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## MODELING OF DIGITAL FILTERS BY LABVIEW WEB APPLICATION FOR EDUCATION IN TELECOMMUNICATIONS

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***Abstract:** This paper provides an opportunity for students to perform computer modeling, research and analysis of digital IIR and FIR filters. In an environment of LabVIEW product are developed virtual applications with interactive, intuitive, accessible and understandable graphical user interface, modeling IIR Comb - Peaking and Notching filters; Optimal FIR filters implemented by Parks-McClellan and Remez algorithms; IIR (Butterworth, Chebyshev, Inverse Chebyshev and Elliptic) and FIR (Kaiser-Window, Doph-Chebyshev Window and Equi-Ripple) filters. By integrating relevant virtual instrument for analysis of IIR and FIR filters in HTML document is created WEB-based application for remote access, visualization and its management. Through the global network Internet users can explore and analyze the overall behavior of the modeled filters, and assess the impact of set parameters on filter characteristics, respectively Magnitude response, Phase response, Impulse response, Step response, Group delay and Pole-Zero plot. In this way students can learn, illustrate and compare different methods, algorithms and mathematical models for modeling digital IIR and FIR filters.*

***Keywords:** IIR and FIR filters; computer modeling; LabVIEW virtual instruments; WEB-based applications; filter parameters and characteristics.*

### INTRODUCTION

Virtual instrumentation is widely used in telecommunication measurements in digital signal processing, automation of industrial sites and processes, agriculture, medicine, etc. In addition to data collection and management, virtual measurement tools are convenient to use in the field of education as they enable simulation modeling and design of specific devices, mathematical data processing and analysis of their various characteristics and others.

According to a large number of scientific publications, the design, research and analysis of digital filters are primarily performed in the MATLAB product using the FDA Tool Graphics User Interface. Many types of artificial neurons, such as multilayer perceptrons, radial base transmission networks, self-learning, regression, Hopfield and other networks, are found a huge application in modelling.

This report demonstrates the possibility of computer modeling of IIR and FIR digital filters using basic methods, algorithms and approximations for filtration in interactive LabVIEW graphical user environment in the process of student and postgraduate study in communications and information technologies. A WEB-based remote access application to LabVIEW is also

presented in the development, which allows students to carry out combined research and analysis of the characteristics of IIR and FIR filter types over the global Internet network.

## EXPOSITION

Virtual instruments (VIs) have been developed in LabVIEW program environment for individual and hybrid modeling of basic types of IIR and FIR digital filters. In Fig. 1 is presented the front panel of the VI allowing the creation of two types of IIR comb filters "notch" and "peak" of first and second order.

