Reconfigurable Intelligent Surfaces for Destructive Beamforming via Manifold Optimization

Luís Gustavo Toledo Zulai, and José Carlos Marinello Filho

Abstract— **Reconfigurable Intelligent Surfaces (RISs) are emerging as a key technology for future wireless systems, enabling control over the propagation environment. While most research focuses on enhancing desired signals, this paper investigates the use of RIS for *destructive beamforming*—intentionally creating signal nulls at specific locations. This capability is crucial for applications like physical layer security, interference mitigation, and deliberate jamming. We formulate the problem of minimizing the signal-to-noise ratio (SNR) at a target user equipment (UE) in both single-input single-output (SISO) and multiple-input single-output (MISO) scenarios by optimizing the RIS phase shifts under practical unit-modulus constraints. For the MISO case, we propose an efficient method based on manifold optimization techniques, specifically the Trust-Region algorithm, to solve the non-convex optimization problem. This approach utilizes multiple random initializations to enhance the likelihood of finding a high-quality solution. Simulation results, considering realistic transmit power and a channel model incorporating Rician fading, realistic path losses, and shadow fading, demonstrate that the proposed approach can significantly suppress the signal power at the target UE, with the suppression deepening as the number of RIS elements increases, validating the potential of RIS for precise destructive beamforming. For instance, with 256 RIS elements, a suppression of approximately 14.1 dB compared to the scenario without RIS is achieved.**

Keywords— **Reconfigurable intelligent surface (RIS), destructive beamforming, signal nulling, physical layer security, manifold optimization, MIMO, 6G, Rician fading.**

I. INTRODUCTION

Reconfigurable Intelligent Surfaces (RISs), also known as Intelligent Reflecting Surfaces (IRSs), have attracted significant research attention as a potential enabling technology for sixth-generation (6G) wireless communication systems [1], [2]. Composed of numerous low-cost, nearly passive reflecting elements, an RIS can manipulate the phase (and potentially amplitude) of incident electromagnetic waves, effectively reconfiguring the wireless propagation environment [3]. Much of the existing literature focuses on leveraging RISs for *constructive* purposes: enhancing signal strength for legitimate users, improving coverage, boosting energy efficiency, and increasing spectral efficiency [4], [5].

However, the ability to precisely control signal propagation also opens up possibilities for *destructive* beamforming, *i.e.*, creating deep signal fades or nulls at specific locations. This capability has critical applications:

- **Physical Layer Security (PLS):** Intentionally degrading the signal quality at potential eavesdroppers while maintaining communication with legitimate users [6], [7].
- **Interference Mitigation/Cancellation:** Nulling interference signals towards sensitive receivers or cancelling co-channel interference in dense deployments [8].
- **Jamming/Denial-of-Service:** In specific authorized scenarios (e.g., security, defense), RIS could be used to actively jam unauthorized transmissions or receivers.

Compared to traditional beamforming at the transmitter or receiver, RIS-based destructive beamforming offers the potential for low-power operation and flexible deployment in the radio environment. While the constructive use of RIS is widely studied, the deliberate creation of nulls represents a distinct but equally important facet of this technology.

Despite its potential, designing RIS phase shifts for destructive beamforming presents challenges. The goal is typically to minimize the received signal power or signal-to-noise ratio (SNR) at one or more target locations. This often leads to non-convex optimization problems due to the unit-modulus constraint on the RIS reflection coefficients [1]. Addressing this non-convexity efficiently is key to realizing the benefits of destructive RIS beamforming.

In this paper, we investigate the problem of RIS-assisted destructive beamforming aiming to minimize the SNR at a target user equipment (UE). Our main contributions are:

- We formulate the SNR minimization problem for both single-input single-output (SISO) and multiple-input single-output (MISO) systems employing an RIS for destructive beamforming.
- We analyze the conditions for signal cancellation in the SISO case and discuss practical limitations.
- We propose an efficient algorithm based on **Manifold Optimization (Trust-Region method)** for optimizing the RIS phase shifts to minimize the SNR under the unit-modulus constraint for the MISO scenario, assuming fixed precoding at the Base Station (BS).
- We present simulation results that validate the effectiveness of the proposed method and demonstrate its signal-suppression capabilities compared to relevant baselines, particularly showing how suppression improves with an increasing number of RIS elements under a channel model incorporating Rician fading, realistic path losses, and shadow fading.

