

Dana Thurston Hughes

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RESEARCH INTERESTS

My research interests involve using modular convolutional and recurrent neural network architectures to perform in-material processing and control of “robotic materials”. Major aspects of my research include designing small, inexpensive sensing and computing nodes to be embedded in engineered materials, and building and training appropriate neural network models for applications of interest. I am particularly interested in automatically determining optimal neural network architectures constrained by limited computing resources, and developing models to learn communication protocols in a multi-node system.

EDUCATION

Doctor of Philosophy, Computer Science expected Spring 2018
University of Colorado Boulder, Boulder, CO
Advisor: Dr. Nikolaus Correll

Master of Science, Computer Science May 2012
College of Charleston, Charleston, SC
Advisor: Dr. Bill Manaris

Master of Science, Electrical Engineering May 2003
University of Missouri Rolla, Rolla, MO
Advisor: Dr. Reza Zoughi
Thesis - *Development of the Embedded Modulated Scattering Technique for Dielectric Material Classification*

Bachelor of Science, Electrical and Computer Engineering May 2000
Colorado State University, Fort Collins, CO

ACADEMIC & RESEARCH EXPERIENCE

Correll Lab August 2012 – Present
Graduate Research Assistant
University of Colorado Boulder, Boulder, CO

- Proposed using a modular convolutional and recurrent neural network architecture as a universal approach to perform autonomous in-material processing in robotic materials [3]. Demonstrated the utility of this approach for several robotic applications:
 - Developed a terrain-sensitive tire to assist control of self-driving vehicles [28].

- Demonstrated that colocating neural network modules with groups of wearable sensors can identify human activity with performance comparable to a monolithic approach [11].
- Designed a robotic skin capable of joint force and proximity sensing, used to perform affective touch recognition and assist with obstacle avoidance [1,9,10,12].
- Designed and implemented a distributed amorphous algorithm for detecting and identifying textures rubbed against a robotic skin with a sparse number of sensing nodes [4,14,29,30].
- Developed *Switchback*, an RF-based e-textile input swatch for wearables [2,13,37].

Computer Music Laboratory

January 2010 – August 2012

Graduate Research Assistant

College of Charleston, Charleston, SC

- Assisted with development and programming of *Monterey Mirror*, a system for computer-assisted composition and performance [5,31].
- Developed a real-time audio to midi transcription algorithm for performing content-based search with *Armonique*, an online music search engine [15].

Applied Microwave Nondestructive Testing Laboratory

January 2001 – April 2003

Graduate Research Assistant

University of Missouri – Rolla, Rolla, MO

- Developed the embedded modulated scattering technique as a novel approach to near-field microwave non-destructive evaluation (NDE) of materials and structures [6,7,16,18,21,25,26,36].
- Performed feasibility studies and analysis of using near-field microwave NDE techniques for detecting cracks and corrosion in metal structures (primarily aircraft components) [8,17,19,27,33,34], analyzing the state of cement-based materials [23,24,32], and detecting defects in fiber-reinforced composites [20,22,26].

Undergraduate Research Assistant

April 1999 – December 2000

Colorado State University, Fort Collins, CO

- Designed, constructed and developed software for a two dimensional scanning table and hand-held scanning device for in-lab and on-site near-field microwave measurements of metal plates, composites and similar structures [35].

TEACHING EXPERIENCE

Graduate Part Time Instructor

January 2014 - May 2014

University of Colorado Boulder, Boulder, CO

Department of Computer Science

- CSCI4448 — Object Oriented Analysis and Design Spring 2014

Teaching Assistant

August 2012 – December 2013

University of Colorado Boulder, Boulder, CO

Department of Computer Science

- CSCI1300 — Computer Science I: Programming Fall 2013

- CSCI3155 — Principles of Programming Languages Fall 2012, Spring 2013

Adjunct Professor

August 2011 – May 2012

College of Charleston, Charleston, SC

Department of Computer Science

- CSCI201 — Game Programming Spring 2012
- CSCI112 — Communications Technology and the Internet Spring 2012
- CSCI120 — Building Virtual Worlds Fall 2011
- CSCI110 — Computer Fluency Fall 2011

Teaching Assistant

January 2011 – May 2011

College of Charleston, Charleston, SC

Department of Computer Science

- CSCI180 — Computer, Music and the Arts Spring 2011

PROFESSIONAL EXPERIENCE

BiblioLabs, LLC

May – August 2012

Software Engineering Intern

Charleston, SC

- Developed tests for porting local MySQL database to Amazon RDS instances.
- Performed quality assurance and testing of *BiblioBoard*, an online curation and anthology authoring application.

