

Sudan University of SCIENCE & Technology

Collage of Graduate Studies

M.Sc in Communication Engineer

Moving Average Filter Design Using MATLAB

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2009

1-BackGROUND

- ▢ In signal processing, the function of a filter is to remove unwanted parts of the signal, or to extract useful parts of the signal.
- ▢ Digital Filter is any electronic filter that works by performing digital mathematical operations on an intermediate form of a signal.
- ▢ Filters are widely employed in signal processing and communication systems in applications such as channel equalization, noise reduction, radar, audio processing, video processing, biomedical signal processing, and analysis of economic and financial data.

2-Problem statements

- The main purpose of this thesis is to design a moving average filter.

3-Objectives

- ▣ Studying the Digital Filters in general.
- ▣ Realization of digital filters using sampling and characteristic equation.
- ▣ Managing the Z transform and its parameters to achieve the best functional situation.
- ▣ Designing a moving average filter using MATLAB.

4-Methodology

- ▮ This thesis dealt with digital filters and took a deep look into the moving average filters studied its abilities as well as its limitations, then used MATLAB to design and developed a moving average filter.

5-Digital Filter Functions

- ▣ Confine a signal into a prescribed frequency band as low-pass, high-pass, and band-pass filters.
- ▣ Decompose a signal into two or more sub-bands as in filter-banks, graphic equalizers, sub-band coders, frequency multiplexers.
- ▣ Modify the frequency spectrum of a signal as in telephone channel equalization and audio graphic equalizers.
- ▣ Model the input-output relationship of a system such as telecommunication channels, human vocal tract, and music synthesizers.

5-Digital Filter Functions-cont



6-Digital Filter Design TechNIQUES

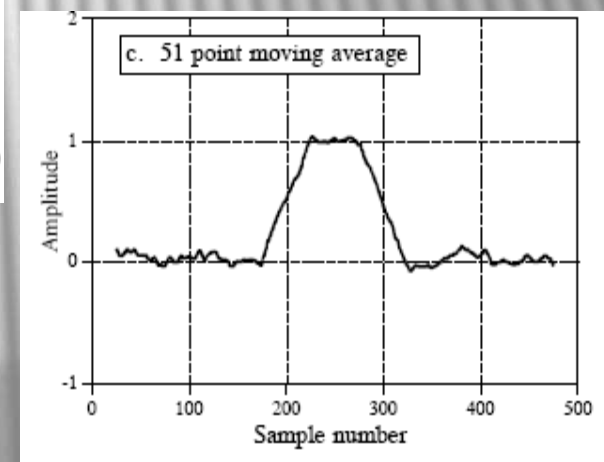
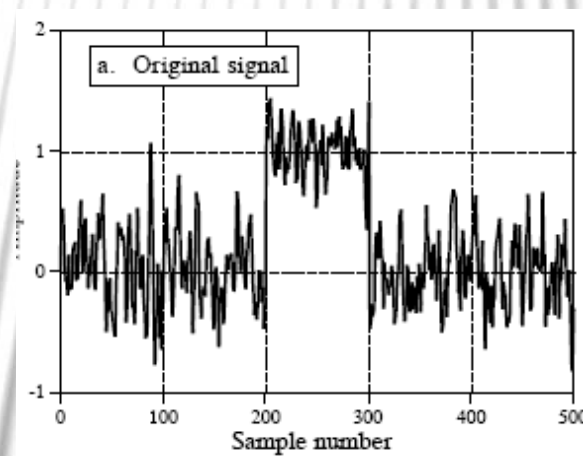
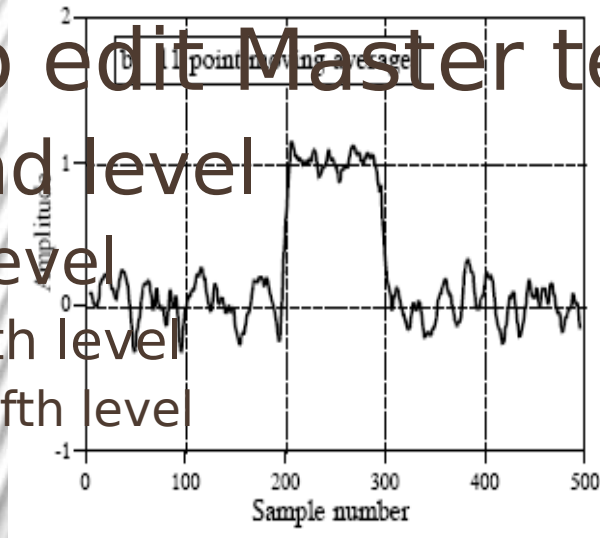
- ▣ FIR filters design based on the use of periodic transfer functions.
- ▣ FIR filters design based on switching and resetting of IIR filters.
- ▣ FIR filters design based on subband decomposition and the use of piecewise-polynomial impulse responses.
- ▣ Multiplier-free FIR filters synthesized using identical subblocks.
- ▣ FIR filter design based on the use of a general multirate multistage structures.

