SIMULATION OF MASSIVE MIMO WIRELESS SYSTEM

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Abstract

This project evaluates modulation techniques for Zero-Forcing (ZF) detection in Massive MIMO. Results, including Bit Error Rate (BER) vs. Signal-to-Noise Ratio (SNR) analysis, show ZF's optimal range and MMSE's performance at low SNR. Comparative analysis reveals nuanced differences, highlighting the suitability of ZF and MMSE in varying SNR conditions for Massive MIMO
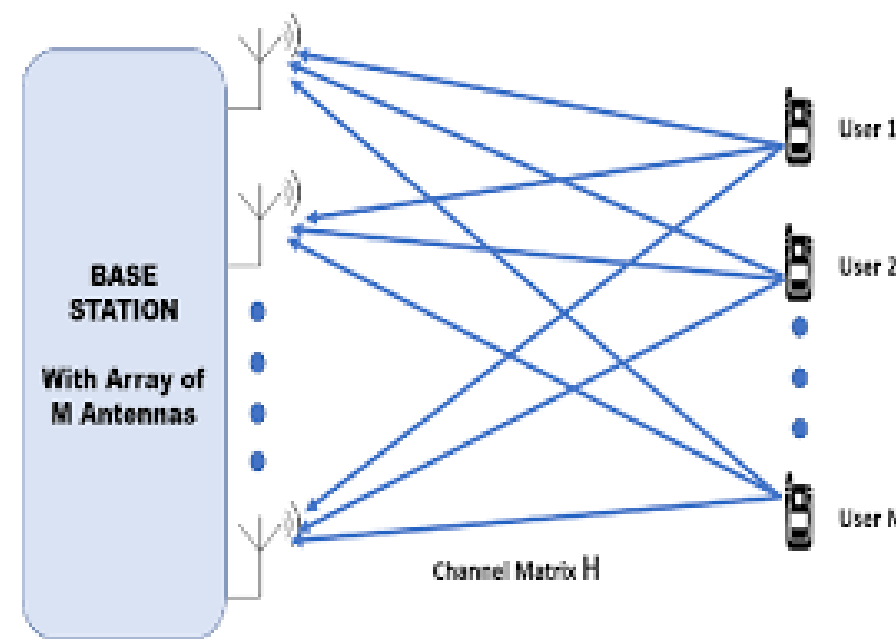
Description and Methods

Fig 1:A Massive MIMO system with M antennas at the base station communicating with N users

- Massive-MIMO: Utilizes numerous base station antennas
- Boosts spectral efficiency and wireless capacity
- Enables spatial multiplexing
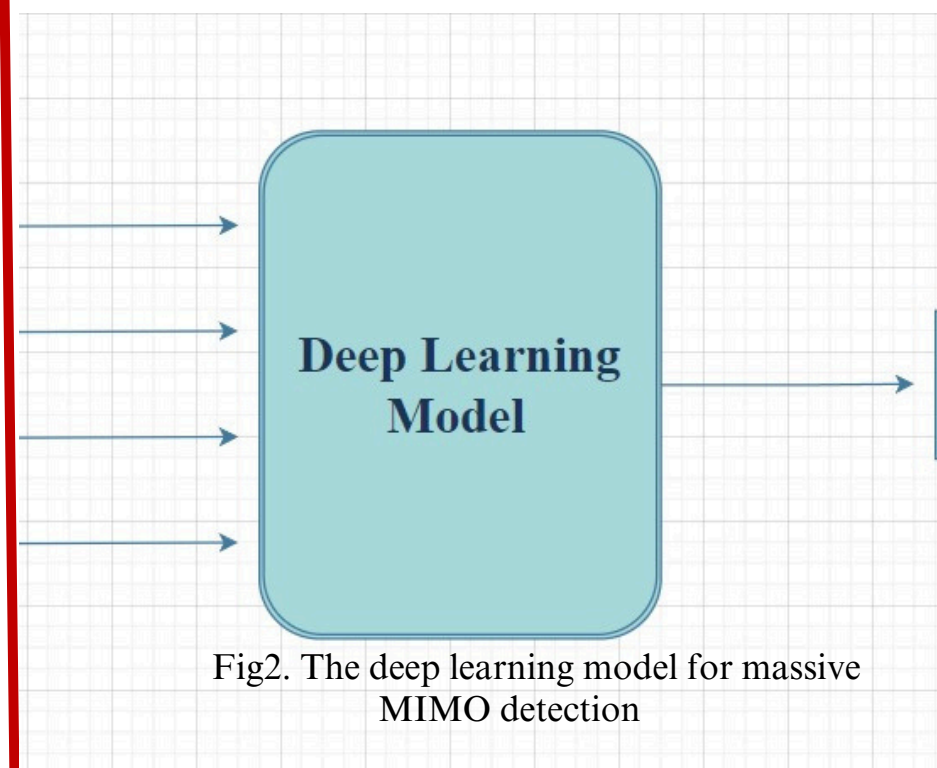- Crucial for 5G and beyond

