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Cooperative Communication in Beam Forming Analysis for MIMO System using Multiple Relay Path Channels

Jothi Priya. G, Vembu. P
Department of Electronics and Communication Engineering,
Sri Ramakrishna College of Engineering,
Perambalur, Tamilnadu.

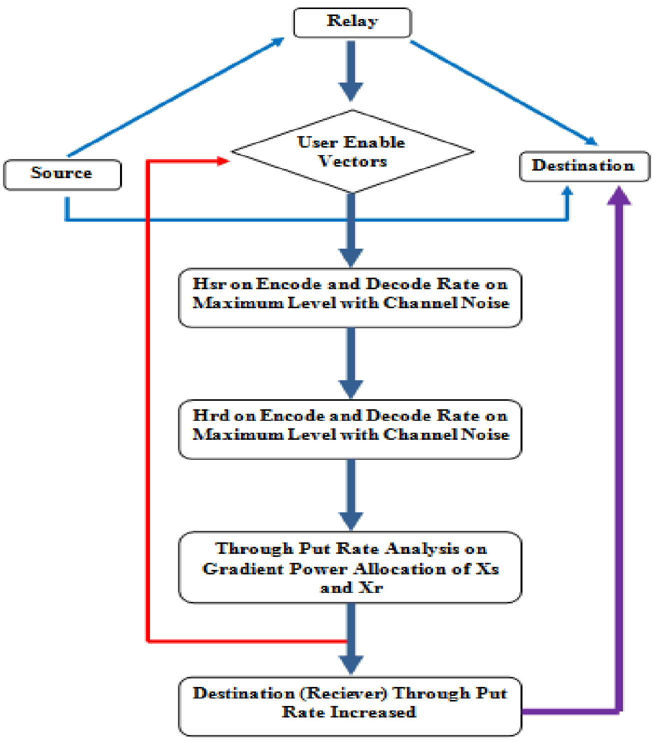
Abstract*: The project explains a transmit beam forming design for multiple-input–multiple-output (MIMO) decode-and-forward (DF) half-duplex two-hop relay channels with a direct source–destination link. For the scenario where source and relay nodes are equipped with multiple antennas and the destination node is deployed with single antenna, the optimal beam forming vectors for source and relay nodes jointly are have to formulated and solved. Specifically, several unique properties of the optimal solutions through mathematical derivation have identified, based on which we develop a systematic approach to arrive at the optimal beam forming vectors for the source and relay nodes for different system *configurations.

I. Introduction

THIRD-GENERATION (3G) wireless systems have been deployed on a broad scale around the world to provide enhanced downlink (DL) and uplink (UL) transmissions. However, due to the emerging technologies and evolving Quality of Service (QoS) requirement, future-generation wireless communication systems are expected to meet even more challenging demands of high data rate and reliable multimedia communications. As a consequence, the Third Generation Partnership Project (3GPP) has launched the long-term evolution (LTE) standard of 3G for wireless communications. The target is to enable high-speed data transmission for mobile phones and data terminals at substantially reduced cost compared to current radio access technologies [1], [2]. In order to improve the spectrum efficiency, the physical layer technologies\ specified in LTE Release 8 incorporate new techniques such as Orthogonal Frequency Division Multiplexing (OFDM) as the DL multiple access scheme and Single-Carrier Frequency Division Multiple Access (SC-FDMA) as the UL scheme. Currently, further enhancements are being studied to improve the existing LTE Release 8 standard. These enhancements are included in LTE-Advanced (also known as LTE Release 10) standard, which is targeted to support much higher peak rates, higher throughput and coverage, and lower latencies, resulting in a better user experience [3].

II. DESCRIPTION FOR PROPOSED MODEL

BLOCK DIAGRAM**:**

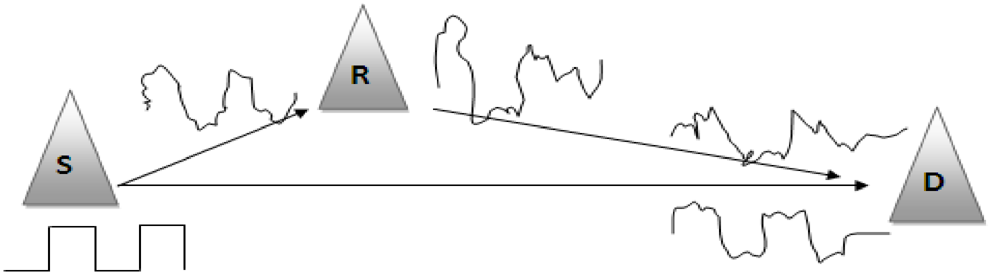


A. Amplify-and-forward (AF)

Here the relay simply amplifies its received signals and then forwards them to the destination.the relay receives a noisy version of the signal transmitted by the source and then amplifies its received