7- Moving Average Filter

- A moving average filter averages a number of input samples and produce a single output sample. This averaging action removes the high frequency components present in the signal.
- The moving average filter is very good for many applications, it is optimal for a common problem, reducing random white noise while keeping the sharpest step response.

7- Moving Average Filter-cont

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8-Z Transform

- In mathematics and signal processing, the Z-transform converts a discrete time-domain signal, which is a sequence of real or complex numbers, into a complex frequency-domain representation.
- The z-transform is useful for the manipulation of discrete data sequences and has acquired a new significance in the formulation and analysis of discrete-time systems

8-Z Transform-cont

- The bilateral or two-sided Z-transform of a discrete-time signal $x[n]$ is the function $X(z)$

$$X(z) = \mathcal{Z}\{x[n]\} = \sum_{n=-\infty}^{\infty} x[n]z^{-n}$$

- The *inverse* Z-transform is:

$$x[n] = \mathcal{Z}^{-1}\{X(z)\} = \frac{1}{2\pi j} \oint_C X(z)z^{n-1}dz$$

9-MATLAB DESIGN PROGRAMING

- MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming environment. Furthermore, MATLAB is a modern programming language environment: it has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming. These factors make MATLAB an excellent tool for teaching and research.

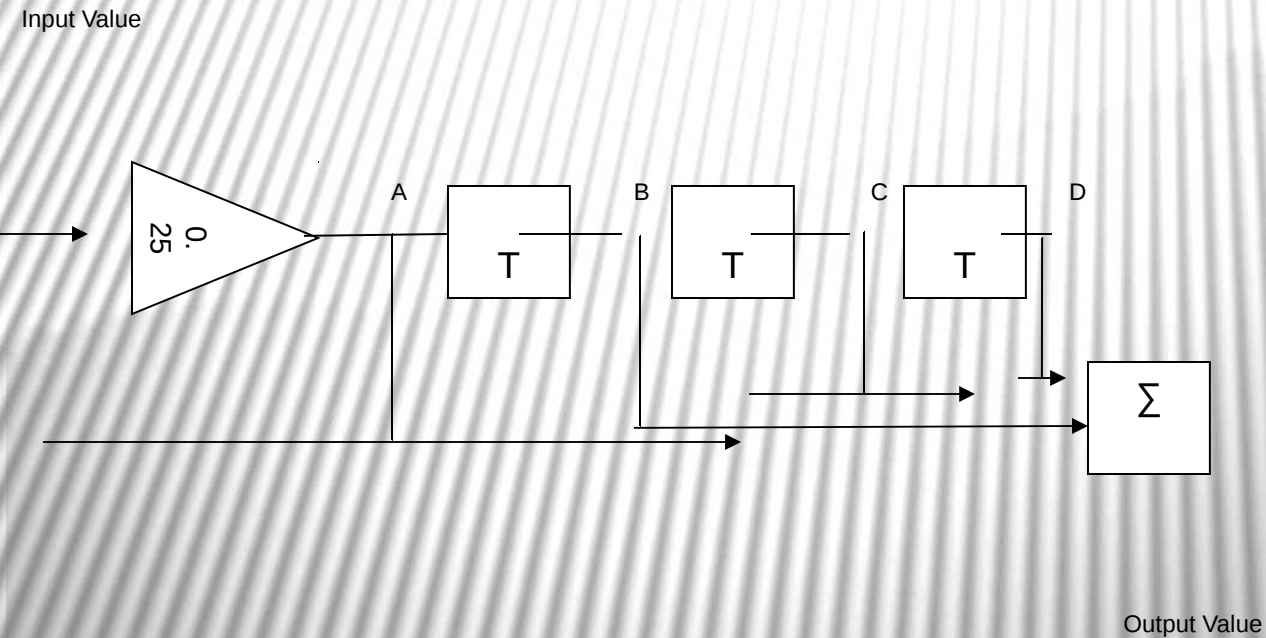
10-Filter Design Steps in MATLAB

- ▣ Using “**Filter Designer And Analyzer**” window.
- ▣ Using “**Filter Realization Wizard**” window .
- ▣ Using **Simulink** block library function generator, oscilloscope and MUX are connected to the filter structure. Using **Simulink** debugger the structure is simulated and the results are observed on the oscilloscope.