Organization: The remainder of this paper is organized as follows. The system model is described in Section II. The proposed RIS phase-shift design approach for destructive beamforming is presented in Section III. Section IV presents

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numerical results. The main conclusions are offered in Section V.

Notations: Boldface lowercase $\mathbf{a}$ (or $\boldsymbol{a}$) and uppercase $\mathbf{A}$ letters represent vectors and matrices, respectively. $[\mathbf{A}]_{i,j}$ represents the element in the i-th row and j-th column of matrix $\mathbf{A}$. $\mathcal{CN}$ denotes the complex Gaussian distribution. $|\cdot|$ represents the magnitude of a scalar. $||\cdot||$ represents the Euclidean norm of a vector. $\{\cdot\}^*$, $\{\cdot\}^T$ and $\{\cdot\}^H$ denote the complex conjugate, transpose, and conjugate transpose (Hermitian) operators, respectively. $\mathrm{diag}(\mathbf{a})$ denotes a diagonal matrix whose diagonal entries are the elements of vector $\mathbf{a}$. $\mathbb{E}[\cdot]$ is the statistical expectation operator. $\angle(\cdot)$ denotes the phase angle of a complex number. $\mathbb{C}$ denotes the set of complex numbers. $\mathrm{j} = \sqrt{-1}$ denotes the imaginary unit.

II. System Model

We consider a downlink scenario where a BS communicates with users, and an RIS is deployed to assist (or in this case, potentially hinder) the communication towards a specific target UE. Channel links are modeled considering Rician fading, incorporating a deterministic Line-of-Sight (LoS) component and a random Non-LoS (NLoS) component, along with large-scale fading (path loss and shadowing).

A. SISO Scenario

We first consider a simple system with a single-antenna BS, a single-antenna target UE, and an RIS with N reflecting elements. We assume quasi-static flat-fading channels. Let $\phi_i = e^{\mathrm{j}\theta_i}$ be the reflection coefficient of the i-th RIS element, where $\theta_i \in [0, 2\pi)$ is the phase shift. We collect these coefficients in the vector $\boldsymbol{\phi} = [\phi_1, \ldots, \phi_N]^T$.

The received signal at the target UE is given by

$$y = \sqrt{\rho}\, h_{\text{eff}}(\boldsymbol{\phi})\, w\, x + n, \tag{1}$$

where $h_{\text{eff}}(\boldsymbol{\phi}) = h_d + \mathbf{h}_r^T \,\mathrm{diag}(\boldsymbol{\phi})\mathbf{h}_k$ is the effective channel coefficient. Here, $h_d \in \mathbb{C}$ is the direct BS-UE link, $\mathbf{h}_r \in \mathbb{C}^{N\times 1}$ is the BS-RIS channel vector, $\mathbf{h}_k \in \mathbb{C}^{N\times 1}$ is the RIS-UE channel vector (details on channel modeling are provided in the MISO scenario and apply analogously here for the scalar/vector dimensions). ρ is the BS transmit power, $w \in \mathbb{C}$ is the scalar transmit precoder ($|w| = 1$), x is the data symbol ($\mathbb{E}[|x|^2] = 1$), and $n \sim \mathcal{CN}\left(0, \sigma_n^2\right)$ is Additive White Gaussian Noise (AWGN). Let $v_i = [\mathbf{h}_r]_i[\mathbf{h}_k]_i$, then $h_{\text{eff}}(\boldsymbol{\phi}) = h_d + \sum_{i=1}^N v_i\phi_i$.

Assuming the BS uses MRT based on the effective channel, $w = h_{\text{eff}}(\boldsymbol{\phi})^*/|h_{\text{eff}}(\boldsymbol{\phi})|$, the resulting SNR at the UE is

$$\gamma(\boldsymbol{\phi}) = \frac{\rho}{\sigma_n^2}\left|h_d + \sum_{i=1}^N v_i\phi_i\right|^2. \tag{2}$$

The RIS aims to minimize this SNR:

$$P_{\text{SISO}}:\quad \underset{\boldsymbol{\phi}}{\text{minimize}} \quad \left|h_d + \sum_{i=1}^N v_i\phi_i\right|^2 \tag{3a}$$

$$\text{subject to} \quad |\phi_i| = 1;\ i = 1, 2, \ldots, N. \tag{3b}$$

To minimize $|h_d + \sum_{i=1}^N v_i\phi_i|^2$, the goal is to make the sum of reflected signals $\sum_{i=1}^N v_i\phi_i$ as close as possible to $-h_d$.

