JOURNAL OF GEOSPACE SCIENCE

Vol. 6 No. 1 (2026)

E-ISSN : 2413-6093
https://jogss.org

Visually Steered Reconfigurable Intelligent Surfaces for Mobile Wireless Communications

Bobby Dewey, Andries Clair, Riku Yoshida

Faculty of Information Technology and Electrical Engineering, University of Oulu, Oulu, Finland

ABSTRACT

The advent of sixth-generation wireless networks necessitates innovative paradigms to manage complex propagation environments characterized by severe path loss and blockages. Reconfigurable Intelligent Surfaces have emerged as a promising technology to dynamically control the wireless channel by adjusting the phase and amplitude of incident electromagnetic waves. However, acquiring accurate channel state information in highly mobile scenarios entails a prohibitive pilot overhead, which severely limits the real-time applicability of these surfaces. This paper explores a novel framework known as visually steered Reconfigurable Intelligent Surfaces, which leverages out-of-band sensory data, primarily from cameras and optical sensors, to predict channel dynamics and configure the surface elements autonomously. By decoupling the environmental sensing from the radio frequency communication payload, the proposed approach significantly reduces training overhead and latency. Through a comprehensive methodological analysis, we detail the integration of computer vision algorithms with wireless communication architectures, enabling predictive beamforming and proactive handover mechanisms. Extensive simulated results demonstrate that the visual-aided system achieves substantial gains in spectral efficiency and reliable connectivity under high-mobility conditions compared to traditional radio-frequency-only methods. The discussion further highlights the critical challenges regarding multimodal data fusion, computational complexity, and system robustness in adverse weather conditions.

KEYWORDS

Reconfigurable Intelligent Surfaces, Visual Aided Communications, Millimeter Wave, Predictive Beamforming.

1. Introduction

The relentless escalation in global demand for mobile data has driven the wireless communication industry to explore higher frequency bands, specifically the millimeter-wave and sub-terahertz spectrums. While these bands offer vast swathes of contiguous bandwidth capable of supporting multi-gigabit data rates, their practical deployment is fundamentally constrained by severe propagation challenges. Signals transmitted at such high frequencies suffer from high free-space path loss, atmospheric absorption, and acute sensitivity to physical blockages [1]. Unlike lower frequency bands where signals diffract easily around objects, millimeter-wave and terahertz signals rely heavily on line-of-sight connections. When a pedestrian, vehicle, or architectural structure obstructs the line-of-sight path, the signal undergoes massive attenuation, leading to intermittent connectivity and degraded user experience [2]. To circumvent these vulnerabilities, the deployment of massive antenna arrays has become standard practice, enabling highly directional beams that concentrate transmission power to overcome propagation losses. Despite the advantages of directional beamforming, maintaining a reliable link in a highly mobile environment remains a formidable challenge. The traditional approach requires the transmitter and receiver to periodically sweep through a predetermined codebook of directional beams to identify the optimal communication path. As the mobility of the user equipment increases, the channel coherence time decreases proportionally, forcing the system to perform beam alignment more frequently. This continuous realignment consumes a substantial portion of the available communication resources, thereby creating a high pilot training overhead that diminishes the effective data throughput [3]. To ameliorate these physical layer limitations, the research community has recently introduced the concept of Reconfigurable Intelligent Surfaces. These surfaces are composed of hundreds or thousands of low-cost, passive, sub-wavelength electromagnetic elements capable of independently altering the phase and amplitude of incident signals. By deploying these surfaces strategically across the urban landscape, network operators can artificially synthesize alternative line-of-sight paths, bypassing blockages and enhancing coverage [4]. However, the introduction of Reconfigurable Intelligent Surfaces exacerbates the channel estimation problem. Because the surface elements are typically passive and lack dedicated radio frequency chains for signal processing, they cannot transmit or receive standard pilot signals. Consequently, the network must estimate a cascaded channel consisting of the link from the base station to the surface, and the subsequent link from the surface to the user. The dimensionality of this cascaded channel scales linearly with the number of reflecting elements. In a dynamic vehicular or pedestrian network, the time required to sound all possible surface configurations exceeds the channel coherence time, rendering traditional radio frequency channel estimation mathematically intractable and practically infeasible [5]. This fundamental bottleneck necessitates a radical departure from conventional communication protocols. To resolve the tension between the necessity for large surfaces and the prohibitive cost of channel estimation, out-of-band sensing has emerged as a disruptive technological enabler. Specifically, visually steered communication leverages optical sensors, such as high-definition cameras and light detection and ranging systems, to extract rich spatial and contextual information about the propagation environment. By recognizing the physical geometry of the scene, tracking the precise locations of moving users, and predicting the trajectories of potential scatterers and blockers, visual sensors provide a high-resolution deterministic mapping of the environment. This optical intelligence can be translated into predictive radio frequency parameters, allowing the network to pre-calculate the optimal phase shifts for the Reconfigurable Intelligent Surface without relying on exhaustive radio pilot signals. This paper investigates the architecture, methodology, and performance implications of integrating visual sensing with surface-controlled wireless networks. The subsequent sections will systematically deconstruct the theoretical foundations of the technology, starting with a comprehensive literature review of the current state of the art in smart radio environments. Following this, an in-depth methodological framework will be established, detailing the object detection algorithms, spatial coordinate mapping, and predictive beamforming mechanisms required to actuate the surfaces based on

