SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution

Coimbatore-35

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB212 – DIGITAL SIGNAL PROCESSING

II YEAR/ IV SEMESTER

UNIT 5 – DSP APPLICATIONS

TOPIC – Adaptive Filters

ADAPTIVE FILTERS

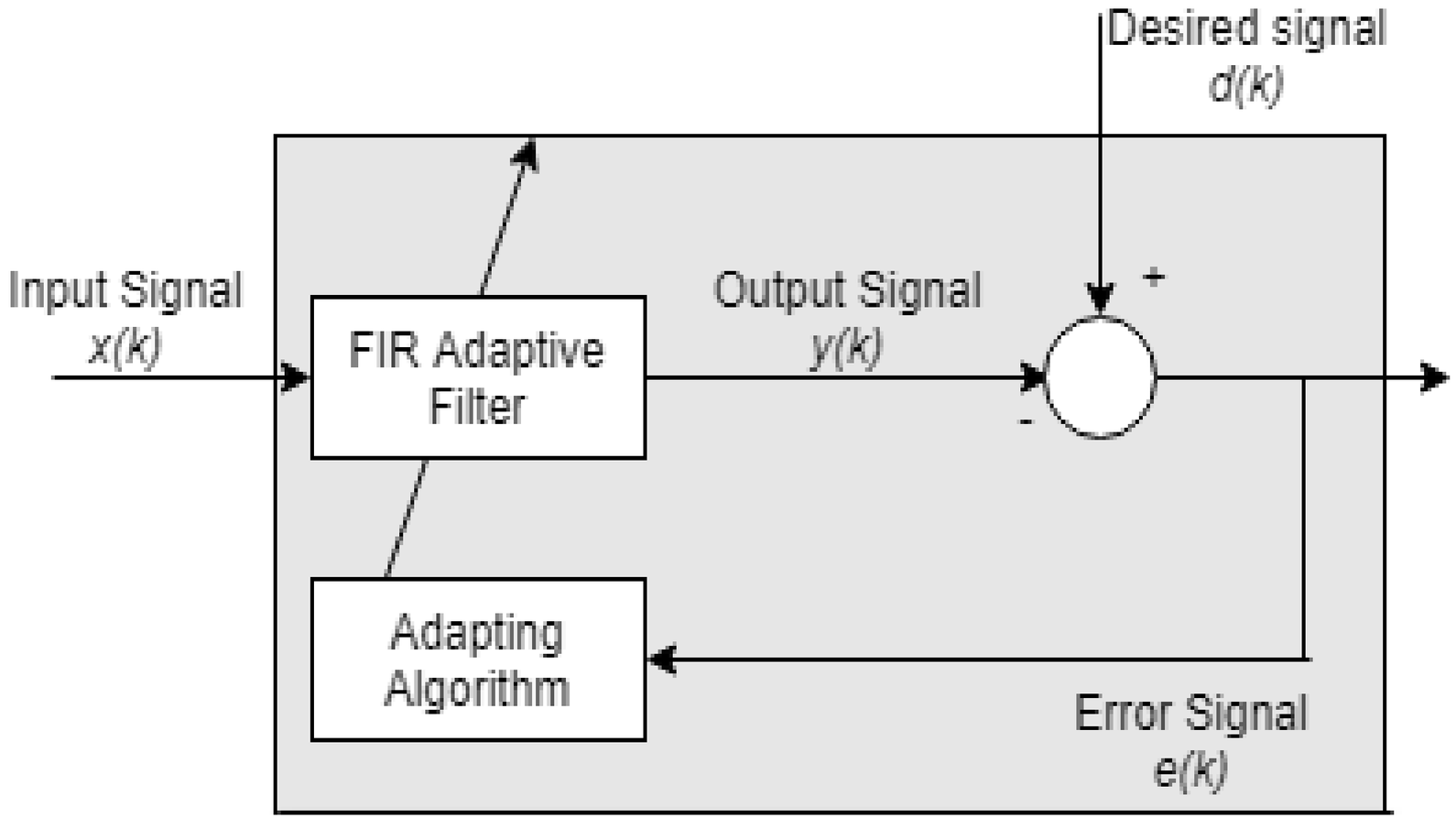
- The term ***Filter*** is often used to describe a device in the form of a piece of physical hard ware or software that is applied to a set of noisy data in order to extract information about a prescribed quantity of interest.
- An **adaptive filter** is a system with a linear filter that has a transfer 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



ADAPTIVE FILTER

- 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)***.