- If $\sum_{i=1}^N |v_i| < |h_d|$ (the maximum possible amplitude of the reflected sum is less than $|h_d|$), perfect cancellation is not possible. In this scenario, the minimum magnitude of $h_d + \sum_{i=1}^N v_i\phi_i$ is achieved when $\sum_{i=1}^N v_i\phi_i$ is made maximally antiparallel to h_d. This is done by setting the phase of each ϕ_i such that $\angle(v_i\phi_i) = \angle(h_d) + \pi$, which means the optimal phase for the i-th element is $\theta_i^{\text{opt}} = \angle(h_d) - \angle(v_i) + \pi$. With this choice, $h_d + \sum_{i=1}^N v_i\phi_i = (|h_d| - \sum_{i=1}^N |v_i|)e^{j\angle(h_d)}$. The squared magnitude is $(|h_d| - \sum_{i=1}^N |v_i|)^2$.
- If $\sum_{i=1}^N |v_i| \geq |h_d|$, the maximum possible amplitude of the reflected signal is sufficient to cancel the direct signal. Thus, it is possible to choose the phases $\{\phi_i\}$ such that the reflected sum $\sum_{i=1}^N v_i\phi_i = -h_d$. This results in $h_d + \sum_{i=1}^N v_i\phi_i = 0$, and thus perfect cancellation with a squared magnitude of 0.

Combining these two cases, the resulting minimum SNR is

$$\gamma^{\min} = \frac{\rho}{\sigma_n^2}\left(\max\left(0, |h_d| - \sum_{i=1}^N |v_i|\right)\right)^2. \tag{4}$$

This shows that perfect cancellation ($\gamma = 0$) is achievable if and only if the sum of the magnitudes of the reflected path components can be made at least equal to the magnitude of the direct path component, *i.e.*, $\sum_{i=1}^N |v_i| \geq |h_d|$. If this condition holds, an optimal RIS phase configuration yields zero SNR. If not (*i.e.*, $\sum_{i=1}^N |v_i| < |h_d|$), the SNR is minimized to the non-zero value given by (4) by phase aligning the reflected signals destructively as described above.

B. MISO Scenario

Now, consider a BS with M antennas serving a single-antenna target UE, assisted by an N-element RIS. The BS uses transmit precoding vector $\mathbf{w} \in \mathbb{C}^{M\times 1}$ with $||\mathbf{w}|| = 1$.

The received signal at the UE is:

$$y = \sqrt{\rho}\left(\mathbf{h}_d^H + \mathbf{h}_{ru}^H \,\mathrm{diag}(\boldsymbol{\phi}^*)\,\mathbf{H}_r^H\right)\mathbf{w}\,x + n, \tag{5}$$

where $\mathbf{h}_d \in \mathbb{C}^{M\times 1}$ is the direct BS-UE channel vector, $\mathbf{H}_r \in \mathbb{C}^{M\times N}$ is the BS-RIS channel matrix, $\mathbf{h}_{ru} \in \mathbb{C}^{N\times 1}$ is the RIS-UE channel vector, $\boldsymbol{\phi} \in \mathbb{C}^{N\times 1}$ contains the RIS phase shifts ($|\phi_i| = 1$), $\mathbf{w} \in \mathbb{C}^{M\times 1}$ is the BS precoder, ρ is the total BS transmit power, x is the data symbol, and $n \sim \mathcal{CN}\left(0, \sigma_n^2\right)$ is AWGN. The effective channel column vector is $\mathbf{h}_{\text{eff}}(\boldsymbol{\phi}) = \mathbf{h}_d + \mathbf{H}_r \,\mathrm{diag}(\boldsymbol{\phi})\mathbf{h}_{ru}$.

