Curriculum Vitae

Wardeh Al-Younis

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EDUCATION

August 2021 **New Mexico State University (NMSU)**, Las Cruces, NM, USA.
Ph.D. Degree in Electrical Engineering, GPA: 3.76/4.
Dissertation Title: Measurement and Prediction of Image Displacement Due to Atmospheric Refraction.
Research Areas: Optical Communication and Imaging through atmosphere, Remote Sensing, Machine Learning.
My dissertation research focuses on studying atmospheric refraction phenomenon and its effects on optical communication and imaging for low-angle and near-ground paths within the Earth's troposphere. These effects were observed and measured experimentally and then predicted using two different approaches: Numerical Weather Prediction (NWP) and Machine Learning Algorithms.

June 2016 **Yarmouk University**, Irbid, Jordan.
Master Degree of Science in Communication Engineering, in Wireless Communication, GPA: 91.1%.
Thesis Title: Fiber Bragg Gratings: Analysis and Application to Pulse Compression.
Research Areas: Fiber-Optics Communication.
My thesis research examines the analysis of Fiber-Bragg Grating (FBG) and its applications in fiber-optics communication system. Pulse compression is one of the most significant applications of FBG that was explored in my research. FBG was chosen and utilized to compensate dispersion in communication networks among other techniques due to its low insertion losses.

August 2012 **Yarmouk University**, Irbid, Jordan.
Bachelor Degree of Science in Communication Engineering, GPA: 82.9%.

Relevant Coursework:
Signal and image processing, random signal analysis, fiber-optics communication, wireless and digital communication system, laser and applications, radiometry and photometry, introduction to optics, fundamental of photonics, statistical optics, optical system design, Fourier optics, atmospheric science, machine learning, data science, electromagnetics systems.

TECHNICAL SKILLS

Computer Languages: Python, MATLAB, C++.

Software/Hardware: Zemax, HFSS, AutoCAD, OptiGrating, Mathcad.

Other Skills: -Supervised and unsupervised Machine Learning: Linear regression models, linear discriminant functions, clustering, feed-forward neural networks, statistical pattern classification and regression, maximum likelihood, naive Bayes, non-parametric density estimation, mixture models, decision trees, and ensemble learning.
-Data visualization and analysis, statistical modeling.
-Experienced with the utilization of lab equipment such as oscilloscopes, digital multimeters, optical systems elements (such as lenses, mirrors, and laser), and function generators.

EXPERIENCE

Research Associate -Optical Communication, Artificial Intelligence, and Machine Learning Engineer, August 2021 – March 2023

New Mexico State University- Las Cruces, NM, USA

- Implemented dense optical flow algorithm using MATLAB software to characterize and quantify the motion of objects in a video stream, for motion-based object detection and tracking systems. The algorithm was applied on real images and videos

captured by our experimental mobile time-lapse camera systems deployed at various locations in NM, USA. The optical flow estimation results were used to remove the effects of well-known atmospheric physical phenomena on optical propagation and imaging such as refraction and turbulence events.
- Implemented different image deblurring algorithms using MATLAB to remove distortion from blurry images captured by our time-lapse camera system, using knowledge of how the optical system blurs a single point of light.
- Developed and implemented different advanced machine/deep learning methods based on physics-infused modeling and data-driven training to predict the effects of atmospheric refraction on images.

Research Assistant – Applied Optics Engineer, January 2017 – July 2021

New Mexico State University- Las Cruces, NM, USA

- **Radiometry and Photometry**: Experienced in radiometric and photometric computations. Spectral Signature Sensing (SSS) analysis and visualization software development was designed for radiometric analysis and modeling of radiant optical energy from a source to a detection system. Transmission through the atmosphere is computed with MODTRAN and the code features multiple-source options and a flexible set of parameters for the detector. It also provides a Google Earth display function to visualize the simulation scenario. Software calculations have been tested and compared with the existing analytical models.

- **Remote Sensing**: Detected and monitored the physical characteristics of areas by developing a special camera that collects remotely sensed images that aid in sensing things about the Earth. The camera system was developed and deployed at various deserts in NM, USA.

- **Image Processing & Computer Vision**:
    - Knowledge of image processing algorithms: encoding / decoding, image segmentation and transformation.
    - Hands-on experience with object detection, tracking, and optical flow algorithms. These were used to process the data collected from our time-lapse camera system to measure effects caused by atmospheric refraction phenomena.
    - Coursework and research interests in Computer Vision and related applications.

- **Statistics/ Machine Learning**:
    - Predictive modeling: Built a predictive linear machine learning (ML) model that can estimate effects of atmospheric refraction on images based on a set of measured metrological data.
    - Employed advanced (non-linear) ML algorithms to improve the accuracy of estimating atmospheric refraction effects by linear modeling.
    - Used statistical methods for analyzing atmospheric refractive data to better model optical propagation.

- **Optical System Design:** Used Zemax software to design and analyze imaging systems such as camera lenses, as well as illumination systems to model optical elements and coatings by performing standard sequential and non-sequential ray tracing, and physical optics beam propagation. Optimization tools were used to maximize system's performance and reduce some optical problems such as diffraction and aberration.

- **Numerical Weather Prediction (NWP):** Developed a numerical weather prediction (NWP) model which is a physics-based model for predicting atmospheric refraction phenomena effects. The numerical weather model (called the Weather Research and Forecasting – WRF model) uses initial and boundary conditions from global-scale reanalysis datasets and topographic effects to generate the refractive gradient data for a particular location at particular time corresponding. Ray tracing techniques have been applied to predict the effects.

