

张 柘 (Zhe Zhang)

研究员, 博士生导师
国家 “海外优青”
中科院 “百人计划”, 江苏省 “双创人才”, 苏州市 “姑苏领军人才”
Professor, Ph.D. Supervisor

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DOB: 01/31/1988
OFFICE (SUZHOU): Room B203-12, Lab 22
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Working Experience (工作经历)

2023.01–	Lab Director Assistant (主任助理), Academic Leader (学术带头人)
2022.04–	Professor (研究员), Ph.D Supervisor (博士生导师)
2021.01–2022.04	Associate Professor (副研究员, “百人计划” 创新研究员), 硕士生导师 Aerospace Information Research Institute, CAS 中国科学院空天信息创新研究院 , Beijing 100190, China Suzhou Aerospace Information Research Institute 苏州空天信息研究院 , Suzhou, Jiangsu 215000, China 研究方向: 稀疏信号处理, 稀疏微波成像, 合成孔径雷达, 三维成像, 深度学习与信号处理的结合, 机器学习.
2023.10–	Double Employed Professor (双聘教授) University of Chinese Academy of Sciences 中国科学院大学 , Beijing 100190, China
2023.09–	Adjunct Professor (兼职教授) Qian Xuesen Honors College, Xi'an Jiaotong University 西安交通大学, 钱学森学院 , Xi'an, Shaanxi 710049, China
2024.10–	Adjunct Professor (兼职教授) Harbin Engineering University 哈尔滨工程大学 , Harbin, Heilongjiang, China
2016.12–2020.06	Post-Doctoral Research Fellow (博士后研究员) George Mason University , Fairfax, VA 22030, USA Advisor: Tian, Zhi (田智), Professor, IEEE Fellow 研究方向: 稀疏信号处理, 原子范数优化, 深度学习与信号处理的结合.
2015.12–2016.11	Post-Doctoral Research Scientist (博士后研究员)

George Washington University, Washington, DC 20052, USA
Advisor: Tian, Zhi (田智), Professor, IEEE Fellow
Cheng, Xiuzhen (成秀珍), Professor, IEEE Fellow
研究方向: 稀疏信号处理, 原子范数优化.

Education (教育经历)

- 2009.09–2015.07 | PH.D. (工学博士) / 信号与信息处理
Institute of Electronics, Chinese Academy of Sciences
University of Chinese Academy of Sciences
中国科学院电子学研究所 / 中国科学院大学, Beijing 100190, China
Supervisor: 吴一戎, 中国科学院院士, 研究员
研究方向: 稀疏微波成像, 稀疏信号处理, 合成孔径雷达.
- 2014.01–2014.04 | VISITING STUDENT (访问学生)
University of Connecticut, Storrs, CT 06269, USA
Supervisor: Zhou, Shengli (周胜利), Professor, IEEE Fellow.
- 2004.09–2008.07 | B. ENG. (工学学士) / 信息工程, 电子与信息工程学院
2003.09–2004.07 | SPECIAL CLASS FOR GIFTED YOUNG (少年班)
Xi'an Jiaotong University
西安交通大学, Xi'an, Shaanxi 710049, China.

Research Projects (研究经历)

- 2023.12– | 多波束星载高分宽幅 SAR 系统技术, 2535 万元
资助: 国家重点研发计划, #2023YFB3904900
项目主持人 (首席科学家).
- 2023.1– | 稀疏信号处理及其在微波成像中的应用研究, 300 万元
资助: 国家自然科学基金 (NSFC) 优秀青年科学基金 (海外)
项目主持人.
- 2021.1–2023.12 | 稀疏信号处理与深度学习及其在微波成像中的应用, 400 万元
资助: 中国科学院 “百人计划”
项目主持人.
- 2021.12– | 微波三维成像的高效感知系统与技术的研发, 50 万元
资助: 苏州市科技发展项目, #ZXL2022381
项目主持人.
- 2023.1– | 智能边端系统算力评估与协同部署研究, 200 万元
资助: KJW * * * * 协同创新中心课题
课题负责人.
- 2023.1– | * * * * * SAR 成像处理与信息提取, 200 万元
资助: 中国科学院 * * * * * 重点部署项目

