Tutorial 5

Resilient Communication Systems
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Released: November 10, 2025.

MIMO Detectors II

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Problem 1

Linear MIMO Detectors: Consider a MIMO communication system with the following channel matrix

$$\mathbf{H} = \begin{bmatrix} 0.2 & -0.2 \\ 0.1 & 0.4 \\ 1 & 0.2 \end{bmatrix}.$$

- Sketch the block diagram of a linear MIMO detector and determine the corresponding filter matrices of maximum ratio combining (MRC), linear zero-forcing (ZF), and minimum mean square error (MMSE), considering $P_x/\sigma_n^2 = 10$ dB. Calculate the total error variance of the mentioned detection schemes and compare them.
- With assuming $\mathbf{y} = [0.6, -0.1, 1.3]^{\mathsf{T}}$, obtain estimation of $\mathbf{x}$ when $\mathcal{A} = \{-1, 1\}$ by using 3 different linear detectors.

Problem 2

Fig. 1 is generated with the MATLAB code in GitHub Repository.

- Based on Fig. 1, determine which color is for which detector? Name them as MRC, ZF, or MMSE.
- Determine the number of receiver antennas (N) if the number of transmitter antenna is $(M = 2)$?
- With the help of the MATLAB code in GitHub Repository, verify your answers for Problem 1.

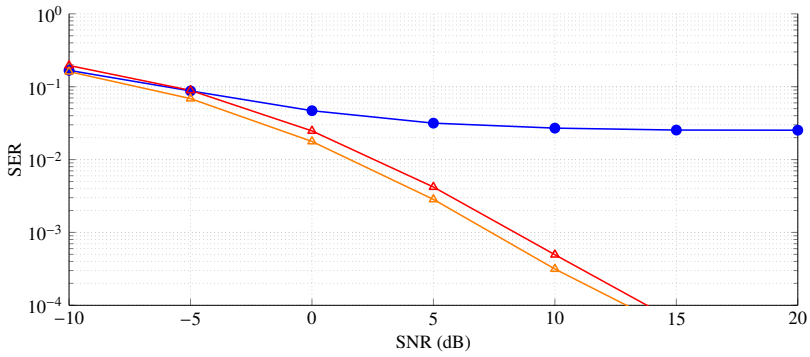

Figure 1: SER of three different linear MIMO detectors.

Understanding linear MIMO detectors is crucial for anyone delving into modern wireless communication systems. These detectors, including Maximum Ratio Combining (MRC), Zero-Forcing (ZF), and Minimum Mean Square Error (MMSE) methods, are fundamental in managing the complexities of MIMO technology. By effectively mitigating interference and enhancing signal quality, they play a pivotal role in improving data transmission rates and reliability. From 20:56 of this video.

Wireless Future

RESILIENT COMMUNICATION SYSTEMS

Arogyaswami J. Paulraj

Arogyaswami J. Paulraj, born on April 14, 1944, in Pollachi, India, is a distinguished Indian-American electrical engineer and Professor Emeritus at Stanford University. He is renowned for inventing MIMO technology, which significantly enhances wireless communication by utilizing multiple antennas at both the transmitter and receiver ends. This innovation underpins modern high-speed Wi-Fi and 4G/5G mobile networks, revolutionizing wireless services globally.

Arogyaswami J. Paulraj
Born: 14 April 1944
age: 80

Paulraj's illustrious career began with 26 years in the Indian Navy, where he led the development of the APSOH sonar system and established key research laboratories. After retiring as a Commodore in 1991, he joined Stanford University, where he continued his groundbreaking work in wireless communications. His contributions have earned him numerous accolades, including the Padma Bhushan from the Indian government in 2010, the IEEE Alexander Graham Bell Medal in 2011, and the Marconi Prize in 2014. In 2018, he was inducted into the National Inventors Hall of Fame.

Beyond academia, Paulraj founded several companies, such as Iospan Wireless and Beceem Communications, which played pivotal roles in advancing MIMO technology in commercial applications. His extensive body of work includes over 400 research publications and numerous patents, solidifying his legacy as a transformative figure in electrical engineering and wireless communications. Read more in Wikipedia.
Reference: Stanford website.