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RIS source decode-and-forward relaying network with interference

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ABSTRACT

We consider in this paper the scenario of reconfigurable intelligent surface (RIS) source decode-and-forward (DF) relaying network with interference. The system includes single source of multiple reflecting elements, multiple DF relays, and single destination with interference at the relays and destination. Assuming Rayleigh fading channels, we obtain closed-form accurate approximations for the outage probability. Additionally, we investigate the behavior at high signal-to-noise ratio (SNR) values where the diversity order and the coding gain are obtained. Findings illustrate that the number of reflecting elements N at the source has a small impact on the system coding gain and not on the diversity gain. Furthermore, results show that the number of relays K is affecting the diversity order and is more impactful on the behavior than N. Findings demonstrate that when $N = 1$, the interference value at the relays and destination is determining, which hop dominates the behavior, whereas when $N > 1$ the behavior is always dominated by the second hop regardless of the interference value.

1. Introduction

Recently and due to their capability to enhance the system performance, the reconfigurable intelligent surfaces (RISs) have attracted a noticeable attention as a promising candidate for future wireless communication networks. An RIS is an artificial surface, made of electromagnetic material that is capable of customizing the propagation of the radio waves impinging upon it [1,2]. It has been proposed as a new low-cost and less complicated solution to realize wireless communication with high spectrum and energy efficiencies.

A detailed overview on the state-of-the-art solutions, fundamental differences of RIS with other technologies, and the most important open research issues in this area of research has been provided recently in [2]. Furthermore, an overview of the basic characteristics of the large intelligent surface/antenna technology and its potential applications has been provided in [3]. In [4], it has been shown that RIS has better performance than conventional massive multiple-input multiple-output systems as well as better performance than multi-antenna amplify-and-forward (AF) relaying networks with smaller number of antennas, while reducing the system complexity and cost. Recently, authors considered in [5] the behavior of RIS-assisted mixed indoor visible light communication/radio frequency (RF) system. They derived closed-form expressions for the outage probability and bit error rate (BER) for AF and decode-and-forward (DF) relaying schemes. A study that compares the performance of relay-assisted and RIS-assisted wireless networks from coverage, probability of signal-to-noise ratio (SNR) gain, and delay outage rate aspects has been provided in [6].

The outage probability and BER performance of a dual-hop mixed free space optical-RF relay network with RIS has been studied in [7]. In [8], authors utilized RIS to improve the quality of a source signal that is sent to destination through an unmanned aerial vehicle. The average BER of a RIS-assisted network with space-shift keying has been recently studied in [9]. In [10], analytical expression has been derived for the secrecy outage probability of RIS-assisted network in the presence of direct link and eavesdropper.

It is important to mention here that most of the previous works on RIS-assisted networks performed their analysis based on the central limit theorem (CLT), which makes them applicable only for large number of reflecting elements [11]. Following other approaches and to cover the case of low number of reflecting elements, authors in [11] and [12] have derived accurate approximations for the channel distributions and performance metrics of RIS-assisted networks assuming Rayleigh fading channels. Recently, some works on RIS-assisted networks over Nakagami-m fading channels started to appear in literature [13,14].

Some papers on RIS-assisted networks with relays started to appear recently in literature [15–18]. In [15], authors sent the source signal to destination through both RIS path and DF relay path. On the other hand, a study that compares large RIS-assisted

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