	课题负责人.
2021.7-	结构信号的自适应高效感知理论及在微波成像中的应用, 130 万元 资助: 中科院空天院前沿科学与颠覆性先导专项 项目主持人.
2023.1-	* * * * * 星载 SAR 系统技术, 8500 万元 资助: KJW * * * * 创新特区重点项目 项目核心参与人, 处理系统负责人.
2023.1-	街角盲区建筑布局重建机理与方法, 500 万元 资助: KJW * * * * 基础加强课题 子课题负责人.
2020.1-	合成孔径雷达微波视觉三维成像理论与应用基础研究, 2000 万元 资助: 国家自然科学基金 (NSFC) 重大项目, #61991421, 61991420 子课题负责人.
2018.8-2018.11	A Gated LFM CW TDMA MIMO SAR based Hidden Chamber Detector, 15 万美元 资助: USSOCOM SBIR, #S173-004-0118 信号处理及仿真负责人.
2015.12-2020.6	Task-Cognizant Sparse Sensing for Inference, 40 万美元 资助: National Science Foundation (NSF) Standard Grant, #1527396 参与.
2010.04-2015.07	稀疏微波成像的理论、体制和方法研究, 3300 万元 资助: 国家重大基础科学研究计划 (973 计划), #2010CB731900 机载部分负责人.
2012.04-2015.07	先进微波探测与信息处理, 430 万元 资助: 中国科学院 / 国家外国专家局 “创新团队” 合作伙伴计划 核心参与人.

Honors (荣誉)

2024.09	江苏省首席科技传播专家 / 江苏省科协
2024.11	Wiley 威立中国高贡献作者 (Wiley China Excellent Author Program) / Wiley
2022.01	国家优秀青年基金 (海外) / 国家自然科学基金委员会 (NSFC)
2021.01	中国科学院 “百人计划” / 中国科学院
2021.12	苏州市 “姑苏领军人才” / 苏州市
2022.12	江苏省 “双创人才” / 江苏省

2022 | 中国科学院“青年交叉团队”成员 / 中国科学院

Awards (获奖)

2022.03	全国颠覆性技术创新大赛 / 中华人民共和国科技部 总决赛优秀奖
2021.12	优胜奖
2021.12	优秀奖
2008.04	德州仪器 (TI) DSP 大奖赛 / <i>Texas Instruments</i> 优胜奖
2008.02	美国大学生数学建模竞赛 / <i>COMAP</i> <i>Meritorious</i> (一等奖)
2007.02	<i>Honorable Mentioned</i> (二等奖)
2006.09	中国大学生数学建模竞赛 / 中国工业与应用数学学会 (<i>CSIAM</i>) 二等奖

Professional Skills (专业技能)

专业方向: 深度学习/AI, 机器学习与信号处理方法的结合, 稀疏信号处理与低秩优化, 合成孔径雷达.

专业技能: 大型在线社区开发、运营与维护, Linux 运维, GNU 工具链, \LaTeX .
MATLAB, C/C++/Python/JavaScript.

Languages (语言)

ENGLISH: Professional (Reside in US for 5 years, CET-6/PETS-5/WSK pass, TOEFL 96)

JAPANESE: Fair

Hobbies (兴趣)

IT, 开源, 编程, Linux, 数码, 互联网.

音乐, 动漫, 历史, 常旅客.

Open Source Projects and Services (主持开源项目)

2006.04–2015.11	兵马俑 BBS (http://bbs.xjtu.edu.cn/ , http://bmybbs.com/) Host: https://github.com/bmybbs?type=source <i>Technical Leader</i> 兵马俑 BBS 是中国教育网最大的 BBS 站点之一, 属于西安交通大学. 兵马俑 BBS 服务 50000 多名用户, 同时在线数最高 5000. 项目代码超过 10 万行.
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2010.06–2019.04	科苑星空 BBS (http://bbsucas.ac.cn/ , http://kyxk.net/) <i>Technical Leader</i> 科苑星空 BBS 是中国科学院的官方社区. 科苑星空 BBS 服务 30000 多名用户, 同时在线数最高 1500. 项目代码超过 12 万行.
2018.09–	hCNN (https://github.com/pzhg/hCNN) <i>Principle Developer</i> hCNN 是一个开源的、深度学习与信号处理结合的开发框架, 可方便的进行深度学习开发与训练, 并与传统信号处理方法兼容.