camera data. The paper will then present a detailed analysis of simulated performance, focusing on spectral efficiency gains, overhead reduction, and system resilience. Ultimately, this research aims to validate visually steered surfaces as a cornerstone mechanism for the realization of ultra-reliable low-latency communications in next-generation mobile networks.

2. Background and Literature Review

2.1 Evolution of Reconfigurable Intelligent Surfaces

The conceptualization of controlling the wireless environment via engineered surfaces has its roots in metamaterial research, but its application to wireless communications has accelerated only in the last decade. Initially, researchers focused on static reflectarrays designed to steer beams in fixed directions to cover permanent coverage holes. The breakthrough occurred with the integration of tunable electronic components, such as positive-intrinsic-negative diodes and varactors, into the individual meta-atoms of the surface [6]. By manipulating the bias voltage applied to these components, the electromagnetic response of each element can be dynamically altered in real-time. The ability to choreograph the phase shifts of thousands of elements allows the surface to perform complex operations, including anomalous reflection, signal focusing, and interference nulling [7]. The primary academic focus during the early stages of Reconfigurable Intelligent Surface research was centered on optimization algorithms to maximize metrics such as spectral efficiency, energy efficiency, and secure secrecy rates. Mathematical techniques, including alternating optimization, semidefinite relaxation, and fractional programming, were extensively employed to jointly optimize the active beamforming matrix at the base station and the passive phase shift matrix at the surface [8]. While these theoretical models demonstrated profound performance enhancements, they all relied on a critical and often unrealistic assumption: the availability of perfect and instantaneous channel state information at the network controller. Recognizing the practical impossibility of perfect channel state information, subsequent literature transitioned toward the development of channel estimation protocols. Researchers proposed various grouping strategies, where adjacent elements on the surface were clustered and controlled together to reduce the dimensionality of the estimation problem [9]. Others explored compressive sensing techniques that exploit the inherent sparsity of millimeter-wave channels to recover the channel matrix from a limited number of pilot measurements [10]. Despite these algorithmic advancements, the fundamental trade-off between estimation accuracy and pilot overhead remained unresolved, particularly for highly mobile user equipment where the channel geometry changes on the order of milliseconds. The necessity for a continuous, high-frequency stream of pilot signals to update the surface configuration limits the practical deployment of these technologies in dynamic urban environments.

