# SNS COLLEGE OF TECHNOLOGY

## An Autonomous Institution

## Coimbatore-35

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

# DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

## 19ECB212 – DIGITAL SIGNAL PROCESSING

II YEAR/ IV SEMESTER

## UNIT 5 – DSP APPLICATIONS

TOPIC – Adaptive Filters

# ADAPTIVE FILTERS

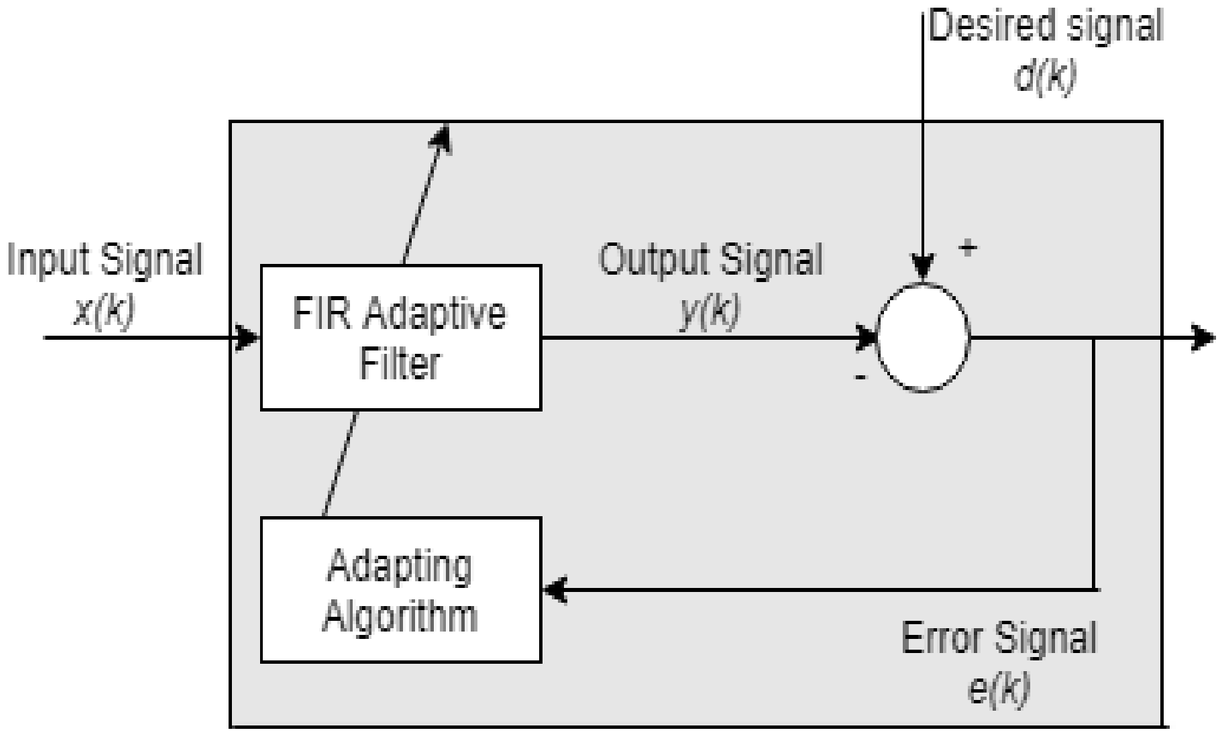
- The term ***Filter*** is often used to describe a device in the form of a piece of physical hard ware or software that is applied to a set of noisy data in order to extract information about a prescribed quantity of interest.
- An **adaptive filter** is a system with a linear filter that has a transfer function controlled by variable parameters and a means to adjust those parameters according to an optimization algorithm.
- An adaptive filter is one which can automatically design itself and can detect system variation in time.

# DEFINING AN ADAPTIVE FILTER

An adaptive filter is defined by four aspects:

1. The ***signals*** being processed by the filter.
2. The ***structure*** that defines how much the output signal of the filter is computed from its input signal.
3. The ***parameters*** within this structure that can be iteratively changed to alter the filter's input-output relationship.
4. The ***adaptive algorithm*** that describes how the parameters are adjusted from one time instant to next.

