OSTBC in Multiple Polarized MIMO-OFDM Systems

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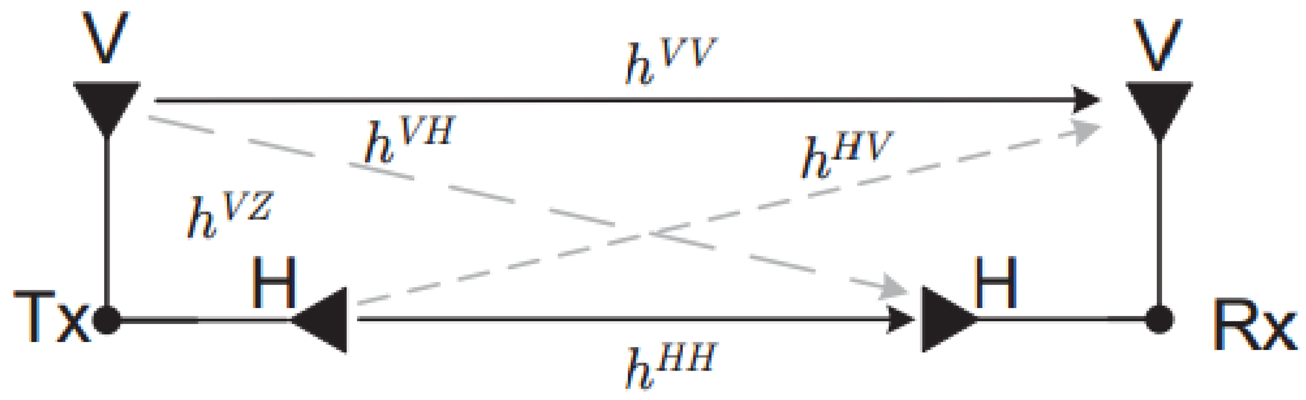
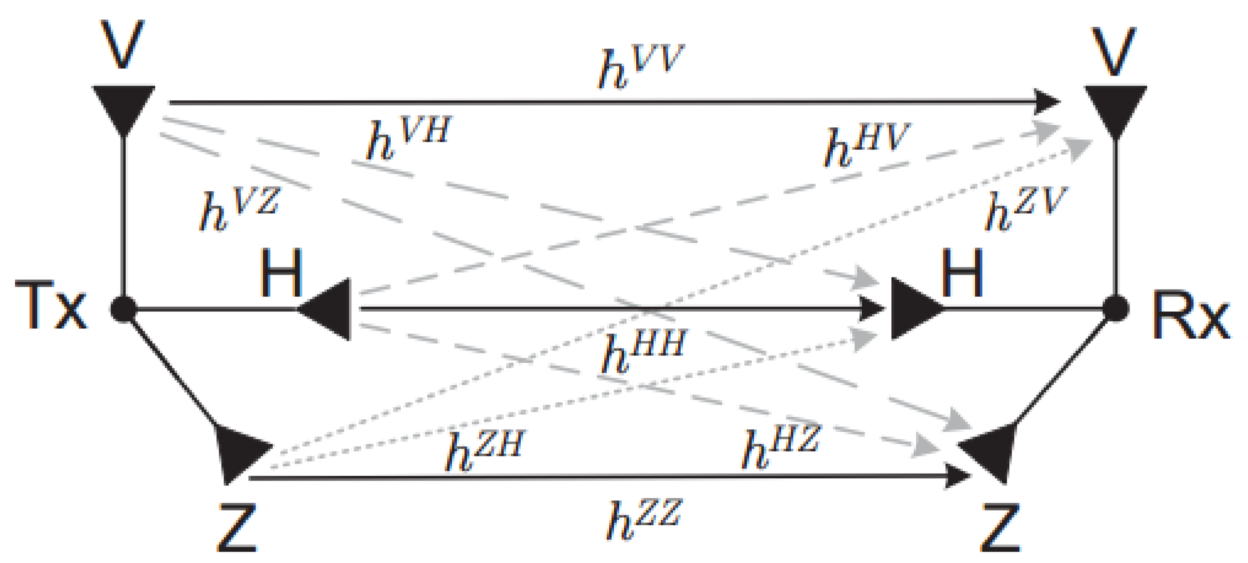
Abstract

Uses of dual- and triple-polarized antennas are promising solutions for realizing compact devices and also robust against many imperfections as compared to spatially separated antenna systems. This research is aiming to model the dual- and triple-polarized MIMO channel and investigate the BER performance of orthogonal space-time block coding (OSTBC) in MIMO-OFDM systems using proposed dual- and triple-polarized MIMO channel models.

