Hui CHEN

Postdoctoral Researcher · Electrical Engineering

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Research Interests

- **5G/6G Radio Localization**: 6D localization; mmWave/THz; near-field; beam squint; hardware impairment; mobility.
- **RIS-Aided Localization**: sidelink positioning; calibration; layout optimization; profile design; multi-static sensing.
- **ML for Signal Processing**: learning-based localization; stochastic optimization; human-machine interaction.

Professional Experience

Chalmers University of Technology (CTH) *Gothenburg, Sweden*

Postdoctoral Researcher | Supervisor: Prof. Henk Wymeersch *Aug. 2021 - Present*

- **Hexa-X** (A Flagship for B5G/6G Vision and Intelligent Fabric of Technology Enablers) (**European Project** | 08/21-Present)
- **RISE-6G** (Reconfigurable Intelligent Sustainable Environments for 6G Wireless Networks) (**European Project** | 08/22-Present)
- **5GPOS** (5G Cellular Positioning for Vehicular Safety) (**Swedish Project** | 11/21-06/22)

NEOM Smart City *Riyadh, Saudi Arabia*

Mixed Reality Developer (Internship) | Supervisor: Dr. Andrew Yip *Mar. 2020 - Apr. 2020*

- **VR Kitchen** (Virtual Kitchen Simulator for virtual agent training (VR) and smart glass (AR))

Education

King Abdullah University of Science and Technology (KAUST) *Thuwal, Saudi Arabia*

Ph.D. Electrical & Computer Engineering | Supervisor: Prof. Tareq Al-Naffouri *2016.08 - 2021.08*

- Thesis: Stochastic Optimization in Target Positioning and Location-based Applications
- KAUST Fellowship

University of Chinese Academy of Sciences (UCAS) *Beijing, China*

M.S. Computer Application Technology *2013.09 - 2016.07*

- Recommended for Direct Admission without Exams

Beijing Forestry University *Beijing, China*

B.S. Electrical Engineering *2009.09 - 2013.07*

- National Scholarship (Three Times), Outstanding Graduate of Beijing

Research Experience

5G/6G Localization and Sensing ***Chalmers, Gothenburg, Sweden***

Postdoctoral Researcher *Aug. 2021 - Present*

- RIS-aided localization: Multi-RIS-enabled sidelink positioning; zero-BS cooperative localization; joint RIS calibration and UE localization; dual polarization; algorithm design, performance evaluation, and localizability analysis.
- Learning-based Localization: ML/DL methods for challenging resource allocation and localization scenarios (e.g., RIS-enabled sidelink positioning, near-field localization, model mismatch mitigation).
- Localization under hardware impairments (HWI): Signal modeling with HWI (e.g., phase noise, IQ imbalance, PA nonlinearity); performance analysis using MCRB; localization and sensing algorithms design with hardware impairment mitigation.
- Doppler-assisted localization and sensing: Problem formulation & performance analysis to show the benefit of UE mobility; channel estimation & localization algorithm design.
- Array and BS layout optimization: 3D array design and BS layout optimization to improve coverage at high-frequency communication systems.
- Onsite 5G Positioning Experiments: Data collection and processing using Ericsson 5G base station (Tx) and Silvers mmWave board (Rx) for vehicular positioning (5GPOS project).

Terahertz-band Signal Localization (THz Localization) for 6G Systems ***ISL, KAUST, Thuwal, Saudi Arabia***

Main Researcher *Oct. 2020 - Aug. 2021*

- Developed THz signal channel model and analyzed the effect of THz-specific features (e.g., misalignment, near-field model, beam split/squint effect).
- Provided a detailed tutorial on localization performance analysis using CRB/PCRB/CCRB/MCRB (for LOS, RIS, and NLOS channels) and formulated localization coverage for system optimization.
- Surveyed localization and tracking algorithms with the concepts of array-of-subarray (AOSA) structure.
- Evaluated the localization performance of mmWave/THz systems, discussed lessons learned, and provided future directions.

Stochastic Optimization in Target Positioning and Location-based Applications ***KAUST, Thuwal, Saudi Arabia***

Main Researcher (Ph.D. Thesis) *Aug. 2016 - Aug. 2021*

- Analyzed performance and designed algorithm for joint TDOA/PDOA localization.
- Designed DOA estimation and text classification algorithms for a real-time ultrasonic air-writing system.
- Designed greedy and deep learning (DL)-based antenna selection algorithms for switch-based MIMO systems.
- Designed and tested signals/algorithms for a real-time ultrasonic indoor localization system.