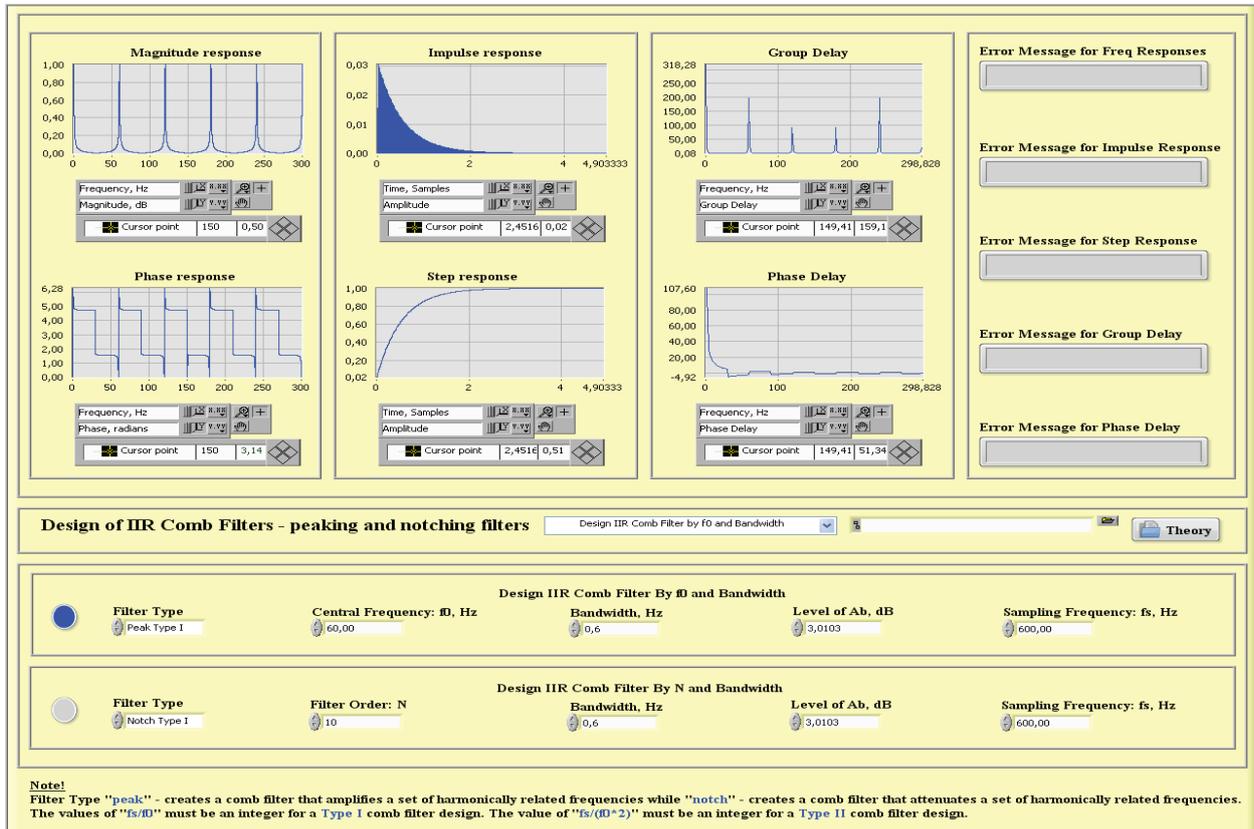


Fig.1. Digital IIR comb filter

The design method is selected using drop-down menus. Two variances of filter creation are provided, respectively by selecting the frequency  $f_0$  or the order of the  $N$  filter. The main filtering characteristics: Magnitude response, Phase response, Impulse response, Step response, Group delay and Phase delay are visualized on graphical indicators. Output error messages are displayed by Symbol indicators for each of the listed features with incorrect filter parameters - Central frequency  $f_0$ , Bandwidth, Level of  $A_b$ . (Attenuation) and Sampling Frequency  $f_s$ . An option for a pdf file with the required information for the designed filters is provided by clicking on the Theory button.

Front panel for modeling optimal FIR digital filters Parks-McClellan and Remez methods by set parameters: Filter order, Band parameters - Amplitude, Lower Frequency, Higher Frequency is shown in Fig. 2. Virtual oscilloscopes output the corresponding characteristics similar to the previous VI on both algorithms, allowing a comparative analysis between them.

Pressing the Theory button loads a pdf file with a description of the design algorithms. The tabular form displays the filter order and coefficients calculated after the Calculation button has been executed. The obtained coefficients can automatically be stored in Excel format.

Virtual instrument for the computational computer modeling of IIR filters using Butterworth, Chebyshev, Inverse Chebyshev and Elliptic approximations and Kaiser Window, Doph-

Chebyshev Window and Equi-Ripple FIR filters was developed (Fig. 3). LEDs illustrate the type and method of design chosen by the drop-down menus. Unlike the previous two virtual instruments, a graphical interpretation of the Pole-zero plot defining filter resistance is given instead of phase delay.