# BLOCK DIAGRAM



# BLOCK DIAGRAM EXPLANATION

- An adaptive filter consists of two distinct parts- a digital filter to perform the desired filtering, and an adaptive algorithm to adjust the coefficients of the filter.
- In the block diagram, where ***d(k)*** is a desired (or primary input) signal, ***y(k)*** is the output of a digital filter driven by a reference input signal ***x(k)***, and an error signal ***e(k)*** is the difference between ***d(k)*** and ***y(k)***.
- The adaptive algorithm adjusts the filter coefficients to minimize the mean-square value of ***e(k)***.

# BLOCK DIAGRAM EXPLANATION

- The optimization criterion is a cost function, which is most commonly the mean square of the error signal between the output of the adaptive filter and the desired signal.
- As the filter adapts its coefficients, the mean square error (MSE) converges to its minimal value.
- At this state, the filter is adapted and the coefficients have converged to a solution.
- The filter output, *y(k)*, is then said to match very closely to the desired signal, *d(k)*.
- When you change the input data characteristics, sometimes called *filter environment*, the filter adapts to the new environment by generating a new set of coefficients for the new data.

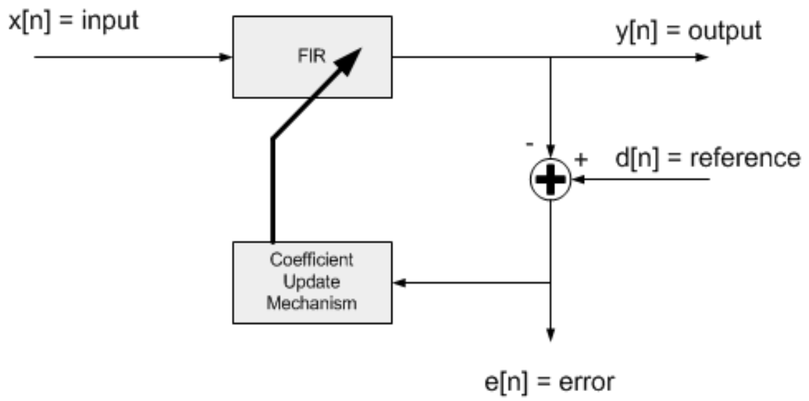
# TYPES OF ADAPTIVE FILTERS

The Most common **types of Adaptive Filters** are,

- **Least Mean Squares Filter (LMS)**
- **Recursive Least Squares Filter (RLS).**

# LEAST MEAN SQUARES FILTER

- **Least mean squares (LMS)** algorithms are a class of adaptive **filter** used to mimic a desired **filter** by finding the **filter** coefficients that relate to producing the least mean square of the error signal (difference between the desired and the actual signal.



# LEAST-MEAN-SQUARE (LMS) ALGORITHM

The LMS Algorithm consists of two basic processes,

**1.Filtering process**

i) Calculate the output of FIR filter by convolving input and taps.

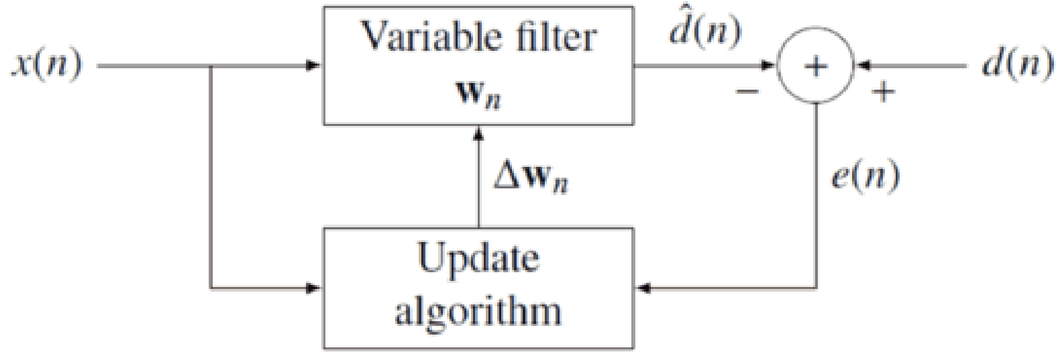
ii) Calculate estimation error by comparing the output to desired signal.

**2.Adaptation process**

i) Adjust tap weights based on the estimation error.

# RECURSIVE LEAST SQUARES FILTER (RLS)

- **Recursive least squares (RLS)** is an adaptive **filter algorithm** that **recursively** finds the coefficients that minimize a weighted linear **least squares** cost function relating to the input signals.



# THANK YOU