FPGA-based Time-to-Digital Converter ***UCAS, Beijing, China***

Research Assistant (M.S. Thesis) *Sep. 2014 - June. 2016*

- Designed a digital circuit to measure the time (60ps resolution) between two rising edges of a signal based on Virtex-5 FPGA.
- Developed a user interface using C# language running on Windows OS.

Publications

Ongoing Works

[*J19] P. Zheng, **H. Chen**, T. Ballal, M. Valkama, H. Wymeersch and T.Y. Al-Naffouri. "JrCUP: Joint RIS Calibration and User Positioning for 6G Wireless Systems." [In preparation for IEEE Transactions on Wireless Communications, *draft available*]

[*J18] M. Ammous, **H. Chen**, H. Wymeersch and S. Valaee. "Zero Access Points 3D Cooperative Sidelink Positioning via Reconfigurable Intelligent Surface." [In preparation for IEEE Transactions on Mobile Computing, *draft available*]

[*J17] **H. Chen**, M.F. Keskin, S. Aghdam, H. Kim, S. Lindberg, A. Wolfgang, T.E. Abrudan, T. Eriksson, and H. Wymeersch. "Modeling and Analysis of 5G/6G Localization under Hardware Impairments." [Submitted to IEEE Transactions on Wireless Communication, *arXiv available*, Mar. 2023]

[*J16] **H. Chen**, P. Zheng, M.F. Keskin, T.Y. Al-Naffouri and H. Wymeersch. "Multi-RIS-Enabled 3D Sidelink Positioning." [Submitted to IEEE Journal of Selected Areas in Communications, *arXiv available*, Feb. 2023]

[*J15] Y. Ge, H. Khosravi, F. Jiang, **H. Chen**, S. Lindberg, P. Hammarberg, H. Kim, O. Brunnegard, O. Eriksson, B.E. Olsson, F. Tufvesson, L. Svensson, and H. Wymeersch. "Experimental Validation of Single BS 5G mmWave Positioning and Mapping for Intelligent Transport." [Submitted to IEEE Journal of Selected Areas in Communications, *arXiv available*, Feb. 2023]

[*J14] H. Kim, **H. Chen**, M.F. Keskin, Y. Ge, K. Keykhosravi, G.C. Alexandropoulos, S. Kim, and H. Wymeersch. "RIS-Enabled and Access-Point-Free Simultaneous Radio Localization and Mapping." [Submitted to IEEE Transactions on Wireless Communications (Major Revision), *arXiv available*, Nov. 2022]

[*J13] R. Ghazalian, **H. Chen**, G.C. Alexandropoulos, G. Seco-Granados, H. Wymeersch, and R. Jantti. "Joint User Localization and Location Calibration of A Hybrid Reconfigurable Intelligent Surface." [Submitted to IEEE Transactions on Vehicular Technology (Major Revision), *arXiv available*, Oct. 2022]

[*J12] P. Zheng, T. Ballal, **H. Chen**, H. Wymeersch, and T.Y. Al-Naffouri. "Coverage Analysis of Joint Localization and Communication in THz Systems with 3D Arrays." [Submitted to IEEE Transactions on Wireless Communications, *arXiv available*, Sep. 2022]

[*B1] "Positioning and Location-based Analytics in 5G and Beyond. Ch02-Positioning Technologies and Methods; Ch04-Enablers towards 6G Positioning and Sensing." [Ongoing Book Chapters, Willeys, 2023]

Journal Papers

[J11] **H. Chen**, H. Kim, M. Ammous, G. Seco-Granados, G.C. Alexandropoulos, S. Valaee, and H. Wymeersch. "RISs and Sidelink Communications in Smart Cities: The Key to Seamless Localization and Sensing."*IEEE Communications Magazine*, 2023.

[J10] A. Behravan, V. Yajnanarayana, M.F. Keskin, **H. Chen**, D. Shrestha, T.E. Abrudan, T. Svensson, K. Schindhelm, A. Wolfgang, S. Lindberg, and H. Wymeersch. "Positioning and sensing in 6G: Gaps, Challenges and Opportunities." *IEEE Vehicular Technology Magazine*, 2023.

