Andrew R. Buck, Ph.D.

U. S. Citizen
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Education

University of Missouri – Columbia, MO
Doctorate in Electrical & Computer Engineering May 2018
- Dissertation: "Multicriteria Pathfinding in Uncertain Simulated Environments"

University of Missouri – Columbia, MO
Master of Science in Computer Engineering May 2012
- Thesis: "An Evolutionary Framework for Matching Geospatial Object Configurations"

University of Missouri – Columbia, MO
Bachelor of Science in Computer Engineering May 2009
Bachelor of Science in Electrical Engineering May 2009
- Minors: Computer Science, Mathematics, Information Technology, and Music

Professional Experience

Assistant Research Professor | University of Missouri – Columbia, MO

Department of Electrical Engineering and Computer Science (MINDFUL Lab) 2019 to present
- Investigated methods for self-supervised monocular depth estimation
- Developed a 3D simulation environment for scene understanding from point clouds
- Designed algorithms for autonomous control of small aerial drones
- Guided the construction of a custom UAV platform for data collection and autonomy research

Postdoctoral Fellow | University of Missouri – Columbia, MO

Center for Eldercare and Rehabilitation Technology 2018 to 2019
- Designed and implemented a research framework for managing large heterogeneous temporal datasets
- Built a web API and visualization tool for the interactive exploration of a person's data timeline
- Supported ongoing real-time data collection efforts and student projects

Graduate Research Assistant | University of Missouri – Columbia, MO

Research on Explosive Hazard Detection 2015 to 2018
- Organized and managed the processing workflow of big data sets for target detection applications
- Designed a novel 3D feature descriptor for volumetric radar imagery to improve classification performance
- Fused data from LIDAR, radar, and acoustic sensors to detect roadside explosive hazards

Research on Human Geography 2012 to 2015
- Visualized uncertain variables in human hyperspectral geographic data
- Implemented agent-based models of bounded rationality for decision-making with partial information
- Investigated methods for path planning and navigation in dynamic multi-objective environments

Research on Spatial Relationships 2009 to 2012
- Developed an evolutionary algorithm to conflate a hand-drawn map to satellite imagery
- Modeled uncertainty in spatial knowledge using fuzzy weighted graphs

Teaching Assistant | University of Missouri – Columbia, MO

Introduction to Computational Intelligence Fall 2011 & Fall 2013

- Taught lectures on fuzzy systems, neural networks, and evolutionary computation
- Created class projects based on developing an agent to compete in an international game competition
- Graded homework and projects, and provided one-on-one assistance to students

PUBLICATIONS

A. R. Buck, D. T. Anderson, J. M. Keller, C. Bethel, and A. Aldridge, "Designing reliable navigation behaviors for autonomous agents in partially observable grid-world environments," in *2024 International Joint Conference on Neural Networks (IJCNN)*, Yokohama, Japan, 2024.

D. R. Buffum, **A. R. Buck**, J. Akers, R. Camaioni, M. Deardorff, D. T. Anderson, and R. H. Luke III, "Autonomous drone behavior via MCDM of UFOMap layers," in *Proc. SPIE 13037, Geospatial Informatics XIV*, 2024.

J. Kerley, D. T. Anderson, **A. R. Buck**, and B. Alvey, "Generating simulated data with a large language model," in *Proc. SPIE 13035, Synthetic Data for Artificial Intelligence and Machine Learning: Tools, Techniques, and Applications II*, 2024.

A. Soloviov, D. T. Anderson, **A. R. Buck**, and B. Alvey, "MizSIM: a headless open-source simulation framework for training and evaluating artificial intelligence," in *Proc. SPIE 13035, Synthetic Data for Artificial Intelligence and Machine Learning: Tools, Techniques, and Applications II*, 2024.

A. Buck, P. Popescu, D. Anderson, J. Keller, and M. Talbott, "Leveraging a digital twin to train, evaluate, and understand single image depth estimation for infrared imaging," *MSS*, 2024.

