

Resume of Professor Lixin Ran

Professor Lixin Ran graduated from Zhejiang University, China, as a bachelor, master and PhD student in Electronic Engineering in 1991, 1994 and 1997, respectively. He became an associate, and then a full professor at the same University in 1999 and 2004. As a visiting scientist, he visited the Research Laboratory of Electronics (RLE) of Massachusetts Institute of Technology (MIT) in 2005, 2009 and 2012, respectively. He has authored or coauthored multiple book chapters and 100+ peer-reviewed papers, focusing on scientific research and technological development in frontiers of electromagnetic wave theory.

Publications of Professor Lixin Ran

Book Chapters

Zhang Y, et al., Ran L. "Hand gesture recognition based on SIMO Doppler radar sensors". Short-Range Micro-Motion Sensing with Radar Technology. IET press, 2019.

Fan Z, et al., Ran L. "Improving Read Ranges and Read Rates for Passive RFID Systems", RFID Systems, Research trends and challenges. John Wiley&Sons, 2010.

Grzegorzczk T, et al., Ran L. "Refraction experiments in waveguide environments". Metamaterials - Physics and Engineering Explorations, IEEE press, 2006.

Grzegorzczk T, Ran L, et al., "Two dimensional periodic approach for the study of left-handed metamaterials", Wave Propagation, Scattering and Emission in Complex Media, World Scientific, 2003.

Selected papers as the corresponding author

2023

Shen F, et al, Ran L. Statistical Computation for Multipactors in Arbitrary Microwave Devices, *IEEE Transactions on Microwave Theory and Techniques*, accepted for publication.

Shen F, et al, Ran L. Wideband microwave sensor for downhole water-cut monitoring. *IEEE Transactions on Geoscience and Remote Sensing*, accepted for publication.

Wang Z, et al, Ran L. Novel Multi-Functional Reconfigurable Wide-Band Frequency-Selective Filter/Shielding with Independently Controlled Operating modes, *IEEE Transactions on Electromagnetic Compatibility*, accepted for publication.

Zhang Q, et al, Ran L. Microwave imaging enhanced by duplexed random phase modulations. *IEEE Transactions on Microwave Theory and Techniques*, accepted for publication.

2022

Zhu C, et al, Ran L. Testing of Passive Intermodulation Based on an Ultra-Wideband Dual-Carrier Nulling. *IEEE Transactions on Microwave Theory and Techniques*, vol. 70, no. 8, 2022.

Shen F, et al, Ran L. Wideband Microwave Sensor for Downhole Water-Cut Monitoring. *IEEE Transactions on Geoscience and Remote Sensing*, vol. 60, No. 4, 2022.

Zhu C, et al, Ran L. Doppler cardiogram detected by a V-band Doppler radar sensor. *IEEE Transactions on Microwave Theory and Techniques*, vol. 70, no. 1, 2022.

2021

Peng T, et al, Ran L. A Compact Microwave Imager Integrated with a Miniaturized Dual-angle Anechoic Chamber. *IEEE Transactions on Microwave Theory and Techniques*, vol. 69, no. 11, 2021.

Zhang Q, et al, Ran L. A microwave imager implemented with a space-fed randomized aperture. *IEEE Transactions on Microwave Theory and Techniques*, vol. 69, no. 9, 2021.

Zhang Y, et al, Ran L. Hand Gesture Recognition for Smart Devices by Classifying Deterministic Doppler Signals. *IEEE Transactions on Microwave Theory and Techniques*, vol. 69, no. 1, 2021.

Ma C, et al, Ran L. Implementation of a 2-D Reconfigurable Fresnel-Zone-Plate Antenna, *IEEE Transactions on Antennas and Propagation*, vol. 69, no. 1, 2021.

Lv Q, et al, Ran L. Time-Domain Doppler Biomotion Detections Immune to Unavoidable DC Offsets, *IEEE Transactions on Instrumentation and Measurement*, vol. 71, 2021.

2020

Xi Q, et al, Ran L. A reconfigurable Planar Fresnel Lens for Millimeter-wave 5G Frontends. *IEEE Transactions on Microwave Theory and Techniques*, vol. 68, no. 11, 2020.