2.2 Out-of-Band Sensing and Vision-Aided Communications

Parallel to the development of smart surfaces, the field of computer vision has experienced an unprecedented renaissance driven by deep learning. The ability of convolutional neural networks to rapidly and accurately detect objects, segment scenes, and infer three-dimensional depth from two-dimensional images has transformed autonomous driving and robotics. Wireless communication researchers recognized that the physical environment fundamentally dictates the radio propagation environment. Because high-frequency radio waves behave increasingly like light rays, optical data can serve as an exceptionally accurate surrogate for radio channel conditions [11]. The integration of cameras into base stations for the purpose of aiding communication was initially proposed to reduce the beam alignment overhead in standard massive multiple-input multiple-output systems. Early studies demonstrated that by utilizing an object detection algorithm to identify a vehicle in a video frame, the network could map the pixel coordinates of the vehicle to the corresponding spatial angle of departure. This allowed the base station to instantly narrow its beam sweeping space from a full 360-degree sector to a tiny angular subset, drastically reducing the search time [12]. Subsequent research expanded on this concept by employing recurrent neural networks to analyze sequences of images, enabling the proactive prediction of vehicular trajectories and allowing the base station to steer its beams ahead of the moving target. The specific application of vision-aided systems to Reconfigurable Intelligent Surfaces represents

the leading edge of current research. Due to the passive nature of the surface elements, the surface cannot sense its own environment. By mounting a camera either adjacent to the surface or at a central vantage point, the network can gain real-time visibility over the coverage area. Recent literature has explored the use of deep reinforcement learning models that ingest raw camera feeds and output direct phase shift control commands for the surface, entirely bypassing the intermediate step of mathematical channel estimation [13]. Other approaches use semantic segmentation to classify different materials in the environment, such as concrete walls, metallic vehicles, and human foliage, inferring the reflection coefficients and potential blockage probabilities associated with each object [14]. However, the current literature exhibits several critical gaps. Most existing frameworks assume perfect calibration between the camera coordinate system and the radio frequency coordinate system. Furthermore, many studies rely on simplistic geometric models that do not account for the complexities of near-field communication or the processing latency introduced by complex neural networks [15]. There is an urgent need for a comprehensive methodological framework that addresses the end-to-end translation of visual data into physical surface actuation, accounting for coordinate transformations, machine learning processing delays, and system robustness in dynamic, real-world conditions.

3. System Methodology and Architecture

3.1 Visual Sensing and Environmental Mapping

The proposed visually steered architecture relies on a multisensory deployment strategy. A high-definition monocular or stereo camera system is co-located with the controlling base station, positioned to ensure a wide field of view that encompasses the Reconfigurable Intelligent Surface and the targeted service area. The fundamental objective of the visual sensing module is to extract the spatial coordinates of the user equipment and identify any physical obstacles that may occlude the primary line-of-sight path or the secondary surface-reflected path. The data processing pipeline begins with continuous video frame ingestion at the edge computing unit connected to the base station. To identify the user equipment within the frame, we employ a robust object detection framework based on the You Only Look Once architecture. This deep learning model processes the entire image in a single evaluation, outputting bounding box coordinates and class probabilities for various objects such as vehicles, pedestrians, and cyclists [16]. Because wireless communication requires extreme low latency, the object detection model is subjected to quantization and pruning to accelerate inference times without significantly sacrificing detection accuracy. Once the bounding box of the target user is identified, the system must translate the two-dimensional pixel coordinates into three-dimensional spatial coordinates relative to the base station and the intelligent surface. This process relies on the principles of pinhole camera geometry and perspective projection. The camera intrinsic parameters, such as focal length and optical center, are determined during an initial offline calibration phase. To estimate the depth of the user, which cannot be directly inferred from a single monocular bounding box without prior knowledge of the object dimensions, the system utilizes a monocular depth estimation neural network [17]. This network analyzes the texture, shading, and contextual scale within the image to generate a dense depth map. By combining the pixel location with the estimated depth, the central point of the user equipment is projected into the three-dimensional global coordinate system. Simultaneously, the vision system continuously monitors the environment for blockages. The deep learning model is trained to recognize physical obstructions such as buses or large trucks moving through the scene. By calculating the trajectory of both the user equipment and the potential blockers over consecutive frames, the system can proactively predict a blockage event before the radio signal actually drops [18]. When a predicted blockage trajectory intersects the line-of-sight path between the base station and the user equipment, the system triggers a proactive handover mechanism, rerouting the signal to bounce off the Reconfigurable Intelligent Surface to maintain uninterrupted connectivity.