Multiple Polarized MIMO Channel Model

Cross-polar discrimination (XPD) and spatial correlations are taken into consideration in modeling the multiple polarized MIMO channels. Two figures below shows the configuration of dual- and triple-polarized MIMO systems respectively.





Dual-polarized MIMO channel: $H_{DP} = D \otimes G$

$$G = \frac{1}{\sqrt{1+\chi}} \begin{bmatrix} \cos\gamma & -\sin\gamma \\ \sin\gamma & \cos\gamma \end{bmatrix} \begin{bmatrix} 1 & \sqrt{\chi} e^{j\theta} \\ -\sqrt{\chi} e^{j\theta} & 1 \end{bmatrix} \begin{bmatrix} \cos\zeta & -\sin\zeta \\ \sin\zeta & \cos\zeta \end{bmatrix}^T$$

$$\mathbf{D} = \mathbf{\Gamma}_t^{1/2} \mathbf{H} \mathbf{\Gamma}_r^{1/2}$$

$$\Gamma_t = \begin{pmatrix} 1 & \delta_t^* & \delta_t^{2^*} & \cdots & \delta_t^{N_t-1^*} \\ \delta_t & 1 & \delta_t^* & \cdots & \delta_t^{N_t-2^*} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \delta_t^{N_t-1} & \delta_t^{N_t-2} & \delta_t^{N_t-3} & \cdots & 1 \end{pmatrix} \quad \Gamma_r = \begin{pmatrix} 1 & \delta_r^* & \delta_r^{2^*} & \cdots & \delta_r^{N_r-1^*} \\ \delta_r & 1 & \delta_r^* & \cdots & \delta_r^{N_r-2^*} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \delta_r^{N_r-1} & \delta_r^{N_r-2} & \delta_r^{N_r-3} & \cdots & 1 \end{pmatrix}$$

Triple-polarized MIMO channel: $H_{TP} = D \otimes G$

$$D = \begin{bmatrix} 1 & \cos\gamma & -\sin\gamma \\ \sin\gamma & 1 & -\cos\gamma \\ \sin\gamma & -\cos\gamma & 1 \end{bmatrix} \tilde{G} \begin{bmatrix} 1 & \cos\zeta & -\sin\zeta \\ \sin\zeta & 1 & -\cos\zeta \\ \sin\zeta & -\cos\zeta & 1 \end{bmatrix}^T$$

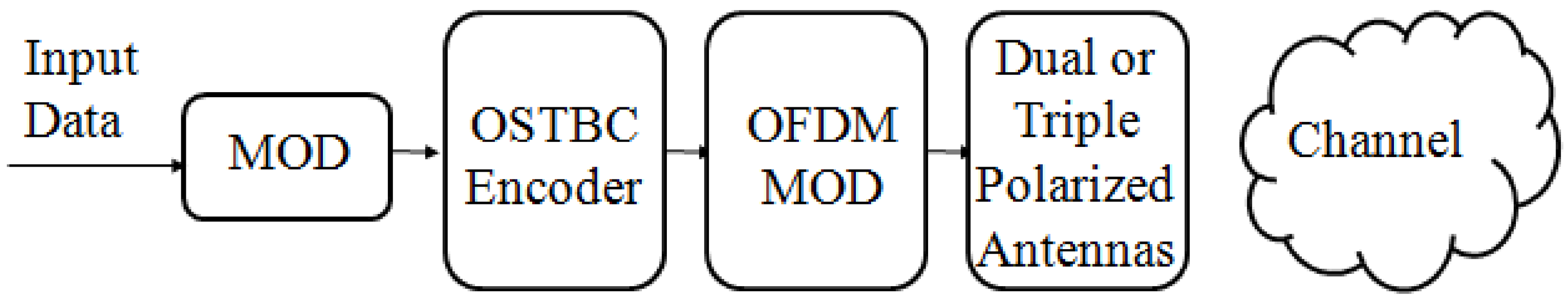
$$\tilde{G} = \frac{1}{\sqrt{1+\chi}} \begin{bmatrix} 1 & \sqrt{\chi} e^{j\theta} & -\sqrt{\chi} e^{j\theta} \\ -\sqrt{\chi} e^{j\theta} & 1 & \sqrt{\chi} e^{j\theta} \\ \sqrt{\chi} e^{j\theta} & -\sqrt{\chi} e^{j\theta} & 1 \end{bmatrix}$$