AF scheme can be simplified into three phases:

- Phase 1, the source node transmits the signals by way of broadcasting, while the destination node and the relay node receive the signals.
- Phase 2, the relay node amplifies the powers of the signals received from the source node and forwards them to the destination node.
- Phase 3, the destination node combines & decodes the signals received from the source node in Phase 1 and the relay node in Phase 2 so as to restore the original information.



B. COOPERATIVE BEAM FORMING

- In this paper, we also consider the joint source-relay beam forming design for the three-node MIMO DF relay network with source-destination direct link.
- We assume that both the source and relay nodes are equipped with multiple antennas while the destination node is only deployed with single antenna.
- Such a transmission scenario is readily applicable to the downlink transmission of a relay-enhanced cellular system where the base-station and the relay can accommodate multiple antennas but the mobile user equipment can only afford a single antenna due to size or other constraints.

C. MATLAB-SOFTWARE DESCRIPTION:

MATLAB, software is a technical matrix manipulating based computation software manipulating matrices leads to big data analysis. The things to learn in MATLAB are entering matrices, usage of the: (colon) operator, invoking function. At the heart of MATLAB is a new high level language due to its multi language inheritance fully exploits it power. Matrix manipulation and function working will be the basics of MATLAB and. Users will be rewarded with high productivity, high- creativity, and strong computing power that will change the way us work.

D. Calculation

Users will be rewarded with high productivity, high- creativity, and strong computing power that will change the way us work

Step 1: Determine the given **H** matrix is Singular.

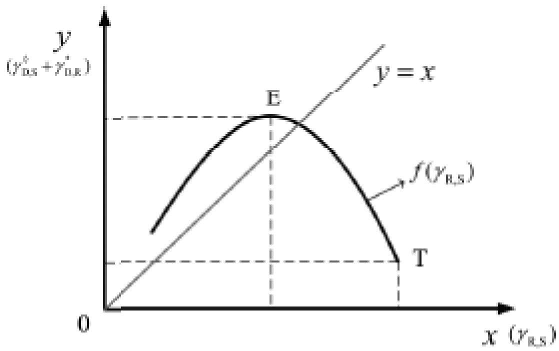
Step 2: Find $\mathbf{H}^T$ from given **H** matrix. Step 3: Multiply $\mathbf{H}^T*\mathbf{H}$.

Step 4: To find Characteristic equation. Step 5: To find the Eigen values and Eigen vectors.

Step 6: To find the **S** matrix. Step 7: To find the **V** matrix. Step 8: To find the **U** matrix. Step 9: Multiply $\mathbf{U}*\mathbf{S}*\mathbf{V}^T$.

Step 10: Finally the original **H** matrix is obtained.

Optimal beamforming method



$\gamma_{\mathrm{R,S}}$ to $\gamma'_{\mathrm{D,S}} + \gamma^*_{\mathrm{D,R}}$.

The points XE,XT,YE and YT can be calculated from the following equations

$$\begin{cases} x_T = \lambda_1^2 P_{\mathrm{S}} \\ y_T = \beta_1^2 P_{\mathrm{S}} + \|\mathbf{h}_{\mathrm{D,R}}\|^2 P_{\mathrm{r}}, \end{cases}$$

And

$$\begin{cases} x_E = \dfrac{\sum \lambda_i^2 \beta_1^2}{\beta_1^2 + \ldots + \beta_{N_s}^2} P_{\mathrm{S}}; \\ y_E = \sum \beta_i^2 P_{\mathrm{S}} + \|\mathbf{h}_{\mathrm{D,R}}\|^2 P_{\mathrm{r}}, \end{cases}$$