The term L_{link} used in the channel coefficient equations (*e.g.*, L_{bu}, L_{br}, L_{ru}) represents the channel power gain, which incorporates the effects of distance-dependent path loss and shadow fading. It is modeled as:

$$L_{\text{link}} = L_0 \cdot (d_{\text{link}}/d_0)^{-\kappa} \cdot 10^{X_{\text{sh}}/10}. \tag{6}$$

Here, $d_0 = 1$ m is the reference distance, L_0 is the path loss at the reference distance, κ is the path loss exponent, and $X_{\text{sh}} \sim \mathcal{N}(0, \sigma_{\text{sh}}^2)$ is the shadow fading in dB. Specific Rician K-factors (K_{BR}, K_{RU}) for the BS-RIS, and RIS-UE links, respectively, are introduced below and specified in Table I.

On the other hand, we assume Rayleigh fading for the BS-UE link, such that the direct BS-UE channel vector $\mathbf{h}_d \in \mathbb{C}^{M\times 1}$ is modeled as$\mathbf{h}_d = \sqrt{L_{bu}}\,\tilde{\mathbf{h}}_d$, where L_{bu} is the channel power gain from (6) for the BS-UE link (distance d_{bu}), and $\tilde{\mathbf{h}}_d \in \mathbb{C}^{M\times 1}$ is the small-scale fading vector with i.i.d. elements $\sim \mathcal{CN}(0,1)$ and $E[\|\tilde{\mathbf{h}}_d\|^2] = M$. This choice reflects scenarios where the direct link might be obstructed and lack a dominant LoS path.

The BS-RIS channel matrix $\mathbf{H}_r \in \mathbb{C}^{M\times N}$ is modeled with Rician fading as:

$$\mathbf{H}_r = \sqrt{L_{br}}\left(\sqrt{\frac{K_{BR}}{K_{BR}+1}}\bar{\mathbf{H}}_{r,\text{LoS}} + \sqrt{\frac{1}{K_{BR}+1}}\tilde{\mathbf{H}}_{r,\text{NLoS}}\right), \tag{7}$$

where L_{br} is the channel power gain for the BS-RIS link (distance d_{br}), $K_{BR} \geq 0$ is the Rician K-factor. $\bar{\mathbf{H}}_{r,\text{LoS}} \in \mathbb{C}^{M\times N}$ is the deterministic LoS component matrix, *i.e.*, its (m,n)-th element represents the phase of the LoS path between BS antenna m and RIS element n, incorporating array steering vectors for BS and RIS, normalized such that $\|\bar{\mathbf{H}}_{r,\text{LoS}}\|_F^2 = MN$. $\tilde{\mathbf{H}}_{r,\text{NLoS}} \in \mathbb{C}^{M\times N}$ is the NLoS component matrix with i.i.d. elements $\sim \mathcal{CN}(0,1)$, and $E[\|\tilde{\mathbf{H}}_{r,\text{NLoS}}\|_F^2] = MN$.

Similarly, the RIS-UE channel vector $\mathbf{h}_{ru} \in \mathbb{C}^{N\times 1}$ is modeled with Rician fading as:

$$\mathbf{h}_{ru} = \sqrt{L_{ru}}\left(\sqrt{\frac{K_{RU}}{K_{RU}+1}}\bar{\mathbf{h}}_{ru,\text{LoS}} + \sqrt{\frac{1}{K_{RU}+1}}\tilde{\mathbf{h}}_{ru,\text{NLoS}}\right), \tag{8}$$

where L_{ru} is the channel power gain for the RIS-UE link (distance d_{ru}), $K_{RU} \geq 0$ is the Rician K-factor. $\bar{\mathbf{h}}_{ru,\text{LoS}} \in \mathbb{C}^{N\times 1}$ is the deterministic LoS component vector, *i.e.*, its n-th element represents the phase of the LoS path between RIS element n and the UE, normalized such that $\|\bar{\mathbf{h}}_{ru,\text{LoS}}\|^2 = N$. $\tilde{\mathbf{h}}_{ru,\text{NLoS}} \in \mathbb{C}^{N\times 1}$ is the NLoS component vector with i.i.d. elements $\sim \mathcal{CN}(0,1)$, and $E[\|\tilde{\mathbf{h}}_{ru,\text{NLoS}}\|^2] = N$. The use of Rician fading for RIS-related links is motivated by the typical deployment strategy of placing RISs in locations that ensure strong LoS paths to maximize their reconfigurability.

