This paper introduces an innovative Intelligent Reflecting Surface (IRS) assisted Integrated Sensing and Communication (ISAC) system operating in the millimeter-wave (mmWave) band. The proposed ISAC system seamlessly integrates communication and radar functionalities on the same hardware platform, enabling simultaneous detection and communication with multiple targets and users. The IRS dynamically manipulates the amplitude or phase of the radio signal through its reflecting elements, thereby reconfiguring the radio propagation environment and enhancing the transmission rate of the ISAC system in the mmWave band.

To optimize the performance of the ISAC system, a sum-rate maximization problem is formulated, jointly optimizing the radar Signal Covariance (RSC) matrix, the communication beamforming vector, and the IRS phase shift. The non-convex nature of the problem, attributed to multivariate coupling, is addressed by decomposing it into two distinct subproblems. Firstly, a closed-form solution for the RSC matrix is derived based on the desired radar waveform. Subsequently, the Quadratic Transformation (QT) technique is applied to one subproblem, and an Alternating Optimization (AO) approach is employed to determine both the communication beamforming vector and the IRS phase shift. The proposed approach effectively reduces computational complexity, and a closed-form solution for the entire problem is derived.

Additionally, the deployment of the Majorization-Minimization (MM) algorithm is discussed for solving the IRS phase shift, further contributing to computational efficiency. Numerical simulations are conducted to validate the proposed scheme, demonstrating that the IRS significantly improves the ISAC system's transmission rate in the mmWave scenario. The results affirm the effectiveness of the algorithm and establish the IRS as a valuable tool for enhancing ISAC system performance.