Jeong Min Kong

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Introduction

- Birth Date: December 7th, 1998
- Place of Birth: **Republic of Korea**
- Nationality: **Canada**

Education

- **University of Toronto - MASc Electrical Engineering** 2022-2024
  -Advisor: Professor Elvino Sousa.
  -Affiliation: Communications Group.
- **University of Toronto** - **BASc Electrical and Computer Engineering** 2016 - 2022
  -Majoring in Communications, Signal Processing, and Photonics.
- **Regiopolis-Notre Dame Catholic Secondary School** - OSSD 2012 - 2016

Position

- **Research Assistant** - Department of Mathematics, University of Toronto 2021/5 - 2021/8
  Advisor: Professor **Adrian Nachman**
- **Research Intern** - Huawei Mathematical and Algorithmic Sciences Lab 2020/5 - 2021/4
  Advisor: Professor **Merouane Debbah** and Professor **George Alexandropoulos**
- **Research Assistant** - Department of ECE, University of Manitoba 2019/9 - 2020/4
  Advisor: Professor **Ekram Hossain**
- **Research Student** - Department of Physics, The University of Tokyo and RIKEN 2018/11 - 2019/2
  Advisor: Professor **Kathrin Wimmer**
- **Research Assistant** - Department of ECE, University of Toronto and TELUS 2018/5 - 2018/9
  Advisor: Professor **Raviraj Adve**

Interest

- Communication theory, information theory, machine learning.

Research

- **Evaluating the Performance of New WGAN-GP With Modified Gradient Penalty**
  Professor Adrian Nachman | University of Toronto 2021/5 - 2021/8
  Graduate researcher of Professor Nachman proposed that his version of WGAN-GP, with a new gradient penalty, would result in better convergence and stability than the original WGAN-GP, especially when the training dataset is primarily composed of low-contrast images. We devised the code for this new WGAN-GP model using PyTorch, and trained this WGAN-GP & original WGAN-GP on MNIST and Fashion-MNIST datasets under various circumstances, such as various image contrast level, learning rate of the critic and the generator, etc, to 1) examine the validity of this hypothesis, and 2) better understand under which settings the new WGAN-GP performs significantly better than the original WGAN-GP. Research is still ongoing. Prior to the commencement of this project, I learned the basics of Optimal Transport Theory, and the mathematics behind diverse generative models, such as VAE, GAN, WGAN, and WGAN-GP, as well as other widely-used deep learning architectures, such as CNN and RNN.
- **Simulation Software for Jointly Optimizing Reconfigurable Intelligent Surface (RIS) Position and Configurations in Various 3-Dimensional Environments**
  Professor Merouane Debbah and Professor George Alexandropoulos | Huawei 2020/5 - 2021/4
  One of the most promising technologies in 6G is expected to be Reconfigurable Intelligent Surface (RIS). RIS consists of many passive elements that behave like antennas, and each of these small elements are able to execute distinct capabilities that metasurface possesses, like manipulate phase, wavelength, power, and angle of the reflecting signals. Such unique abilities of RIS will make it possible to control the signal propagation environment for the first time ever, and this groundbreaking technology is expected to improve and resolve many of the problems facing today's 4G and 5G communication systems, especially the bandwidth and energy

efficiency issues, which are projected to worsen at an accelerating rate due to the rapid advancements of technologies like IoT and autonomous vehicles. Given this powerful tool, it becomes extremely important to ask: where should they be placed, and what should their configurations be such that received power and SNR are maximized? Using recently published RIS channel model as the basis, we have developed an RIS-assisted communication simulation software (with GUI) which allows researchers to design and examine diverse simulation environments that satisfy the constraints of their RIS-associated research problem. By conducting many simulations under various appropriate settings, optimal number of RISs, position and plane of the RISs, and configurations of the RISs (ex. size, element number, gain, etc) that maximizes the received power and SNR can be determined. Latest simulation results were discussed at IEEE PIMRC 2020 RIS Tutorial and IEEE Globecom 2020 RIS Tutorial.