[J9] **H. Chen**, H. Wymeersch. "Phone signals can help you find your way in cities even without GPS." *Nature News & Views*, 2022. [https://www.nature.com/articles/d41586-022-03696-3]

[J8] **H. Chen**, T. Ballal, M.E. Eltayeb, and T.Y. Al-Naffouri. "Antenna Selection in Switch-Based MIMO Array via DOA Threshold Region Approximation." *IEEE Transactions on Vehicular Technology*, 2022.

[J7] X. Liu, T. Ballal, **H. Chen**, and T.Y. Al-Naffouri. "Constrained Wrapped Least Squares: A Tool for High Accuracy GNSS Attitude Determination." *IEEE Transactions on Instrumentation and Measurement*, 2022.

[J6] **H. Chen**, H. Sarieddeen, T. Ballal, H. Wymeersch, M.S. Alouini, and T.Y. Al-Naffouri. "A Tutorial on Terahertz-Band Localization for 6G Communication Systems." *IEEE Communications Surveys & Tutorials*, 2022.

[J5] S. Tarboush, H. Sarieddeen, **H. Chen**, M.H. Loukil, H. Jemma, M.S. Alouini, and T.Y. Al-Naffouri. "TeraMIMO: A Channel Simulator for Wideband Ultra-Massive MIMO THz Communications." *IEEE Transactions on Vehicular Technology*, 2021.

[J4] **H. Chen**, T. Ballal, and T.Y. Al-Naffouri. "DOA Estimation with Non-Uniform Linear Arrays: A Phase-Difference Projection Approach." *IEEE Wireless Communications Letters*, 2021.

[J3] X. Ma, T. Ballal, **H. Chen**, O. Aldayel, and T.Y. Al-Naffouri. "A Maximum-Likelihood TDOA Localization Algorithm Using Difference-of-Convex Programming." *IEEE Signal Processing Letters*, 2021.

[J2] **H. Chen**, T. Ballal, A.H. Muqaibel, X. Zhang, and T.Y. Al-Naffouri. "Air-Writing via Receiver Array Based Ultrasonic Source Localization." *IEEE Transactions on Instrumentation and Measurement*, 2020.

[J1] **H. Chen**, T. Ballal, N. Saeed, M.S. Alouini, and T.Y. Al-Naffouri. "A Joint TDOA-PDOA Localization Approach Using Particle Swarm Optimization." *IEEE Wireless Communications Letters*, 2020.

Patents

[P2] **Hui Chen**, Tarig Ballal Khidir Ahmed, and Tareq Yousef Al-Naffouri. "Ultrasound Based Air-Writing System and Method." U.S. Patent Application 16/969,037, filed February 4, 2021.

[P1] **Hui Chen**, Tarig Ballal Khidir Ahmed, Mohamed Saadeldin, and Tareq Yousef Al-Naffouri. "Angle-of-Arrival-Based Gesture Recognition System and Method." U.S. Patent 10,386,481, issued August 20, 2019.

Technical Reports

[R3] Hexa-X D3.3: "Final models and measurements for localization and sensing." [Ongoing, available in Jul. 2023]

[R2] Hexa-X D3.2: "Initial models and measurements for localization and sensing." Oct. 2022. [Report] [Slides]

[R1] Hexa-X D3.1: "Localization and sensing use cases and gap analysis." Dec. 2021. (European 6G Flagship Project **Hexa-X** Deliverables) [Report] [Slides]

Conference Papers

[C17] P. Zheng, **H. Chen**, T. Ballal, H. Wymeersch, T. Y. Al-Naffouri. "Misspecified Cramér-Rao Bound of RIS-Aided Localization Under Geometry Mismatch." In *Proc. IEEE Int. Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, 2023.

[C16] H. Kim, A. Fascista, **H. Chen**, Y. Ge, G.C. Alexandropoulos, G. Seco-Granados, and H. Wymeersch. "RIS-Aided Monostatic Sensing and Object Detection with Single and Double Bounce Multipath." In *Proc. IEEE International Conference on Communication (ICC) Workshop*, 2023.

[C15] R. Ghazalian, **H. Chen**, G.C. Alexandropoulos, G. Seco-Granados, H. Wymeersch, and R. Jantti. "RIS Position and Orientation Estimation via Multi-Carrier Transmissions and Multiple Receivers." In *Proc. IEEE International Conference on Communications (ICC)*, 2023.

[C14] Y. Lu, **H. Chen**, J. Talvitie, H. Wymeersch, and M. Valkama. "Joint RIS Calibration and Multi-User Positioning." In *Proc. IEEE Vehicular Technology Conference (VTC) workshop*, 2022.