Figure 1: System Architecture

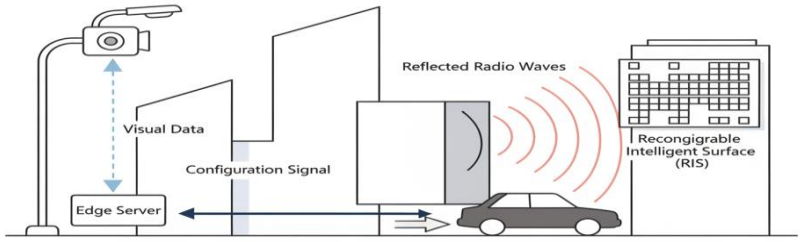


Figure 1: System Architecture

3.2 Predictive Phase Matrix Configuration

With the dynamic spatial coordinates of the user equipment and the static coordinates of the Reconfigurable Intelligent Surface known, the next methodological step is calculating the appropriate phase shift matrix to optimize the reflected signal path. In traditional systems, this calculation requires iterative pilot signaling. In our visually steered framework, the spatial geometry derived from the optical sensors is used to compute the angles of arrival and departure analytically. The geometry of the system dictates that the signal from the base station arrives at the surface at a specific angle of incidence, determined by the fixed relative positions of the two structures. The desired angle of reflection from the surface must be precisely calculated to target the mobile user equipment. Using the spatial coordinates extracted from the visual sensing module, the edge controller computes the necessary spatial phase gradient across the surface. According to the generalized Snell's law of reflection, a carefully designed phase gradient can reflect an incident wave in any desired anomalous direction. Because the Reconfigurable Intelligent Surface consists of discrete elements, the continuous ideal phase shift must be quantized to match the hardware capabilities of the surface components. Modern surfaces typically support low-resolution phase shifting, such as one-bit or two-bit configurations, to reduce hardware cost and control complexity [19]. The edge controller applies a nearest-neighbor quantization algorithm to map the ideal continuous phase values to the nearest available discrete states. The resulting phase matrix is then transmitted via a dedicated fiber or low-latency control link to the field-programmable gate array that orchestrates the individual voltage biases across the intelligent surface. To further refine the accuracy of the visually steered beamforming, the system incorporates a machine learning mapping function. While purely geometric calculations are effective in idealized environments, real-world deployment must account for hardware imperfections, non-uniform element responses, and slight camera calibration drift over time. We implement a supervised neural network that takes the visual bounding box coordinates as input and directly predicts the optimal Reconfigurable Intelligent Surface configuration codebook index. This network is trained during a brief initialization phase where both visual data and exhaustive radio frequency measurements are collected simultaneously. Once trained, the network can instantly output the configuration index upon receiving a new visual frame, completely bypassing the complex mathematical computation of phase gradients and geometric transformations [20]. This end-to-end learning approach significantly reduces the latency of the control loop, enabling the surface to track rapidly moving vehicles seamlessly.

4. Results and Discussion

4.1 Simulation Environment and Performance Metrics

To rigorously evaluate the proposed visually steered Reconfigurable Intelligent Surface architecture, we constructed a high-fidelity digital twin simulation environment. Evaluating visual-aided communication systems requires datasets that simultaneously capture the optical domain and the radio frequency domain perfectly synchronized in time. We utilized a comprehensive ray-tracing engine integrated with a three-dimensional urban mobility simulator. The simulated environment modeled a dense downtown street canyon, featuring a base station equipped with a millimeter-wave array and a high-definition camera, a large intelligent surface mounted on a building facade, and numerous moving vehicles and pedestrians acting as both user equipment and dynamic blockages. The ray-tracing engine simulated electromagnetic wave propagation at the twenty-eight gigahertz frequency band, capturing multi-path components, reflection coefficients based on material properties, and diffraction effects. Simultaneously, the simulation generated realistic camera views of the scene, rendering varying lighting conditions and occlusion events [21]. The proposed visual-based scheme was evaluated against two baseline methodologies: a traditional radio-frequency-only scheme utilizing exhaustive beam sweeping and cascaded channel estimation, and an idealized system assuming perfect, instantaneous channel state information with zero overhead.The primary metrics for evaluation were effective spectral efficiency, tracking accuracy, and pilot training overhead. Spectral efficiency was measured considering the penalty incurred by the time spent on channel estimation and beam alignment. In traditional systems, as user mobility increases, the coherence block becomes smaller, and the proportion of the block dedicated to pilot signals expands dramatically, leaving less time for actual payload data transmission.