Services (学术服务)

Professional Society Membership and Services (学术组织与服务)

2021.07–	Xi'an Jiaotong-Liverpool University (西交利物浦大学)
2021.11–	<i>External Mentor (校外导师)</i>
	<i>Pilotage Mentor (领航导师)</i>
	IEEE
2024.01–	<i>Senior Member</i>
2016.01–2024.01	<i>Member</i>
2010.01–2015.12	<i>Student Member</i>
	CSIG (中国图象图形学会)
	微波智能成像专业委员会 (筹)
2024.06–	专委会委员
	CNC-ISDE (国际数字地球学会中国国家委员会)
	微波对地观测专业委员会
2024.06–	专委会会员
	苏州市青科协
2024.11–	理事
	CIE (中国电子学会)
2021.04–	<i>Member (会员)</i>
	JSAAI (江苏省人工智能学会)
2020.11–	<i>Member (会员)</i>

Journal Reviewers (期刊审稿人)

- *IEEE Transactions on Signal Processing Journal*, SCI.
- *IEEE Signal Processing Letters Journal*, SCI.
- *IEEE Open Journal of Signal Processing Journal*, SCI.
- *IEEE Journal of Selected Topics in Signal Processing Journal*, SCI.
- *Signal Processing Journal*, SCI.

- *National Science Open Journal*, SCI.
- *IEEE Transactions on Geoscience and Remote Sensing Journal*, SCI.
- *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing Journal*, SCI.
- *IEEE Geoscience and Remote Sensing Letters Journal*, SCI.
- *IET Radar, Sonar & Navigation Journal*, SCI.
- *IET Electronics Letters Journal*, SCI.
- *IET Signal Processing Journal*, SCI.
- *Science China Information Science Journal*, SCI.
- *Cogent Engineering Journal*, SCI.
- 雷达学报 Journal, EI.

Organizing Committee Member and Technical Program Chair (学术会议组委会成员及学术主席)

- 2022 International Workshop on Microwave Vision and 3D SAR Imaging (MiViSAR 2022), Suzhou, China, Oct 17-19, 2022.

Session Chair (学术会议分会场主席)

- 2023 IET International Radar Conference, Chongqing, China, Dec 3-5, 2023.
- 2024 Photonics and Electromagnetics Research Symposium (PIERS), Chengdu, China, Apr 21-25, 2024.
- 2024 IEEE International Conference on Signal, Information and Data Processing (ICSIDP), Zhuhai, China, Nov 22-24, 2024.

TPC Member / Reviewer (学术会议学术委员会成员 / 审稿人)

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| <i>2024</i> | PIERS 2024, ICC 2024, CoSeRa 2024, EECSI 2024, Globecom2024, IJEECS 2024, EET 2024, ICSIDP 2024. |
| <i>2023</i> | EECSI 2023, iSemantic 2023, Globecom 2023, SIRS 2023, IJCDS 2023, IJEECS 2023, IET Radar 2023. |
| <i>2022</i> | EET 2022, EECSI 2022, IJCDS, IJECE 2021-22, FSDM 2022. |
| <i>2021</i> | IJEECS 2021, BEEI 2020-21, ICITech 2021, FSDM 2021, TELKOMNIKA 2021. |
| <i>2020</i> | CITEI 2020, SIRS 2020, FSDM 2020. |
| <i>2019</i> | SIRS 2019, DISP 2019 |

2018 | CoSeRa 2018, SIRS 2018, EECSI 2018, ICW-TELKOMNIKA 2018, FSDM 2018.

2017 | ICITech 2017, EECSI 2017, SIRS 2017, FSDM 2017.

2016 | CoSeRa 2016.

2015 | CoSeRa 2015, ISSPIT 2015, ICSPDM 2015.