- **UAV and Intelligent Reflecting Surface (IRS) Assisted Large Scale Wireless Networks Simulation Software for 6G Research**
  Professor Ekram Hossain | University of Manitoba 2019/9 - 2020/4
  By the next decade, there are expected to be over 40 billion devices that rely on connection, and such mass demand for connectivity will require careful examination of spectrum and energy efficiency problems in today's wireless communication systems. 5G addresses such issues by utilizing frequencies in the mmWave spectrum and deploying systems like Massive MIMO, but 6G aims to further enhance the overall communication system performance by incorporating new technologies like UAVs, which are highly mobile, and Intelligent Reflecting Surfaces (IRSs), which will make it possible to intelligently control signal propagation environments through its abilities to adjust phase, wavelength, power and angle of the reflecting signal. Over the past few months, there have been many published papers that outline the improvement in SNR at the receiver through the deployment of UAVs and IRSs, but even though these studies showed outstanding results, they did not account for the interference signals coming from the transmitters in the adjacent cells, and thus the SINR, which is a more accurate performance measurement. We developed a more realistic UAV, IRS, as well as UAV & IRS integrated communication simulation program that considers the presence of multiple cell towers, UAV transmitters, user terminals, and ground-based IRSs in a group of Voronoi cells, to ultimately examine how SINR at each cell tower vary under diverse simulation conditions. Together with machine learning, this simulation program will be used to tackle various optimization problems. Project report is available upon request.
- **Discovery of β- Decay in the Isomer Investigated at ISOLDE Facility, CERN**
  Professor Kathrin Wimmer | The University of Tokyo 2018/11 - 2019/2
  The final report is currently under review by collaborators in Germany before submitting for publication. Specific details will be added once the results are published. Will be the lead author of the paper.
- **Optical Photon Time Tracking Simulation Software for Future Gamma Spectroscopy Experiments Using GAGG Scintillator**
  Professor Kathrin Wimmer | The University of Tokyo and RIKEN 2018/11 - 2019/2
  In gamma spectroscopy experiments, which is a popular method used for understanding many mysteries underlying nuclear structures, scintillator efficiency and arrangement are extremely important factors to consider as only a short amount of time is available to conduct experiments due to the restricted use of large particle colliders. From the efficiency view, GAGG has been verified to be an excellent scintillation material candidate because it has very high density compared to the formerly used materials such as NaI and CsI. However, due to the lack of simulation programs available, it was previously very difficult to determine which GAGG scintillator design especially yield the best time resolution. We contributed in modelling the best time resolution GAGG scintillator design for future exotic nuclei experiments at RIBF Facility at RIKEN by developing an algorithm that is capable of accurately measuring the times of over 1 million photocathode-detected optical photons with the consideration of complex combinations of physics phenomena, successfully implementing it using GEANT4, and visualizing the results for time resolution measurements using ROOT. Project report is available upon request.
- **Exploring the Relationship Between Gamma PDF and Cellular Data Rates at Microwave Frequencies**
  Professor Raviraj Adve | University of Toronto 2018/5 - 2018/9
  Researchers have recently made an observation that cellular data rates at microwave frequencies can be very well modelled with Gamma probability density function under diverse conditions. We further contributed in better understanding this phenomenon by conducting simulations of various scenarios using the Python 4G/5G wireless coverage simulation program, and ultimately presenting new mathematical relationships between the shape and scale parameters of the Gamma pdf and the simulation parameters. Presented the results to the Principal Technology Architect from TELUS. Project report is available upon request.
- **5G (mmWave) Wireless Coverage Simulation Software for Efficient Network Planning**
  Professor Raviraj Adve | University of Toronto and TELUS 2018/5 - 2018/9

5G promises to make communication extremely fast, and one way it aims to accomplish this is by utilizing the mmWave spectrum. Researchers are currently working on solving many problems surrounding the mmWave concept, one being signals not being able to propagate long distances due to their high-attenuation property. One possible way to solve this issue is by having short relay hops, but without careful planning, this method could become very costly as it requires many transceivers. We helped researchers at TELUS develop efficient mmWave transceiver placement plans by building them a mmWave wireless coverage design & analysis simulation software program with GUI using Python. Project report is available upon request.

Reference

- **Professor Adrian Nachman**, University of Toronto: nachman@math.toronto.edu
- **Professor Merouane Debbah**, TII, Huawei, CentraleSupelec: merouane.debbah@tii.ae
- **Professor George Alexandropoulos**, University of Athens: alexandg@ieee.org
- **Professor Ekram Hossain**, University of Manitoba: ekram.hossain@umanitoba.ca
- **Professor Kathrin Wimmer**, GSI: k.wimmer@gsi.de
- **Professor Raviraj Adve**, University of Toronto: rsadve@ece.utoronto.ca

Skill

- **Multilingual** English, Korean.
- **Laboratory** Developing simulation program, performing data analysis, mathematical modelling.
- **Computing** Python, C++, C, MATLAB, Simulink, Julia, OptiWave, GEANT4, ROOT, Assembly (Elementary), HTML, CSS, LaTeX, Excel.
- **Library** NumPy, SciPy, Matplotlib, Tkinter, Pandas, PyTorch.
- **Coursework** Communication Systems, Digital Communications, Wireless Communications/Advanced Cellular Systems, Optical Communications and Networks, Multimedia Systems, Signals and Systems, Optics, Fields and Waves, Electric and Magnetic Fields, Quantum and Semiconductor Physics, Algorithms and Data Structures, Medical Imaging, Multivariable and Vector Calculus, Complex Analysis, Probability Theory and Applications, Differential Equations, Linear Algebra, Engineering Economics.

Other Position

- **Summer Orientation Teacher** - Algonquin & Lakeshore Catholic District School Board 2016 - 2017
  Introduced concepts in grade 9 mathematics and literacy to approximately 120 incoming secondary school students during the final week of August.
- **Dishwasher & Cleaner** - Cactus Club Cafe 2018 - 2018
  Dishwashed through lunch and early dinner hours, and cleaned the floor and the stairs. The income was used to additionally financially support the internship in Japan.

Honor

- **2nd Place, Microsoft College Team Coding Competition**, University of Toronto (2017)
- **President's Scholarship**, University of Toronto (2016)
- **Mary Alice Murray Scholarship**, City of Kingston (2016)
- **Research Assistant Fellowship**, Nobel Laureate in Physics Professor Theodor Haensch's Group at Max Planck Institute of Quantum Optics (2019) (Declined due to Visa issue)