ROHINI COLLEGE OF ENGINEERING & TECHNOLOGY (AUTONOMOUS)

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Sample matrix inversion

C.PRISCILLA,AP/ECE

Principle

- SMI is a **direct implementation of the Wiener solution**, using an estimated covariance matrix from finite data samples.
- The SMI beamformer replaces the true covariance matrix with a sample covariance matrix, yielding a practical implementation of optimal beamformers such as Wiener or MVDR (Capon) beamformers.

1. Collect data snapshots

$$\{\mathbf{x}(1), \mathbf{x}(2), \ldots, \mathbf{x}(N)\}$$

2. Estimate covariance matrix

$$\hat{\mathbf{R}} = \frac{1}{N} \sum_{n=1}^{N} \mathbf{x}(n)\mathbf{x}^H(n)$$

3. Invert covariance matrix

$$\hat{\mathbf{R}}^{-1}$$

4. Compute weight vector
   - Wiener or MVDR formula
5. Apply beamformer

$$y(n) = \mathbf{w}^H \mathbf{x}(n)$$

SMI for Wiener Beamforming (MMSE)

Minimize mean square error:

$$J = E\{|d(n) - \mathbf{w}^H \mathbf{x}(n)|^2\}$$

Wiener solution

$$\mathbf{w}_{\text{opt}} = \mathbf{R}^{-1}\mathbf{p}$$

where:

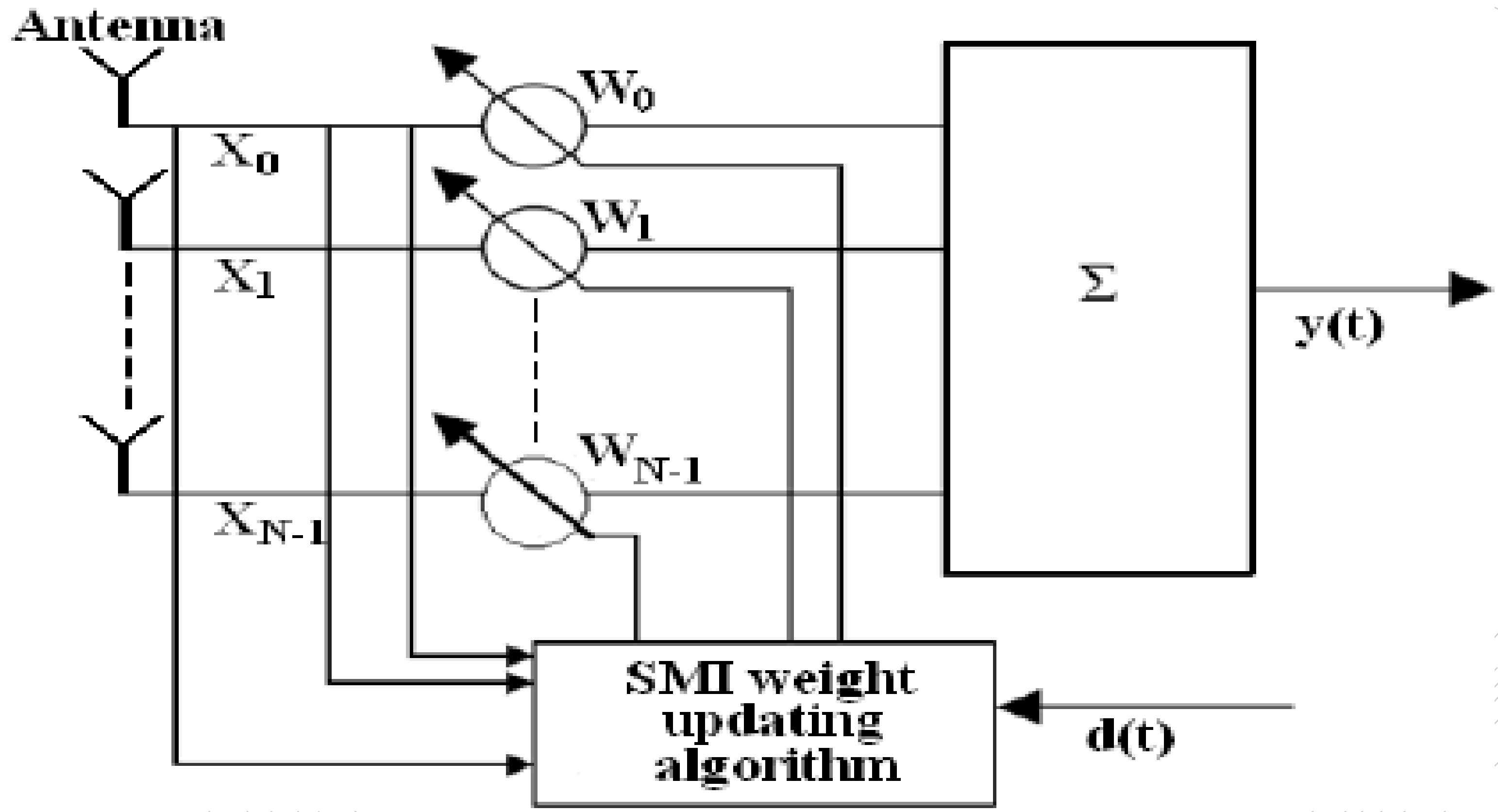
$$\mathbf{p} = E\{\mathbf{x}(n) d^*(n)\}$$