Publications (Bold for Corresponding / First Authorship)

JOURNAL ARTICLES

1. Y. Zhao, D. Xiao, Z. Pan, B. W. K. Ling, Y. Tian, and **Z. Zhang***, “Sparse SAR Imaging Based on Non-Local Asymmetric Pixel-Shuffle Blind Spot Network,” *Remote Sens.*, vol. 16, no. 13, p. 2367, Jun. 2024, doi: 10.3390/rs16132367.
2. X. Qiu, Y. Luo, S. Song, L. Peng, Y. Cheng, Q. Yan, S. Shangguan, Z. Jiao, **Z. Zhang**, and C. Ding, “Microwave Vision Three-dimensional SAR Experimental System and Full-polarimetric Data Processing Method,” *Journal of Radars*, vol. 13, no. 5, pp. 941–954, Sep. 2024, doi: 10.12000/JR24137, in Chinese.
3. S. Gao, M. Wang, **Z. Zhang***, B. Zhang, and Y. Wu, “Efficient Gridless DOA Estimation for Nonuniformly Spaced Linear Arrays in Automotive Radar Sensors,” *IEEE Sens. J.*, vol. 24, no. 17, pp. 27737–27749, Sep. 2024, doi: 10.1109/JSEN.2024.342
4. M. Wang, X. Qiu*, **Z. Zhang**, and S. Gao, “A domain adaptation framework for cross-modality SAR 3D reconstruction point clouds segmentation utilizing LiDAR data”, *Int. J. Appl. Earth Obs. Geoinf.*, vol. 133, p. 104103, Sep. 2024, doi: 10.1016/j.jag.2024.104103.
5. Y. Wu, R. Song, **Z. Zhang***, X. Qiu, and W. Yu, “GSAT-Net: An Azimuth Ambiguity Suppression Network Based on Group Sparsity and Adaptive Threshold for Undersampling SAR Imaging,” *IEEE Geosci. Remote Sens. Lett.*, vol. 21, pp. 1–5, 2024, doi: 10.1109/LGRS.2024.3452796.
6. S. Gao, M. Wang, **Z. Zhang***, B. Zhang, and Y. Wu, “Efficient gridless 2D DOA estimation based on generalized matrix-form atomic norm minimization,” *Electron. Lett.*, vol. 60, no. 10, p. e13212, May 2024, doi: 10.1049/ell2.13212..
7. Y. Zhao, C. Ou, H. Tian, B. W.-K. Ling, Y. Tian, and **Z. Zhang***, “Sparse SAR Imaging Algorithm in Marine Environments Based on Memory-Augmented Deep Unfolding Network,” *Remote Sens.*, vol. 16, no. 7, p. 1289, Apr. 2024, doi: 10.3390/rs16071289.
8. S. Gao, W. Wang, M. Wang, **Z. Zhang***, Z. Yang, X. Qiu, B. Zhang, and Y. Wu, “A Robust Super-resolution Gridless Imaging Framework for UAV-borne SAR Tomography,” *IEEE Trans. Geosci. Remote Sens.*, vol. 62, pp. 1–17, 2024, doi: 10.1109/TGRS.2024.3393972..
9. Z. Wang, Z. Wang, X. Qiu, and **Z. Zhang***, “Global Polarimetric Synthetic Aperture Radar Image Segmentation with Data Augmentation and Hybrid Architecture Model,” *Remote Sens.*, vol. 16, no. 2, p. 380, Jan. 2024, doi: 10.3390/rs16020380.