If the BS employs MRT based on the full effective channel, $\mathbf{w} = \mathbf{h}_{\text{eff}}(\boldsymbol{\phi})/\|\mathbf{h}_{\text{eff}}(\boldsymbol{\phi})\|$, the SNR is:

$$\gamma(\boldsymbol{\phi}) = \frac{\rho}{\sigma_n^2}\left\|\mathbf{h}_d + \mathbf{H}_r \operatorname{diag}(\boldsymbol{\phi})\mathbf{h}_{ru}\right\|^2. \tag{9}$$

This precoding strategy assumes the BS has perfect knowledge of the RIS-configured effective channel. It represents the scenario where the transmitter actively tries to maximize the signal power, while the RIS simultaneously tries to minimize it. The RIS optimization problem for destructive beamforming under this adaptive MRT precoder is therefore:

$$P_{\text{MIMO}}: \quad \underset{\boldsymbol{\phi}}{\text{minimize}} \quad \|\mathbf{h}_d + \mathbf{H}_r \operatorname{diag}(\boldsymbol{\phi})\mathbf{h}_{ru}\|^2 \tag{10a}$$

$$\text{subject to} \quad |\phi_i| = 1;\ i = 1,2,\ldots,N. \tag{10b}$$

This remains a non-convex optimization problem due to the unit-modulus constraints.

III. Proposed Phase-Shift Design Method

The core objective of destructive beamforming in this work is to minimize the Signal-to-Noise Ratio (SNR) at the target UE by carefully designing the RIS phase-shift vector $\boldsymbol{\phi}$. As formulated in (10), this involves minimizing the squared norm of the effective channel vector $\mathbf{h}_{\text{eff}}(\boldsymbol{\phi}) = \mathbf{h}_d + \mathbf{H}_r \operatorname{diag}(\boldsymbol{\phi})\mathbf{h}_{ru}$, subject to the unit-modulus constraint on each element of $\boldsymbol{\phi}$.

The objective function in (10) simplifies to:

$$f(\boldsymbol{\phi}) = \|\mathbf{h}_d + \mathbf{H}'_r\boldsymbol{\phi}\|^2, \tag{11}$$

with $\mathbf{H}'_r = \mathbf{H}_r \operatorname{diag}(\mathbf{h}_{ru})$.

This problem involves minimizing a quadratic function over the set of unit-modulus complex vectors $\boldsymbol{\phi}$. This constraint set, $\{\boldsymbol{\phi} \in \mathbb{C}^N : |\phi_i| = 1, \forall i\}$, defines a product of complex circles, which is a specific type of complex manifold.

Due to the non-convex nature of the objective function and the manifold constraint, finding the global optimum is generally challenging. However, efficient algorithms exist to find locally optimal solutions on manifolds. As indicated by our simulation implementation (see Section IV), we propose leveraging *Manifold Optimization* (M.O.) techniques [9]. Specifically, we employ algorithms designed for optimization problems on the complex circle manifold $\mathcal{M} = \{\boldsymbol{\phi} \in \mathbb{C}^N : |\phi_i| = 1,\ \forall i\}$.

The optimization problem can be formally stated as:

$$\underset{\boldsymbol{\phi}\in\mathcal{M}}{\text{minimize}} \quad f(\boldsymbol{\phi}) = \|\mathbf{h}_d + \mathbf{H}'_r\boldsymbol{\phi}\|^2. \tag{12}$$

To apply gradient-based manifold optimization algorithms, such as the Trust-Region method [10] (as implemented using the Manopt toolbox [11]), we need the gradient of the cost function. The Euclidean gradient of $f(\boldsymbol{\phi})$ with respect to $\boldsymbol{\phi}$ (derived for $\boldsymbol{\phi}$ being column vector) is given by:

$$\nabla_{\boldsymbol{\phi}} f(\boldsymbol{\phi}) = 2(\mathbf{A}\boldsymbol{\phi} + \mathbf{b}), \tag{13}$$

with $\mathbf{A} = \mathbf{H}'^H_r\mathbf{H}'_r$, and $\mathbf{b} = \mathbf{H}'^H_r\mathbf{h}_d$. Manifold optimization algorithms utilize this Euclidean gradient $\nabla_{\boldsymbol{\phi}} f(\boldsymbol{\phi})$ to compute the Riemannian gradient on the manifold $\mathcal{M}$ and determine search directions (*e.g.*, steepest descent direction or trust-region subproblem solutions) that inherently respect the unit-modulus constraint. The Trust-Region method, in particular, builds a quadratic model of the objective function at the current iteration and solves a subproblem to find the next step within a "trust region," where the model is deemed accurate. The algorithm iteratively updates $\boldsymbol{\phi}$ along these directions until convergence is met (*e.g.*, small gradient norm or step size).

