GREG FURLICH

Remote Sensing Research Scientist

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Research scientist with 8 years experience in remote sensing research. Expertise in signal and image processing; algorithm development for a variety of sensor types (EOIR, Radar, Lidar, and SAR); data fusion for object detection, tracking, and state estimation; and machine learning with images. A recognized technical talent who leads innovative research and technical development with mission design and data processing. PhD in Physics from the University of Utah with a thesis on the ultraviolet remote sensing of ultra-high energy cosmic ray interactions within in the atmosphere.

EDUCATION

Doctorate of Philosophy, *Physics*   2014 - 2020
Master of Science, *Physics*   2014 - 2018
University of Utah, Salt Lake City, UT

Bachelor of Science, *Physics*   2010 - 2014
Michigan Technological University, Houghton, MI   *Magna Cum Laude*
Minors: Mathematical Sciences and German

RESEARCH EXPERIENCE

Senior Research Scientist   Jan 2021 - Present
Lockheed Martin Space Systems,
Advanced Programs and Exploitations (APEX)

- Develop innovative algorithms which improved the efficiency and accuracy in signal and image processing for a variety of sensor types (EOIR, Radar, Lidar, and SAR). Develop data fusion algorithm for object detection, object tracking, and object state estimation.
- Design novel machine learning networks for super resolution, image-to-image translation, and style transfer with Generative Adversarial Networks (GANs), image segmentation with UNETs and FCNs, and object classification with Convolution Neural Networks (CNNs).
- Improve methods for synthetic radiometric scene generation to enhance fidelity of an optical payload simulation.
- Selected as a Recognized Technical Talent for technical contributions within first year.
- Generated intellectual property which provides technical advantage for many applications and was therefore awarded and protected as a trade secret.

Graduate Research Assistant in Cosmic Rays   2014 - 2020
Telescope Array (TA) Cosmic Ray Observatory, Institute of High Energy Astrophysics,
Department of Physics and Astronomy, University of Utah
Research Advisor: Douglas Bergman
Thesis : Observation of the GZK Suppression with the Telescope Array Fluorescence Telescopes and Deployment of the Telescope Array Expansion

- Analyzed 10 years of monocular fluorescence data to create a Cosmic Ray Energy Spectrum. Raw cosmic ray event data were analyzed by reconstructing event geometry and energy. The event information was aggregated into a large database to produce the event energy distribution. The aperture of the detectors in monocular mode was calculated through Monte Carlo thrown events over TA and simulating the response of the detectors.
- Analyzed the significance of the Greisen–Zatsepin–Kuzmin (GZK) Suppression at the highest energies of cosmic rays in the 10 year cosmic ray spectrum. Analyzed other features that give insight into cosmic ray populations or propagation effects.
- Classified weather over TA with the fluorescence detector photomultiplier tube baselines to create false color images of the detectors' field of view. Videos of these snapshots were then used as inputs in a Recurrent Convolution Neural Network (RCNN) model constructed with Keras machine learning framework to determine clear weather data for further cosmic ray analysis.
- Refurbished, tested, calibrated, and deployed the system of ultraviolet fluorescence telescopes for the TAx4 expansion. Collected first light with these new instruments.
- Analyzed the preliminary data from the new fluorescence detectors for the expansion of TA known as TAx4 into a preliminary Cosmic Ray Energy Spectrum and compared to previous results to gauge the new detector's abilities.

Project Data Analyst
2019

College of Computing, University of Utah

- Collaborated on a College of Computing PhD Candidate's thesis project by analyzing air quality data with Python and Pandas DataFrames to query, aggregate, and present data in infographical plots in a rapid fashion during face-to-face interviews with study participants.
- Aggregated outside data of local weather conditions and Air Quality Index though web application programming interfaces to give prospective to study participants about their collected home air quality data.

  Contributions are noted in:

  Exploring the Personal Informatics Analysis Gap: 'There's a Lot of Bacon', Jimmy Moore, Pascal Goffin, Jason Wiese, Miriah Meyer, IEEE Transactions on Visualization and Computer Graphics (VIS), 95-105, doi:10.1109/TVCG.2021.3114798, 2021

  An interview method for engaging personal data, Jimmy Moore, Pascal Goffin, Jason Wiese, Miriah Meyer, The Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies (IMWUT), 5(4): 1-28,doi:10.1145/3494964, 2021.