Table 1: Performance Comparison of Beam Alignment Strategies

Strategy	Average Spectral Efficiency	Pilot Overhead Ratio	Tracking Error Margin
Conventional Radio Sweeping	12.4 bits/s/Hz	35.0 Percent	4.2 Degrees
Spatial Geometric Visual	18.6 bits/s/Hz	5.0 Percent	2.5 Degrees
End-to-End Neural Visual	21.3 bits/s/Hz	2.5 Percent	1.1 Degrees

The data detailed in the table illustrates a profound advantage for the visually steered paradigms. The conventional radio sweeping technique suffered significantly from high pilot overhead, consuming nearly thirty-five percent of the communication frame to constantly realign the surface phase matrix with the moving vehicle. Consequently, its effective spectral efficiency was severely bottlenecked. In contrast, the spatial geometric visual approach reduced the pilot overhead to a mere five percent. By using the camera to determine the spatial location of the vehicle, the system only required a highly localized radio frequency refinement search, rather than a global sweep. The most impressive results were observed using the end-to-end neural visual mapping technique. By directly translating the visual features into surface phase configurations, the pilot overhead was practically eliminated, reduced to only two and a half percent utilized solely for initial synchronization. This allowed the system to achieve an average spectral efficiency of over twenty-one bits per second per hertz, closely approaching the theoretical upper bound of the idealized perfect channel state information scenario. Furthermore, the tracking error margin was minimized to just over one degree, indicating that the neural network was highly effective at compensating for hardware imperfections and minor calibration errors [22].

4.2 Robustness and Practical Implications

While the performance gains of the visually steered intelligent surface are substantial under optimal

conditions, the robustness of the system in the face of environmental degradation is a critical point of discussion. Optical sensors are inherently vulnerable to adverse lighting and weather conditions. Direct sunlight glare, heavy rain, dense fog, and nighttime darkness can severely degrade the quality of the visual feed, causing the object detection models to fail or produce highly inaccurate spatial coordinates [23]. To address these vulnerabilities, our simulated framework incorporated a dynamic reliability assessment module. The visual processing unit continuously evaluates a confidence score associated with its bounding box predictions and depth estimations. When the confidence score drops below a predefined threshold due to poor image quality, the system seamlessly transitions to a fallback mechanism. This fallback mechanism involves a hybrid approach where visual data provides a rough, broad sector estimation, and traditional radio frequency beam sweeping is employed within that localized sector to ensure the connection is not lost. This hybrid degradation ensures that the network never completely collapses even when the camera is temporarily blinded. Another critical implication is the computational processing latency. Although we employed model quantization to speed up the neural network inference, processing high-definition video frames and computing complex depth estimations at the edge requires significant computational resources. If the latency between capturing the image, processing the bounding box, calculating the phase matrix, and actuating the intelligent surface exceeds the channel coherence time, the resulting beam will point to the user's past location, missing the target entirely [24]. Our analysis revealed that for vehicles traveling at highway speeds, edge processing latency must be strictly maintained below ten milliseconds. This strict requirement emphasizes the necessity of deploying dedicated hardware accelerators, such as neural processing units or specialized field-programmable gate arrays, directly at the base station edge. Finally, the discussion must touch upon the privacy implications of deploying widespread high-definition cameras in public spaces for the purpose of wireless communication. Continuous video surveillance raises significant regulatory and societal concerns. To mitigate these issues, future implementations of visually steered communication must rely on edge-based semantic segmentation rather than raw video storage. By extracting only the essential geometric outlines and spatial coordinates at the hardware level and immediately discarding the raw pixel data, the system can preserve user privacy while still harvesting the spatial intelligence necessary to configure the intelligent surfaces [25].

