Juhyung Lee

[Linkedin] [Github] [Google Scholar] [Website]

Email: juhyung.lee@usc.edu
Mobile: +1-213-245-9356

Research Interests

- Wireless communication systems
- AI for PHY/MAC layer and network optimization
- Protocol design for LEO satellite networks

Experience

- **University of Southern California** — Los Angeles, USA
  Postdoctoral Researcher, Wireless Devices and Systems Group (Head: Prof. Andreas Molisch) — *Apr. 2022 - Present*

  ML-based Radio Map Prediction [Github]
  - Developed an ML-based city map-scale channel (pathloss) prediction framework [1, 2]
  - Built a network optimization system for automatic base station deployment and beam management, based on the developed large-scale channel predictions (*e.g.*, Digital Twin)

  On-Device AI Communication [Github]
  - Implemented a pre-trained language model (`BART`) into a 5G-NR compatible link-level simulator (`NVIDIA Sionna`), using Natural Language Processing (NLP) techniques [3, 4]
  - Designed and demonstrated an effective approach for enhancing on-device LLM communication in 5G-NR settings.

- **Samsung Research America** — Dallas, USA
  AI/Wireless Senior Research Engineer — *Dec. 2023 - Jan. 2024 (Seasonal)*

  NR-MIMO Channel Estimation/Prediction
  - Implemented generative model-based channel estimation/prediction framework

- **Korea University** — Seoul, Korea
  Research Professor, Research Institute for Information & Communication — *Sep. 2021 - Feb. 2023*

  PHY/MAC Protocol Design for LEO Satellite Networks
  - Designed a contention-based random access protocol for LEO satellite networks, using satellite positional information (*e.g.*, GNSS data and orbital patterns) [5]
  - Designed a 3GPP-compatible handover protocol for LEO satellites using Deep Reinforcement Learning (DRL) [6]

Skills

- **Programming**: Python, C/C++, CUDA C++, MATLAB, Verilog, Labview
- **ML Methodologies**: Generative Model (`DDPM, GAN, VQ-VAE`), Language Model (`BART`), Computer Vision (`DeepLapV3+, UNet, CNN`), Time Series (`Transformer, RNN`), Reinforcement (`PPO, A3C, DQN`)
- **Tool & Library**: ML (`Pytorch, Tensorflow`), Link (System)-Level Simul. (`NVIDIA Sionna, MATLAB-5G`), Ray-Tracing (`WirelessInSite, Sionna-RT`), GIS (`OpenStreetMap`)
- **HW**: USRP, FPGA

Education

- **Korea University** — Seoul, Korea
  Ph.D. in Electrical and Computer Eng. (Awarded by Research Excellence) — *Mar. 2016 – Aug. 2021*
  - **Optimization of NTN:** Developed a routing protocol [7] and an resource allocation algorithm [8] for NTN
  - [**Demo**] **Radio-over-FSO (RoFSO):** Built a RoFSO system, integrating 802.11 RF system and laser-based optical transceivers; Demonstrated the RoFSO system in high-speed (*e.g.*, Gbps) transmission [9]

- **Korea University** — Seoul, Korea
  B. Eng. in Electrical and Electronic Eng. (National Sci. & Tech. Scholarship - Full Tuition) — *Mar. 2011 – Feb. 2016*

Projects

- **AI for Site-Specific Radio Propagation Modeling in mmWave/THz Communications**
  - Built a channel measurement dataset using ray-tracing simulations (`WirelessInsite`) on real maps (*e.g.*, USC, UCLA, and Boston area)
  - Designed a supervised-learning framework, using Computer Vision techniques, to predict radio maps [1]
  - **1st-rank** in ML competition (*IEEE ICASSP Radio-Map Prediction Challenge* [2]), achieving the highest accuracy
  - Developed a transfer learning method to adapt models to new, unseen network scenarios
- **Integrating Pre-Trained Language Model on PHY Communications**
  - Built a framework integrating language model (`BART`) with link-level simulator (`NVIDIA Sionna`), utilizing a compression technique (`VQ-VAE`)
  - Demonstrated the framework in realistic 5G-NR communication scenario (Modules: LDPC/Polar Coding, QAM, OFDM, and MIMO; Channels: 3GPP CDL-{A∼E}) [4]
- **DRL-based PHY/MAC Protocol Design**
  - Designed radio resource scheduling, initial access [5], and handover [6] protocols for LEO satellite networks
  - Designed beam management for mmWave Vehicle-to-Infrastructure (V2I) networks [10]