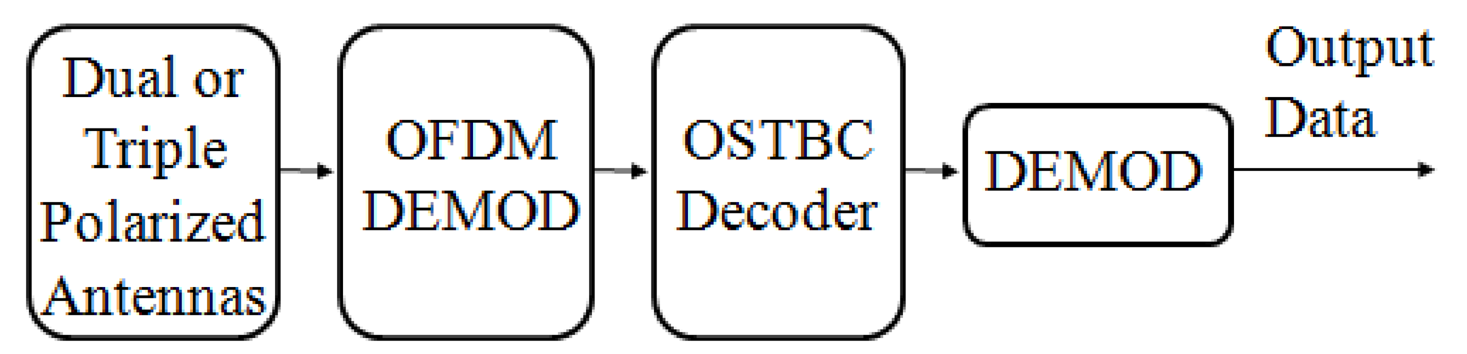
$$\mathbf{D} = \mathbf{\Gamma}_t^{1/2} \mathbf{H} \mathbf{\Gamma}_r^{1/2}$$

$$\Gamma_r = \begin{pmatrix} 1 & \delta_r^* & \delta_r^{2^*} & \cdots & \delta_r^{N_r-1^*} \\ \delta_r & 1 & \delta_r^* & \cdots & \delta_r^{N_r-2^*} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \delta_r^{N_r-1} & \delta_r^{N_r-2} & \delta_r^{N_r-3} & \cdots & 1 \end{pmatrix} \quad \Gamma_t = \begin{pmatrix} 1 & \delta_t^* & \delta_t^{2^*} & \cdots & \delta_t^{N_t-1^*} \\ \delta_t & 1 & \delta_t^* & \cdots & \delta_t^{N_t-2^*} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \delta_t^{N_t-1} & \delta_t^{N_t-2} & \delta_t^{N_t-3} & \cdots & 1 \end{pmatrix}$$

OSTBC-MIMO-OFDM System Model

Two figures below show the block diagrams of the transmitter and receiver respectively.