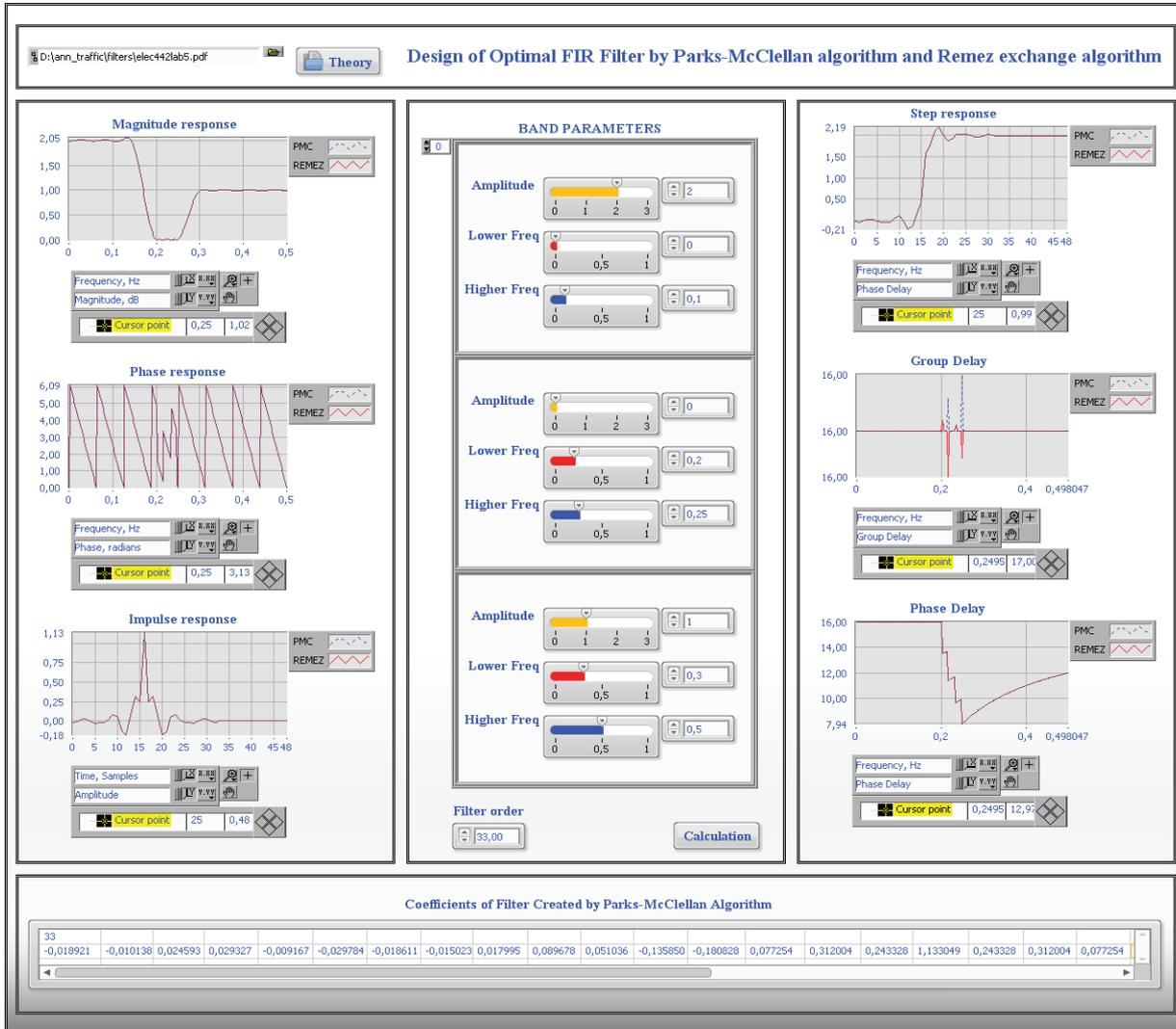


Fig.2. Digital optimized FIR filters implemented on Parks-McClellan and Remez algorithms

The viewing VI is integrated into an HTML document, thus creating a WEB-based remote control access application (Fig. 4), providing remote access, visualization and control over the Internet in real time, also providing the ability to evaluate and analyze the behavior of model filters. The content of the application contains brief descriptions of the main filtering characteristics, the types IIR and FIR filters and the areas of their application. In addition, links are included with more detailed information about them and filter specifications.

