# Digital Channel Equalization

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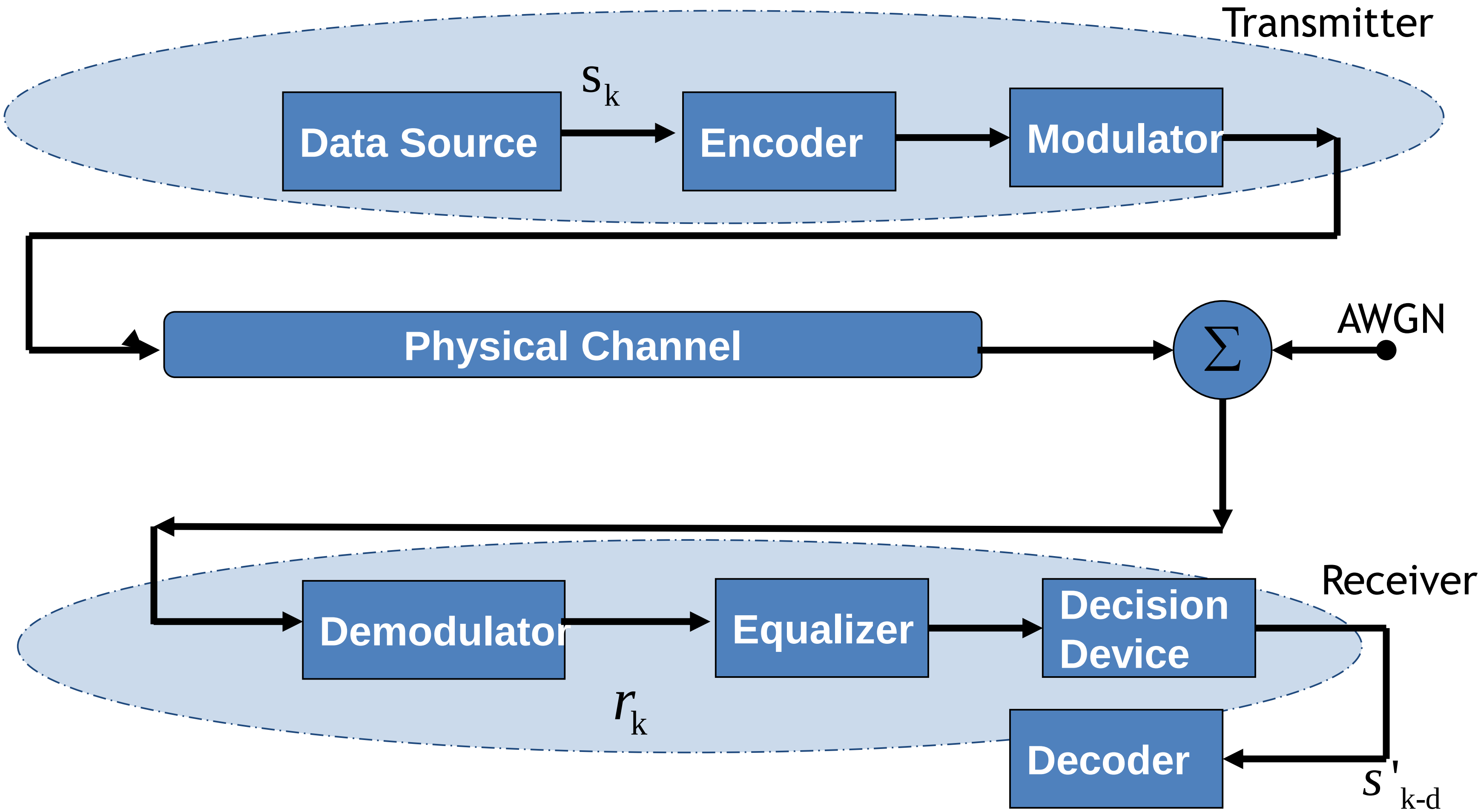
# Digital Communication