Zhang Y, et al, Ran L. 3-D Motion Imaging in a Multipath Coordinate Space Based on a TDM-MIMO Radar Sensor, *IEEE Transactions on Microwave Theory and Techniques*, vol. 68, no. 11, 2020.

- Wang H, et al, Ran L. Analytical Approach to Microwave Orientations Based on a Strongly Coupled Array, *IEEE Transactions on Microwave Theory and Techniques*, vol. 68, no. 9, 2020.
- Shen F, et al, Ran L. Induction Logging Through Casing by Detecting Lateral Waves: A Numerical Analysis, *IEEE Transactions on Geoscience and Remote Sensing*, vol. 58, no. 4, 2020.
- Dong S, et al, Ran L. Doppler Cardiogram: a Remote Detection of Human Heart Activities, *IEEE Transactions on Microwave Theory and Techniques*, vol. 68, no. 3, 2020.
- Li H, et al, Ran L. Reconfigurable Fresnel Lens Based on an Active Second-order Bandpass Frequency Selective Surface. *IEEE Transactions on Antennas and Propagation*, vol. 68, no. 5, 2020.
- Shen F. et al, Ran L. Nonstationary Statistical Theory for Single-surface Dielectric Multipactors. *IEEE Transactions on Plasma Science*, vol. 48, no. 2, 2020.

2019

- Peng T, et al, Ran L. Miniaturized Anechoic Chamber Constructed Based on an Inhomogeneous PML Model. *IEEE Transactions on Microwave Theory and Techniques*, vol. 67, no. 9, 2019.
- Zhou T, et al, Ran L. Microwave Imaging Customized on Demand Under Random Field Illumination. *IEEE Transactions on Microwave Theory and Techniques*, vol. 67, no. 3, 2019.
- Gu Z, et al, Ran L. Remote Blind Motion Separation Using a Single-tone SIMO Doppler Radar Sensor. *IEEE Transactions on Geoscience and Remote Sensing*, vol. 57, no. 1, 2019.
- Gu Z, et al, Ran L. Blind Separation of Doppler Human-gesture Signals Based on Continuous-Wave Radar Sensors. *IEEE Transactions on Instrumentation and Measurements*, vol. 68, no. 7,

2018

- Lv Q, et al, Ran L. Doppler Vital Signs Detection in the Presence of Large-Scale Random Body Movements. *IEEE Transactions on Microwave Theory and Techniques*, vol. 66, no. 9, 2018.
- Qi X, et al, Ran L. Bio-Inspired In-grid Navigation and Positioning Based on an Artificially established Magnetic Gradient. *IEEE Transactions on Vehicular Technology*, vol. 67, no. 11, 2018.
- Qi X, et al, Ran L. Wireless Indoor Positioning with Vertically Uniform Alternating Magnetic Fields. *IEEE Transactions on Instrumentation and measurements*, vol. 67, no 11., 2018.

Zhu A, et al, Ran L. Indoor Localization for Passive Moving Objects Based on a Redundant SIMO Radar Sensor. *IEEE Journal on Emerging and Selected Topics in Circuits and Systems*, vol. 8, no. 2, 2018.

Li H, et al, Ran L. Dual-band Fresnel Zone Plate Antenna with Independently Steerable beams. *IEEE Transactions on Antennas and Propagation*, vol. 66, no. 4, 2018.

2017

Li H, et al, Ran L. Theory and Implementation of Scattering-dark-state Particles at Microwave Frequencies. *IEEE Transactions on Antennas and Propagation*, vol. 65, no. 12, 2017.

Ye D, et al, Ran L. Observation of Reflectionless Absorption Due to Spatial Kramers-Kronig Profile. *Nature Communications*, vol. 8, no. 51, 2017.

Zhang M, et al, Ran L. Localization of Passive Intermodulation Based on the Concept of k-Space Multicarrier Signal. *IEEE Transactions on Microwave Theory and Techniques*, vol. 65, no. 12, 2017.

Wang X, et al, Ran L. Monte Carlo Analysis of Occurrence Thresholds of Multicarrier Multipactors. *IEEE Transactions on Microwave Theory and Techniques*, vol. 65, no. 8, 2017.

