Hui CHEN

Postdoctoral Researcher · Electrical Engineering

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Education

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

Ph.D. Electrical & Computer Engineering (Defended on 27/07/2021) *08/08/2016 - 22/08/2021*

- KAUST Fellowship

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

M.S. Computer Application Technology *01/09/2013 - 01/07/2016*

- Recommended for Direct Admission without Exams

Beijing Forestry University *Beijing, China*

B.S. Electrical Engineering *01/09/2009 - 01/07/2013*

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

Research Experience

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

Postdoctoral Researcher | Advisor: Prof. Henk Wymeersch *23/08/2021 - Present*

- 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.
- Joint RIS calibration and UE localization: Problem formulation & CRB-/PCRB-based performance analysis; practical algorithm and cooperative strategy design (multi-RIS co-existence and multi-UE cooperation).
- 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 for 9D estimation (3D position, 3D orientation, and 3D velocity) to improve coverage at high-frequency communication systems.

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

Main Researcher *01/10/2020 - 22/08/2021*

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

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

Main Researcher (Ph.D. Thesis) | Advisor: Prof. Tareq Al-Naffouri *08/08/2016 - 27/07/2021*

- 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 - 01/07/2016*

- 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

[*J] **H. Chen**, S. Aghdam, M.F. Keskin, Y. Wu, S. Lindberg, A. Wolfgang, U. Gustavsson, T. Eriksson, and H. Wymeersch. "Modeling and Analysis of 6G Localization under Hardware Impairments." [In Preparation for IEEE TWC, draft ready]

[*J] H. Kim, **H. Chen**, K. Keykhosravi, M.F. Keskin, G.C. Alexandropoulos, S. Kim, and H. Wymeersch. "RIS-Enabled and Access-Point-Free Simultaneous Localization and Radio Mapping." [In Preparation for IEEE TWC]

[*J] R. Ghazalian, **H. Chen**, G.C. Alexandropoulos, G. Seco-Granados, H. Wymeersch, and R. Jantti. "A Low Complexity Estimator for Joint Hybrid RIS and User Localization." [In Preparation for IEEE TVT]

[*J] 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." [Submitted to IEEE Vehicular Technology Magazine]

[*B] "Positioning and Location-based Analytics in 5G and Beyond." [Ongoing Book Chapters, Willeys, 2022]

Journal Papers

[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." accepted by *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." accepted by *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.

Technical Reports

[R2] Hexa-X D3.2: "Initial models and measurements for localization and sensing." [Ongoing, available in Oct. 2022]

[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

[C14] Y. Lu, **H. Chen**, J. Talvitie, H. Wymeersch, and M. Valkama. "Joint RIS Calibration and Multi-User Positioning." accepted by *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." accepted by *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." accepted by *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." accepted by *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." accepted by *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." accepted by *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.

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.

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 is developed to reduce water wastage. Both onside 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.

Research Projects, Funding & Supports

Research works funded/supported partially by:

23/08/2021-now	**HEXA-X** (A flagship for B5G/6G vision and intelligent fabric of technology enablers connecting human, physical, and digital worlds), by the European Commission. (Grant No. 101015956)
02/12/2021-31/07/2022	**5GPOS** (5G Cellular Positioning for Vehicular Safety), by Strategic Vehicle Research and Innovation, Vinnova. (Grant No. 2019-03085)
08/08/2016-22/08/2021	**KAUST's Office of Sponsored Research** (Award OSR2016-KKI-2899) **The KAUST-MIT-TUD Consortium** (Grant No. OSR-2015-Sensors-2700) **The Center of Excellence for NEOM Research at KAUST** **KAUST-KSU Collaborative Research Initiative**

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

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 & Outreach

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

Professional Experience

03/2020 **Mixed Reality Developer**, 4-week Internship, NEOM Smart City
Fall 2018 **Teaching Assistant**, EE242 Digital Communication and Coding, KAUST
Fall 2017 **Teaching Assistant**, EE242 Digital Communication and Coding, KAUST

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 Communications Magazine
IEEE Wireless Communications Magazine
IEEE Transactions on Wireless Communications
IEEE Transactions on Vehicular Technology
IEEE Open Journal of the Communication Society
IEEE Communications Letters
IEEE Signal Processing Letters
Springer Nature

Professional Memberships

IEEE Member
IEEE Communication Society Member
IEEE Vehicular Technology Society Member