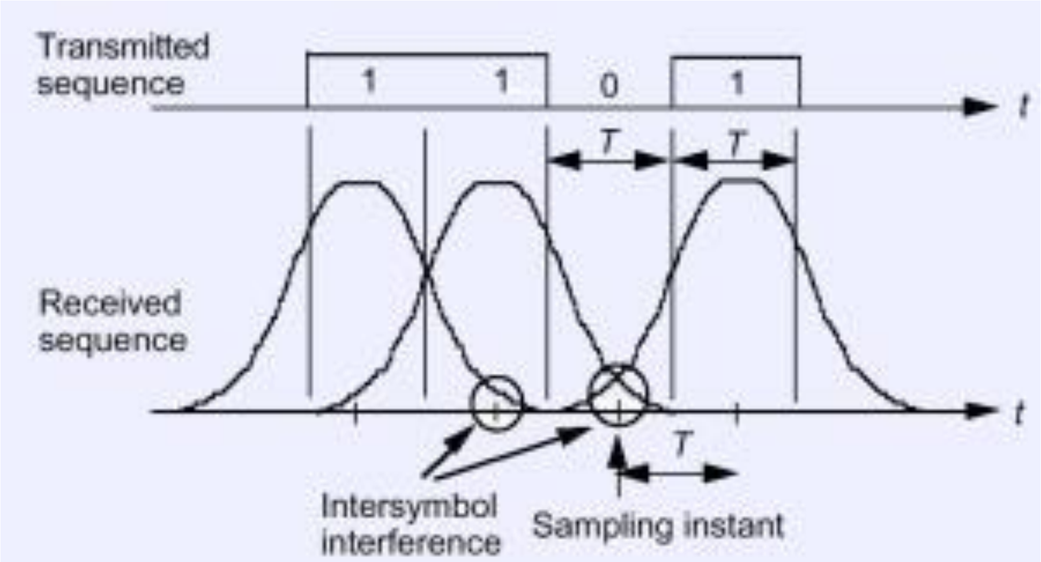
# Channel Equalization

Digital Channel Equalizers : -

- Located in the front end of the receivers ( in series with channel )
- Inverse system of the channel model ( Transfer function of the equalizer is inverse to the transfer function of the channel )
- Use to reduce -
  - Inter-Symbol Interference (ISI)
  - Inter User Interference in the form of Co-channel Interference
  - Adjacent Channel Interference ( ACI )
    - in the presence of Additive White Gaussian Noise (AWGN).

# Inter-Symbol Interference (ISI)

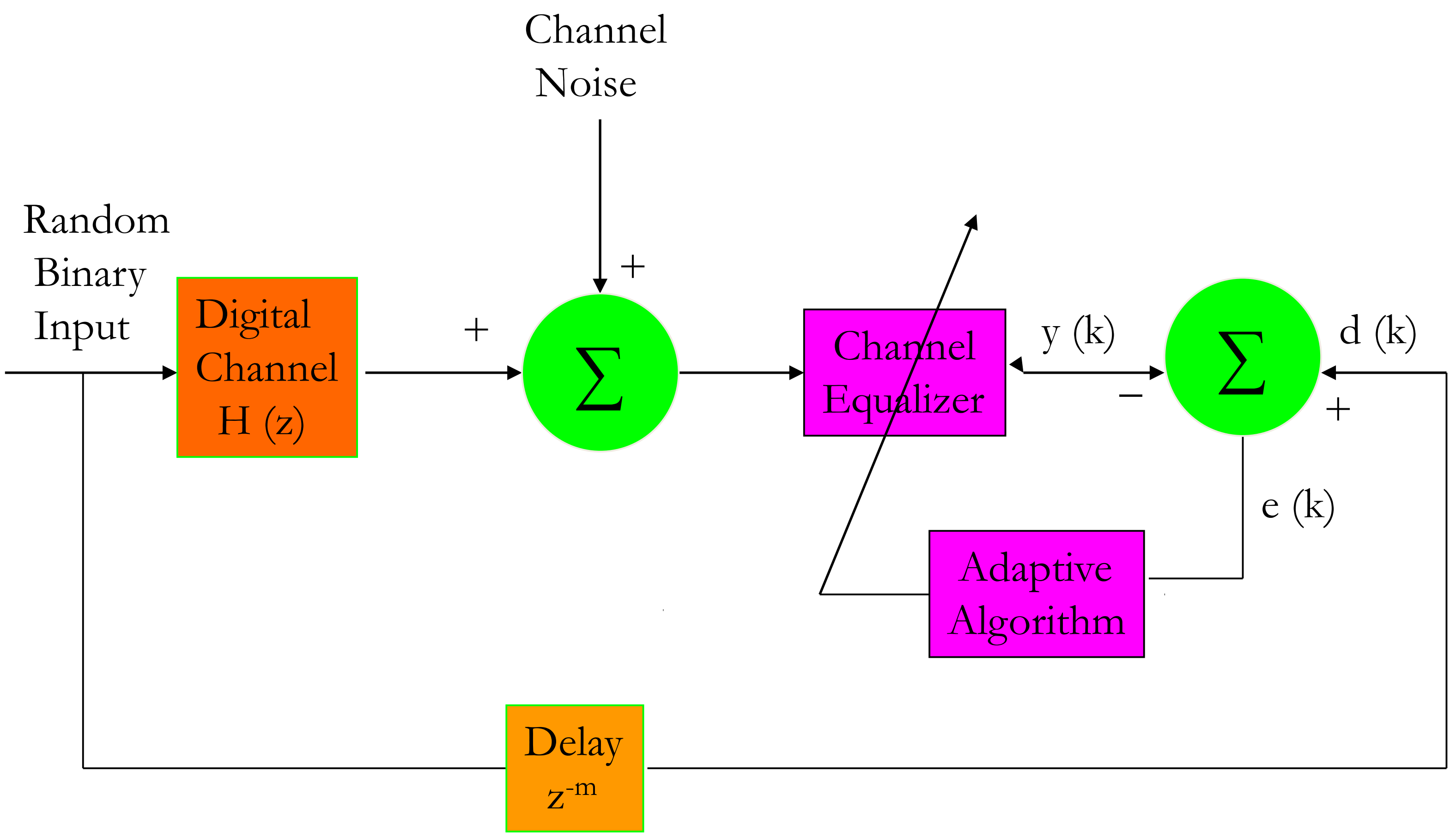
In Communication Inter-symbol Interference (ISI) is a form of distortion of a signal in which one symbol interferes with subsequent symbols