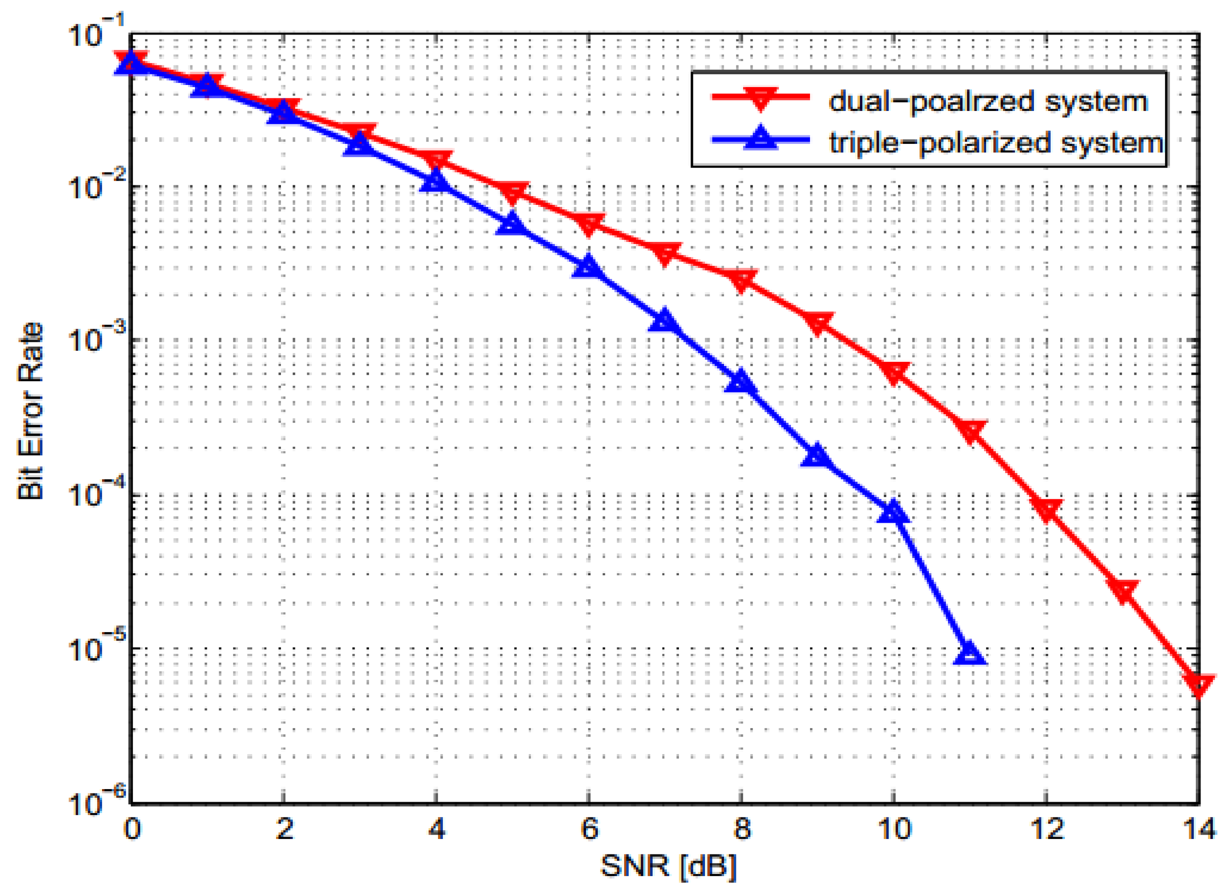




Simulation Parameter

Antenna System Configurations	2x2 triple-polarized antennas 3x3 dual-polarized antennas
Spatial Correlation	0.4 at TX, 0.6 at RX
Channel Type	Frequency-Selective Rayleigh Fading
Multipath Number	6
Modulation Format	QPSK
Subcarrier Number	48
FFT Size	64
Guard Interval Length	16
Noise Type	AWGN

Simulation Result



Conclusion & Future Work

From the simulation result, we can find that the BER performance of OSTBC in triple-polarized MIMO-OFDM systems outperforms that of dual-polarized systems.

One direction of future work is use antenna selection technique in order to further improve the BER performance in multiple polarized systems.

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