[C13] **H. Chen**, F. Jiang, Y. Ge, H. Kim, and H. Wymeersch. "Doppler-Enabled Single-Antenna Localization and Mapping without Synchronization." In *Proc. IEEE Global Communications Conference (GLOBECOM)*, 2022.

[C12] **H. Chen**, A. Elzanaty, R. Ghazalian, M.F. Keskin, R. Jantti, and H. Wymeersch. "Channel Model Mismatch Analysis for XL-MIMO Systems from a Localization Perspective." In *Proc. IEEE Global Communications Conference (GLOBECOM)*, 2022.

[C11] Y. Ge, O. Kaltiokallio, **H. Chen**, F. Jiang, J. Talvitie. M. Valkama, L. Svensson, and H. Wymeersch. "Exploiting Doppler in Bistatic mmWave Radio SLAM." In *Proc. IEEE Global Communications Conference (GLOBECOM)*, 2022.

[C10] P. Zheng, T. Ballal, **H. Chen**, H. Wymeersch, and T.Y. Al-Naffouri. "Localization Coverage Analysis of THz Communication Systems with a 3D Array." In *Proc. IEEE Global Communications Conference (GLOBECOM)*, 2022.

[C9] R. Ghazalian, K. Keikhorsravi, **H. Chen**, H. Wymeersch, and R. Jantti. "Bi-Static Sensing for Near-Field RIS Localization." In *Proc. IEEE Global Communications Conference (GLOBECOM)*, 2022.

[C8] Y. Ge, **H. Chen**, F. Jiang, M. Zhu, H. Khosravi, S. Lindberg, H. Herbertsson, O. Eriksson, O. Brunnegard, B.E. Olsson, P. Hammarberg, F. Tufvesson, L. Svensson, and H. Wymeersch. "Experimental Validation of Single Base Station 5G mmWave Positioning: Initial Findings." In *Proc. IEEE International Conference on Information Fusion (FUSION)*, 2022.

[C7] H. Wymeersch, A. Parssinen, T.E. Abrudan, A. Wolfgang, K. Haneda, M. Sarajlic, M.E. Leinonen, **H. Chen**, S. Lindberg, P. Kyosti, T. Svensson, and X. Yang. "6G Radio Requirements to Support Integrated Communication, Localization, and Sensing." In *Proc. European Conference on Networks and Communications (EUCNC) & 6G Summit*, 2022.

[C6] **H. Chen**, S. Aghdam, M.F. Keskin, Y. Wu, S. Lindberg, A. Wolfgang, U. Gustavsson, T. Eriksson, and H. Wymeersch. "MCRB-based Performance Analysis of 6G Localization under Hardware Impairments." In *Proc. IEEE International Conference on Communication (ICC) Workshop*, 2022.

[C5] **H. Chen**, T. Ballal, and T.Y. Al-Naffouri. "Phase-Difference-Based 3-D Source Localization Using a Compact Receiver Configuration." In *Proc. 28th European Signal Processing Conference (EUSIPCO)*, pp. 251-255. IEEE, 2020.

[C4] **H. Chen**, T. Ballal, X. Liu, and T.Y. Al-Naffouri. "Realtime 2-D DOA Estimation Using Phase-Difference Projection (PDP)." In *Proc. 27th European Signal Processing Conference (EUSIPCO)*, pp. 1-5. IEEE, 2019.

[C3] **H. Chen**, T. Ballal, and T.Y. Al-Naffouri. "A Decomposition Approach for Complex Gesture Recognition Using DTW and Prefix Tree." In *Proc. IEEE Conference on Virtual Reality and 3D User Interfaces (VR)*, pp. 876-877, 2019.

[C2] **H. Chen**, T. Ballal, and T.Y. Al-Naffouri. "Fast Phase-Difference-Based DOA Estimation Using Random Ferns." In *Proc. IEEE Global Conference on Signal and Information Processing (GlobalSIP)*, pp. 256-260, 2018.

[C1] **H. Chen**, T. Ballal, M. Saad, and T.Y. Al-Naffouri. "Angle-of-Arrival-Based Gesture Recognition Using Ultrasonic Multi-frequency Signals." In *Proc. 25th European Signal Processing Conference (EUSIPCO)*, pp. 16-20. IEEE, 2017.

