

Radar Target Recognition Based on Electromagnetic Scattering Characteristics and Simulated Echo Data

Chang Liu^a, Lele Cui^a, Zhifa Wang^a, Zien Zhang^a, Zeyu Jin^a, Guangwei Zhang^{a,b,*}

^a School of Mechatronic Engineering, Beijing Institute of Technology, China

^b Science and Technology on Electromechanical Dynamic Control Laboratory, China

* Corresponding author

liuchang0118@bit.edu.cn, 3120240256@bit.edu.cn, 3397073817@qq.com, 1732955442@qq.com, 758743342@qq.com, 6120240118@bit.edu.cn

Abstract—In complex electromagnetic environments, noise, rough-surface scattering, and clutter severely degrade radar target recognition performance. To enhance recognition capability under low Signal-to-Noise Ratio (SNR) conditions, this paper proposes a radar target recognition method that integrates electromagnetic scattering modelling, CST-based Radar Cross Section (RCS) simulation, and an improved one-dimensional Convolutional Neural Network (1D CNN). High-fidelity Linear Frequency-Modulated (LFM) echo signals are constructed from CST-based multi-angle RCS data. A wavelet transform module, a convolutional denoising block, and the Transformer are introduced to strengthen multi-scale feature representation and noise robustness. Experimental results demonstrate that the proposed model outperforms conventional CNN methods in terms of accuracy and F1-score, and maintains a recognition rate of 93% in low-SNR scenarios, indicating strong robustness and practical applicability.

Keyword—Radar Target Recognition, Target Scattering Characteristics, RCS Simulation, CNN, LFM Radar Echo



Chang Liu received the B.S. degree in Mechatronic Engineering from the Beijing Institute of Technology, Beijing, China, in July 2025. She is currently pursuing the M.S. degree with the School of Mechatronic Engineering, Beijing Institute of Technology. Her research interests include deep learning, signal classification, and signal processing.



Lele Cui received the BS degree in Mechatronic Engineering from Beijing Institute of Technology in 2024, having graduated as an undergraduate student. He is now pursuing his MS degree in School of Mechatronic Engineering at the same institution. His research interests include wireless network simulation and wireless communication.



Zhifa Wang received the BS degree from Beijing Institute of Technology in 2025. He is currently pursuing a Master's degree in the School of Mechatronic Engineering at Beijing Institute of Technology. His research interests include signal processing, signal classification, object recognition, and related applications in intelligent systems.



Zeyu Jin received the BS degree in Beijing Institute of Technology in 2025. Now he is a master degree candidate in School of Mechatronic Engineering, Beijing Institute of Technology. His research interests include signal processing, signal classification, machine learning and so on.



Zien Zhang obtained his Bachelor of Engineering degree from China Agricultural University in 2024. Currently, he is a master's student at the School of Mechatronical Engineering, Beijing Institute of Technology. His research interests include signal processing, target detection, and fuze jamming.



Guangwei Zhang received Ph.D. degree in school of Mechatronical Engineering from Beijing Institut in 2021. He is currently pursuing the postdoctor in Beijing Institute of Technology, while working at the Science and Technology on Electromechanical Dynamic Control Laboratory. He is working radar signal processing and intelligent detection, network simulation and emulation and so on.