

Tutorial 12

Resilient Communication Systems

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Space-Time-Block Coding II

Problem

Assume $\mathbf{X}(s) = \sum_{k=1}^K (\mathbf{C}_k \Re\{\mathbf{s}_k\} + \mathbf{D}_k \Im\{\mathbf{s}_k\})$, where $\Re\{\cdot\}$ and $\Im\{\cdot\}$ are real and imaginary parts of a complex number (see lecture notes slides 204-207).



- Derive sufficient conditions on matrices $\mathbf{C}_k$ and $\mathbf{D}_k$ to hold $\mathbf{X}(s)^H \mathbf{X}(s) = c(\sum_{k=1}^K |\mathbf{s}_k|^2) \mathbf{I}_M$.
- Using the result of the first part conclude $\mathbf{A}^H \mathbf{A} = c \|\mathbf{H}\|_F^2 \mathbf{I}_{2K}$, where $\mathbf{A} = [\mathbf{C}_1 \mathbf{H} \cdots \mathbf{C}_K \mathbf{H} \quad \mathbf{D}_1 \mathbf{H} \cdots \mathbf{D}_K \mathbf{H}]$ and $\mathbf{Y} = \begin{pmatrix} \text{vec}(\Re\{\mathbf{Y}\}) \\ \text{vec}(\Im\{\mathbf{Y}\}) \end{pmatrix}$.

Vahid Tarokh

Vahid Tarokh is a prominent Iranian-American mathematician and engineer, best known for his influential work in wireless communications, particularly in space-time coding. His research has played a key role in improving the efficiency and reliability of modern communication systems, especially MIMO technology.

Born in Tehran, Iran, Tarokh later earned his Ph.D. in electrical engineering from the University of Waterloo in Canada. In 1998, he gained widespread recognition for his groundbreaking papers on space-time block codes, which expanded on Siavash Alamouti's earlier work [1, 2]. Tarokh's codes offered more flexibility and higher performance, becoming an essential part of wireless technologies like 3G, 4G, and Wi-Fi.



Vahid Tarokh

Over the years, Tarokh has combined academic research with industry expertise, holding influential roles at institutions such as Harvard University, Duke University, and AT&T Labs. His work has earned him numerous awards, including the IEEE Information Theory Society Paper Award, and he is widely regarded as a leader in his field.

Through his contributions, Vahid Tarokh has shaped the wireless technologies that connect people across the globe, leaving a lasting impact on both research and industry.

Read more in [Wikipedia](#).

References

- [1] V. Tarokh, N. Seshadri, and A. Calderbank, "Space-time codes for high data rate wireless communication: performance criterion and code construction," *IEEE Transactions on Information Theory*, vol. 44, no. 2, pp. 744–765, 1998.
- [2] V. Tarokh, H. Jafarkhani, and A. Calderbank, "Space-time block codes from orthogonal designs," *IEEE Transactions on Information Theory*, vol. 45, no. 5, pp. 1456–1467, 1999.