10. Y. Zhao, Q. Liu, H. Tian, B. W.-K. Ling, and Z. Zhang*, "DeepRED Based Sparse SAR Imaging," *Remote Sens.*, vol. 16, no. 2, p. 212, Jan. 2024, doi: 10.3390/rs16020212.
11. Y. Zhao, Q. Liu, H. Tian, M. Luo, B. W.-K. Ling, and Z. Zhang*, "New convex approaches to general MVDR robust adaptive beamforming problems," *Electron. Lett.*, vol. 59, no. 18, p. e12957, Sep. 2023, doi: 10.1049/ell2.12957.
12. Y. Bai, J. Kang, X. Ding, A. Zhang, Z. Zhang, and N. Yokoya, "LaMIE: Large-Dimensional Multipass InSAR Phase Estimation for Distributed Scatterers," *IEEE Trans. Geosci. Remote Sens.*, vol. 61, pp. 1–15, Nov. 2023, doi: 10.1109/TGRS.2023.3330971.
13. D. Zhao, Z. Zhang*, D. Lu, J. Kang, X. Qiu, and Y. Wu, "CVGG-Net: Ship Recognition for SAR Images Based on Complex-Valued Convolutional Neural Network," *IEEE Geosci. Remote Sens. Lett.*, vol. 20, pp. 1–5, 2023, doi: 10.1109/LGRS.2023.3316133.
14. M. Shao, Z. Zhang*, J. Li, J. Kang, and B. Zhang, "TADCG: A Novel Gridless Tomographic SAR Imaging Approach Based on the Alternate Descent Conditional Gradient Algorithm With Robustness and Efficiency," *IEEE Trans. Geosci. Remote Sens.*, vol. 62, pp. 1–13, 2024, doi: 10.1109/TGRS.2023.3345454.
15. Y. Wu, Z. Zhang*, X. Qiu, Y. Zhao, and W. Yu, "MF-JMoDL-Net: A Sparse SAR Imaging Network for Undersampling Pattern Design towards Suppressed Azimuth Ambiguity," *IEEE Trans. Geosci. Remote Sens.*, vol. 62, pp. 1–18, 2024, doi: 10.1109/TGRS.2024.3397826..
16. G. Zhou, Z. Xu, Y. Fan, Z. Zhang, X. Qiu, B. Zhang, K. Fu* and Y. Wu, "HPHR-SAR-Net: Hyper-pixel High-resolution SAR Imaging Network Based on Nonlocal Total Variation," *IEEE J. Sel. Top. Appl. Earth Obs. Remote Sens.*, vol. 16, pp. 8595–8608, 2023, doi: 10.1109/JSTARS.2023.3295728.
17. M. Wang, Z. Zhang*, X. Qiu, S. Gao, and Y. Wang, "ATASI-Net: An Efficient Sparse Reconstruction Network for Tomographic SAR Imaging with Adaptive Threshold," *IEEE Trans. Geosci. Remote Sens.*, vol. 61, pp. 1–18, 2023, doi: 10.1109/TGRS.2023.3268132.
18. R. Shi, Z. Zhang*, X. Qiu, and C. Ding, "A Novel Gradient Descent Least-Squares (GDLs) Algorithm for Efficient Gridless Line Spectrum Estimation With Applications in Tomographic SAR Imaging," *IEEE Trans. Geosci. Remote Sens.*, vol. 61, pp. 1–13, 2023, doi: 10.1109/TGRS.2023.3273568.
19. J. Li, Z. Xu, Z. Li, Z. Zhang*, B. Zhang, and Y. Wu, "An Unsupervised CNN-Based Multichannel Interferometric Phase Denoising Method Applied to TomoSAR Imaging," *IEEE J. Sel. Top. Appl. Earth Obs. Remote Sens.*, vol. 16, pp. 3784–3796, Jul. 2023, doi: 10.1109/JSTARS.2023.3263964.
20. Y. Zhao, Y. Chen, H. Tian, X. Quan, B. W.-K. Ling, and Z. Zhang*, "Wide angle SAR imaging method based on hybrid representation," *Electron. Lett.*, vol. 59, no. 15, p. e12897, Aug. 2023, doi: 10.1049/ell2.12897.
21. P. Jiang, Z. Zhang*, B. Zhang, and Z. Xu, "A novel TomoSAR imaging method with few observations based on nested array," *IET Radar, Sonar Navig.*, vol. 17, no. 6, pp. 925–938, Jun. 2023, doi: 10.1049/rsn2.12388.