Then if the condition satisfies the flow will come to 2:2:1 scenario

Then for 2:2:1 scenario the alpha value can be calculated according to the following equations

$$\begin{cases} \alpha_1 = \dfrac{1 - 2AB \pm \sqrt{1 - 4ABP_s - 4B^2}}{2 + 2P_S^2} \\ \alpha_2 = 1 - \alpha_1, \alpha_1, \alpha_2 \geq 0, \end{cases}$$

where

$$\begin{cases} A = \dfrac{\lambda_1^2 - \lambda_2^2 - \beta_1^2 + \beta_2^2}{2\beta_1\beta_2} \\ B = \dfrac{\lambda_2^2 P_S - \beta_2^2 P_S - \gamma_{D,R}^*}{2\beta_1\beta_2}. \end{cases}$$

Once find out the alpha value the by using lemma 1 the beamforming matrix w* can be calculated.

Then by using the beamforming matrix w*,the capacity can be calculated.

Then while coming to Ns:1:1 scenario the W* matix can be calculated according to the following equations,

the optimal solution $\{|\mu_1|^*, |\mu_2|^*\}$ can be obtained by solving the following equation set

$$\begin{cases} (|\mu_1|^* H_1)^2 = \left(|\mu_1|^* |H_{12}| + |\mu_2|^* \|\mathbf{e}_2\|^2\right)^2 + \gamma_{D,R}^*, \\ (|\mu_1|^*)^2 H_1 + (|\mu_2|^*)^2 \|\mathbf{e}_2\|^2 = 1. \end{cases}$$

This equation set may have four pairs of solutions, where, however, only the one composed of two positive real number can be selected as the final optimal solution $(|\mu_1|^*, |\mu_2|^*)$. Once $(|\mu_1|^*, |\mu_2|^*)$ is determined, one can calculate the optimal $(|\mu_1|^*, |\mu_2|^*)$ in terms of the following

$$\begin{cases} \mu_1^* = |\mu_1|^*, \\ \mu_2^* = |\mu_2|^* \angle(\mathbf{h}_1{}^H \mathbf{h}_2). \end{cases}$$

Then the beamforming matrix w* can be calculated according to the following equations

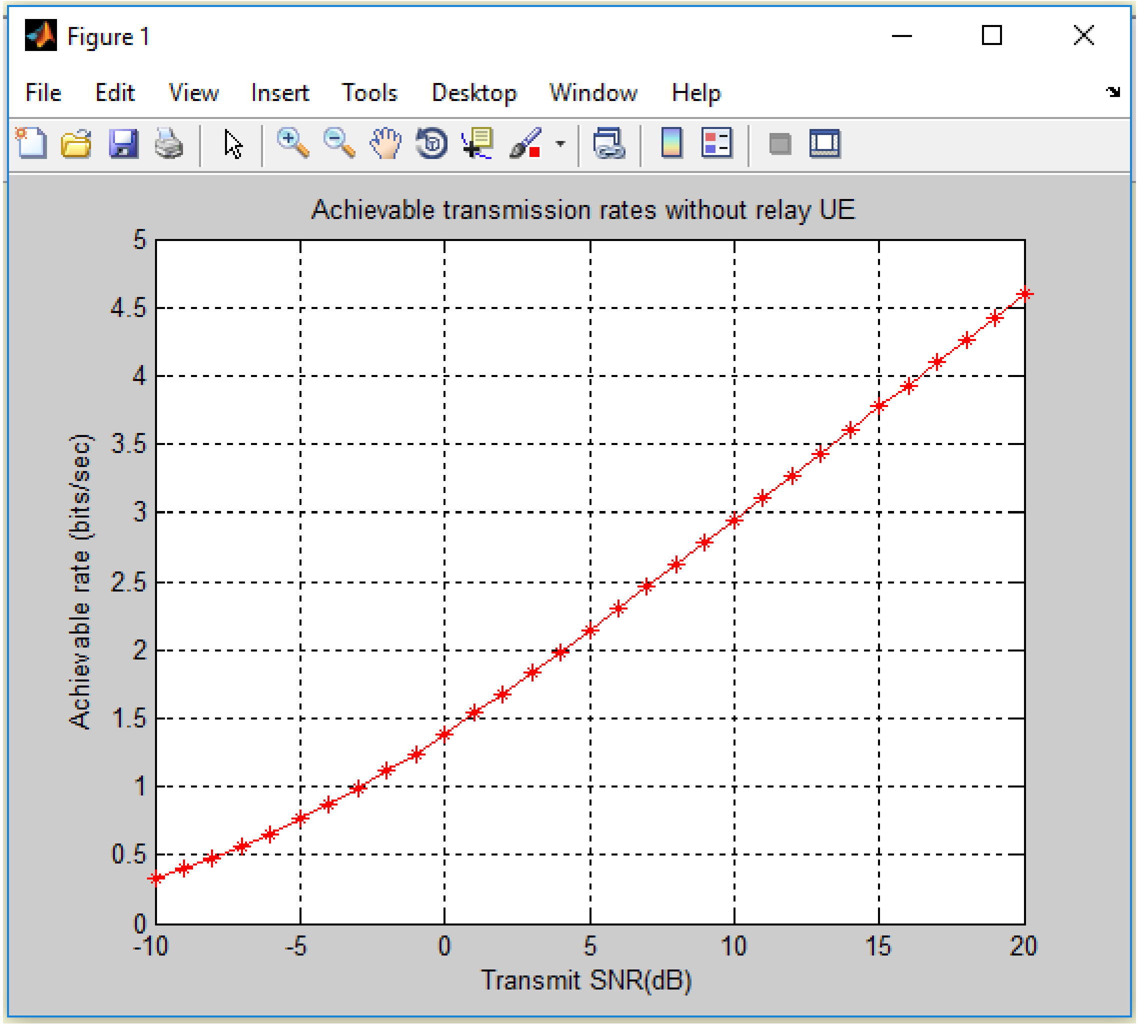
$$\begin{cases} \mathbf{e}_1 = \overline{\mathbf{h}}_1 \\ \mathbf{e}_2 = \overline{\mathbf{h}}_2 - \frac{\mathbf{h}_2{}^H \mathbf{h}_1}{H_1} \overline{\mathbf{h}}_1. \end{cases}$$