Recognizing that manifold optimization algorithms typically converge to local minima, and the quality of the solution may depend on the starting point, we adopt a multi-start strategy. The optimization algorithm (*e.g.*, Trust-Regions) is run multiple times (`num_inits` in simulation code, denoted K_{init} here) starting from different random initial phase vectors $\boldsymbol{\phi}^{(0)}$ (where each $\phi_i^{(0)}$ is drawn uniformly from the unit circle). The solution $\boldsymbol{\phi}^{\text{opt}}$ that yields the lowest objective function value $f(\boldsymbol{\phi}^{\text{opt}})$ across all initializations is selected as the final phase configuration for the RIS. This approach significantly increases the probability of finding a high-quality solution that is close to the global minimum, mitigating the risks associated with the non-convex landscape.

The overall procedure for designing the destructive RIS phases for a given channel realization $(\mathbf{h}_d, \mathbf{H}_r, \mathbf{h}_{ru})$ is summarized in Algorithm 1. This optimized $\boldsymbol{\phi}^{\text{opt}}$ is then configured at the RIS to achieve destructive beamforming towards the target UE.

Algorithm 1 RIS Phase-Shifts Optimization for Destructive Beamforming

Require: Channels $\mathbf{h}_d \in \mathbb{C}^{M\times 1}$, $\mathbf{H}_r \in \mathbb{C}^{M\times N}$, $\mathbf{h}_{ru} \in \mathbb{C}^{N\times 1}$, number of random restarts K_{init}, transmit power ρ; noise variance σ^2.

Ensure: Optimal phase vector $\boldsymbol{\phi}^{\text{opt}}$ and minimum objective value $f_{\min}$

1: $\mathbf{H}'_r \leftarrow \mathbf{H}_r \operatorname{diag}(\mathbf{h}_{ru})$,
2: $\mathbf{A} \leftarrow \mathbf{H}'^H_r \mathbf{H}'_r$,
3: $\mathbf{b} \leftarrow \mathbf{H}'^H_r \mathbf{h}_d$,
4: $f(\boldsymbol{\phi}) \leftarrow \|\mathbf{h}_d + \mathbf{H}'_r\boldsymbol{\phi}\|^2$ ▷ Objective function
5: $\nabla f(\boldsymbol{\phi}) \leftarrow 2(\mathbf{A}\boldsymbol{\phi} + \mathbf{b})$, ▷ Euclidean gradient w.r.t. $\boldsymbol{\phi}$
6: $f_{\min} \leftarrow +\infty$
7: **for** $k = 1$ **to** K_{init} **do**
8: $\boldsymbol{\phi}^{(0)} \leftarrow \exp(\mathrm{j}2\pi\mathbf{u})$, $\mathbf{u} \sim \mathcal{U}(0,1)^N$,
9: $\boldsymbol{\phi}^{(k)} \leftarrow \arg\min_{\boldsymbol{\phi}\in\mathcal{M}} f(\boldsymbol{\phi})$, starting from $\boldsymbol{\phi}^{(0)}$,
10: **if** $f(\boldsymbol{\phi}^{(k)}) < f_{\min}$ **then**
11: $f_{\min} \leftarrow f(\boldsymbol{\phi}^{(k)})$; $\boldsymbol{\phi}^{\text{opt}} \leftarrow \boldsymbol{\phi}^{(k)}$
12: **end if**
13: **end for**
14: $\text{SNR}^{\star}_{\text{dB}} \leftarrow 10\log_{10}(\rho\, f_{\min}/\sigma^2)$,

IV. Numerical Results

In this section, we evaluate the performance of the proposed RIS phase-shift design for destructive beamforming using numerical simulations. The simulation parameters are detailed in Table I. Specifically, we consider a system with $M = 64$ BS antennas, a single target UE ($K_{ue} = 1$), transmit power $\rho = 37$ dBm (≈ 5.01 W), and noise variance $\sigma_n^2 = 10^{-10}$ W. The channels are generated based on the Rician fading model for the BS-RIS and RIS-UE links, and Rayleigh fading model for the BS-UE link, as described in Section II, incorporating a realistic path loss model and log-normal shadow fading (standard deviation 4 dB per link). The Manifold Optimization approach (Trust-Region method) detailed in Section III was employed with $K_{init} = 10$ random initializations for each of the 200 channel realizations.