Demos

[D4] Abdulwahab Felemban, Lucas Bezerra, **Hui Chen** Yerzhan Orazayev, Mohammed Al-Sharif. "**Smart Tap**." (NEOM AI Challenge Project, 2020) [Online Page] [Demo Video]
An AI-controlled tap using a depth camera (graph neural network-based action recognition) is developed to reduce water wastage. Both onside and VR demos are provided.

[D3] **Hui Chen**. "**Virtual Kitchen Simulator**." (Personal Project, 2020) [Online Page] [Demo Video]
A virtual kitchen environment with multiple purposes: user training, behavior analysis, layout optimization, etc.

[D2] **Hui Chen**, Tarig Ballal, Mohamed Saad, and Tareq Y. Al-Naffouri. "**UBAS: An Ultrasound Based Air-writing System**." (ICASSP Demo session, Calgary, Alberta, Canada, 2018) [Online Page] [Demo Video] [Reference]
An ultrasound-based air mouse with "Mouse", "Keyboard", and "Air-writing" mode.

[D1] **Hui Chen**, Mohammed Al-Sharif, Mohamed Saad, Tarig Ballal, Chris Bleakley, and Tareq Y. Al-Naffouri. "**KAUST Acoustic Positioning System**." (Microsoft Indoor Localization Competition, IPSN, Pittsburgh, PA, USA, 2017) [Online Page]
A 3D ultrasonic indoor positioning system for Microsoft Indoor localization competition.

Scholarships, Honors & Awards

Scholarships

2016-2021 **KAUST Fellowship**, by King Abdullah University of Science and Technology
2013-2016 **Recommended for Direct Admission to UCAS (top 3%)**, Tuition-waiver & Monthly Stipend
2013 **UCAS Excellent Student Scholarship**, by University of Chinese Academy of Sciences
2010-2012 **National Scholarship (top 2‰)**, 3 times, by Ministry of Education of China *¥8K×3 awards*

Honors & Awards

2023 **Seal of Excellence** (90.4/100), Marie Curie Fellowship (MSCA-PF), European Commission
2021 **1 of the 10 selected teams in 'SMECEYI' Initiative**, Swiss Pavilion, Expo Dubai, UAE
2021 **1st Place in Digital Innovation Awards-Digital Research Track**, by MCIT, KSA *$21.3K price*
2020 **Top-5 finalists (100+ Teams) in Energy-Track**, NEOM AI Challenge, KSA
2017 **4th place in Microsoft Indoor Localization Competition**, Pittsburgh, PA, USA
2013 **'Outstanding Graduate of Beijing' Award**, by Beijing Municipal Commission of Education
2012 **1st Prize in Beijing, 3rd Prize in China, iCAN Contest**, Wuxi, China
2011 **'Merit Student of Beijing' Award**, by Beijing Municipal Commission of Education

Professional Development & Service

Skills

Languages Chinese (Mother tongue), English (Fluent)
Programming MATLAB, Python (TensorFlow), C# (Unity 3D), C/C++ (Arduino), Verilog, VHDL
IT Skills VR/AR Development, Interactive Simulation & Visualization, 3D Modeling

Teaching

Spring 2023 **Guest Lecturer**, SSY135 Wireless Communications, Chalmers, Sweden
Fall 2018 **Teaching Assistant**, EE242 Digital Communication and Coding, KAUST, KSA
Fall 2017 **Teaching Assistant**, EE242 Digital Communication and Coding, KAUST, KSA

Service and Outreach

2019-2020 **Startup 'Wisensing' Co-founder**, TAQADAM Accelerator (2019-Cohort 3) *$20K funding*
2019-2020 **Residential Assistant**, Office of Residential Life, Graduate Affairs, KAUST

Peer Review

IEEE Wireless Communications
IEEE Communications Magazine
IEEE Journal on Selected Areas in Communications (JSAC)
IEEE Journal of Selected Topics in Signal Processing (JSTSP)
IEEE Transactions on Wireless Communications (TWC)
IEEE Transactions on Communications (TCOM)
IEEE Transactions on Vehicular Technology (TVT)
IEEE Open Journal of the Communication Society (OJ-COMS)
IEEE Communications Letters (COMML)
IEEE Signal Processing Letters (SPL)
Springer Nature

Technical Program Committee (TPC) Member

IEEE International Conference on Communications (ICC 2023) Workshop
IEEE Vehicular Technology Conference (VTC 2023)

Professional Memberships

IEEE Member
IEEE Communication Society Member
IEEE Vehicular Technology Society Member