

Interactive Distant Education of Signal Processing Using MATLAB Web Server

J. Blaska, M. Sedlacek

Czech Technical University in Prague, Faculty of Electrical Engineering
e-mail: {xblaska, sedlaceM}@fel.cvut.cz

Introduction

Our aim was to prove possibilities of Internet in distant education. We wanted to use it interactively to support teaching course "Signal and Image Processing" at the Department of Measurement at the Czech Technical University in Prague, Faculty of Electrical Engineering. We are using program MATLAB and its Signal Processing Toolbox which contain many algorithms used in signal processing for fundamental algorithm demonstration in tutorial of signal processing. MATLAB is an open system of company MathWorks (www.mathworks.com) which allows comfortable generation of mathematical applications and graphical user's interface. At present in our course MATLAB was running on every computer together with relevant toolbox. It indeed put emphasis to hardware equipment in laboratory. Therefore student could use MATLAB only at the time of courses. That is why we welcomed the new component of MATLAB - MATLAB Web Server [1].

MATLAB Web Server

The MATLAB Web Server enables to create MATLAB applications that use capabilities of the Internet (especially World Wide Web) to send data to MATLAB for computation and to display the results in Web browser. In the simplest configuration, a Web browser runs on client workstations, while MATLAB, the MATLAB Web Server, and the Web server daemon run on another machine – server. The MATLAB Web Server depends upon TCP/IP networking for transmission of data between the client system and MATLAB.

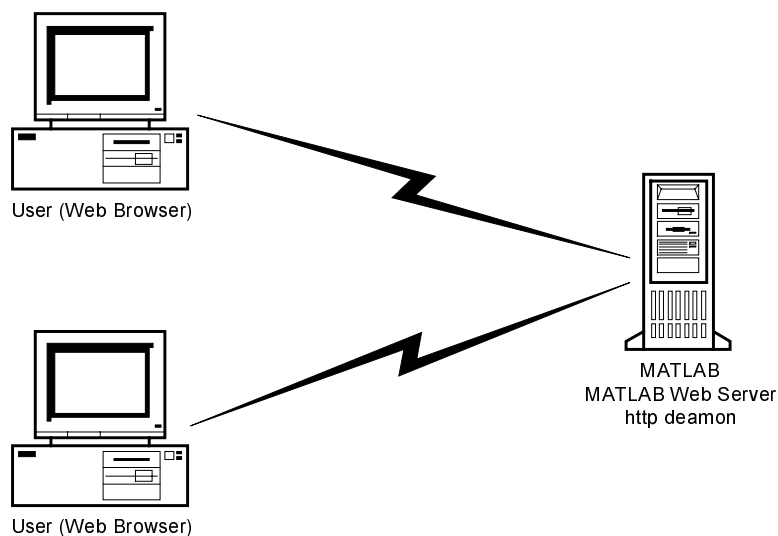


Fig.1 Using and configuration of the MATLAB Web Server

To submit input and to receive output from the MATLAB Web Server, a Web browser must be installed on client computers. Current version of the MATLAB Web Server has been tested with Netscape Navigator and Microsoft Internet Explorer. It's necessary to install Web server software on the system where MATLAB is running. There are a lot of suitable programs, for example freely distributed Apache Web Server or Microsoft Personal Web Server. MATLAB Web Server applications are a combination of M-files (source files for MATLAB), Hypertext Markup Language (HTML) [2], and graphics. Knowledge of MATLAB programming and basic HTML is the only requirement. The application development process requires three simple steps. Creation the HTML documents for collection of the input data (Fig. 2 – left part of screen) from users is the first step. Next step is creation of the HTML document for display output from MATLAB (Fig. 2 – right part of screen). The last step is writing a MATLAB M-file that receives data entered in the HTML input form, analyzes the data and generates any requested graphics. All communication between the user and MATLAB proceed

therefore only through WWW interface. The user even need not to know that generated output comes from MATLAB.

Examples of MATLAB Web Server applications

In the following parts there are described three examples of some basic teaching items using the MATLAB Web Server. Fig 2 to Fig.5 are copies of screens of WWW browser on client computer, so they show what sees the user.