Research Assistant in Cosmic Rays
2013 - 2014

Department of Physics, Michigan Technological University

Research Advisor: Brian Fick

Senior Research Project: Preliminary Search for Exotic Events in the Auger Cosmic Ray Observatory Surface Detector Data

- Conducted a preliminary search for exotic particle events in the Pierre Auger Cosmic Ray Observatory surface detector data by identifying possible delayed development features in the cosmic ray's interaction in our atmosphere.

Research Assistant in Nanofabrication
2011 - 2012

Department of Physics, Michigan Technological University

Research Advisor: Yoke Khin Yap

- Analyzed growth parameters for Boron Nitride Nanotubes and Vertically Aligned Multi-Walled Carbon Nanotubes in a Chemical Vapor Deposition method.
- Adapted Chemical Vapor Deposition synthesis method to a scanning thermal source for greater growth yield.

KEY SKILLS

Remote Sensing: Electro-Optical and Infrared (EOIR)   Multispectral   Radar   Lidar   Synthetic Aperture Radar (SAR)   Geostationary Operational Environmental Satellite (GOES)   Sentinel   Landsat   Shuttle Radar Topography Mission (SRTM)   Multilateration (TDOA/FDOA)

Programming Languages: Python (Keras, TensorFlow, Numpy, Scipy, Pandas, Pyroot)   MATLAB   C   C++   CERN ROOT

Development Environments: Jupyter Notebooks   Linux Virtual Machines (VMs)   High Performance Computing (HPC)   Graphical Processing Unit (GPU)   Kubeflow

Miscellaneous: Strong analytic and problem solving experience, exceptional verbal and written communication skills, and collaborative finesse.

AWARDS

Recognized Technical Talent, Lockheed Martin	Selected 2021
Departmental Scholar, Department of Physics, Michigan Technological University	2013
Sigma Pi Sigma, Physics Honor Society	Inducted 2013
Michigan Space Grant Consortium Recipient	2012

PUBLICATIONS

SubPixel Localization of Objects Using Multiple Spectral Bands, M. Gupta, J. Chan, M. Krouss, G. Furlich, P. Martens, M. Chan, M. L. Comer, E. J. Delp, IEEE Aerospace Conference, 2022, *accepted*

Observation of the GZK Suppression with the Telescope Array Fluorescence Telescopes and Deployment of the Telescope Array Expansion, Greg Furlich, Thesis, University of Utah, April 2020

Constraints on the diffuse photon flux with energies above $10^{18}eV$ using the surface detector of the Telescope Array experiment, R.U. Abbasi et al. (Telescope Array Collaboration), Astropart. Phys. 110 (2019)

Testing a Reported Correlation between Arrival Directions of Ultra-high-energy Cosmic Rays and a Flux Pattern from nearby Starburst Galaxies using Telescope Array Data, R.U. Abbasi et al. (Telescope Array Collaboration), ApJ 867 2 (2018)

The Cosmic-Ray Energy Spectrum between 2 PeV and 2 EeV Observed with the TALE detector in monocular mode, R.U. Abbasi et al. (Telescope Array Collaboration), ApJ 865 74 (2018)

Evidence of Intermediate-scale Energy Spectrum Anisotropy of Cosmic Rays $E \geq 10^{19.2}eV$ with the Telescope Array Surface Detector R.U. Abbasi et al. (Telescope Array Collaboration), ApJ 862 91 (2018)

Depth of Ultra High Energy Cosmic Ray Induced Air Shower Maxima Measured by the Telescope Array Black Rock and Long Ridge FADC Fluorescence Detectors and Surface Array in Hybrid Mode, R.U. Abbasi et al. (Telescope Array Collaboration), ApJ 858 76 (2018)

Gamma-ray Showers Observed at Ground Level in Coincidence With Downward Lightning Leaders, R.U. Abbasi et al. (Telescope Array Collaboration), Journal of Geophysical Research: Atmospheres 123 (2018)

Increasing the Yield of Boron Nitride Nanotubes in a CVD Method, Greg Furlich, Michigan Space Grant Consortium, Michigan in Space 14 (2012)

PROCEEDINGS AND PRESENTATIONS

Multispectral Object Detection Algorithms, Joint Algorithm Workshop, Lockheed Martin, Orlando, Florida, April 2022