Equations:

Fig2. The deep learning model for massive MIMO detection

Received Signal Vector:
$$\mathbf{y} = \mathbf{H} \cdot \mathbf{x} + \mathbf{n}$$

Zero Forcing (ZF) Estimation:
$$\hat{\mathbf{x}} = \mathbf{W}\mathbf{y}$$
where $\mathbf{W} = (\mathbf{H}^H\mathbf{H})^{-1}\mathbf{H}^H$

Error Calculation:
$$Error = \|\mathbf{x} - \hat{\mathbf{x}}\|$$

Interference Signal:
$$Interference\ Signal = \mathbf{H} \cdot \mathbf{x}$$

Signal-to-Interference-plus-Noise Ratio (SINR):
$$SINR = \frac{\|\mathbf{H} \cdot \mathbf{x}\|^2}{\|\mathbf{n}\|^2}$$

Results

The plot here shows the BER vs SNR plot of the ZERO FORCING detection technique

Motivation

Our major motivation is the significant complexity of massive symbol detection, this complexity leads to the exploration of suboptimal solutions, including linear detectors and deep learning approaches, to address the challenges effectively.
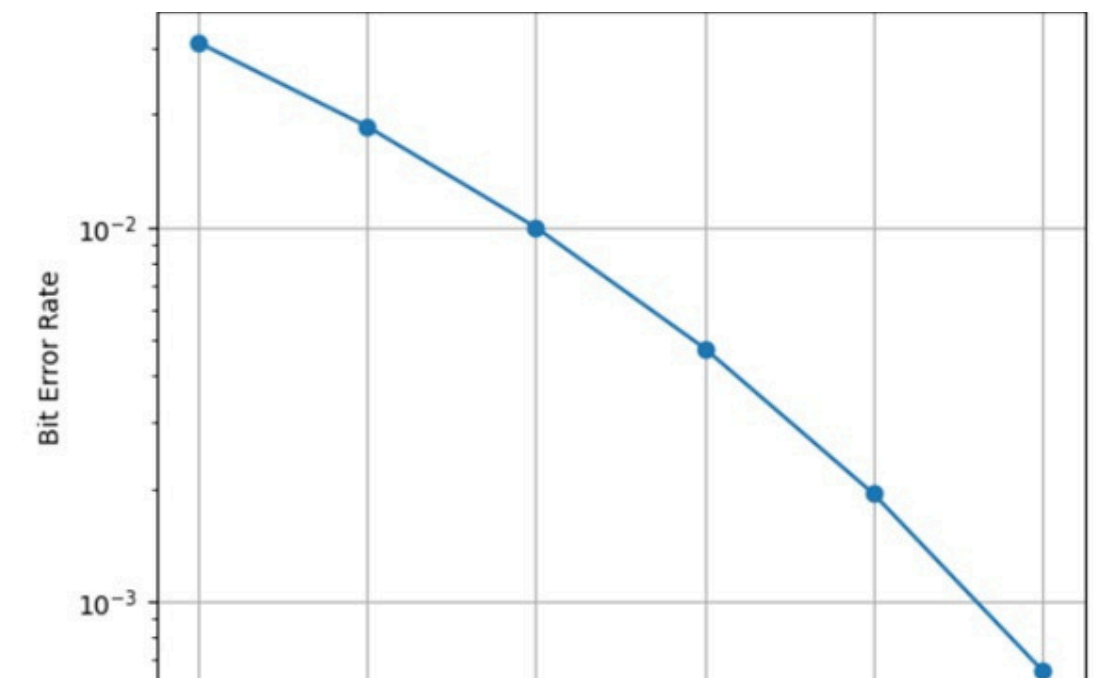
Conclusion

- Implementing Zero Forcing (ZF) detection to simplify computations in Massive MIMO.
- Using plots to illustrate Bit Error Rate (BER) dynamics under varying Signal-to-Noise Ratio (SNR).
- Gaining insights into optimal SNR ranges and trade-offs between BER and SNR.
- Informing parameter tuning and potential optimizations for improved Massive MIMO performance

Key References

Björnson, Emil, Erik G. Larsson, and Thomas L. Marzetta. "Massive MIMO: Ten myths and one critical question." IEEE Communications Magazine 54, no. 2:114-123