JMO Woodworks

May 2003 – May 2011

Cabinetmaker

Charleston, SC

- Built and installed custom hardwood doors, windows, cabinetry and architectural details.

FELLOWSHIPS AND GRANTS

Graduate Assistanceship in Areas of National Need (GAANN)

August 2001 – April 2003

PROFESSIONAL AFFILIATIONS

Graduate Student Member of the IEEE

Student Member of the ACM

Upsilon Pi Epsilon Honors Society

AWARDS & HONORS

Ralph J. Slutz Student Excellence Award Department of Computer Science, University of Colorado Boulder	Fall 2017
Outstanding Research Paper Award Department of Computer Science, University of Colorado Boulder	Spring 2016
Ralph J. Slutz Student Excellence Award Department of Computer Science, University of Colorado Boulder	Fall 2015
Outstanding Teaching Assistant Award Department of Computer Science, University of Colorado Boulder	Spring 2013
Outstanding Teaching Assistant Award Department of Computer Science, University of Colorado Boulder	Fall 2012

PUBLICATIONS

Journal Articles

1. **D. Hughes**, J. Lammie and N. Correll, “A Robotic Skin for Collision Avoidance and Affective Touch Recognition,” *Robotics and Automation Letters*, vol. 3, no. 3, pp. 1386-1393, January 2018.
2. **D. Hughes**, H. Profita, S. Radzihovsky and N. Correll, “Intelligent RF-Based Gesture Input Devices Implemented using e-Textiles,” *Sensors*, vol. 17, no. 2, pg. 219, January 2017.
3. **D. Hughes** and N. Correll, “Distributed Machine Learning in Materials that Couple Sensing, Actuation, Computation and Communication,” *arXiv preprint arXiv:1606.03508*, 2016.
4. **D. Hughes** and N. Correll, “Texture Recognition and Localization in Amorphous Robotic Skin,” *Bioinspiration & Biomimetics*, vol. 10, no. 5, September 2015.
5. B. Manaris, **D. Hughes** and Y. Vassilandonakis, “Monterey Mirror: An Experiment in Interactive Music Performance Combining Evolutionary Computation and Zipf’s Law,” *Evolutionary Intelligence*, vol. 8, no. 1, pp. 23-35, November 2014.
6. **D. Hughes** and R. Zoughi, “A Novel Method for Determination of Dielectric Properties of Materials Using a Combined Embedded Modulated Scattering and Near-Field Microwave Techniques. Part I – Forward Model,” *IEEE Transactions on Microwave Theory and Techniques*, vol. 54, no. 6, pp. 2389-2397, December 2005.
7. **D. Hughes** and R. Zoughi, “A Novel Method for Determinztion of Dielectric Properties of Materials Using a Combined Embedded Modulated Scattering and Near-Field Microwave Techniques. Part II – Dielectric Property Recalculation,” *IEEE Transactions on Microwave Theory and Techniques*, vol. 54, no. 6, pp. 2398-2401, December 2005.
8. B. Akuthota, **D. Hughes**, R. Zoughi, J. Myers and A. Nanni, “Near-Field Microwave Detection of Disbond in Carbon Fiber Reinforced Polymer Composites used for Strengthening Cement-Based Structures and Disbond Repair Verification,” *Journal of Materials in Civil Engineering*, vol. 16, no. 5, pp. 540–546, 2004.
9. **D. Hughes**, N. Wang, T. Case, K. Donnell, R. Zoughi, R. Austin and M. Novack, “Microwave Nondestructive Detection of Corrosion Under Thin Paint and Primer in Aluminum Panels,” Special Issue of *Subsurface Sensing Technologies and Applications: On Advances and Applications in Microwave and Millimeter Wave Nondestructive Evaluation*, vol. 2, no. 4, pp. 435-451, 2001.

Conference Papers

10. S. Aguasvivas Manzano, **D. Hughes** and N. Correll, “Wireless Online Impact Source Localization on a Composite,” *4th International Conference on System-Integrated Intelligence*, Hanover, Germany, June 19–20, 2018.
11. **D. Hughes**, A. Krauthammer and N. Correll, “Recognizing Social Touch Gestures using Recurrent and Convolutional Neural Networks,” *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, pp. 2315–2321, Singapore, May 29–June 3, 2017.
12. **D. Hughes** and N. Correll, “Distributed Convolutional Neural Networks for Human Activity Recognition in Wearable Robotics,” *Distributed Autonomous Robotic Systems (DARS)*, London, UK, November 7, 2016.

