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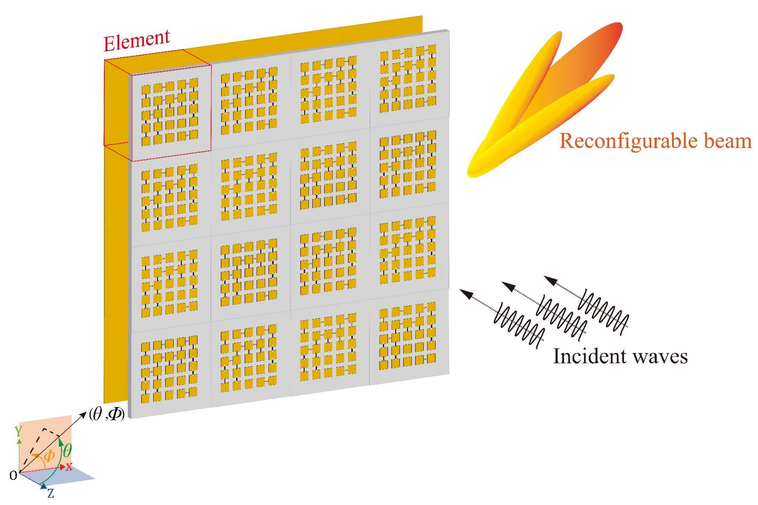
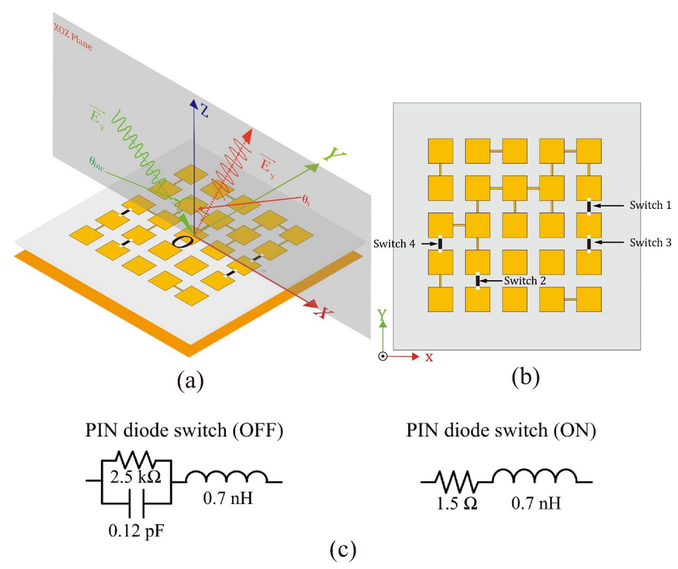
Department of Electronic and Computer Engineering

Reconfigurable Intelligent Surface with Wide-Angle Passive Beamforming for Future Wireless Communication Systems

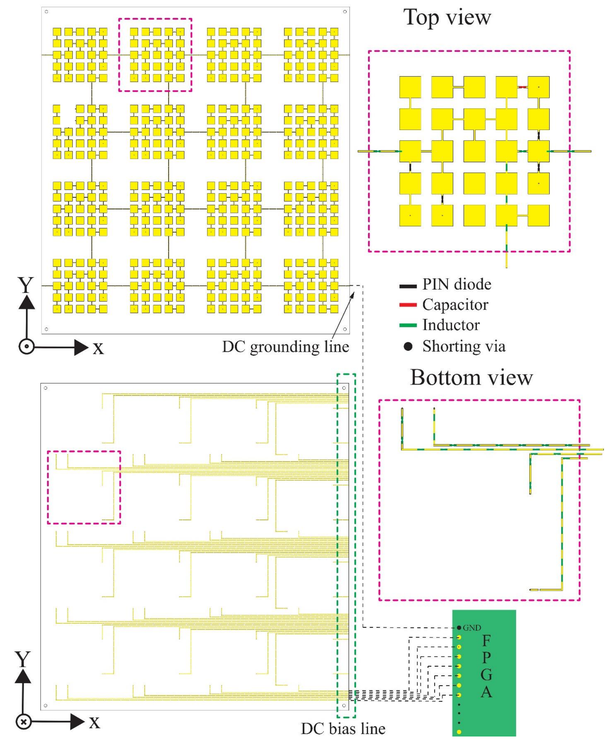
Prof. Ross Murch's Research Group



Reconfigurable Intelligent Surface (RIS) is a promising technology for future wireless communication. Their scattering can be controlled to enhance characteristics such as coverage, energy efficiency, and signal quality. We have developed a novel highly reconfigurable intelligent surface design that enables 3-D passive reflective beamforming in sub-6 GHz frequency bands.