And

$$\mathbf{w_s}^* = \mu_1 \mathbf{e}_1 + \mu_2 \mathbf{e}_2.$$

Once the W* value can be calculated the achievable information rates(capacity)can be calculated by using the above system model equations

*III.**Output***



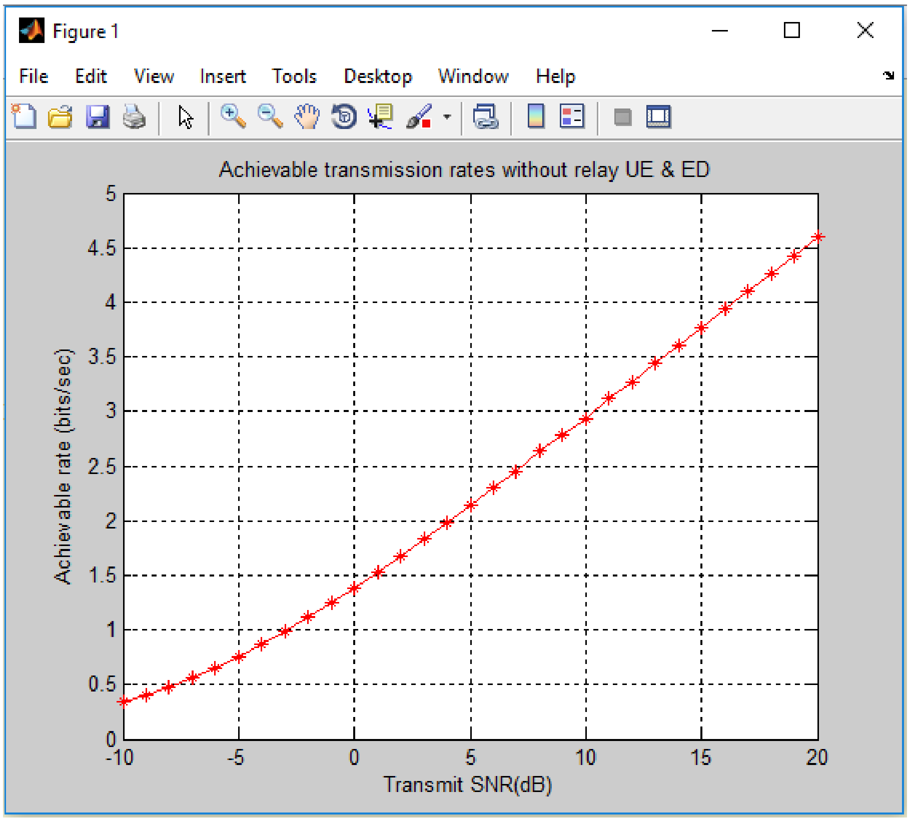


Figure 1
File Edit View Insert Tools Desktop Window Help
Achievable transmission rates without relay UE & ED
Achievable rate (bits/sec)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
-10
-5
0
5
10
15
20
Transmit SNR(dB)