13. **D. Hughes**, N. Farrow, H. Profita and N. Correll, "Detecting and Identifying Tactile Gestures using Deep Autoencoders, Geometric Moments and Gesture Level Features," *2015 ACM International Conference on Multimodal Interaction (ICMI 2015), Recognition of Social Touch Challenge*, Seattle, WA, USA, November 9, 2015.
14. **D. Hughes**, H. Profita and N. Correll, "Switchback: An On-Body RF-Based Gesture Input Device," *Proceedings of the 18th International Symposium on Wearable Computers (ISWC)*, pp. 63-66, Seattle, WA, USA, September 13, 2014.
15. **D. Hughes** and N. Correll, "A Soft, Amorphous Skin that can Sense and Localize Texture," *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, pp. 1844-1851, Hong Kong, China, May 31-June 5, 2014.
16. **D. Hughes** and B. Manaris, "Fractal Dimensions of Music and Automatic Playlist Generation-Similarity Search via MP3 Song Uploads," *Proceedings of the 8th IEEE International Conference on Intelligent Information Hiding and Multimedia Signal Processing (IIH-MSP 2012)*, Piraeus-Athens, Greece, July 20, 2012.
17. J. Lai, **D. Hughes**, E. Gallaher and R. Zoughi, "Determination of the Thickness and Dielectric Constant of a Dielectric Slab Backed by Free-Space or a Conductor through Inversion of the Reflection Coefficient of a Rectangular Waveguide Probe," *Proceedings of the IEEE Instrumentation and Measurement Technology Conference (IMTC'04)*, pp. 56-60, Como, Italy, May 18-20, 2004.
18. **D. Hughes** and R. Zoughi, "Calculation of the Impedance of a Rectangular Waveguide Aperture in the Presence of a Loaded Dipole Antenna Embedded in a Generally Lossy Material," *Proceedings of the IEEE Instrumentation and Measurement Technology Conference (IMTC'03)*, pp. 1126-1130, Vail, CO, May 20-22, 2003.
19. **D. Hughes**, J. Lai, C. Behrens and R. Zoughi, "Combined Bi-Static Near-Field Microwave and Modulated Scattering Techniques for Detection of Embedded Targets," *Proceedings of the Eleventh International Symposium on Nondestructive Characterization of Materials*, pp. 355-356, Berlin, Germany, June 24-28, 2002.
20. G. Cariveau, **D. Hughes**, N. Qaddoumi and R. Zoughi, "Microwave Nondestructive Evaluation and Characterization of Tank Inner-Liners," *Proceedings of the Eleventh International Symposium on Nondestructive Characterization of Materials*, pp. 319-324, Berlin, Germany, June 24-28, 2002.
21. **D. Hughes** and R. Zoughi, "Near-Field Microwave and Embedded Modulated Scattering Techniques for Dielectric Characterization of Materials-Experimental Results", *Proceedings of the 29th Annual Review of Progress in Quantitative Nondestructive Evaluation*, vol. 22A, pp. 443-448, Bellingham, WA, July 14-19, 2002.
22. **D. Hughes** R. Zoughi, R. Austin, N. Wood and R. Engelbart, "Near-Field Microwave Detection of Corrosion Precursor Pitting under Thin Dielectric Coatings in Metallic Substrates," *Proceedings of the 29th Annual Review of Progress in Quantitative Nondestructive Evaluation*, vol. 22A, pp. 462-469, Bellingham, WA, July 14-19, 2002.
23. **D. Hughes** and R. Zoughi, "Near-Field Microwave and Embedded Modulated Scattering Technique for Dielectric Characterization of Material," *Proceedings of the Eleventh International Symposium on Nondestructive Characterization of Materials* (Organized by Johns Hopkins University Center for Nondestructive Evaluation), Berlin, Germany, June 24-28, 2002.
24. **D. Hughes**, M. Kazemi, K. Marler, J. Myers, R. Zoughi and T. Nanni, "Microwave Detection of Delamination between Fiber Reinforced Polymer (FRP) Composites and Concrete Substrate," *Proceedings of the 28th Annual Review of Progress in Quantitative Nondestructive Evaluation*, vol. 21A, pp. 512-519, Brunswick, ME, July 29-August 3, 2001.