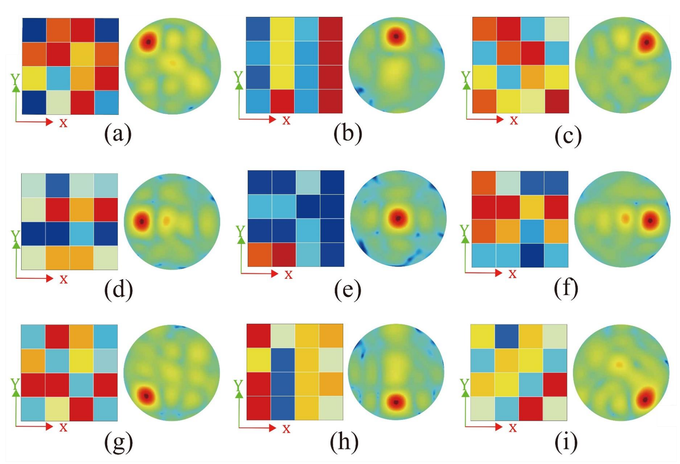


Each element has 5 x 5 sub-elements with four electronic switches connecting sub-elements providing 16 states. Phase entropy is used to optimize the element to cover all 16 reflective phase states within the 0-360 degree range.

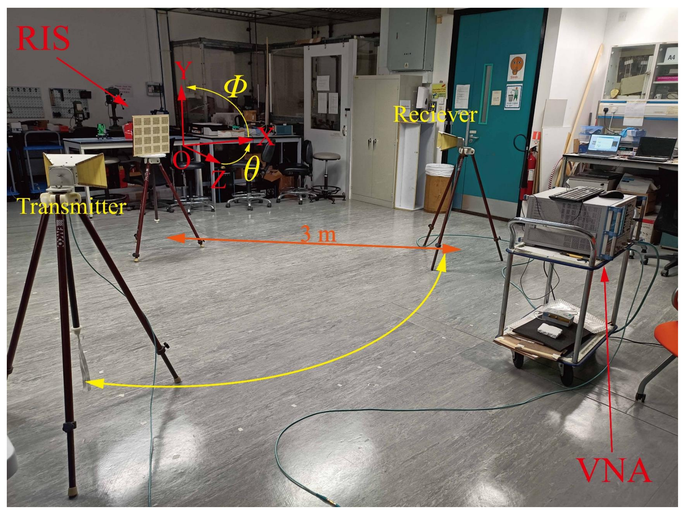


Geometry of the proposed RIS with 16 elements and associated controlling lines. A total of 64 diodes with inductors as chokes are mounted on the 16 elements.

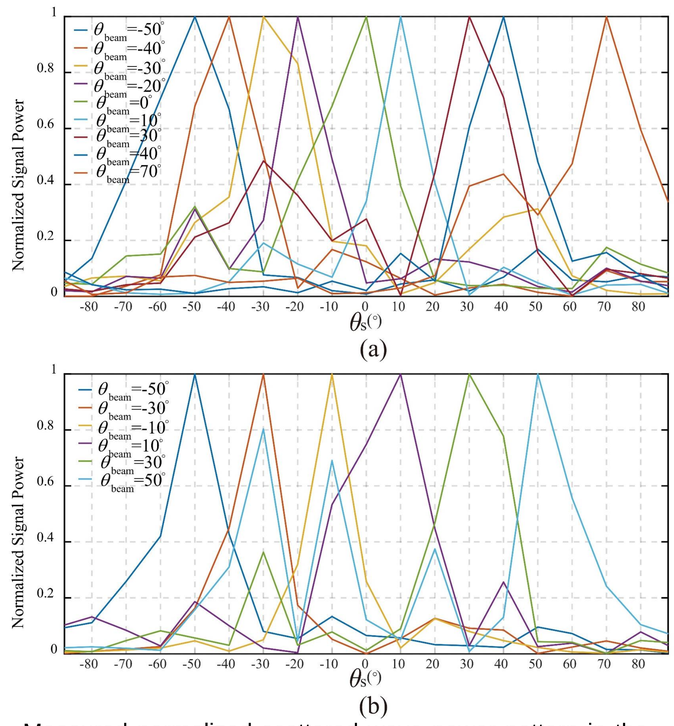
Simulation and Experimental Results



Examples of the simulated normalized scattered wave pattern and RF switch configurations when the incident waves arrive at 0^o and the main beam is optimized to steer to different directions. The red dot in the round diagrams denotes the maximum strength of the scattered beam and its direction. In the square diagrams, the color of each grid represents the optimized state of each of the 16 elements.