SMI approximation

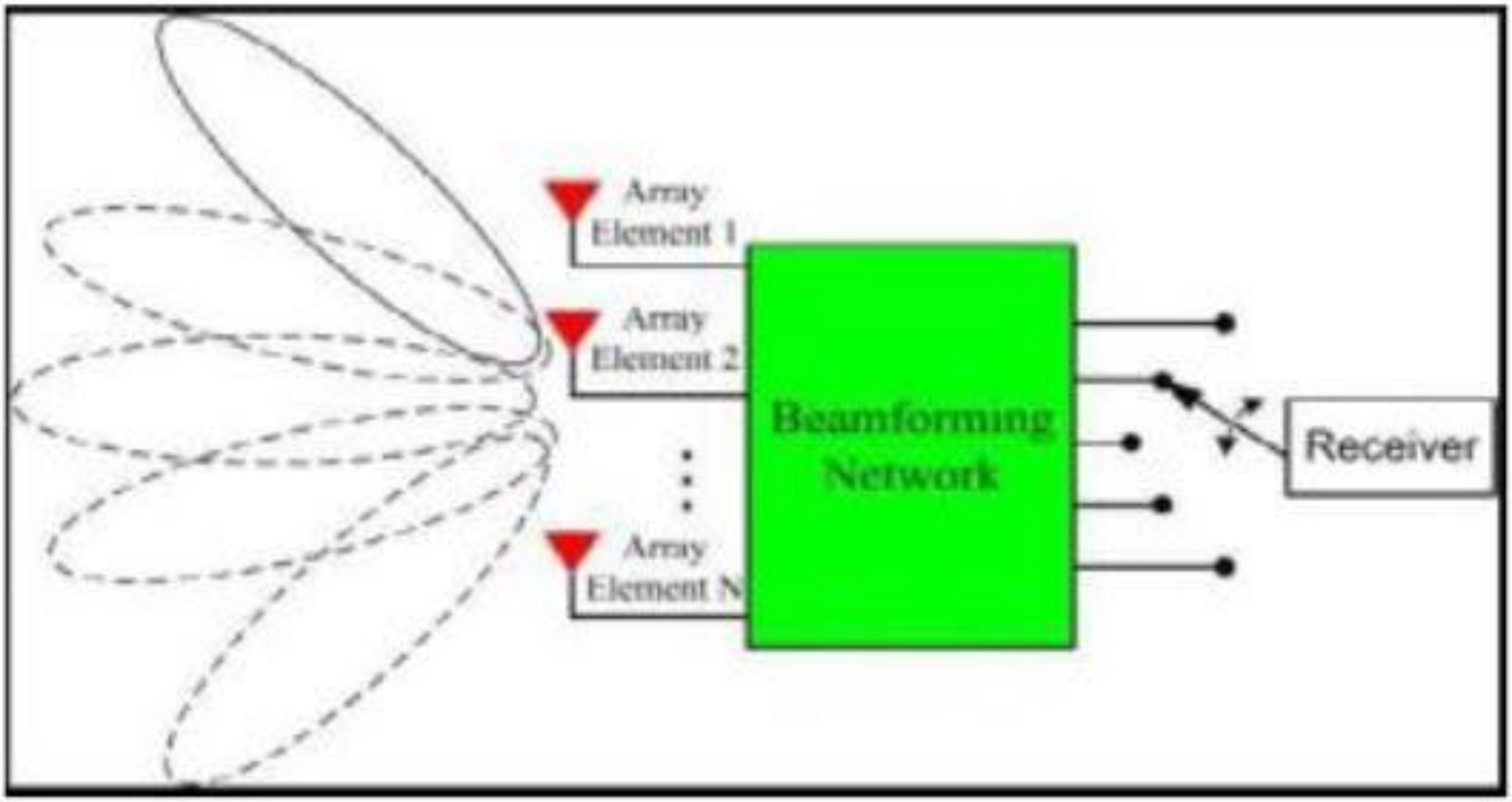
$$\boxed{\mathbf{w}_{\text{SMI}} = \hat{\mathbf{R}}^{-1}\hat{\mathbf{p}}}$$

with:

$$\hat{\mathbf{p}} = \frac{1}{N}\sum_{n=1}^{N} \mathbf{x}(n) d^*(n)$$



Antenna
W0
X0
W1
X1
Σ
y(t)
WN-1
XN-1
SMI weight updating algorithm
d(t)



Array
Element 1
Array
Element 2
Array
Element N
Beamforming
Network
Receiver

Applications

- Radar and sonar
- Smart antennas
- Direction-of-arrival (DOA) estimation preprocessing
- Wireless base stations