- **Causes of ISI**

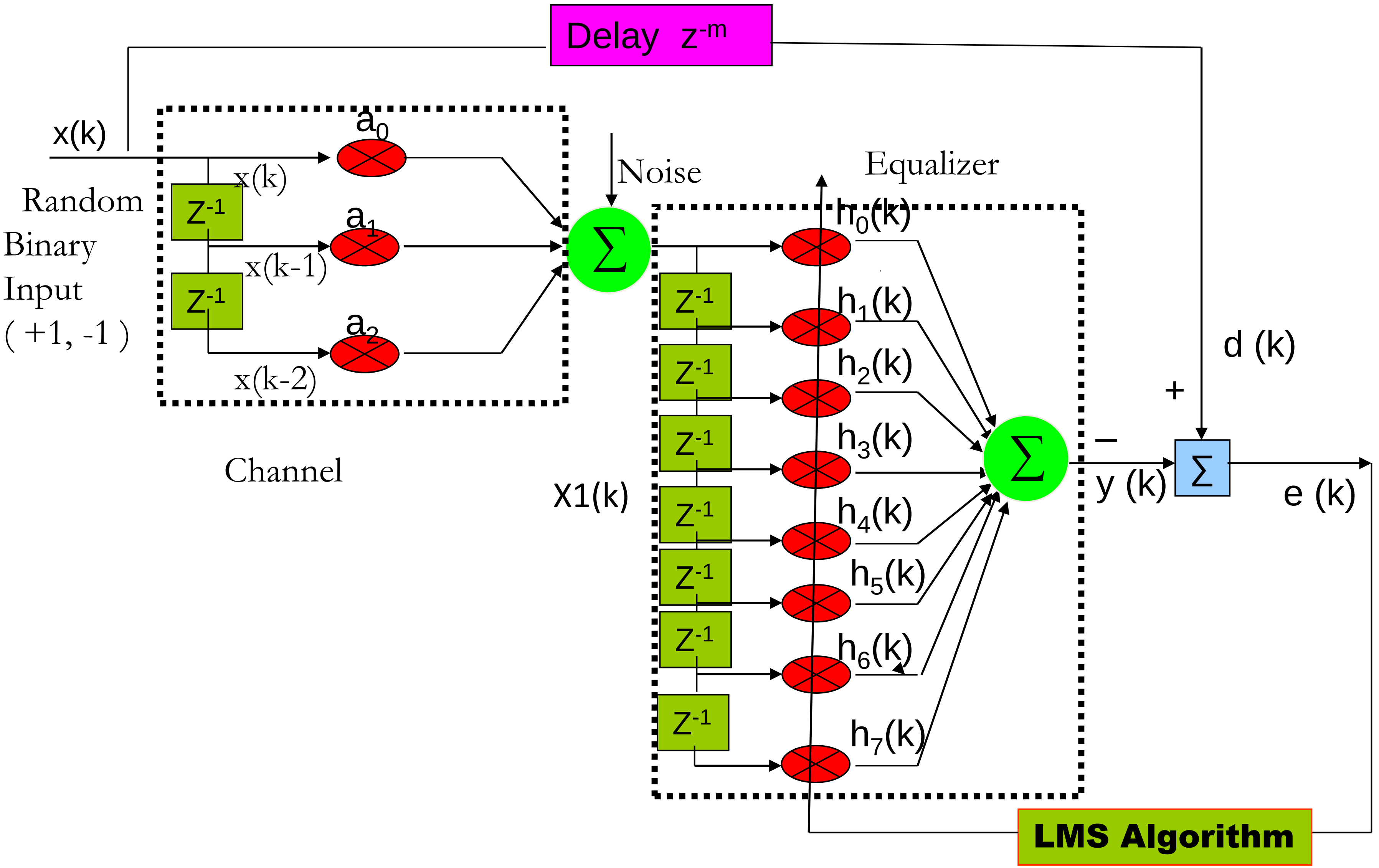
  - Multipath propagation (wireless signal from a transmitter reaches the receiver via multiple paths, example : reflection, refraction)
  - Bandlimited channels (example, FM radio is often broadcast in the 87.5–108 MHz range)