A. R. Buck, J. D. Akers, D. T. Anderson, J. M. Keller, R. Camaioni, M. Deardorff, and R. H. Luke III, "Frame selection strategies for real-time structure-from-motion from an aerial platform," in *2023 IEEE Applied Imagery Pattern Recognition Workshop (AIPR)*, St. Louis, MO, USA, 2023.

J. Akers, **A. Buck**, D. Anderson, J. Keller, R. Camaioni, M. Deardorff, and R. Luke III, "Improving real-time aerial 3D reconstruction: towards fusion of a hand-crafted SfM algorithm with a data-driven deep neural network," in *2023 IEEE Applied Imagery Pattern Recognition Workshop (AIPR)*, St. Louis, MO, USA, 2023.

A. R. Buck, D. T. Anderson, R. Camaioni, J. Akers, R. H. Luke III, and J. M. Keller, "Capturing uncertainty in monocular depth estimation: towards fuzzy voxel maps," in *2023 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, Songdo Incheon, Korea, 2023.

B. Alvey, D. Anderson, J. Keller, and **A. Buck**, "Linguistic Explanations of Black Box Deep Learning Detectors on Simulated Aerial Drone Imagery," *Sensors* 23(15), 6879, Aug. 2023.

A. R. Buck, D. T. Anderson, J. Fraser, J. Kerley, and K. Palaniappan, "Ignorance is bliss: flawed assumptions in simulated ground truth," in *Proc. SPIE 12529, Synthetic Data for Artificial Intelligence and Machine Learning: Tools, Techniques, and Applications*, 2023.

J. Akers, **A. Buck**, R. Camaioni, D. T. Anderson, R. H. Luke III, J. M. Keller, M. Deardorff, and B. Alvey, "Simulated gold-standard for quantitative evaluation of monocular vision algorithms," in *Proc. SPIE 12525, Geospatial Informatics XIII*, 2023.

J. Kerley, D. T. Anderson, B. Alvey, and **A. Buck**, "How should simulated data be collected for AI/ML and unmanned aerial vehicles?" in *Proc. SPIE 12529, Synthetic Data for Artificial Intelligence and Machine Learning: Tools, Techniques, and Applications*, 2023.

B. Mooers, A. L. Aldridge, **A. Buck**, C. L. Bethel, D. T. Anderson, "Human-robot teaming for a cooperative game in a shared partially observable space," in *Proc. SPIE 12525, Geospatial Informatics XIII*, 2023.

A. Buck, J. Kerley, D. Anderson, and J. Keller, "Simulated data to train and evaluate deep learning-based passive monocular vision algorithms at medium to long ranges," *MSS*, 2023.

A. R. Buck, D. T. Anderson, J. M. Keller, R. H. Luke III, and G. Scott, "A comparison of relative position descriptors for 3D objects," in *2022 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, Padua, Italy, 2022.

A. Buck, R. Camaioni, B. Alvey, D. T. Anderson, J. M. Keller, R. H. Luke III, and G. Scott, "Unreal Engine-based photorealistic aerial data generation and unit testing of artificial intelligence algorithms," in *Proc. SPIE 12099, Geospatial Informatics XII*, 2022.

R. Camaioni, R. H. Luke III, **A. Buck**, D. T. Anderson, "EpiDepth: a real-time monocular dense-depth estimation pipeline using generic image rectification," in *Proc. SPIE 12099, Geospatial Informatics XII*, 2022.

J. Kerley, A. Fuller, M. Kovaleski, P. Popescu, B. Alvey, D. T. Anderson, **A. Buck**, J. M. Keller, G. Scott, C. Yang, K. E. Yasuda, H. A. Ryan, "Procedurally generated simulated datasets for aerial explosive hazard detection," in *Proc. SPIE 12116, Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) Sensing XXIII*, 2022.