Figure 1 presents the average SNR (in dB) at the target UE as a function of the number of RIS elements (N). The RIS is always considered as a squared uniform planar array, *i.e.*, with the same number of vertical and horizontal elements. We compare the performance of the proposed destructive beamforming method ("Proposed Destructive") against three baselines: constructive beamforming optimized for the target UE ("Constructive") via manifold optimization, random RIS phases ("Random"), and the absence of RIS ("No RIS"). The locations are BS at $(0, 0)$ m, RIS at $(100, 0)$ m, and UE at $(100, 20)$ m, with a carrier frequency of 3 GHz.

As observed in Figure 1 and detailed in Table II, the "No RIS" baseline exhibits an average SNR around 13.4 dB, which is determined only by the direct channel, and thus is independent of N. When the RIS is present but with random phases ("Random"), the average SNR remains very close to the "No RIS" case (*e.g.*, 14.31 dB for $N = 256$), indicating that an unoptimized RIS offers negligible consistent impact. The slight increase in SNR for the "Random" case with large N can be attributed to the non-coherent addition of power from the many reflected paths, which, on average, adds a small amount of energy to the received signal.

Conversely, the "Constructive" RIS approach, where phases are optimized to maximize SNR at the UE with the aid of manifold optimization, demonstrates significant gains, with the SNR increasing from 13.89 dB at $N = 4$ to 40.35 dB at $N = 1024$. This highlights the substantial potential of RIS for signal enhancement and serves as a strong upper bound. It is worth mentioning that to employ manifold optimization for signal enhancement in an RIS-aided network, one has just

TABLE I
SIMULATION PARAMETERS

Parameter	Value
System Configuration	
Carrier frequency (f_c)	3 GHz ($\lambda = 0.10$ m)
# of BS antennas (M)	64
BS Antenna spacing (d_B)	$\lambda/2 = 0.05$ m
# of RIS elements (N)	$4, 16, 64, 256, 1024$
RIS element spacing (d_R)	$\lambda/2 \approx 0.05$ m
# of UEs (K_{ue})	1
Transmit power (ρ)	37 dBm (≈ 5.01 W)
Noise Variance (σ_n^2)	1×10^{-10} W (-70 dBm)
M.O. initializations (K_{init})	10
Channel and Geometry	
Rician K-factor (BS-RIS, K_{BR})	5 dB
Rician K-factor (RIS-UE, K_{RU})	5 dB
Path loss exponent for the BS-UE link	3.8
Path loss exponent for the BS-RIS link	2.2
Path loss exponent for the RIS-UE link	2.2
Shadowing std. dev.(σ_{sh})	4 dB
Reference distance (d_0)	1 m
Path loss at the ref. dist. (L_0)	-35.3 dBm
BS location (2D coordinates)	$(0, 0)$ m
RIS location (2D coordinates)	$(100, 0)$ m
UE location (2D coordinates)	$(100, 20)$ m
# of channel realizations	200

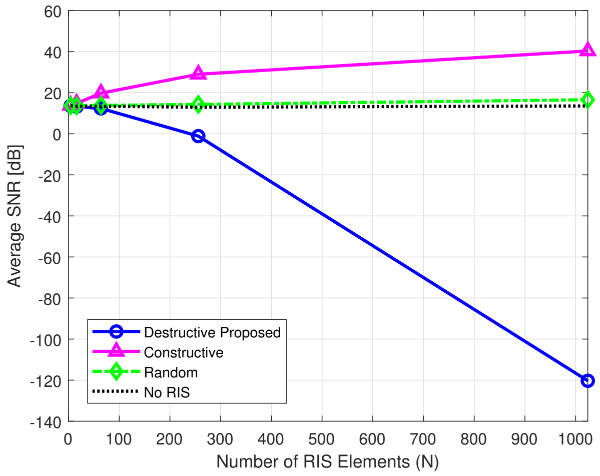

Fig. 1. Average SNR at the target UE *versus* the number of RIS elements (N) for $M = 64$ antennas, $f_c = 3$GHz, $\rho = 37$ dBm.