Wang X, et al, Ran L. Generation of Coherent Multicarrier Signals for the Measurement of Multicarrier Multipactor. *IEEE Transactions on Instrumentation and Measurements*, vol. 66, no. 12, 2017

Zhou T, et al, Ran L. Short-range Wireless Localization Based on Meta-aperture Assisted Compressed Sensing. *IEEE Transactions on Microwave Theory and Techniques*, vol. 65, no. 7, 2017.

Peng Z, Ran L and Li C. A K-Band Portable FMCW Radar With Beamforming Array for Short-Range Localization and Vital-Doppler Targets Discrimination. *IEEE Transactions on Microwave Theory and Techniques*, vol. 65, no. 4, 2017.

Peng Z, et al, Ran L and Li C. A Portable FMCW Interferometry Radar with Programmable Low-IF Architecture for Localization, ISAR Imaging, and Vital Sign Tracking. *IEEE Transactions on Microwave Theory and Techniques*, vol. 65, no. 4, 2017.

Qi X, et al, Ran L. Simulations to True Animal's Long-Distance Geomagnetic Navigation. *IEEE Transactions on Magnetics*, vol. 53, no. 1, 2017.

2016

Fan T, et al, [Ran L](#). Wireless Hand Gesture Recognition Based on Continuous-wave Doppler Radar Sensors. *IEEE Transactions on Microwave Theory and Techniques*, vol. 64, no. 11, 2016.

Ye D, et al, [Ran L](#). Invisible metallic mesh. *Proceedings of the National Academy of Sciences of the United States (PNAS)*, vol. 113, no. 10, 2016.

Dong J, et al, [Ran L](#). Non-contact Measurement of Complex Permittivity of Electrically Small Samples at Microwave Frequencies. *IEEE Transactions on Microwave Theory and Techniques*, vol. 64, no. 9, 2016.

Peng Z, et al, [Ran L](#). Radio Frequency Beamforming Based on a Complex Domain Frontend. *IEEE Transactions on Microwave Theory and Techniques*, vol. 64, no. 1, 2016.

2015

Lu L, Wang Z, Ye D, [Ran L](#), Fu L, Joannopoulos J, Soljacic M. Experimental observation of Weyl points, *Science*, vol.349, no.6248, 2015.

Li H, et al, [Ran L](#). Reconfigurable Diffractive Antenna Based on Switchable Electrically Induced Transparency. *IEEE Transactions on Microwave Theory and Techniques*, vol. 63, no. 3, 2015.

Xu K, et al, [Ran L](#). Analytical Beam Forming for Circularly Symmetric Conformal Apertures. *IEEE Transactions on Antennas and Propagation*, vol. 63, no. 4, 2015.

Zhao J, et al, [Ran L](#). Power synthesis at 110-GHz Frequency Based on Discrete Sources. *IEEE Transactions on Microwave Theory and Techniques*, vol. 63, no. 5, 2015.

Xu K, et al, [Ran L](#). Multiplicative-regularized FFT twofold subspace-based optimization method for inverse scattering problems. *IEEE Transactions on Geoscience and Remote Sensing*, vol. 53, no. 2, 2015.

2014

Ye D, et al, [Ran L](#), Xin H. Microwave gain medium with negative refractive index. *Nature Communications*, Vol. 5, No. 5841, 2014.

Lv Q, et al, [Ran L](#). High-Dynamic-Range Motion Imaging Based on Linearized Doppler Radar Sensor. *IEEE Transactions on Microwave Theory and Techniques*, vol. 62, no. 9, 2014.

Salamin Y, et al, [Ran L](#). Eliminating the Impacts of Flicker Noise and DC Offset in Zero-IF Architected Pulse Compression Radars. *IEEE Transactions on Microwave Theory and Techniques*, vol. 62, no. 4, 2014.

Wang R, et al, Ran L. Optimal matched rectifying surface for space solar power satellite applications. *IEEE Transactions on Microwave Theory and Techniques*, vol. 62, no. 4, 2014. (Golden Award of 2014 Inventions Geneva).

Shen F, et al, Ran L. Non-contact measurement of complex permittivity based on the principle of mid-range wireless power transfer. *IEEE Transactions on Microwave Theory and Techniques*, vol 62, no 3, 2014.

Zhao Z, et al, Ran L. Long-distance geomagnetic navigation: imitations of animal migration based on a new assumption. *IEEE Transactions on Geoscience and Remote Sensing*, vol 52, no 10, 2014.