ADAPTIVE FILTER

- 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)*.

ADAPTIVE FILTERS

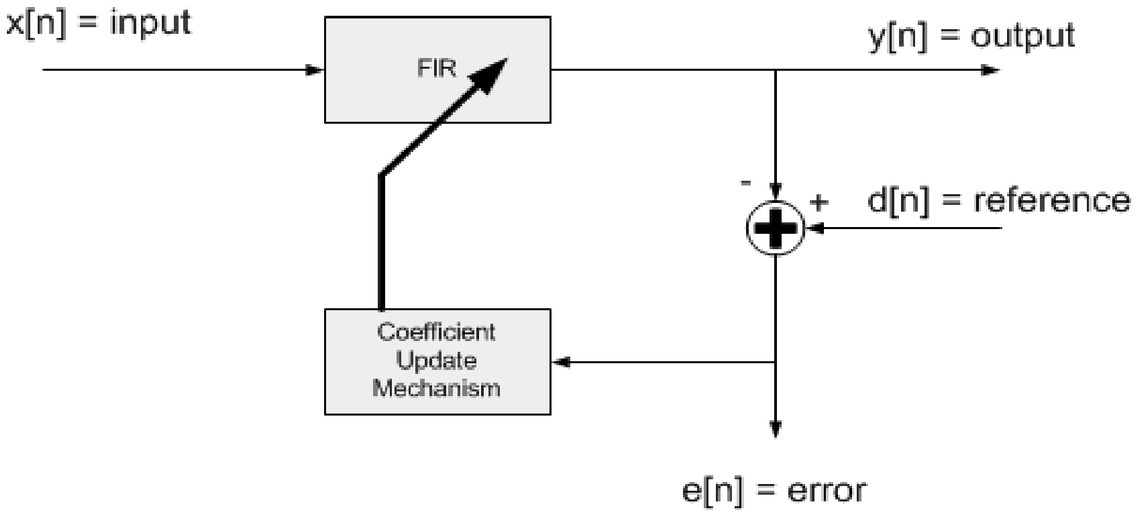
- When you change the input data characteristics, sometimes called filter environment, the filter adapts to the new environment by generating a new set of coefficients for the new data.

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.

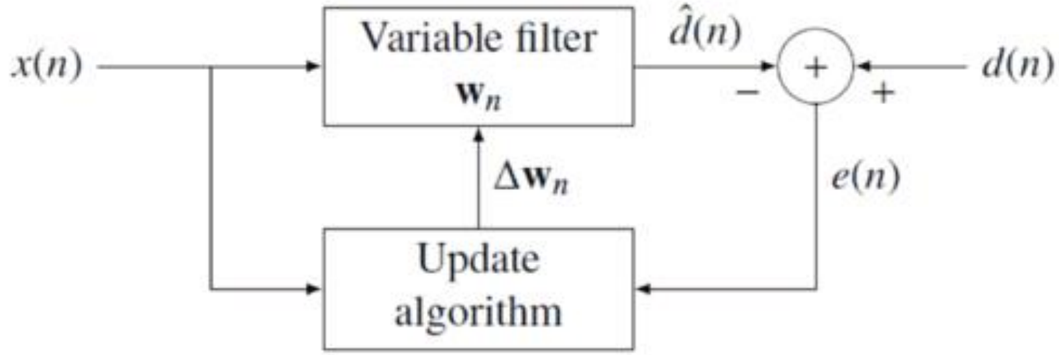
ii) Calculate estimation error by comparing the output to desired signal.

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.



ASSESSMENT

1. Define adaptive filter.
2. An adaptive filter is defined by four aspects. They are ----------, ---------- , --------- and ----------
3. The error signal ***e(k)*** is the difference between ---------- and ----------
4. List the types of adaptive filters.
5. The LMS Algorithm consists of two basic processes, they are ---------- and ----------
6. ---------- 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