TABLE II
AVERAGE SNR (dB) *vs* NUMBER OF RIS ELEMENTS (N)

N	Destructive	Constructive	Random	No RIS
4	13.57	13.89	13.69	13.65
16	13.20	14.82	13.58	13.46
64	12.35	19.79	13.84	13.41
256	-1.13	29.01	14.31	12.95
1024	-120.31	40.35	16.61	13.57

to employ the objective and gradient functions presented in equations (11) and (13), but with opposite signals.

The "Proposed Destructive" method effectively minimizes the SNR at the target UE. The average SNR decreases monotonically as the number of RIS elements N increases. Starting from 13.57 dB for $N = 4$ (a minimal reduction from "No RIS"), the suppression becomes substantial with more elements: 13.20 dB for $N = 16$, 12.35 dB for $N = 64$, -1.13 dB for $N = 256$, and reaching a notable low of -120.31 dB for $N = 1024$. For $N = 256$, this represents a suppression of approximately 14.08 dB compared to the "No RIS" scenario (using 12.95 dB as reference) and about 30.14 dB compared to the "Constructive" scenario. The exceptionally deep null for $N = 1024$ demonstrates the theoretical power of having many degrees of freedom to precisely cancel the signal. In a real-world deployment, this level of suppression would be limited by factors like imperfect channel estimation and hardware phase noise, but it serves as a powerful illustration of the concept's potential. These results clearly validate the capability of the proposed manifold optimization approach to design RIS phases for effective destructive beamforming, with increasing N leading to deeper signal nulls at the target location under the specified channel conditions. The trend of decreasing SNR with increasing N for the destructive case is now consistently observed across all tested values of N.

Finally, we have also evaluated the influence of the K_{init} parameter on the performance of the proposed destructive beamforming method. Although the results provided in Fig. 1 have been evaluated with $K_{init} = 10$, if one evaluates the proposed method with a single initialization for $N = 256$, a slight performance loss of 2.722 dB SNR increase would be observed at the target UE. On the other hand, if the method is evaluated with $K_{init} = 5$, the performance loss drops to only 0.581 dB SNR increase. These results show that, although better performances can be achieved with a higher number of initializations, if one prefers to save computational cost by reducing the number of initializations, the proposed method still performs quite consistently.

V. CONCLUSION

This paper investigated the use of Reconfigurable Intelligent Surfaces (RISs) for destructive beamforming, aiming to minimize the received SNR at a specific target user in a MISO system. We formulated the RIS phase-shift optimization problem under practical unit-modulus constraints and employed an efficient Manifold Optimization approach (Trust-Region method with multiple random initializations), assuming an adaptive MRT precoder at the BS. Our simulation results, conducted for a 3 GHz system with realistic transmit power (37 dBm) and a channel model incorporating Rician fading for BS-RIS and RIS-UE links, Rayleigh fading for BS-UE link, channel power gain, and log-normal shadow fading, demonstrated the significant effectiveness of the proposed technique. The average SNR at the target UE was shown to decrease substantially and monotonically with an increasing number of RIS elements (N) for the destructive scheme. For instance, with $N = 256$ elements, the proposed method achieved an average SNR of -1.13 dB. This represents a substantial reduction of approximately 14.08 dB compared to the scenario without an RIS (average SNR around 12.95 dB for $N = 256$) and is over 30.14 dB lower than what could be achieved with constructive RIS beamforming (29.01 dB).

These findings clearly validate the potential of RIS technology for actively creating deep signal nulls and underscore the utility of manifold optimization for this non-convex optimization problem. The consistent improvement in suppression with larger N confirms the scalability of the approach for enhanced destructive beamforming under realistic channel conditions. Future work could explore joint BS precoder and RIS phase design for destructive purposes, investigate the impact of channel estimation errors, consider hardware impairments such as discrete phase shifts, and extend the study to multi-user scenarios or different channel environments. Experimental validation would also be an important step towards practical implementation.

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