Wang J, et al, Ran L. Non-contact distance and amplitude independent vibration measurement based on an extended DACM algorithm. *IEEE Transactions on Instrumentation and Measurement*, Vol. 63, No. 1, 2014.

2013

Ye D, et al, Ran L, Ultrawideband dispersion control of a metamaterial surface for perfectly-matched-layer-like absorption. *Physical Review Letters*, vol. 111, no. 18, 2013.

Wang J, et al, Ran L. 1-D microwave imaging of human cardiac motion: an ab-initio investigation. *IEEE Transactions on Microwave Theory and Techniques*, vol. 61, no. 5, 2013.

Wang J, et al, Ran L. PLL-based self-adaptive resonance tuning for a wireless-powered potentiometer, *IEEE Transactions on Circuits and Systems*, Vol. 60, No. 7, 2013.

Shen J, et al, Ran L. Inverse scattering problems of reconstructing perfectly electric conductors with TE illumination. *IEEE Transactions on Antennas and Propagation*, vol. 61, no. 9, 2013.

Xu K, et al, Ran L. Versatile beam forming with concentric excitations based on multiple weighted sinc or Bessel function distribution. *IEEE Transactions on Antennas and Propagation*, Vol. 61, No. 8, 2013.

2012

Wang Z, et al, Ran L. Gyrotropic response in the absence of a bias field. *Proceedings of the National Academy of Sciences of the United States (PNAS)*, Vol. 109, No. 33, 2012.

Ye D, et al, Ran L. Towards experimental perfectly-matched layers with ultra-thin metamaterial surfaces. *IEEE Transactions on Antennas and Propagation*, Vol. 60, 2012.

Jiang T, et al, Ran L. Low DC voltage controlled steering antenna utilizing tunable active metamaterial. *IEEE Transactions on Microwave Theory and Techniques*, Vol. 60, No. 1, 2012.

Li D, Shen M, et al, Ran L. Wireless Sensing System-on-Chip for Near-Field Monitoring of Analog and Switch Quantities. *IEEE Transactions on Industrial Electronics*, Vol. 59, No. 2, 2012.

2011 and before

Jiang T, et al, Ran L, Xin H. Active microwave negative-index transmission line with gain. *Physical Review Letters*. PRL107, 205503, 2011.

Wang Z, et al, Ran L. Harmonic image reconstruction assisted by a nonlinear metamaterial surface. *Physical Review Letters*. PRL 106, 047402, 2011.

Gu C, et al, Ran L. Instrument-Based Non-Contact Doppler Radar Vital Sign Detection System Using Heterodyne Digital Quadrature Demodulation Architecture. *IEEE Transactions on Instrumentation and Measurement*. Vol. 59, No. 6, 2010.

Xi S, Chen H, Jiang T, Ran L, Huangfu J, Wu B, Kong J, Chen M. Experimental Verification of Reversed Cherenkov Radiation in Left-Handed Metamaterial. *Physical Review Letters*, PRL103, 194801, 2009. (Co-corresponding author)

Peng L, Ran L, et al. Experimental observation of left-handed behavior in an array of standard dielectric resonators. *Physical Review Letters*, PRL 98, 157403, 13 April 2007.

Li Y, Ran L, et al. Experimental Realization of a One-Dimensional LHM-RHM Resonator. *IEEE Transactions on Microwave Theory and Techniques*, Vol. 53, No. 4, 2005.

Topics of the seminar

6 short reports presented by 6 PhD students.

Estimated time: 2 hours.

1. Reconfigurable Planar Fresnel Lens for Millimeter-wave 5G Frontends

Speaker: Qiangli Xi, PhD student, Zhejiang University

The development of millimeter-wave phased array based on digital beamforming architectures needs to overcome a physical-level challenge due to the contradiction between the massively integrated TR devices and the compact volume for thermal dissipation. In this talk, we theoretically analyze and experimentally demonstrate a space-fed, reconfigurable Fresnel lens, based on which a new-concept mmWave beamforming frontend can be implemented with significantly reduced number of TR devices. It replaces the convex lens used in the recently proposed hybrid beamforming solutions. The implemented Ka-band lens is simple-structured, cost-effective and easy to control, providing multiple modes for “beam-space” massive-MIMO communications.