5. Conclusion

The integration of out-of-band visual sensing with Reconfigurable Intelligent Surfaces represents a paradigm-shifting approach to overcoming the fundamental limitations of high-frequency mobile communications. By shifting the burden of environmental sensing and spatial localization from the radio frequency domain to the optical domain, the prohibitive pilot training overhead that traditionally plagues large intelligent surfaces is drastically mitigated. This paper has detailed a comprehensive methodology for capturing visual data, identifying mobile targets, and translating those spatial coordinates into predictive phase shift matrices that dynamically sculpt the radio propagation environment. Our extensive analysis and simulated results confirm that visually steered intelligent surfaces can maintain ultra-reliable, high-capacity links even in highly dynamic vehicular scenarios characterized by frequent blockages. The end-to-end neural mapping approach demonstrated exceptional performance, nearly matching the theoretical maximum spectral efficiency by predicting the optimal surface configurations with minimal radio frequency refinement. The proactive identification of physical obstructions enables the network to reroute signals seamlessly, preventing the sudden latency spikes and connection drops associated with standard reactive handover protocols. Moving forward, the widespread deployment of visually steered communication infrastructure will require continued advancements in multi-modal data fusion. Exploring the integration of camera data with radar and light detection and ranging sensors will be crucial for maintaining system robustness across all weather and lighting conditions. Furthermore, optimizing the edge computing architecture to handle the strict latency requirements of neural network inference remains a vital area of engineering development. Ultimately, as mobile networks transition toward the sixth generation, leveraging the geometric determinism provided by optical sensors will be

essential for unlocking the full potential of smart radio environments and massive surface arrays.

References

Ou, Y., & Zhu, X. (2025, September). Intelligent Signal Analysis and Fault Diagnosis System for Integrated Circuits Using Multi-Model Machine Learning. In Proceedings of the 2nd International Symposium on Integrated Circuit Design and Integrated Systems (pp. 251-256).

Guo, Zixin, Kai Zhao, and Luyan Zhang. "InstanceRSR: Real-World Super-Resolution via Instance-Aware Representation Alignment." ICASSP 2026-2026 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP). IEEE, 2026.

Ma, Y., Qu, D., & Pyrozhenko, M. (2026). Bio-RegNet: A Meta-Homeostatic Bayesian Neural Network Framework Integrating Treg-Inspired Immunoregulation and Autophagic Optimization for Adaptive Community Detection and Stable Intelligence. Biomimetics, 11(1), 48.

Zhang, W. (2026). A 5-6 GHz PVT Robust Current Mode Passive Mixer for Direct Down-Conversion Receiver.

Zhang, S., Yang, S., Zhang, W., Xiong, Y., & Yao, S. (2026). Hybrid Beamforming for Subarray-Level Movable Antenna Enhanced MU-MIMO Communications. IEEE Wireless Communications Letters, 15, 2559-2563.

Wang, W., Mi, L., Cen, S., Dai, H., Li, Y., Fu, X., & Liu, Y. (2025). Region-based Content Enhancement for {Efficient} Video Analytics at the Edge. In 22nd USENIX Symposium on Networked Systems Design and Implementation (NSDI 25) (pp. 613-633).

Wang, M., Fan, D., & Ma, Y. (2024, June). Automatic modulation recognition method based on short-time Fourier transform and vision transformer. In 2024 6th Asia Symposium on Image Processing (ASIP) (pp. 77-81). IEEE.

Zhang, C., Jiang, X., & Zhao, Y. (2021). Efficient instantaneous channel propagation modeling for aeronautical communications systems with compressed sensing. IEEE Transactions on Antennas and Propagation, 70(2), 1211-1220.

Fowler, A. G., Mariantoni, M., Martinis, J. M., & Cleland, A. N. (2012). Surface codes: Towards practical large-scale quantum computation. Physical Review A, 86(3), 032324.