- **Digital Communications Engineer**: Ability to handle and prioritize multiple software projects that consist of mini simulation projects of the following problems using MATLAB:
    - Simulation of bandwidth analysis and error performance of baseband modulations,
    - Bandpass modulation and demodulation techniques, and
    - Channel codes analysis and construction and studying their performance.

Teaching Assistant/Engineer -New Mexico State University, January 2018 – May 2021

New Mexico State University- Las Cruces, NM, USA

- Teaching assistant of introduction to optics lab for undergraduate students: The lab requires scientific demonstration of simple optical experiments demos including light reflection and refraction, imaging using lenses and mirrors components, polarization, refraction in prism, and diffraction phenomena.
- Teaching assistant of photonics lab for undergraduate and graduate students. The lab requires to build optical elements and systems including ray, wave and guided optics, lasers and thermal sources, radiometry, photon detection, elements of photonic crystals, polarization, acousto-optics, electro-optics, and optical nanostructures.

Trainee at Orange Company, Feb 2012 - August 2012, ~ 6 months

Orange Company- Amman/Jordan

- Position: Network and digital service engineer.
- Experienced with the utilization of telephone network components, Public Switching Telephone Network (PSTN), and Asymmetric Digital Subscriber Line (ADSL) services.
- Ability to relate problems and network failures faced by subscribers to PSTN and ADSL.
- Programming any kind of ADSL modem.
- Having excellent background about Leased line, SDSL, HDSL, SHDSL services.

COURSES

- Training Certificate: Attended training course of 30 hours at Yarmouk University in participating academic work in universities and university colleges. The course was held on May 2022 and included the following topics:
  1. Teaching and Learning,
  2. Using Modern Teaching Methods,
  3. Educational Technology, and
  4. Open Sources E-Learning Platforms.
- Granted a work license certificate from the higher education, Jordan.

PROJECTS

- Physics Based Modeling Tool for Hostile Fire Spectral Signatures Sensing at Range and through Atmospheric Attenuation project supported by the US Army Research Laboratory through Contract W911QX-15-D-0022 with New Mexico State University (Physical Science Laboratory).
- Novel Characterization Measurements and Meteorological-Driven Modeling of Turbulence and Refraction in the Lower Atmosphere for Directed Energy Applications supported by the Directed Energy Joint Transition Office; Award No. N00014-17-1-2535.

MEMBERSHIP

- Active member of the International Society for Optics and Photonics (SPIE).
- Active member of Optica (formerly known as The Optical Society of America (OSA)).

HONORS & AWARDS

- A scholarship to peruse MSc degree at Yarmouk University, Jordan, 2013-2015. (Sponsor: The Ministry of Higher Education and Scientific Research, Jordan).

Publications

1. W. Al-Younis, S. Sandoval, and D. Voelz, "A Physics-guided Neural Network to Predict the Effects of Atmospheric Refraction." Is currently in preparation to be submitted in optics continuum journal.

2. W. Al-Younis and D. Voelz, "Correction and Analysis of Turbulence Effects in Time- Lapse Images Using Optical Flow Registration." to be presented in Optica Imaging Congress, 2023.

3. W. Al-Younis, S. Sandoval, D. Voelz, and M. Abdullah-Al-Mamun, “A Physics-Guided Machine Learning Model for the Prediction of Atmospheric Refraction,” In *Propagation Through and Characterization of Atmospheric and Oceanic Phenomena*, pp. PTh4F-4. Optica Publishing Group, 2022.

4. W. Al-Younis, S. Sandoval, D. Voelz, and P. Miller, “Extended Analysis of Atmospheric Refraction Effects Captured by Time-Lapse Imaging: Long-Term Trends and Machine Learning Image Shift Prediction,” presented in *Proc. SPIE*, *Laser Communication and Propagation through the Atmosphere and Oceans X 2021*, 11834-1 (August 2021).

5. M. Abdullah-Al-Mamun, W. Al-Younis, E. Wijerathna, and D. Voelz, “Beam Trajectory Studies of Diurnal Refraction Effects for a Near-Ground Path involving Numerical Weather Prediction and Time-Lapse Imaging Measurements,” presented in *Proc. SPIE*, *Laser Communication and Propagation through the Atmosphere and Oceans X 2021*, 11834-1 (August 2021).

6. W. Al-Younis, C. Nevarez, M. Abdullah-Al-Mamun D. Voelz, S. Sandoval, and S. Basu, "Image Shift Due to Atmospheric Refraction: Prediction by Numerical Weather Modeling and Machine Learning”. *Opt. Eng*. 59(8), 2020.

7. W. Al-Younis, C. Nevarez, D. Voelz, S. Sandoval, and S. Basu, "Predicting atmospheric refraction with weather modeling and machine learning", *Proc. SPIE 11133, Laser Communication and Propagation through the Atmosphere and Oceans VIII*, 111330E (6 September 2019).

8. W. Al-Younis, C. Nevarez, and D. Voelz, "Time-lapse Imaging for Studying Atmospheric Refraction: Measurements with Natural Targets," *IEEE Aerospace Conference,* Big Sky, MT, USA, 2019.

9. W. Al-Younis and M. Bataineh, "Pulse compression using Fiber Bragg gratings," *2017 4th International Conference on Electrical and Electronic Engineering (ICEEE),* Ankara, 2017.
