Zihang Song

PhD Student in Information and Communication Systems, 6GIC, University of Surrey

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RESEARCH INTERESTS

My research is at the intersection of learning-driven **cognitive-communication and signal processing**. I am especially interested in solving the sparse inverse problems from compressive samples of the wideband radio signals and practical sensing matrices designed by optimization and learning methods.

I am passionate about **hardware design of state-of-the-art communication systems**. I have developed the first known prototype of the uniform periodic sampling architecture (link), which achieves sparse spectrum sensing over 2G Hz bandwidth by sampling at an average rate of 400M Hz. I am also interested in the development of software-defined transceiver platforms.

EDUCATION

2020 – Now	**University of Surrey**, PhD Candidate, Information and Communication Systems, 6GIC

- Postgraduate Researcher, EPSRC project GHz bandwidth sensing (GBSense)
- Thesis (**about to submit**): *Compressed Spectrum Sensing Based on a Periodic Nonuniform Sub-Nyquist Sampling Framework: from Theory to Practice*
- Supervisors: Prof Yue Gao and Prof Rahim Tafazolli

2019-2020	**Queen Mary University of London**, PhD Student, Electronic engineering
2016-2018	**Beihang University**, China, MSc, Radio Physics (Frist Class)
2012-2016	**Beihang University**, China, BSc, Applied Physics (First Class)

RESEARCH EXPERIENCES

Research Assistant, **EPSRC Fellowship Project GHz Bandwidth Sensing (GBSense)**,   2019 – Now

- Compressed spectrum sensing (CSS) framework design and hardware verification for mmWave communication
- Signal processing software and interface development on portable Linux platform (C Language and C++ based on Qt Environment, with python script embedded)
- FPGA development of interleaved high-speed data transmission (VHDL and Verilog on Lattice/Xilinx FPGA)
- Embedded system development for the CSS system (C Language on low-power MCU)
- Software development on National Instruments mmWave Transceiver System (LabVIEW)
- Design and manage the website www.gbsense.net for data sharing and research cooperation
- DNN-based Sub-Nyquist automatic modulation recognition

Research Assistant, NSFC Deep Space Environment Frequency Modulation Atomic Force Microscopy,   2016 – 2019

- Amplitude control algorithm based on Kalman filter for frequency-modulated AFM and FPGA development
- Fast image reconstruction algorithm based on Bayesian compressed sensing

Principle Investigator, National Undergraduate Innovation & Entrepreneurship Program   2015 - 2016

REVIEWERSHIPS

- IEEE Transactions on Signal Processing
- IEEE Transactions on Cognitive Communications and Networking
- IEEE Transactions on Vehicular Technology
- IEEE Internet of Things Journal
- Frontiers of Computer Science

TEACHING ACTIVITES

- Teaching assistant, EEE1028 – Laboratories, Design & Professional Studies, 2020
- Undergraduate thesis tutor 2018
- Teaching assistant, Undergraduate Physical Experiments 2016 – 2018

FUNDINGS AND AWARDS

- Huawei Funding Studentship 2020 - 2022
- QMUL Electronic Engineering and Computer Science Research Studentship 2019 - 2020
- QMUL Doctoral College Initiative Fund 2019
- Outstanding Graduate Student 2018
- Departmental Graduate Study Scholarship 2016 - 2018
- Outstanding Award of National Undergraduate Innovation and Entrepreneurship Program (as PI) 2015 – 2016
- Guanghua Outstanding Undergraduate Scholarship 2015

PUBLICATIONS

Journal Papers

[J1] **Z. Song**, J. Yang, H. Zhang, and Y. Gao, "Approaching Sub-Nyquist Boundary: Optimized Compressed Spectrum Sensing Based on Multicoset Sampler for Multiband Signal," IEEE Transactions on Signal Processing, vol. 70, pp. 4225-4238, 2022.

[J2] **Z. Song**, Y. Gao, and R. Tafazolli, "A Survey on Spectrum Sensing and Learning Technologies for 6G," *IEICE Transactions on Communications*, vol. 104, no. 10, pp. 1207–1216, 2021.

[J3] Y. Gao, **Z. Song**, H. Zhang, S. Fuller, A. Lambert, Z. Ying, P. Mähönen, Y. Eldar, S. Cui, M.D. Plumbley, C. Parini and A. Nallanathan, "Sub-Nyquist Spectrum Sensing and Learning Challenge," *Frontiers of Computer Science*, vol. 15, no. 4, pp. 1–5, 2021.

[J4] J. Yang, **Z. Song**, Y. Gao, X. Gu and Z. Feng, "Adaptive Compressed Spectrum Sensing for Multiband Signals," *IEEE Transactions on Wireless Communications*, vol. 20, no. 11, pp. 7642–7654, 2021.