# Channel Equalization




**Block Diagram For Channel Equalization**

# Channel Equalization (LMS algorithm)



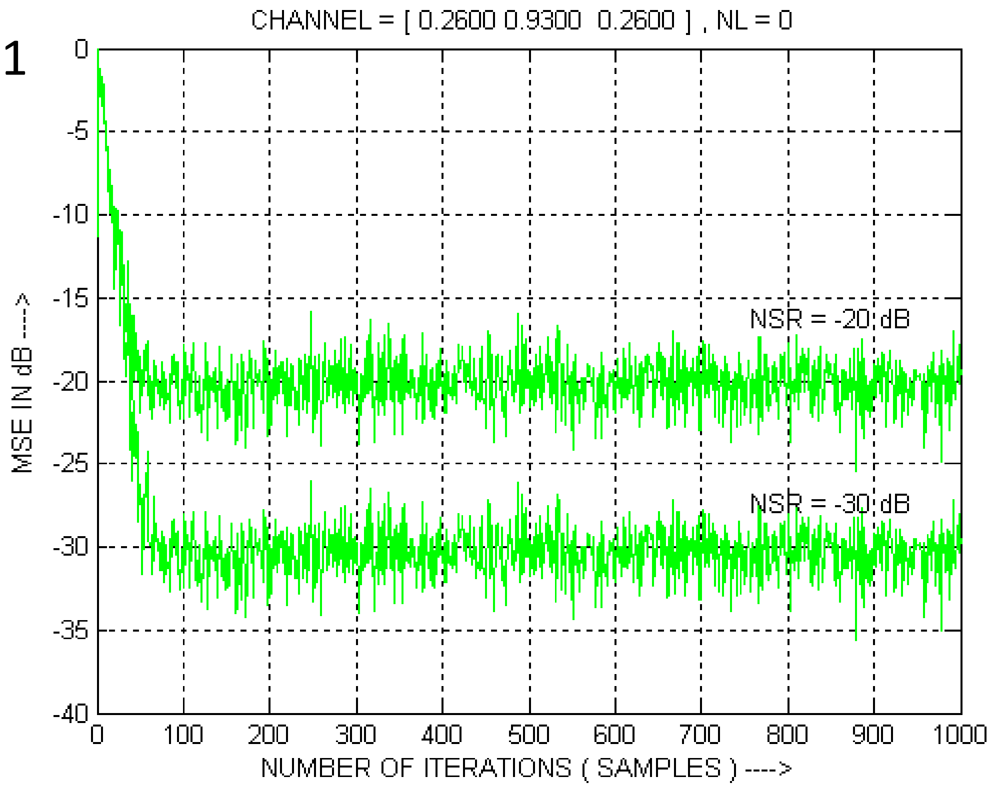
# LMS algorithm

Cost Function for minimization $MSE = \frac{1}{N}\sum_{k=1}^{N} e^2(k)$

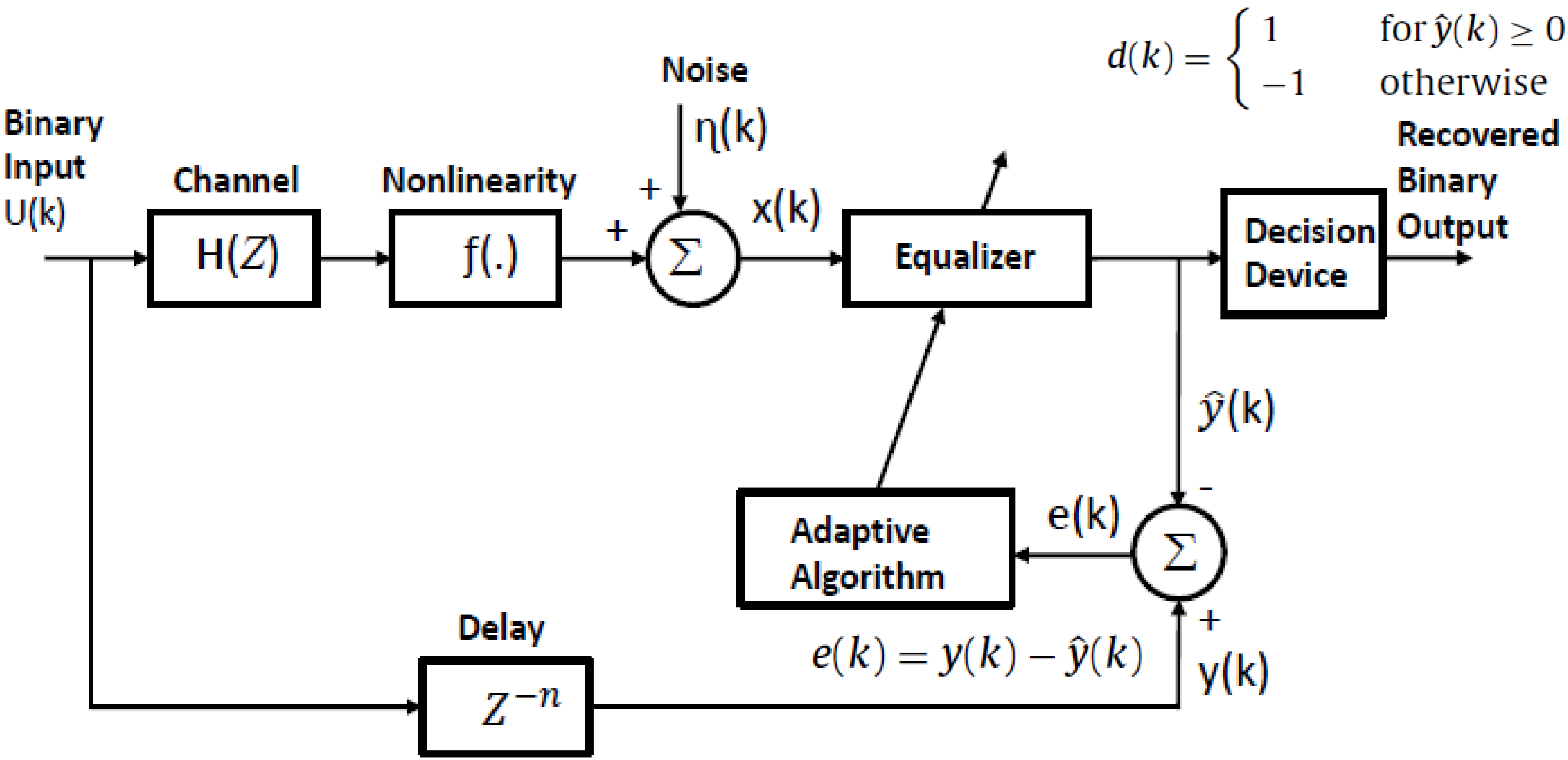
Error signal $e(k) = y(k) - \widehat{y}(k)$

Weight Update $\hat{h}(k+1) = \hat{h}(k) + 2 \times \mu \times x1(k) \times e(k)$

Where $\mu$ is learning rate $0 < \mu < 1$



# Channel Equalization with Nonlinearity




$$x(k) = f\left(\sum_{i=1}^{N} h(i)u(k-i)\right) + \eta(k)$$

$$\hat{y}(k) = \sum_{j=1}^{Q} x(k-j)w(j)$$

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# Robust nonlinear channel equalization using WNN trained by symbiotic organism search algorithm

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ABSTRACT

In the present world of 'Big Data,' the communication channels are always remaining busy and overloaded to transfer quintillion bytes of information. To design an effective equalizer to prevent the inter-symbol interference in such scenario is a challenging task. In this paper, we develop equalizers based on a nonlinear neural structure (wavelet neural network (WNN)) and train it's weighted by a recently developed meta-heuristic (symbiotic organisms search algorithm). The performance of the proposed equalizer is compared with WNN trained by cat swarm optimization (CSO) and clonal selection algorithm (CLONAL), particle swarm optimization (PSO) and least mean square algorithm (LMS). The performance is also compared with other equalizers with structure based on functional link artificial neural network (trigonometric FLANN), radial basis function network (RBF) and finite impulse response filter (FIR). The superior performance is demonstrated on equalization of two non-linear three taps channels and a linear twenty-three taps telephonic channel. It is observed that the performance of the gradient algorithm based equalizers fails in the presence of burst error. The robustness in the performance of the proposed equalizers to handle the burst error conditions is also demonstrated.

# Publication & References


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# THANK YOU