working on problems in quantum computing and quantum communications
- Conducted research on construction of deterministic compressed sensing matrices and recovery of large supports of unknown sparse vectors

Research Assistant, Dr. Gregory Huff’s Group, Jan. 2014 – Aug. 2014

Texas A&M University, College Station, TX, USA

- Worked on the MUSIC algorithm to triangulate and localize the origin of a wave through its interception with a network of buoy sensors
- Developed a C++ utility with Qt Creator IDE for field sensing and analysis

SKILLS

Core: Information and Coding Theory, Signal Processing, Quantum Computing, Graphical Models and Inference, Linear Algebra, Combinatorics, Probability, Wireless Communication

General: Theoretical Research, Teaching, Programming, Technical and Formal Writing

Languages: MATLAB, C, C++, Arduino, Mathematica

TEACHING

Teaching Assistant, Error Correction Coding, Fall 2017

Duke University, Durham, NC, USA

- Prepared several homework and exam problems inspired from research
- Delivered two lectures on quantum error correcting codes, circuits and logical operators

Teaching Assistant, Digital Audio Processing, Spring 2017

Duke University, Durham, NC, USA

- Developed several assignments, labs and exam problems
- Prepared and presented notes and associated MATLAB and Simulink tutorials on some topics
- Delivered two lectures on Fourier transforms, frequency domain processing and DSP flow diagrams

Teaching Assistant, Senior Capstone Design, Spring and Fall 2015

Texas A&M University, College Station, TX, USA

- Assisted undergraduate students in their senior design project

- Developed and delivered tutorials on essential hardware, software, and their integration

INDUSTRY EXPERIENCE

Graduate Research Intern, June – Aug. 2015

Alcatel-Lucent Bell Labs, Stuttgart, Germany

- Analyzed Spatially-Coupled Regular LDPC codes on burst erasure channels
- Rigorously proved that removal of 4-cycles and increasing left-degree can guarantee block erasure rates of $O(10^{-15})$ for some code ensembles
- Published in two IEEE conferences and in the IEEE Transactions on Information Theory

Undergraduate Summer Intern, June – July 2012

Ericsson India Global Services Private Limited, Chennai, India

- Developed, with 5 fellow interns, a web portal (using Drupal and PHP) to facilitate the internal processing system of Ericsson's Revenue Management Division
- Prepared extensive documentation for the developed system

SELECTED PROJECTS

Synthesis of Logical Clifford Operators, Nov. 2017 – Present

Duke University, Durham, NC, USA

- Exploited the binary symplectic geometry connection of Clifford operators to efficiently synthesize logical Clifford operators for stabilizer codes
- Using symplectic transvections, developed algorithms for enumerating all symplectic matrices satisfying a system of linear equations
- Developed a full package of MATLAB code and released it open-source on GitHub. Available at: <https://github.com/nrenga/symplectic-arxiv18a>
- Paper accepted for the 2018 IEEE International Symposium on Information Theory
- Preprint of longer paper posted to arXiv and submitted to the Quantum journal

Quantum Channels, Quantum Message Passing, Mar. 2017 – Present

Duke University, Durham, NC, USA

- Studied and prepared notes for understanding duality of channels and codes, based on a recent paper
- Performed analysis on a recent quantum belief propagation algorithm

Deterministic Compressed Sensing and Support Recovery, May – Dec. 2016

Duke University, Durham, NC, USA

- Studied the performance of deterministic compressed sensing matrices for support recovery
- Demonstrated empirically that matrices based on Kerdock codes can recover large supports under a recently proposed reformulation of the compressed sensing problem

Spatially-Coupled LDPC Codes on Burst Erasure Channels, June – Aug. 2015

Alcatel-Lucent Bell Labs, Stuttgart, Germany

- Analyzed Spatially-Coupled Regular LDPC codes on burst erasure channels
- Rigorously proved that removal of 4-cycles and increasing left-degree can guarantee block erasure rates of $O(10^{-15})$ for some code ensembles

- Used the developed analyses on simple channel models to closely estimate performance on the more realistic block erasure channel (BLEC) model
- Published in two conferences and in the IEEE Transactions on Information Theory

Cyclic Polar Codes, M.S. Thesis, Sep. 2014 – Dec. 2015

Texas A&M University, College Station, TX, USA

- Modified polar codes to produce cyclic codes over suitable Galois fields
- Achieved higher rates on the erasure channel than binary polar codes for a target block erasure rate
- Paper presented in the 2015 IEEE International Symposium on Information Theory

Hands On, “Sensing, Acquisition and Innovation Lab” Course Project, Fall 2013

Texas A&M University, College Station, TX, USA

- As a team, developed a device for testing coordination of both hands simultaneously
- Developed a GUI using Qt Creator IDE to receive and visualize IMU data
- Performed real-time testing on participants on Demo Day

Wireless Electrocardiogram (ECG) Monitoring, B.Tech. Project, Jul. 2012 – May 2013