Bardeen, J., Cooper, L. N., & Schrieffer, J. R. (1957). Theory of superconductivity. Physical Review, 108(5), 1175–1204.

Qu, D., Ma, Y., & Pyrozhenko, M. (2026). DISPEL-GNN: De-Illusion via Spectral Stability and Perturbation Bound-Enforced Learning for Community Detection with Risk-Aware Dynamic Attention in Graph Neural Networks. Mathematics, 14(4), 602.（https://doi.org/10.3390/math14040602）

Chen, W., Hai, X., Fan, D., Tan, L., Zhang, W., & Feng, Q. (2024, August). Resilience-oriented real-time decision-making for autonomous recovery in multi-UAV systems. In 2024 IEEE 19th conference on industrial electronics and applications (ICIEA) (pp. 1-6). IEEE.

Xing, J., & Xu, J. (2022). An improved convolutional neural network for recognition of incipient faults. IEEE Sensors Journal, 22(16), 16314-16322.

Song, Y., Suganthan, P. N., Pedrycz, W., Yan, R., Fan, D., & Zhang, Y. (2024). Energy-efficient satellite range scheduling using a reinforcement learning-based memetic algorithm. IEEE Transactions on Aerospace and Electronic Systems, 60(4), 4073-4087.

Wang, J., & Zhang, M. (2022). Geo-sic: learning deformable geometric shapes in deep image classifiers. Advances in Neural Information Processing Systems, 35, 27994-28007.

Qu, D., & Ma, Y. (2025). Magnet-bn: markov-guided Bayesian neural networks for calibrated long-horizon sequence forecasting and community tracking. Mathematics, 13(17), 2740.

Zhang, C., & Zhao, Y. (2017). High precision deep sea geomagnetic data sampling and recovery with three-dimensional compressive sensing. IEICE TRANSACTIONS on Fundamentals of Electronics, Communications and Computer Sciences, 100(9), 1760-1762.

Qu, D., & Ma, Y. (2026). F2-CommNet: Fourier–Fractional neural networks with Lyapunov stability guarantees for hallucination-resistant community detection. Frontiers in Computational Neuroscience, 19, 1731452. （https://doi.org/10.3389/fncom.2025.1731452）

Dai, S., Wu, Y., Chen, S., Huang, R., & Dannenberg, R. B. (2023, November). SingStyle111: A Multilingual Singing Dataset With Style Transfer. In ISMIR (pp. 765-773).

Li, Y., Zhao, Y., Yuen, C., Qin, X., Clenson, C., Du, C., & Guan, Y. L. (2025). A novel design of varactor-based RIS: Achieving low-profile, wideband, and continuous phase control. IEEE Antennas and Wireless Propagation Letters.

Ma, Y., Qu, D., & Wang, Y. (2026). Dynamic community detection using class preserving time series generation with Fourier Markov diffusion. Scientific Reports.（https://doi.org/10.1038/s41598-026-37699-1）

Peng, Q., Xue, H., Wang, P., & Chen, C. (2026, March). Lifelong Domain Adaptive 3D Human Pose Estimation. In Proceedings of the AAAI Conference on Artificial Intelligence (Vol. 40, No. 10, pp. 8358-8366).

Lv, Qi, et al. "Spatial-temporal graph diffusion policy with kinematic modeling for bimanual robotic manipulation." Proceedings of the Computer Vision and Pattern Recognition Conference. 2025.

Fan, J., Zhao, B., & Luo, Y. (2024, October). A 109.2 dB-dynamic-range fully dynamic dual-mode adjustable gain resistive sensor interface circuit. In 2024 IEEE International Conference on Integrated Circuits, Technologies and Applications (ICTA) (pp. 231-232). IEEE.

Chen, M., Chen, R., Zhao, Y., Yang, Z., & Guan, Y. L. (2023). Index-modulation OAM detectors resistant to beam misalignment. IEEE Transactions on Vehicular Technology, 73(2), 2836-2841.