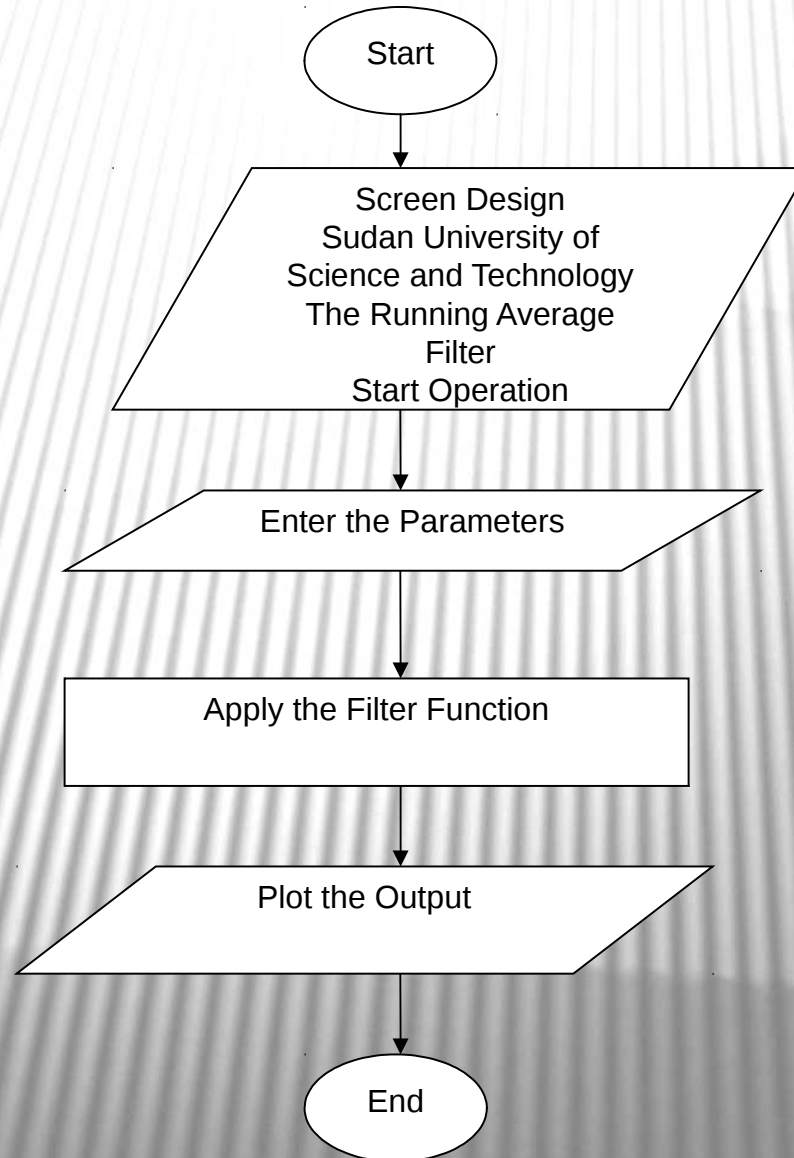
11-MOVING AVERAGE FILTER DESIGN

- By the use of MATLAB functions based on filter characteristic equations this thesis was accomplished. As MATLAB already has multiple built-in functions, it helps design FIR filters, in this case the moving average filter.
- Two main steps were done in order to design this filter:
 - Drawing the Flow chart
 - Writing the code

12-Moving Average Filter Block Diagram

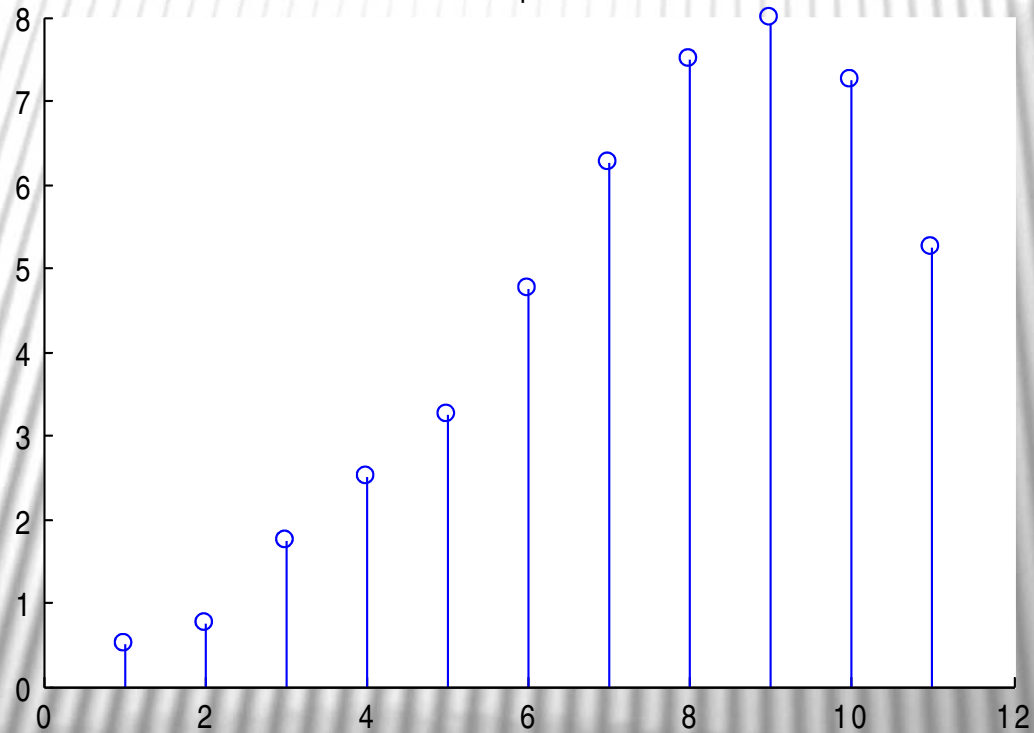


13-Moving Average Filter Flow Chart



14-Moving Average Filter Output

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The Running Average Filter Design
Start Operation



15-conclusion

- ▣ Filters are designed according to what kind of manipulation of the signal is required for a particular application. Digital filters are implemented using three fundamental building blocks: an adder, a multiplier, and a delay element.
- ▣ The design process of a digital filter is long and tedious if done by hand. With the aid of computer programs performing filter design algorithms, designing and optimizing filters can be done relatively quickly.

16-Recomendation

- Due to the need for this kind of digital filters and after running the code and studying the results, more experiments, studies and the use of new design language should be suggested to design even more effective filters.

17- References

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Thank You