M. Kovaleski, A. Fuller, J. Kerley, B. Alvey, P. Popescu, D. Anderson, **A. Buck**, J. Keller, G. Scott, C. Yang, K. E. Yasuda, H. A. Ryan, "Explosive hazard pre-screener based on simulated data with perfect annotation and imprecisely labeled real data," in *Proc. SPIE 12116, Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) Sensing XXIII*, 2022.

A. Buck, M. Deardorff, B. Murray, D. Anderson, J. Keller, M. Popescu, D. Ho, and G. Scott, "Estimating depth from a single infrared image," *MSS*, 2022.

B. J. Murray, M. Islam, **A. Buck**, C. Veal, D. Anderson, J. Keller, M. Popescu, G. Scott, and D. K. C. Ho, "You only morph once (YOMO): morphology-based object detection and localization neural architecture," *MSS*, 2022.

B. J. Alvey, D. T. Anderson, C. Yang, **A. Buck**, J. M. Keller, K. E. Yen, and H. A. Ryan, "Characterization of deep learning-based aerial explosive hazard detection using simulated data," in *2021 IEEE Symposium Series on Computational Intelligence (SSCI)*, 2021.

B. Alvey, D. T. Anderson, **A. Buck**, M. Deardorff, G. Scott, and J. M. Keller, "Simulated photorealistic deep learning framework and workflows to accelerate computer vision and unmanned aerial vehicle research," in *2021 IEEE/CVF International Conference on Computer Vision Workshops (ICCVW)*, 2021.

A. R. Buck, D. T. Anderson, J. M. Keller, R. H. Luke III, and G. Scott, "A fuzzy spatial relationship graph for point clouds using bounding boxes," in *2021 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, Luxembourg, 2021.

A. Buck, M. Deardorff, D. T. Anderson, T. Wilkin, J. M. Keller, G. Scott, R. H. Luke III, and R. Camaioni, "VADER: a hardware and simulation platform for visually aware drone autonomy research," in *Proc. SPIE 11758, Unmanned Systems Technology XXIII*, 2021.

M. Deardorff, B. Alvey, D. T. Anderson, J. M. Keller, G. Scott, D. Ho, **A. Buck**, C. Yang, and B. Libbey, "Metadata enabled contextual sensor fusion for unmanned aerial system-based explosive hazard detection," in *Proc. SPIE 11750, Detection and Sensing of Mines, Explosive Objects, and Obscured Targets XXVI*, 2021.

B. Ruprecht, D. T. Anderson, F. Petry, J. Keller, C. Michael, **A. Buck**, G. Scott, and C. Davis, "Concept learning based on human interaction and explainable AI," in *Proc. SPIE 11735, Pattern Recognition and Tracking XXXII*, 2021.

J. Schulz, **A. Buck**, D. T. Anderson, J. M. Keller, G. Scott, and R. H. Luke III, "Human-in-the-loop extension to stream classification for labeling of low altitude drone imagery," in *Proc. SPIE 11748, Autonomous Systems: Sensors, Processing, and Security for Vehicles and Infrastructure*, 2021.

B. Alvey, D. T. Anderson, J. M. Keller, **A. Buck**, G. Scott, D. Ho, C. Yang, and B. Libbey, "Improving explosive hazard detection with simulated and augmented data for an unmanned aerial system," in *Proc SPIE 11750, Detection and Sensing of Mines, Explosive Objects, and Obscured Targets XXVI*, 2021.

M. A. Islam, B. Murray, **A. Buck**, D. T. Anderson, G. J. Scott, M. Popescu, and J. Keller, "Extending the morphological hit-or-miss transform to deep neural networks," *IEEE Transactions on Neural Networks and Learning Systems*, Oct. 2020.

A. R. Buck, D. T. Anderson, J. M. Keller, T. Wilkin, and M. A. Islam, "A weighted matrix visualization for fuzzy measures and integrals," in *2020 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, Glasgow, United Kingdom, 2020.