Recent measurement of the Telescope Array energy spectrum and observation of the shoulder feature in the Northern Hemisphere, D. Ivanov, D. Bergman, G. Furlich, R. Gonzalez, G. Thomson and Y. Tsunesada, Proceedings of Science 395 (ICRC2021), 341, 37th International Cosmic Ray Conference, Berlin, Germany, July 2021

Telescope Array 10-Year Monocular Spectrum, Douglas Bergman, Greg Furlich, Proceedings of Science 395 (ICRC2021), 339, 37th International Cosmic Ray Conference, Berlin, Germany, July 2021

Observation of the GZK Suppression with the Telescope Array Fluorescence Telescopes and Deployment of the Telescope Array Expansion, Thesis Defense, University of Utah, April 2020

Telescope Array FD Weather Classification using Machine Learning, Greg Furlich, Proceedings of Science (ICRC2019) 261, 36th International Cosmic Ray Conference, Madison, WI, July 2019

Towards a Telescope Array 10 Year FD Monocular Energy Spectrum, Greg Furlich, Douglas Bergman, Proceedings of Science (ICRC 2019) 260, 36th International Cosmic Ray Conference, Madison, WI, July 2019

Weather Classification using Machine Learning at the Telescope Array Cosmic Ray Observatory, APS April Meeting, Denver, CO, April 2019

Weather Classification using Machine Learning at the Telescope Array Cosmic Ray Observatory (Poster), Department of Physics and Astronomy Annual Symposium, University of Utah, Salt Lake City, UT, April 2019

Machine Learning Weather Classification with Fluorescence Detector Pedestal Data at the Telescope Array Cosmic Ray Observatory, APS Four Corners Meeting, University of Utah, Salt Lake City, UT, Oct. 2018

Machine Learning Weather Classification with Fluorescence Detector Pedestal Data at the Telescope Array Cosmic Ray Observatory, Graduate Research Seminar, University of Utah, Salt Lake City, UT, Oct. 2018

Dark Nights and Desert Air: Understanding the Highest Energy Particles in the Universe, Great Basin Astronomy Festival, Great Basin National Park, NV, Sept. 2018

TAx4 Fluorescence Detection (Poster), Physics and Astronomy Symposium, University of Utah, Salt Lake City, UT, April 2017

Hosting Your Own Website from Home with a Raspberry Pi, Graduate Research Seminar, University of Utah, Salt Lake City, UT, Oct. 2017

Once More Unto the Breach: Advice from a Physics graduate Student, Physics Seminar, Weber State University, Ogden, UT, Feb. 2017

Peer Mentoring: Training and Supporting Physics TAs at the University of Utah (Poster), AAPT Idaho-Utah Section Meeting, Pocatello, ID, April 2016

Preliminary Search for Exotic Events in the Pierre Auger Cosmic Ray Observatory Data, Physics Senior Research Oral Presentations, Michigan Technological University, Houghton, MI, April 2014

LEADERSHIP, MENTORING, AND OUTREACH

Research Mentor, Lockheed Martin
Sub-pixel localization and multispectral signal processing, Purdue University PhD Candidate	2021 - Present
Machine learning cloud segmentation in satellite imagery, United States Military Academy Cadet	2021 - Present

Academic Senate, University of Utah
Member, Graduate Assembly Ad Hoc Committee	2019

College of Science, University of Utah
Member, College of Science Council	2017 - 2018
Member, College of Science Curriculum Committee	2017 - 2018
Member, College of Science College Student Council	2017 - 2018

Department of Physics and Astronomy, University of Utah
Chair, Graduate Student Advisory Council	2017 - 2018
Member, Graduate Student Advisory Council	2015 - 2019

Science Outreach
Volunteer, Physics Open House, Weber State University	2017, 2018, 2019
Volunteer, Science Day, University of Utah	2017, 2019
Volunteer and Speaker, Great Basin Astronomy Festival, Great Basin NP	2018

Society of Physics Students, Michigan Technological University Chapter
Treasurer	2012 - 2013

MEDIA COVERAGE

Keeping the Student Voice: Student Involvement in the Tenure Process, Katelyn Collett, The Daily Utah Chronicle, May 22, 2019

Pictured in *Telescope Array TAx4 expansion work: Installation of surface particle detector begins in extreme cold* (translated), Makio Nakamura, ICRR News, 104, Winter and Spring 2019

PhD candidate sheds light on work of Millard County cosmic-ray observatory that's largest in Northern Hemisphere, Rhett Wilkinson, Millard County Chronicle Progress, Sept. 19, 2018