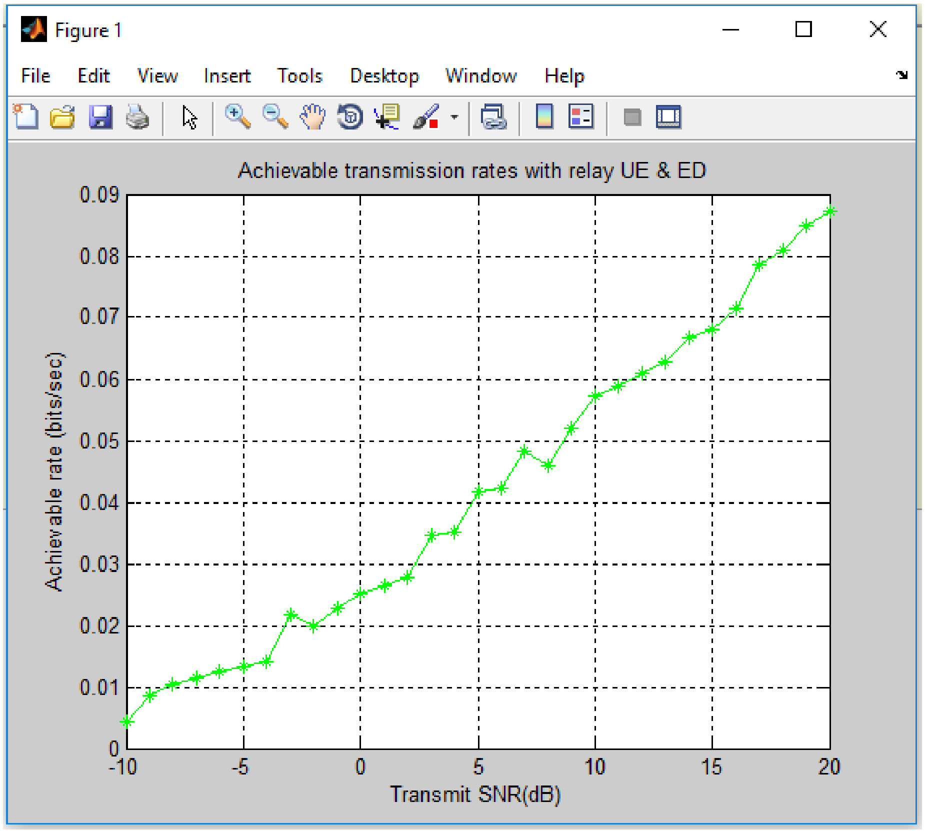


Figure 1
File Edit View Insert Tools Desktop Window Help
Achievable transmission rates with relay UE & ED
Achievable rate (bits/sec)
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
-10
-5
0
5
10
15
20
Transmit SNR(dB)