[J5] Y. Zhang, Y. Li, **Z. Song**, Z. Wang, J. Qian, and J. Yao, "A Novel Method to Remove Impulse Noise from Atomic Force Microscopy Images based on Bayesian Compressed Sensing," *Beilstein Journal of Nanotechnology*, vol. 10, no. 1, pp. 2346–2356, 2019.

[J6] R. Lin, Y. Li, Y. Zhang, T. Wang, Z. Wang, **Z. Song**, Z. Dou, and J. Qian, "Design of a Flexure-Based Mixed-Kinematic XY High-Precision Positioning Platform with Large Range," *Mechanism and Machine Theory*, vol. 142, p. 103609, 2019.

[J7] Y. Li, L. Zhang, G. Shan, **Z. Song**, R. Yang, H. Li, and J. Qian, "A Homemade Atomic Force Microscope Based on a Quartz Tuning Fork for Undergraduate Instruction," *American Journal of Physics*, vol. 84, no. 6, pp. 478–482, 2016.

[J8] H. Liu, Y. Li, Y. Zhang, Y. Chen, **Z. Song** Z. Wang, S. Zhang, and J. Qian, "Intelligent Tuning Method of PID Parameters Based on Iterative Learning Control for Atomic Force Microscopy," *Micron*, vol. 104, pp.26–36, 2018.

[J9] Y. Zhang, Y. Li, Z. Wang, **Z. Song**, R. Lin, J. Qian, and J. Yao, "A Fast Image Reconstruction Method Based on Bayesian Compressed Sensing for the Undersampled AFM Data with Noise," *Measurement Science and Technology*, vol. 30, no. 2, p. 025402, 2019.

[J10] Z. Wang, J. Qian, Y. Li, Y. Zhang, G. Shan, Z. Dou, **Z. Song** and R Lin, "Time-frequency Analysis of the Tip Motion in Liquids Using the Wavelet Transform in Dynamic Atomic Force Microscopy," 2018. *Nanotechnology*, vol. 29, no. 38, p. 385702, 2018.

[J11] Y. Li, **Z. Song**, Y. Zhang, Z. Wang, Z. Xu, R. Lin, and J. Qian, "A Double-Electrolyte Etching Method of High-Quality Tungsten Probe for Undergraduate Scanning Tunneling Microscopy and Atomic Force Microscopy Experiments," *European Journal of Physics*, vol. 40, no. 2, p. 025004, 2019.

Conference Papers

[C1] **Z. Song,** H. Qi, and Y. Gao, "**Real-time Multi-Gigahertz Sub-Nyquist Spectrum Sensing System for mmWave**," in *Proc. ACM Millimeter-wave Networks and Sensing Systems*, Los Cabos, Mexico, Oct. 2019, pp. 33–38

[C2] J. Yang, **Z. Song**, Y. Gao, and X. Gu, "Cross Validation Based Adaptive Compressed Spectrum Sensing without Testing Set," in *in IEEE GLOBECOM,* Taipei, Taiwan, Dec. 2020, pp. 1–6.

[C3] **Z. Song**, Y. Li, Y. Zhang, R. Lin, Z. Wang, and J. Qian, "A Novel Amplitude Control Algorithm for Frequency-Modulation Atomic Force Microscope Based on Kalman Filter", in *International Congress on Microscopy & Spectroscopy*, Istanbul, Turkey, May 2019, pp. 148.

UNPUBLISED WORKS

[U1] **Z. Song**, Y She, H. Zhang, and Y. Gao, "Hardware-based Sensing Matrix Optimization for Sub-Nyquist Spectrum Sensing", *IEEE Transactions on Wireless Communications* (Under review)

[U2] **Z. Song**, H Zhang, S Fuller, A Lambert, Z Ying, P Mähönen, Y Eldar, S Cui, M.D Plumbley, C Parini, A Nallanathan, and Y Gao. "Numerical Evaluation on Sub-Nyquist Spectrum Reconstruction Methods," *Frontiers of Computer Science* (Under review).

[U3] H. Zhang, **Z. Song**, and Y. Gao, "Adversarial Autoencoder Empowered Joint Anomaly Detection and Signal Reconstruction from Sub-Nyquist Samples," *IEEE Transactions on Cognitive Communications and Networking* (Under review).

[U4] **Z. Song**, and Y. Gao, "Software Defined Compressed Spectrum Sensing at Millimeter-Wave for Ubiquitous IoT", *IEEE Internet of Things Journal* (Under review).

SKILLS

Programming languages

- MATLAB, Python, C, C++, Verilog/VHDL, SQL, and LabVIEW

Platforms

- Simulation: MATLAB/SIMUINK, Python
- SDR platforms: LabVIEW, GNURadio
- Circuit design: Altium Designer, Cadence (Orcad)
- FPGA development: ISE/Vivado (for Xilinx), Diamond (for Lattice), LabVIEW (For NI)
- MCU: Keil µVision
- Application and UI development: Visual Studio, Qt