ROHINI
COLLEGE OF ENGINEERING & TECHNOLOGY
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Adaptive Beamforming: Least mean squares, Sample matrix inversion,

C.PRISCILLA/AP-ECE

- **Adaptive beamforming uses an antenna array to enhance a desired signal while suppressing interference and noise by adaptively adjusting the complex weight vector.**

Signal Model

For an array of M sensors:

$$\mathbf{x}(n) = \mathbf{a}(\theta_s)s(n) + \sum_{k=1}^{K} \mathbf{a}(\theta_k)i_k(n) + \mathbf{v}(n)$$

Output:

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

Goal: Choose weights $\mathbf{w}$ to optimize a performance criterion (e.g., minimum mean square error or maximum SINR).

Least Mean Squares (LMS) Beamformer

LMS is a gradient-based adaptive algorithm that minimizes the mean square error (MSE) between the beamformer output and a reference (training) signal.

Error signal

$$e(n) = d(n) - \mathbf{w}^H(n)\mathbf{x}(n)$$

where:

- $d(n)$ = desired (reference) signal

Cost function

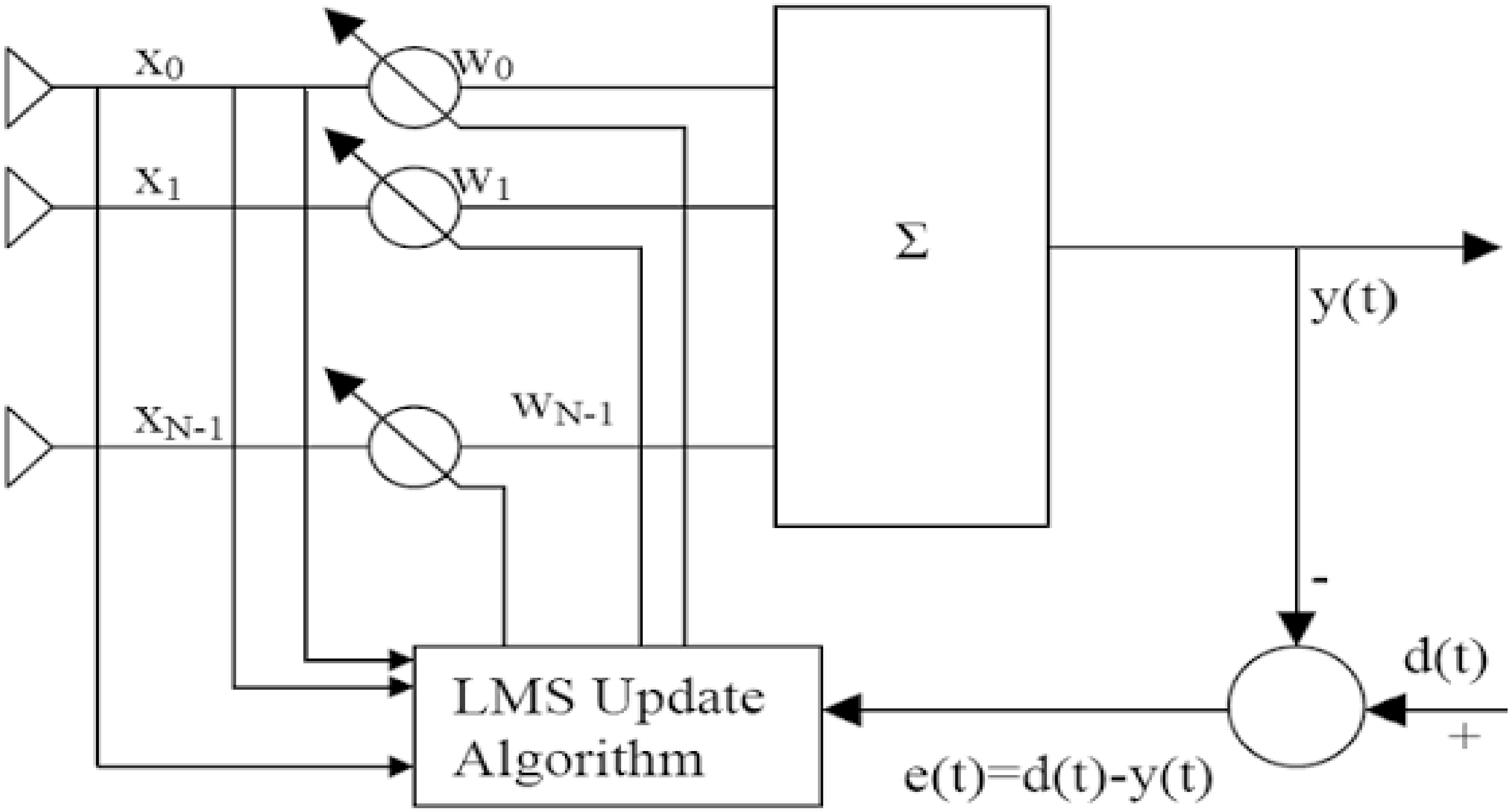
$$J(n) = E\{|e(n)|^2\}$$

Weight update equation

$$\mathbf{w}(n+1) = \mathbf{w}(n) + \mu\mathbf{x}(n)e^*(n)$$

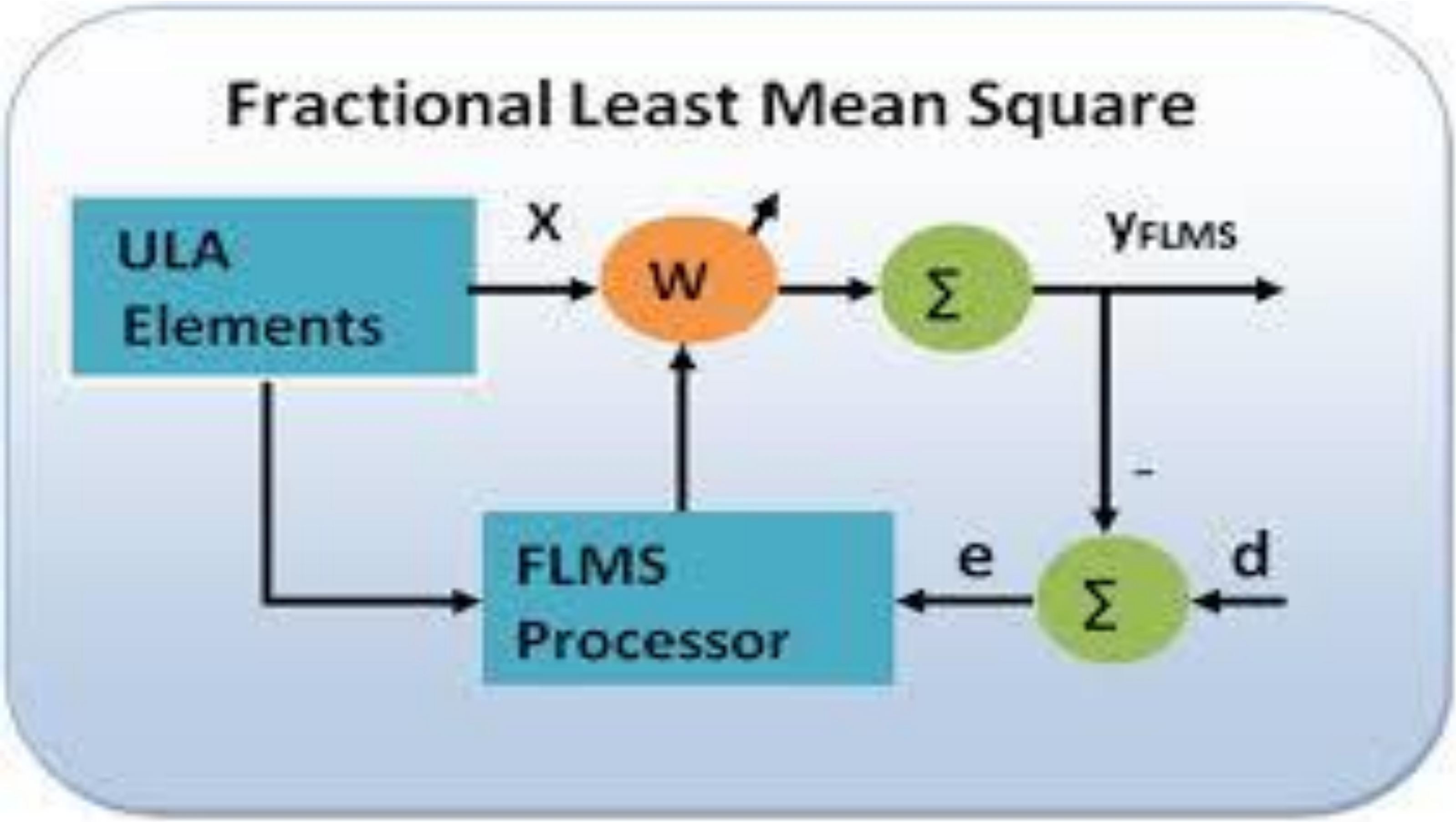
where:

- μ = step size (learning rate)


x0
x1
xN-1
w0
w1
wN-1
Σ
y(t)
-
d(t)
+
LMS Update
Algorithm
e(t)=d(t)-y(t)

Properties

- **Low computational complexity**: $O(M)$
- **No matrix inversion**
- **Slow convergence** (depends on eigenvalue spread of covariance matrix)
- Requires a **training signal**



Fractional Least Mean Square
ULA
Elements
x
w
Σ
yFLMS
-
FLMS
Processor
e
Σ
d