Honors and Awards

- 1st-Rank, *IEEE ICASSP Signal Processing Grand Challenges*, Jun. 2023 [2]
- Best Paper Award, *IEEE ICTC*, Oct. 2022
- Best Paper Award, *IEEE ICTC*, Oct. 2021
- Grand Prize, *Graduate Research Excellence Award*, Korea University, Feb. 2021
- Travel Grant, *IEEE GLOBECOM*, Dec. 2020;
- Bronze Prize, *IEEE Seoul Section Student Paper Award*, Dec. 2020
- Best Paper Award, *Korea Institute of Commun., and Info. Sciences*, Feb. 2020
- Full Tuition Scholarship (B. Eng.), *National Science & Technology Scholarship*, Korea, 2011

Patents

- [USA #2 - pending] **J.-H. Lee** and Y.-C. Ko, "Deep reinforcement learning-based random access method for low earth orbit satellite network and terminal for the operation", US20230189353A1 (06/15/2023)
- [USA #1 - pending] J.-M. Kim, **J.-H. Lee**, and Y.-C. Ko, "Apparatus based on wireless optical communication", US20230083544A1 (03/16/2022)
- [Korea #3] B.-H. Lee, **J.-H. Lee**, and Y.-C. Ko, "Minimum transmission rate maximization using power control and association in ground base station-to-UAV communication", 10-2508442 (03/06/2023)
- [Korea #2] J.-M. Kim, **J.-H. Lee**, and Y.-C. Ko, "Apparatus based on wireless optical communication", 10-2506809 (03/02/2023)
- [Korea #1] **J.-H. Lee**, J. Lee, "Method and apparatus for uploading or downloading file based on tag," 10-2014-0128406 (01/26/2016)

Professional References

- **Prof. Andreas F. Molisch** : Professor (IEEE Fellow, AAAS Fellow), University of Southern California, molisch@usc.edu
- **Dr. Hao Chen** : Manager, Samsung Research America, hao.chen1@samsung.com
- **Prof. Young-Chai Ko** : Professor, Korea University, koyc@korea.ac.kr

Selected Publications (Link for Full-List)

[1] J.-H. Lee and A. F. Molisch, "A scalable and generalizable pathloss map prediction," *arXiv preprint arXiv:2312.03950*, 2024. [**paper**] [**code**].

[2] J.-H. Lee, A. F. Molisch, and et al., "PMNet: Large-scale channel prediction system for radio map prediction challenge," in *IEEE International Conf. on Acoustics, Speech and Signal Processing (ICASSP)*, Jun. 2023. [**1st-Rank in ML Competition**] [**code**].

[3] J.-H. Lee, D.-H. Lee, J. Lee, and J. Pujara, "Integrating pre-trained language model with physical layer communications," *arXiv preprint arXiv:2402.11656*, 2024. [**paper**] [**code**].

[4] J.-H. Lee, D.-H. Lee, E. Sheen, T. Choi, and J. Pujara, "Seq2seq-sc: End-to-end semantic communication systems with pre-trained language model," in *Asilomar Conf. on Signals, Systems, and Computers*, pp. 1–4, 2023. [**paper**] [**code**].

[5] J.-H. Lee, H. Seo, J. Park, M. Bennis, and Y.-C. Ko, "Learning emergent random access protocol for LEO satellite networks," *IEEE Trans. Wireless Commun.*, vol. 22, no. 1, pp. 257–269, 2023. [**paper**].

[6] J.-H. Lee, A. F. Molisch, and et al., "Handover protocol learning for LEO satellite networks: Access delay and collision minimization," *IEEE Trans. Wireless Commun.*, 2024. [**paper**].

[7] J.-H. Lee, J. Park, M. Bennis, and Y.-C. Ko, "Integrating LEO satellites and multi-UAV reinforcement learning for hybrid FSO/RF non-terrestrial networks," *IEEE Trans. Veh. Technol.*, pp. 1–16, 2022.

[8] J.-H. Lee, K.-H. Park, Y.-C. Ko, and M.-S. Alouini, "Spectral-efficient network design for high-altitude platform station networks with mixed rf/fso system," *IEEE Trans. Wireless Commun.*, vol. 21, no. 9, pp. 7072–7087, 2022.

[9] J.-M. Kim, J.-H. Lee, and et al., "Experimental demonstration of RoFSO transmission combining WLAN standard and WDM-FSO over 100m distance," in *IEEE Conf. on Comput. Commun. Workshop (INFOCOM-Demo)*, May 2022. **[Demo]**.

[10] Y. Lee, J.-H. Lee, and Y.-C. Ko, "Beamforming optimization for IRS-assisted mmWave V2I communication systems via reinforcement learning," *IEEE Access*, Jun. 2022.