Amrita University, Coimbatore, Tamilnadu, India

- As a team, built hardware to transmit ECG (input from any reliable, mobile ECG extraction hardware) to the patient’s phone over Bluetooth
- Developed an Android application to receive signals from the hardware in real-time and display it along with key parameters
- Processed the signals using the Pan-Tompkins algorithm to detect key parameters, and raised alerts when necessary via the Short Message Service (SMS)

Integrated Village Development System, Aug. 2011 – June 2012

Amrita University, Coimbatore, Tamilnadu, India

- As a team, used Software Defined Radio (SDR) to demonstrate connectivity between places, with only partial dependence on the internet
- Created a web portal (using JSP language) for Job Classifieds System

PROFESSIONAL ACTIVITIES

Quantum Group Meetings, Mar. 2017 – Present

Duke University, Durham, NC, USA

- Organizing weekly meetings on topics related to quantum computing, communications, algorithms
- Presented papers and my notes on several topics of common interest
- Collaborated with professors to produce work on synthesis of logical Clifford operators

North American School of Information Theory, June 2016

Duke University, Durham, NC, USA

- Assisted in organizing the summer school, handled monetary responsibilities
- Developed an information theory crossword with a colleague

Workshop on Software Defined Radio, Aug. 2012

Amrita University, Coimbatore, Tamilnadu, India

- Learned to work with the Universal Software Radio Peripheral (USRP) Kit

- Developed simple communications system modules in GNU Radio Companion software

THESES

1. N. Rengaswamy, “On Cyclic Polar Codes and the Burst Erasure Performance of Spatially-Coupled LDPC Codes,” Master’s thesis, Texas A&M University, 2015. <http://hdl.handle.net/1969.1/156244>.

PEER-REVIEWED JOURNAL PAPERS

1. V. Aref, **N. Rengaswamy**, and L. Schmalen, “Finite-length analysis of spatially-coupled regular LDPC ensembles on burst-erasure channels,” in press, *IEEE Trans. Inform. Theory*, 2018. [Online]. Available at: <https://arxiv.org/abs/1611.08267>.

PREPRINTS

1. **N. Rengaswamy**, R. Calderbank, S. Kadhe, and H. D. Pfister, “Synthesis of logical Clifford operators via symplectic geometry,” *arXiv preprint arXiv:1803.06987*, 2018. [Online]. Available at: <https://arxiv.org/abs/1803.06987>.

PEER-REVIEWED CONFERENCE PAPERS

4. **N. Rengaswamy**, R. Calderbank, S. Kadhe, and H. D. Pfister, “Synthesis of logical Clifford operators via symplectic geometry,” accepted for *IEEE Int. Symp. Inform. Theory*, 2018.
3. V. Aref, **N. Rengaswamy**, and L. Schmalen, “Spatially coupled LDPC codes affected by a single random burst of erasures,” in *Proc. Int. Symp. on Turbo Codes & Iterative Inform. Proc.*, pp. 166–170, IEEE, 2016. [Online]. Available at: <https://arxiv.org/abs/1607.00918>.
2. **N. Rengaswamy**, L. Schmalen, and V. Aref, “On the burst erasure correctability of spatially coupled LDPC ensembles,” in *Proc. IEEE Intl. Zurich Seminar on Commun.*, pp. 155–159, 2016.
1. **N. Rengaswamy** and H. D. Pfister, “Cyclic polar codes,” in *Proc. IEEE Int. Symp. Inform. Theory*, pp. 1287–1291, June 2015.

TALKS, POSTERS AND WORKSHOPS

7. Poster – **N. Rengaswamy**, H. D. Pfister, and R. Calderbank, “Logical Operators for CSS Codes: A Binary Perspective”, *Duke IBM Day*, Duke University, Oct. 31, 2017.
6. Workshop (participant) – *Beyond I.I.D. in Information Theory*, National University of Singapore, July 24-28, 2017.
5. Poster – **N. Rengaswamy** and H. D. Pfister, “Deterministic Compressed Sensing and Recovery of Large Supports”, *North American School of Information Theory*, Georgia Institute of Technology, June 6-9, 2017.

4. Workshop (participant) – *Communications, Inference, and Computing in Molecular and Biological Systems*, University of Southern California, Dec. 3-4, 2015.
3. Talk – “The Burst Erasure Correctability of Spatially Coupled LDPC Ensembles”, *Information Sciences and Systems Seminar*, Texas A&M University, Nov. 4, 2015.
2. Talk – “Cyclic Polar Codes”, *Information Sciences and Systems Symposium*, Texas A&M University, Oct. 19, 2015.
1. Poster – **N. Rengaswamy** and H. D. Pfister, “Cyclic Polar Codes: How to Achieve Higher Rates than Binary Polar Codes at Finite Blocklengths?”, *Eighth Annual Winedale Workshop*, Round Top, Texas, Oct. 9, 2015.

REFERENCES

1. **Prof. Henry D. Pfister**
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2. **Prof. Robert Calderbank**
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3. **Prof. Jean-Francois Chamberland-Tremblay**
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4. **Dr. Samuel Villareal**
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5. **Dr. Laurent Schmalen**
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