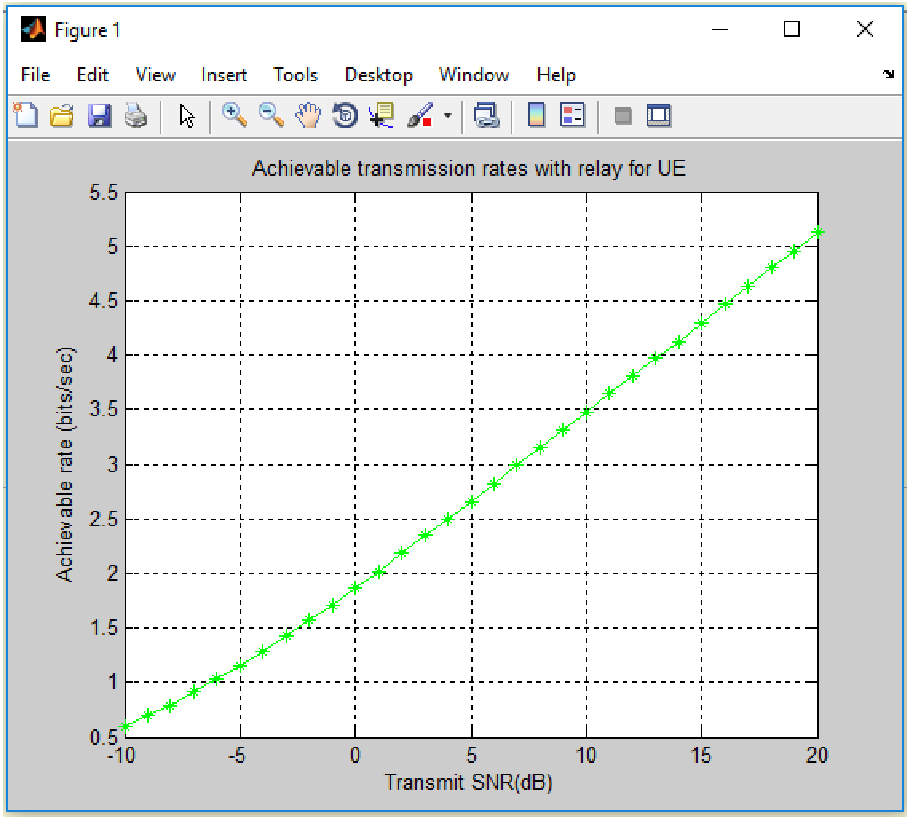


Figure 1
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Achievable transmission rates with relay for UE
Achievable rate (bits/sec)
Transmit SNR(dB)

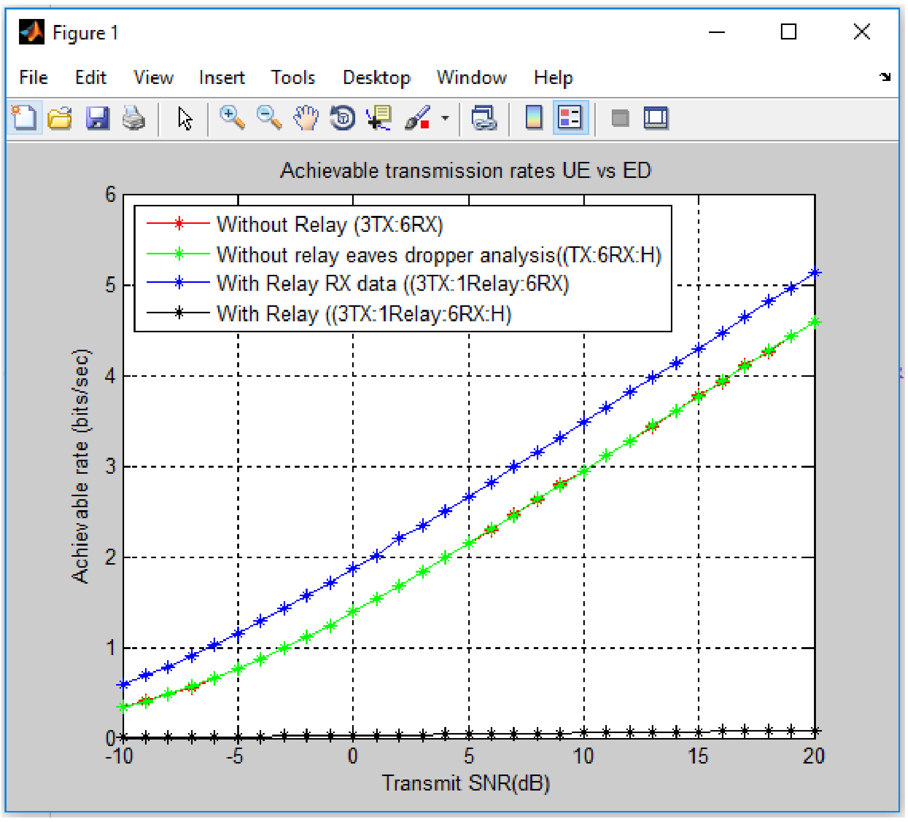
Figure 1
File Edit View Insert Tools Desktop Window Help
Achievable transmission rates UE vs ED
Without Relay (3TX:6RX)
Without relay eaves dropper analysis((TX:6RX:H)
With Relay RX data ((3TX:1Relay:6RX)
With Relay ((3TX:1Relay:6RX:H)
Achievable rate (bits/sec)
Transmit SNR(dB)

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