22. J. Kang*, T. Ji, Z. Zhang, and R. Fernandez-Beltran, "SAR Time Series Despeckling via Nonlocal Matrix Decomposition in Logarithm Domain," *Signal Processing*, vol. 209, p. 109040, Aug. 2023, doi: 10.1016/j.sigpro.2023.109040.
23. J. Kang*, F. Tong, Y. Bai, T. Ji, and Z. Zhang*, "SAR Time Series Despeckling and Component Analysis Method based on Matrix Decomposition," *Journal of Radars*, vol. 12, no. 5, pp. 1031–1043, Mar. 2023, doi: 10.12000/JR22242, in Chinese.
24. X. Ding, J. Kang*, Z. Zhang, Y. Huang, J. Liu, and N. Yokoya, "Coherence-Guided Complex Convolutional Sparse Coding for Interferometric Phase Restoration," *IEEE Trans. Geosci. Remote Sens.*, vol. 60, pp. 1–14, 2022, doi: 10.1109/TGRS.2022.3228279.
25. Z. Zhu, J. Kang*, T. Ji, Z. Zhang, and R. Fernandez-Beltran, "SAR Time-Series Despeckling via Nonlocal Total Variation Regularized Robust PCA," *IEEE Geosci. Remote Sens. Lett.*, vol. 19, pp. 1–5, 2022, doi: 10.1109/LGRS.2022.3227187.
26. Y. Zhao, W. Huang, X. Quan, W.-K. Ling, and Z. Zhang*, "Data-driven sampling pattern design for sparse spotlight SAR imaging," *Electron. Lett.*, vol. 58, no. 24, pp. 920–923, Nov. 2022, doi: 10.1049/ELL2.12650.
27. Z. Xu, B. Zhang, Z. Zhang*, M. Wang, and Y. Wu, "Nonconvex-Nonlocal Total Variation Regularization Based Joint Feature-Enhanced Sparse SAR Imaging," *IEEE Geosci. Remote Sens. Lett.*, vol. 19, pp. 1–1, 2022, doi: 10.1109/lgrs.2022.3222185.
28. Z. Lyu, X. Qiu*, Z. Zhang and C. Ding, "Error Analysis of Polarimetric Interferometric SAR under Different Processing Modes In Urban Areas," *Journal of Radars*, 2022, doi: 10.12000/JR22059, in Chinese.
29. Z. Xu, G. Zhou, B. Zhang, Z. Zhang* and Y. Wu, "Sparse Regularization Method Combining SVA for Feature Enhancement of SAR Images," *Electronics Letters*, Jun. 2022, doi: 10.1049/ell2.12509.
30. Y. Zhao, J. Xu, X. Quan, L. Cui and Z. Zhang*, " L_1 Minimization with Perturbation for Off-grid Tomographic SAR Imaging," *Journal of Radars*, vol. 11, no. 1, pp. 52-61, 2022, in Chinese.
31. B. Du, X. Qiu*, Z. Zhang, B. Lei and C. Ding, "Tomographic SAR Imaging Method Based on Sparse and Low-rank Structures," *Journal of Radars*, vol. 11, no. 1, pp. 62-70, 2022, in Chinese.
32. Z. Zhang*, B. Zhang, C. Jiang, X. Liang, L. Chen, W. Hong and Y. Wu, "The First Airborne Experiment of Sparse Microwave Imaging: Prototype System Design and Result Analysis," Available: <http://arxiv.org/abs/2110.10675>.
33. Z. Zhang*, Y. Wang, and Z. Tian, "Efficient Two-Dimensional Line Spectrum Estimation Based on Decoupled Atomic Norm Minimization," *Signal Processing*, Vol. 163, pp. 95-106, 2019.
34. Z. Zhang*, B. Zhang, W. Hong and Y. Wu, "Accelerated Error Compensation Algorithm of Sparse Microwave Imaging with Combination of Map-drift and SAR Raw Data Simulator," *Journal of Radars*, vol. 5, no. 1, pp. 25-34, 2016, in Chinese.
35. B. Zhang, Z. Zhang*, C. Jiang, Y. Zhao, W. Hong and Y. Wu, "System Design and First Airborne Experiment of Sparse Microwave Imaging Radar: Initial Results," *Science China Information Sciences (Series F)*, vol. 58, no. 6, 2015.

36. C. Jiang*, Y. Zhao, Z. Zhang, B. Zhang, and W. Hong, "Azimuth Sampling Optimization Scheme for Sparse Microwave Imaging Based on Mutual Coherence Criterion," *Journal of Electronics and Information Technology*, vol. 37, no. 3, 2015.
37. Y. Wu, W. Hong, B. Zhang*, C. Jiang, Z. Zhang and Y. Zhao, "Current Developments of Sparse Microwave Imaging," *Journal of Radars*, vol.3, no. 4, pp. 383–395, 2014, in Chinese.
38. C. Jiang*, B. Zhang, J. Fang, Z. Zhang, W. Hong, Y. Wu and Z. Xu, "An efficient Lq regularization algorithm with range-azimuth decoupled for SAR imaging," *Electronics Letters*, vol. 50, no. 3, pp. 204–205, 2014.
39. Z. Zhang*, B. Zhang, C. Jiang, Y. Xiang, W. Hong, and Y. Wu, "Influence factors of sparse microwave imaging radar system performance: approaches to waveform design and platform motion analysis," *Science China Information Sciences (Series F)*, vol. 55, no. 10, pp. 2301–2317, 2012.
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