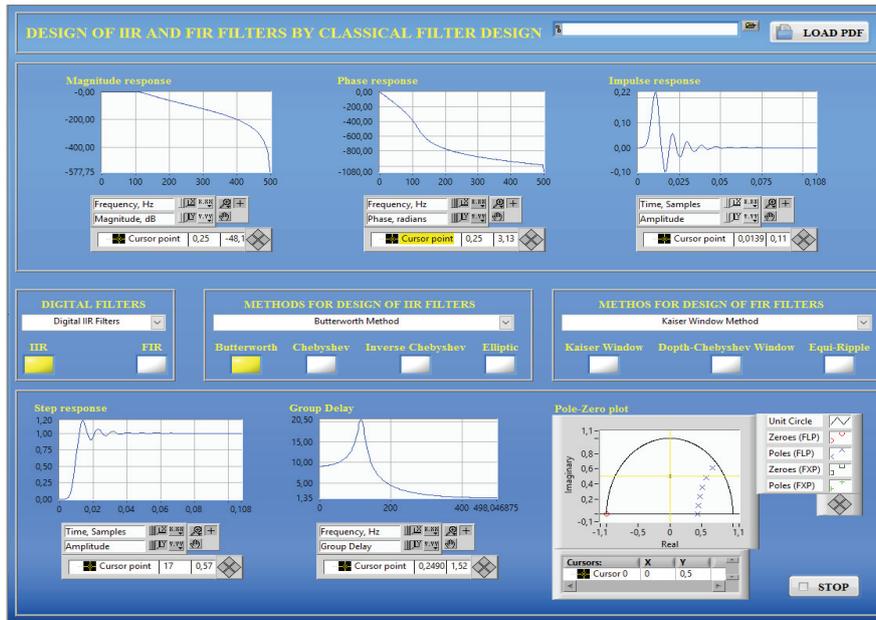


Fig.3. Digital IIR and FIR filters

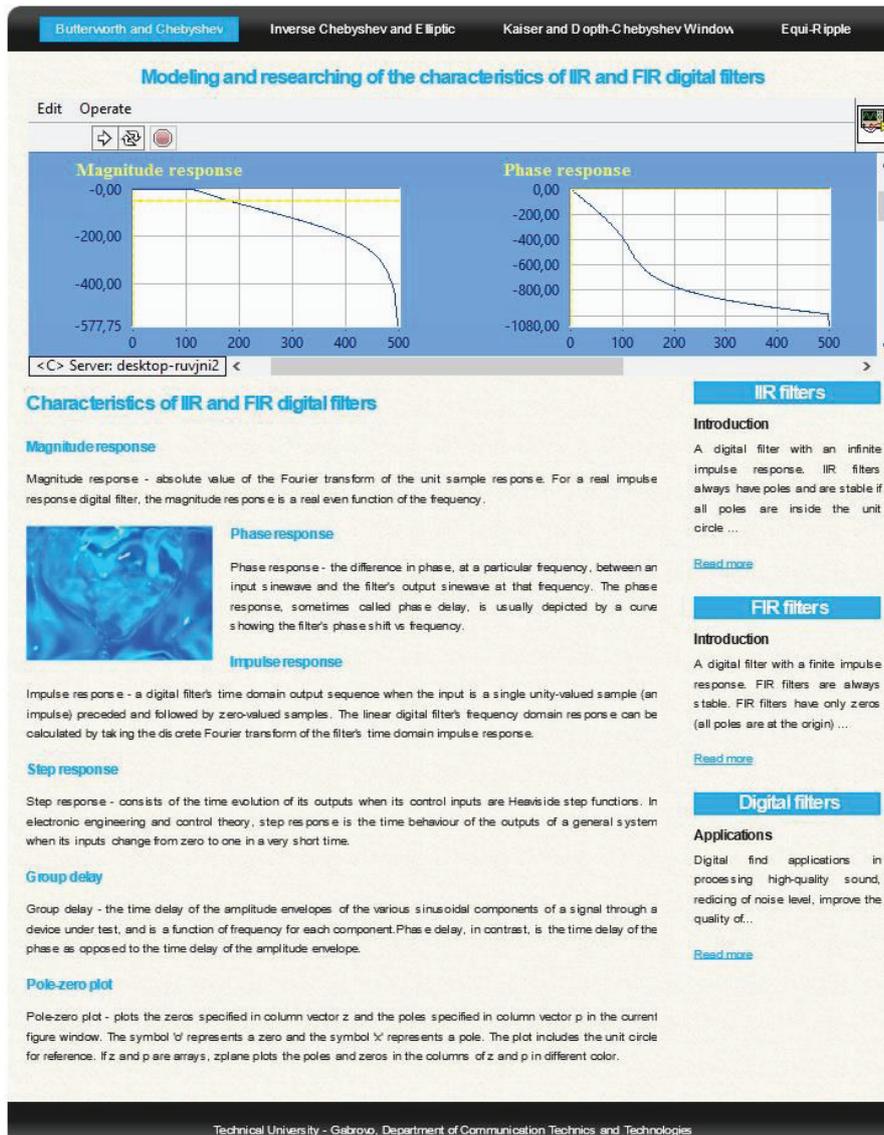


Fig.4. WEB-based application for analysis and study of IIR and FIR filters

## CONCLUSION

With the help of the developed virtual instruments, learners acquire the knowledge, skills and abilities to perform computer modeling, research and analysis of digital filters using various methods, algorithms and mathematical devices through WEB-based remote access applications over the global Internet network. The created application can be incorporated as a structural unit in real telemetry systems that improve the quality of the overall information service for data transmission in communications.

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