C. Veal, J. Schulz, **A. Buck**, D. Anderson, J. Keller, M. Popescu, G. Scott, D. Ho, and T. Wilkin, "Doing more with less: similarity neural nets and metrics for small class imbalanced data sets," in *Proc. SPIE 11418, Detection and Sensing of Mines, Explosive Objects, and Obscured Targets XXV*, 2020.

J. Schulz, C. Veal, **A. Buck**, D. Anderson, J. Keller, M. Popescu, G. Scott, D. K. C. Ho, and T. Wilkin, "Extending deep learning to new classes without retraining," in *Proc. SPIE 11418, Detection and Sensing of Mines, Explosive Objects, and Obscured Targets XXV*, 2020.

D. Anderson, M. Deardorff, T. Havens, S. Kakula, T. Wilkin, M. Islam, A. Pinar, and **A. Buck**, "Fuzzy Integral = Contextual Linear Order Statistic," arXiv:2007.02874 , 2020.

A. R. Buck and J. M. Keller, "Evaluating path costs in multi-attributed fuzzy weighted graphs," in *2019 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, New Orleans, LA, 2019.

P. Plodpradista, D. K. C. Ho, J. M. Keller, M. Popescu, and **A. Buck**, "Analyzing three-dimensional radar voxel data using the discrete Fourier transform for SAEH detection," in *Proc. SPIE 10628, Detection and Sensing of Mines, Explosive Objects, and Obscured Targets XXIII*, 2018.

A. Buck, J. M. Keller, M. Popescu, D. Sheen, and R. H. Luke, "Target detection in high-resolution 3D radar imagery," in *Proc. SPIE 10182, Detection and Sensing of Mines, Explosive Objects, and Obscured Targets XXII*, 2017.

A. R. Buck and J. M. Keller, "A myopic Monte Carlo strategy for the partially observable travelling salesman problem," in *2016 IEEE Congress on Evolutionary Computation (CEC)*, Vancouver, BC, Canada, 2016, pp. 632-639.

A. Buck, J. M. Keller, and M. Popescu, "Improving the detection of explosive hazards with LIDAR-based ground plane estimation," in *Proc. SPIE 9823, Detection and Sensing of Mines, Explosive Objects, and Obscured Targets XXI*, 2016.

A. R. Buck and J. M. Keller, "Visualizing uncertainty with fuzzy rose diagrams," in *2014 IEEE Symposium on Computational Intelligence for Engineering Solutions (CIES)*, Orlando, FL, 2014, pp. 30-36. **(Best Student Paper Award)**

A. Buck, A. Zare, J. Keller, and M. Popescu, "Endmember representation of human geography layers," in *2014 IEEE Symposium on Computational Intelligence in Big Data (CIBD)*, Orlando, FL, 2014, pp. 1-6.

J. M. Keller, **A. R. Buck**, A. Zare, and M. Popescu, "A human geospatial predictive analytics framework with application to finding medically underserved areas," in *2014 IEEE Symposium on Computational Intelligence in Big Data (CIBD)*, Orlando, FL, 2014, pp. 1-6.

A. R. Buck, T. Banerjee, and J. M. Keller, "Evolving a fuzzy goal-driven strategy for the game of Geister: An exercise in teaching computational intelligence," in *2014 IEEE Congress on Evolutionary Computation (CEC)*, Beijing, China, 2014, pp. 28-35.

A. R. Buck, J. M. Keller, and M. Popescu, "An α-Level OWA implementation of bounded rationality for fuzzy route selection," in *Advance Trends in Soft Computing (Studies in Fuzziness and Soft Computing, no. 312)*, Springer, 2014, pp. 253-260.

A. R. Buck and J. M. Keller, "A graph-based memetic approach to sketch geolocation," in *2013 IEEE Workshop on Memetic Computing (MC)*, Singapore, 2013, pp. 44-51. **(Best Paper Award)**

A. R. Buck, J. M. Keller, and M. Skubic, "A Memetic Algorithm for Matching Spatial Configurations with the Histograms of Forces," *IEEE Transactions on Evolutionary Computation*, vol. 17, no. 4, pp. 588-604, Aug. 2013.