2. Doppler Cardiogram Detected by a V-Band Doppler Radar Sensor

Speaker: Chengkai Zhu, PhD student, Zhejiang University

Capable of remote presentation of human heart activities, the doppler cardiogram (DCG) can be detected by an agile Doppler radar sensor. However, as a recently developed technology, its performance needs sustained improvements for the future practical applications. In this talk, we introduce a continuous-wave, V-band Doppler radar sensor to improve the discrimination of the receiver, for detecting micron-level details of heartbeat motions conducted to the chest skin. Besides, new algorithms were derived to achieve a high linearity, to demodulate the Doppler phases and retrieve the fine details of DCG waveforms. Experimental measurements to different subjects showed significantly enhanced robustness and accuracy. The obtained results imply a promising potential of DCGs in wide application scenarios such as medical wisdom and personal healthcare.

3. Microwave Imager Implemented with a Space-Fed Randomized Aperture

Speaker: Qian Zhang, PhD student, Zhejiang University

Microwave imaging is a noncontact sensing technique capable of penetrating dielectric materials and operating in all-weather conditions. It has gained significant attention in various fields. However, the traditional microwave imaging methods often rely on fixed beam scanning to densely sample the imaging objects, which would lead to increased hardware complexity and cost, longer sampling time and higher computational demands. This limitation has motivated researchers to explore new methods to reduce the hardware cost and improve the efficiency of microwave imaging. The recently proposed compressed sensing (CS) has provide promising and fundamentally different perspective of microwave imaging algorithms and imager design. This talk will introduce the basic concept, recent breakthroughs and case studies of the CS based microwave imaging. We have designed a CS based microwave imager that implemented with a space-fed randomized aperture. The theory and the guidelines for implementing such a microwave imager will also be discussed.

4. Beam Steering for Coupled Apertures Interleaved by Multielement Subarrays

Speaker: Ke Huang, PhD student, Zhejiang University

In 5G communications, millimeter-wave phased arrays are faced with implementation problem that the physical aperture is too compact to integrate massive T/R modules. This issue also limits the development of terahertz phased arrays for the coming 6G communication. This talk presents a phased array topology with a coupled aperture interleaved by multielement subarrays. By feeding the array at subarray level, the quantity and cost of the T/R modules can be significantly reduced. To avoid the grating lobe effect and expand the field of view as much as possible, we narrow down the phase center spacing between the subarrays, making the apertures of the subarrays partially overlapped

with each other. Different from reported arrays with interleaved subarrays, this work forms the array with non-sparse subarrays, and provides a guideline on beam steering for such arrays, considering the mutual coupling effect between subarrays. Simulation and experiment results have proved its feasibility.

5. Beamforming Implemented on a Flexible Conformal Aperture

Speaker: Xiaoli Zhi, PhD student, Zhejiang University

Flexible conformal array antennas could perfectly conform to carrier surfaces, which have gained increased attention in many areas, including military, communication, aerospace, radar and healthcare. However, in practical applications, the conformal surface may experience real-time deformations due to various environmental factors, which inevitably degrade the radiation pattern. This talk introduces a self-adaptive phase compensation system for the flexible array based on a six-axis microelectromechanical system (MEMS) sensor array. The acceleration and angular velocity obtained from the MEMS sensors can be used to calculate the rotation matrix allowing for the estimation of the array shape which is the foundation for phase compensation. The implemented system is real-time and lightweight, providing a reliable solution for maintaining optimal antenna performance under dynamically deformable conditions.

6. Digital Remote Phase Coherence between Bistatic Microwave Systems

Speaker: Yue Yu, PhD student, Zhejiang University

Remote, distance-independent phase coherence is a key and challenging technology for bi- and multi-static microwave systems. In this talk, we introduce a digital implementation of the phase coherence based on distributed circuit systems designed with remote phase-locked loops. Taking advantage of the high anti-interference performance of digital circuits, analog signals can be discretized, and the closed-loop operation can be easily implemented by a micro-controller unit (MCU). Analysis, simulation and experiments show that the proposed system can be used to achieve a range-independent phase coherence for remote bistatic systems, establishing phase synchronizations between different microwave systems.