Gukyeong Kwon

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SUMMARY

I am an Applied Scientist at Amazon Web Services (AWS) AI Labs. My research interests are machine learning and computer vision. Recently, I have primarily focused on anomaly detection, zero-shot learning, and multi-modal representation learning for vision and language.

EDUCATION

Georgia Institute of Technology — Atlanta, GA

Ph.D. in Electrical and Computer Engineering (Advisor: Dr. Ghassan AlRegib) — *August 2015 – August 2021*

M.S. in Electrical and Computer Engineering (GPA: 4.0/4.0) — *August 2015 – May 2018*

Sungkyunkwan University (SKKU) — Suwon, South Korea

B.S. in Electronic and Electrical Engineering (GPA: 4.29/4.5) — *March 2009 – August 2015*

RESEARCH AND PROFESSIONAL EXPERIENCE

Applied Scientist (*Mentor: Avinash Ravichandran*) — AWS AI Labs, New York, NY

- **AI-powered Search Services** — *January 2021 – Present*
  - Develop AI systems that understand vision and language.

Applied Scientist Intern (*Mentor: Zhiguo Wang*) — AWS AI Labs, New York, NY

- **Multimodal Representation Learning for Vision and Language** — *May 2020 – August 2020*
  - Developed regularization techniques to minimize the modality gap between vision and language.
  - Two-stream BERT models with the developed regularization techniques achieved improved performance over baselines by 1.9% in visual question answering, 2.9% in image retrieval, and 5.2% in referring expressions tasks.

Deep Learning Research Intern (*Mentor: Jin Woo Jung*) — Panasonic Automotive, Atlanta, GA

- **Vision-Based Driver's Misbehavior Detection** — *May 2018 – July 2018*
  - Developed driver's misbehavior detection algorithms using deep learning-based pose estimation (OpenPose) and hand detection algorithms for autonomous vehicles using Tensorflow.
  - Improved computational time for the hand detection algorithm from 0.35 ms to 11 μs (99.97% ↑) using Caffe and C++ on NVIDIA GTX 1080 Ti and showcased developed algorithms in the Ford Tech Expo 2018.

Graduate Research Assistant (*Advisor: Dr. Ghassan AlRegib*) — Georgia Tech, Atlanta, GA

- **Anomaly Detection Using Neural Networks** — *August 2018 – August 2021*
  - Proposed a gradient-based representation for characterizing knowledge that deep networks have not learned during training to ensure the robustness of deep networks.
  - Developed an anomaly detection algorithm based on the gradient-based representation and achieved state-of-the-art performance in MNIST, fMNIST, CIFAR-10 with an average AUROC of 0.934, 0.973, and 0.664, respectively.
  - Developed an accident event detection algorithm to detect abnormal situations in driving scenarios such as a pedestrian jumping in front of a car or a bumper of car in the middle of the road.
  - Incorporated out-of-distribution detection into Faster-RCNN to detect abnormal objects on the road.

- **Robust Visual Understanding Under Challenging Conditions** — *September 2017 – December 2017*
  - Introduced a large-scale (>2,000,000 images) traffic sign recognition dataset (CURE-TSR) which is among the most comprehensive datasets with controlled synthetic challenging conditions such as rain, snow, and haze.
  - Benchmarked the robustness of data-driven algorithms and analyzed shortcomings using PyTorch.

- **Perceptual Video Quality Assessment** — *August 2016 – August 2017*
  - Analyzed the 3D power spectral density (PSD) of videos to understand how human visual system is affected by various types and levels of distortions such as compression artifacts and packet loss.
  - Developed a perceptual video quality assessment (VQA) metric which achieved the state-of-the-art performance.

PUBLICATIONS

- <u>G. Kwon</u> and G. AlRegib, "A Gating Model for Bias Calibration in Generalized Zero-shot Learning," in *IEEE Transactions on Image Processing,* 2022. [arXiv] [GitHub]

- <u>G. Kwon</u>, M. Prabhushankar, D. Temel and G. AlRegib, "Backpropagated Gradient Representations for Anomaly Detection," In *Proceedings of the the European Conference on Computer Vision (ECCV),* 2020. [arXiv] [GitHub] [Video] [Slides]

- <u>G. Kwon</u>, M. Prabhushankar, D. Temel and G. AlRegib, "Novelty Detection Through Model-based Characterization of Neural Networks," *2020 IEEE International Conference on Image Processing (ICIP),* Abu Dhabi, United Arab Emirates (UAE), 2020. [arXiv] [GitHub] [Video] [Slides]

- <u>G. Kwon</u>*, M. Prabhushankar*, D. Temel and G. AlRegib, "Distorted Representation Space Characterization Through Backpropagated Gradients," *2019 IEEE International Conference on Image Processing (ICIP), Taipei, Taiwan, 2019.* (*: equal contribution, ***Best Paper Award (top 0.1%)***) [arXiv] [GitHub] [Poster] [Award]

- M. Prabhushankar, <u>G. Kwon</u>, D. Temel and G. AlRegib, "Contrastive Explanations in Neural Networks," *2020 IEEE International Conference on Image Processing (ICIP),* Abu Dhabi, United Arab Emirates (UAE), 2020. (***Top Viewed Special Session Paper Award***) [arXiv] [GitHub] [Slides] [Award]

- M. Prabhushankar*, <u>G. Kwon</u>*, D. Temel and G. AlRegib, "Semantically Interpretable and Controllable Filter Sets," *2018 IEEE International Conference on Image Processing (ICIP),* Athens, Greece, October 2018. (*: equal contribution) [arXiv] [GitHub] [Poster]

- D. Temel, <u>G. Kwon</u>*, M. Prabhushankar*, and G. AlRegib, "CURE-TSR: Challenging Unreal and Real Environments for Traffic Sign Recognition," *MLITS workshop in Neural Information Processing Systems (NIPS),* Long Beach, U.S.A, 2017. (*: equal contribution) [arXiv] [GitHub] [Poster]

- M. Aabed, <u>G. Kwon</u>, and G. AlRegib, "Power of Tempospatially Unified Spectral Density for Perceptual Video Quality Assessment," *2017 IEEE International Conference on Multimedia and Expo (ICME), Hong Kong, 2017.* (***Finalist of the World's FIRST 10K Best Paper Award (top 3%)***) [arXiv] [GitHub] [Slides] [Award]

PATENTS

Non-provisional Patent

- G. AlRegib, <u>G. Kwon</u>, M. Prabhushankar, and D. Temel, "Detecting and Classifying Anomalies in Artificial Intelligence Systems," filed on September 4, 2020.

Provisional Patents

- G. AlRegib, M. Prabhushankar, <u>G. Kwon</u>, and D. Temel, "System and Method for Detecting and Protecting Against Deceptive Inputs for AI Systems and Measuring Vulnerabilities of Existing AI Systems," No: 62/899,783, granted on September 13, 2019.

- G. AlRegib, <u>G. Kwon</u>, M. Prabhushankar, and D. Temel, "Task-Generalizable System and Method for Detecting and Classifying Anomalies in Artificial Intelligence Systems," No: 62/895,556, granted on September 4, 2019.

PROGRAMMING SKILLS

- **Languages**: Python, C/C++, MATLAB   **Machine Learning Framework**: PyTorch, Tensorflow, Caffe

PROFESSIONAL SERVICES

- Reviewer for IEEE Transactions on Image Processing.
- Reviewer for Elsevier Signal processing: Image Communication.
- Reviewer for IEEE International Conference on Image Processing.
- Reviewer for IEEE International Conference on Acoustics, Speech and Signal processing.