A. R. Buck, J. M. Keller, M. Skubic, M. Detyniecki, and T. Bärecke, "Object set matching with an evolutionary algorithm," in *2011 IEEE Symposium on Computational Intelligence for Security and Defense Applications (CISDA)*, Paris, France, 2011, pp 43-50.

A. R. Buck, J. M. Keller, and M. Skubic, "A modified genetic algorithm for matching building sets with the histograms of forces," in *2010 IEEE Congress on Evolutionary Computation (CEC)*, Barcelona, Spain, 2010, pp. 1-7.

Awards & Honors

Academic Awards

- Donald K. Anderson Graduate Research Assistant Award (MU Campus) 2015-2016
- Outstanding Ph.D. Student Award (ECE Department) 2015-2016
- Outstanding Masters Student Award (ECE Department) 2011-2012
- IEEE Symposium Series on Computational Intelligence 2011 Student Travel Grant 2011

Competitions

- 1st place (Graduate division) – MU Computer Science and Information Technology Showcase 2015
- 1st place (Graduate division) – MU IEEE Computational Intelligence Society Poster Contest 2015
- 2nd place – IEEE Computational Intelligence Society Student Games Ghosts Competition 2014 2014
- 3rd place (Graduate division) – MU IEEE Computational Intelligence Society Poster Contest 2014
- 2nd place – IEEE Computational Intelligence Society Student Games Ghosts Competition 2013 2013
- 1st place (Graduate division) – MU IEEE Computational Intelligence Society Poster Contest 2011

Professional Contributions & Affiliations

Memberships

- IEEE Member 2018 to Present
- IEEE Student Member 2011 to 2018
- IEEE Computational Intelligence Society (CIS) Member 2011 to Present
- SPIE Member 2023 to Present

Conferences

- Session chair for AIPR 2023 2023
- Session chair for FUZZ-IEEE 2023 2023
- Assisted with the organization of the FUZZ-IEEE 2019 Conference 2019
- Session chair for FUZZ-IEEE 2019 2019

Journal Paper Reviews (41)

- IEEE Transactions on Artificial Intelligence (7) 2021 to Present
- IEEE Transactions on Evolutionary Computation (1) 2018
- IEEE Transactions on Fuzzy Systems (14) 2018 to Present

- IEEE Transactions on Geoscience and Remote Sensing (4) 2018 to Present
- International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems (14) 2019 to Present
- Sensors (1) 2023

Conference Paper Reviews (31)

- International Joint Conference on Neural Networks (IJCNN) (6) 2024
- IEEE International Conference on Fuzzy Systems (FUZZ-IEEE) (22) 2016 to Present
- IEEE Symposium Series on Computational Intelligence (SSCI) (3) 2021

Research Areas & Skills

Research Interests

- Computational intelligence
- Machine learning
- Multi-objective optimization
- Decision-making & uncertainty
- Intelligent agents
- Evolutionary optimization
- Fuzzy systems
- Deep learning
- Computer vision
- 3D graphics
- Data visualization
- Spatial reasoning
- Geospatial intelligence
- Robotics
- Game design

Skills

- MATLAB *Algorithms, visualization, simulations, feature detection, classifiers, etc.*
- Python *Machine learning & deep learning frameworks, web APIs, workflow automation*
- C++ *Optimized data structures and algorithms, OpenGL graphics*
- JavaScript *Web design, data analysis and visualization with D3.js*

Community Involvement

- Columbia Community Band – *Trombone player and webmaster (since 2019)* 2011 to Present
- Columbia Community Band – *Outstanding Band Member of the Year* 2021
- COMO Game Jam V Winning Team – *Best overall video game (out of 10 local submissions)* Feb. 2019
- COMO Game Jam IV Winning Team – *Best overall video game (out of 10 local submissions)* Oct. 2018