25. S. Peer, J. Case, K. Donnell, **D. Hughes**, R. Zoughi and K.E. Kurtis, "Investigation of Microwave Reflection Properties of Mortar Exposed to Wet-Dry Cycles of Tap Water and Chloride Bath," *Proceedings of the 28th Annual Review of Progress in Quantitative Nondestructive Evaluation* vol. 21B, pp. 1269-1276, Brunswick, ME, July 29–August 3, 2001.
26. J. Case, R. Zoughi, K. Donnell, **D. Hughes** and K.E. Kurtis, "Microwave Analysis of Mortar Prepared with Type I/II, III and V Cement and Subjected to Cyclical Chloride Exposure," *Proceedings of the 28th Annual Review of Progress in Quantitative Nondestructive Evaluation* vol. 21A, pp. 498-505, Brunswick, ME, July 29–August 3, 2001.
27. **D. Hughes**, C. Behrens, D. Leathers and R. Zoughi, "Spatial Interaction of a Modulated PIN Diode-Loaded Dipole Antenna and Open-Ended Rectangular Waveguide Probes," *Progress in Electromagnetic Research Symposium (PIERS)*, Osaka, Japan, July 18–22, 2001.
28. **D. Hughes** and R. Zoughi, "A Method for Evaluating the Dielectric Properties of Composites Using a Combined Embedded Modulated Scattering and Near-Field Microwave Non-destructive Testing Technique," *Proceedings of the IEEE Instrumentation and Measurement Technology Conference (IMTC'01)*, pp. 1882-1886, Budapest, Hungary, May 21–23, 2001.
29. **D. Hughes**, N. Wang, T. Case, R. Zoughi, R. Austin and M. Novack, "Detection of Corrosion in Aluminum Panels Under Paint and Primer," *Proceedings of the 27th Annual Review of Progress in Quantitative Nondestructive Evaluation*, vol. 20A, pp. 460-466, Ames, IA, July 17-21, 2000.

Workshop Papers / Posters

30. **D. Hughes**, C. Heckman and N. Correll, "Terrain Sensitive Tires for Autonomous Driving," *Material Robotics*, Workshop at Robotics: Science and Systems, July 12–16, 2017.
31. **D. Hughes** and N. Correll, "In-Material Computation of High-Bandwidth Sensor Signals in Robotic Skin," *The Robotic Sense of Touch: From Sensing to Understanding*, Workshop at IEEE International Conference on Robotics and Automation (ICRA), Singapore, May 29—June 3, 2017.
32. **D. Hughes**, N. Farrow and N. Correll, "Distributed Texture Identification and Localization in Artificial Skin," *2013 International Workshop on Soft Robotics and Morphological Computation*, Monte Veritas, Switzerland, July 14-19, 2013.
33. B. Manaris, **D. Hughes** and Y. Vassilandonakis, "Monterey Mirror: Combining Markov Models, Genetic Algorithms, and Power Laws," *Proceedings of the 1st Workshop in Evolutionary Music, 2011 IEEE Congress on Evolutionary Computation (CEC2011)*, pp. 33-40, New Orleans, LA, USA, June 5, 2011.

Technical Reports

34. K. Donnell, **D. Hughes**, T. Case and R. Zoughi, "Near-Field Microwave Nondestructive Evaluation of Refractory Bricks," Final Report, Johns Manville, Littleton, CO, p. 51, September 2000.
35. R. Zoughi, N. Qaddoumi and **D. Hughes**, "Near-Field Microwave Nondestructive Inspection of Rubber Coated Steel—A Preliminary Study," Final Report, Science Applications International Corporation (SAIC), p. 20, August 2000.
36. N. Wang, **D. Hughes**, T. Case, K. Donnell and R. Zoughi, "Feasibility Study of Corrosion Detection Under Paint in Aluminum Panels," Final Report, Texas Research Institute at

Austin (TRI-Austin), p. 78, July 2000.

37. **D. Hughes**, J. Nelson and R. Zoughi, “2-D Scanning Table,” Manual, Naval Surface Warfare Center, Carderock Division, Survivability, Structures and Materials Directorate, Bethesda, MD, p. 11, August 1999.

Theses

38. **D. Hughes**, “Development of the Embedded Modulated Scattering Technique for Dielectric Material Characterization,” M.S. Thesis, Electrical and Computer Engineering Department, University of Missouri–Rolla, Rolla, MO, p. 286, April 2003.

Patents

39. **D. Hughes**, H. Profita and N. Correll, “RF-Based Gesture Input Device and Associated Method of Use,” U.S. Patent WO2016040938 A1, Application Number PCT/US2015/049963, 2016.