Experiment setup for measuring the scattered wave pattern of RIS. The RIS is located at the back and two horn antennas are used as the transmitter and receiver. A VNA is utilized to measure the S21 parameter between these two antennas with RIS present.

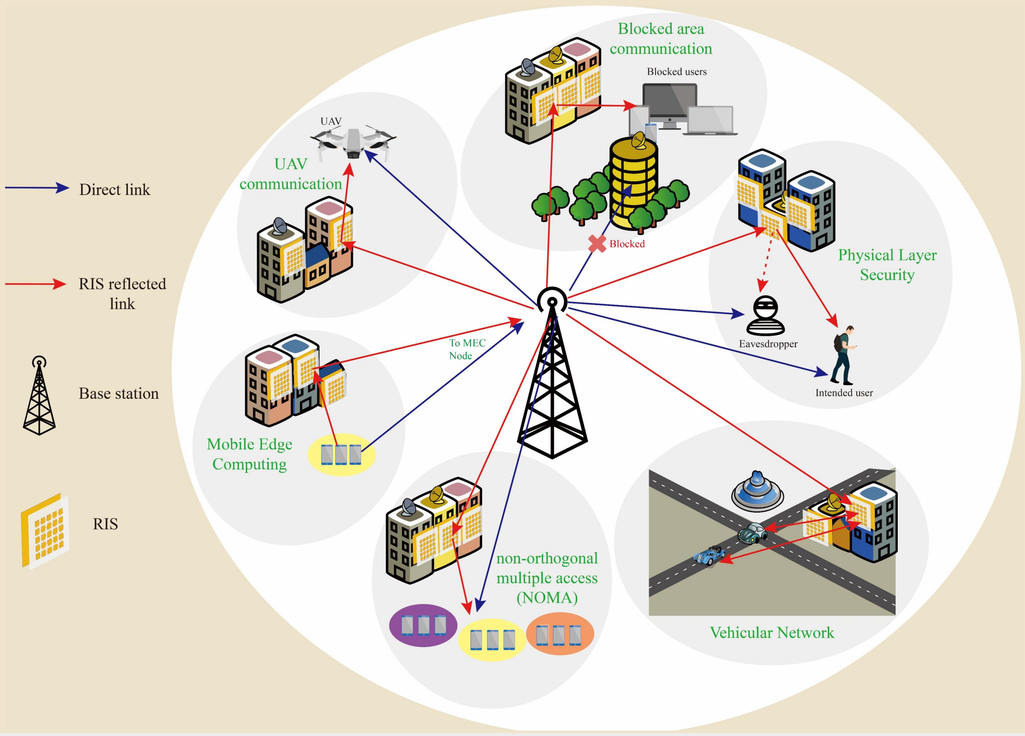


Measured normalized scattered wave power pattern in the xoz plane with different steered beam θ_{beam} when (a) $(\theta,\phi)_{inc}$=(0^o, 0^o) and (b) $(\theta,\phi)_{inc}$=(45^o, 0^o).

Our Related Journal Publications

1. J. Rao, Y. Zhang, S. Tang, Z. Li, S. Shen, C. -Y. Chiu and R. Murch, "A Novel Reconfigurable Intelligent Surface for Wide-Angle Passive Beamforming," in ***IEEE Transactions on Microwave Theory and Techniques***, vol. 70, no. 12, pp. 5427-5439, Dec. 2022, doi: 10.1109/TMTT.2022.3195224.
2. J. Rao, Y. Zhang, S. Tang, Z. Li, C. -Y. Chiu and R. Murch, "An Active Reconfigurable Intelligent Surface Utilizing Phase-Reconfigurable Reflection Amplifiers," in ***IEEE Transactions on Microwave Theory and Techniques***, doi: 10.1109/TMTT.2023.3237029.
3. N. K. Kundu, Z. Li, J. Rao, S. Shen, M. R. McKay and R. Murch, "Optimal Grouping Strategy for Reconfigurable Intelligent Surface Assisted Wireless Communications," in ***IEEE Wireless Communications Letters***, vol. 11, no. 5, pp. 1082-1086, May 2022, doi: 10.1109/LWC.2022.3156978.
4. Z. Li, N. K. Kundu, J. Rao, S. Shen, M. R. McKay and R. Murch, "Performance Analysis of RIS-Assisted Communications With Element Grouping and Spatial Correlation," in ***IEEE Wireless Communications Letters***, vol. 12, no. 4, pp. 630-634, April 2023, doi: 10.1109/LWC.2023.3237232.

Reconfigurable Intelligent Surfaces have significant potential in future 6G wireless communication systems



Acknowledgment

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