1. Demonstration of discrete Fourier transform

In this exercise there are demonstrated some characteristic features of the discrete Fourier transform, e.g. leakage of spectrum. In the left part of screen (Fig. 2) the user can enter parameters of a discrete signal, e.g. the signal frequency, amplitude and sampling frequency. Length of discrete Fourier transform can be defined next and the type of window can be chosen afterwards. After entering chosen values they are sent by pressing button "Start" to the server. There they pass on by the help of HTTP server and MATLAB Web Server for calculation into MATLAB. MATLAB then returns signal waveform graph and signal spectrum, which will be displayed in right part of window of client WWW browser (Fig. 2). Because all graphs are returned as JPEG pictures, it is impossible to check appropriate details in graphs. We have therefore provided a zoom, by the help of which the user can choose a region of graph for detailed inspection.

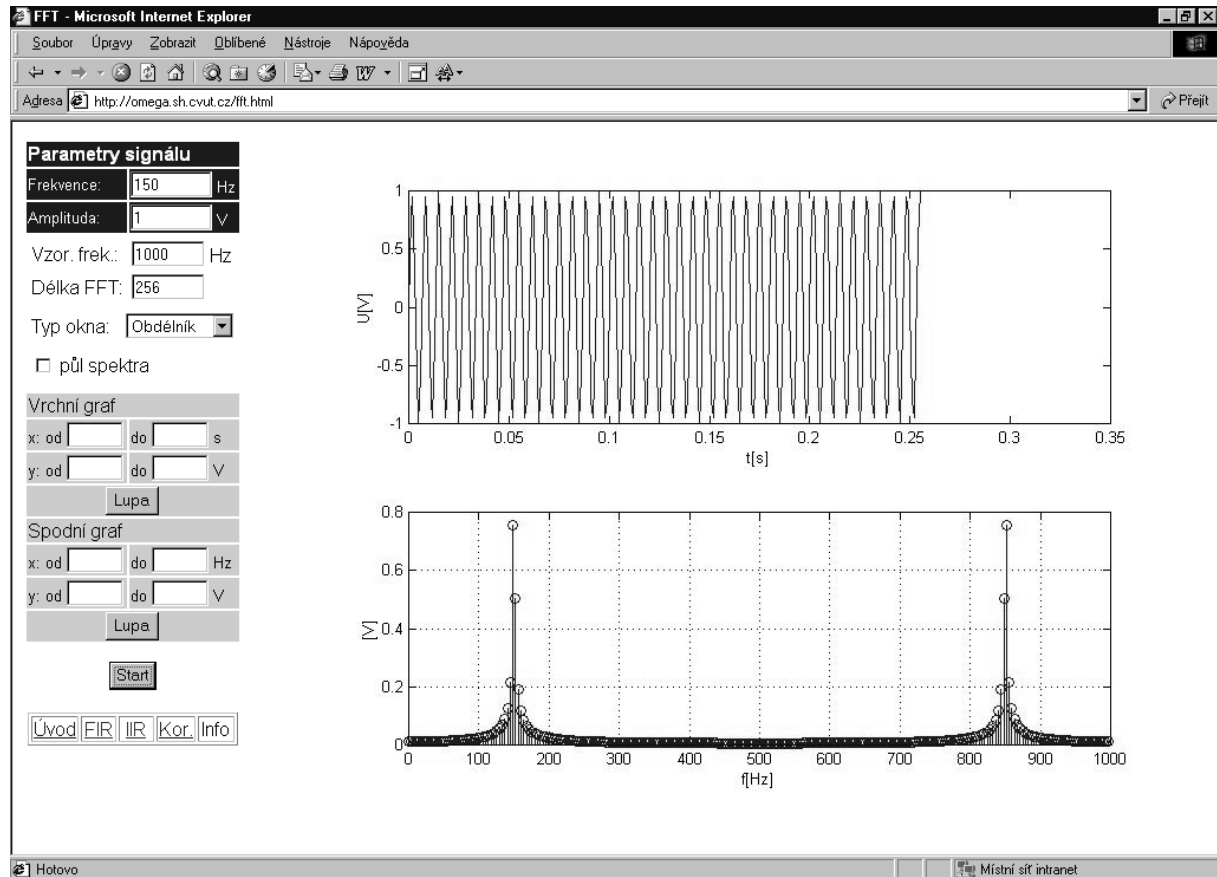


Fig.2 Screen appearance of WWW browser for demonstration of the FFT

2. Demonstration of digital filtering

Next task is focused on design of digital filters both the FIR and IIR types. User sets parameters of signal, which will be filtered, as frequency, amplitude, DC offset, sampling rate and type of additive noise. As parameters of filter there can be set the type of filter (lowpass, highpass, bandpass or bandstop), the cut-off frequencies and the order of filter. Is possible to change the type of window with FIR type digital filter and with IIR type filters to set their analog model. The MATLAB generates required signals and computes coefficients of the desired filter. Output is a graph of input waveform, filtered signal and frequency response of the designed filter (Fig. 3).

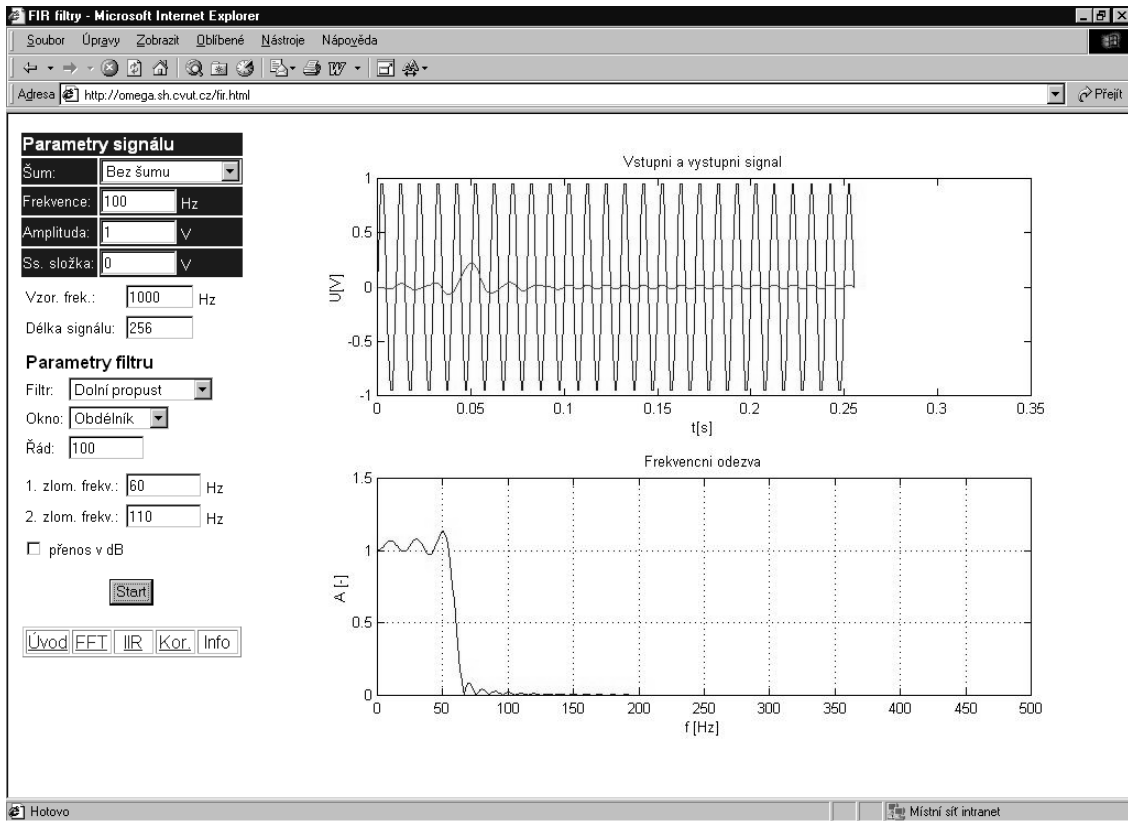


Fig. 3 Screen appearance of WWW browser for demonstration of design of a digital filter type FIR

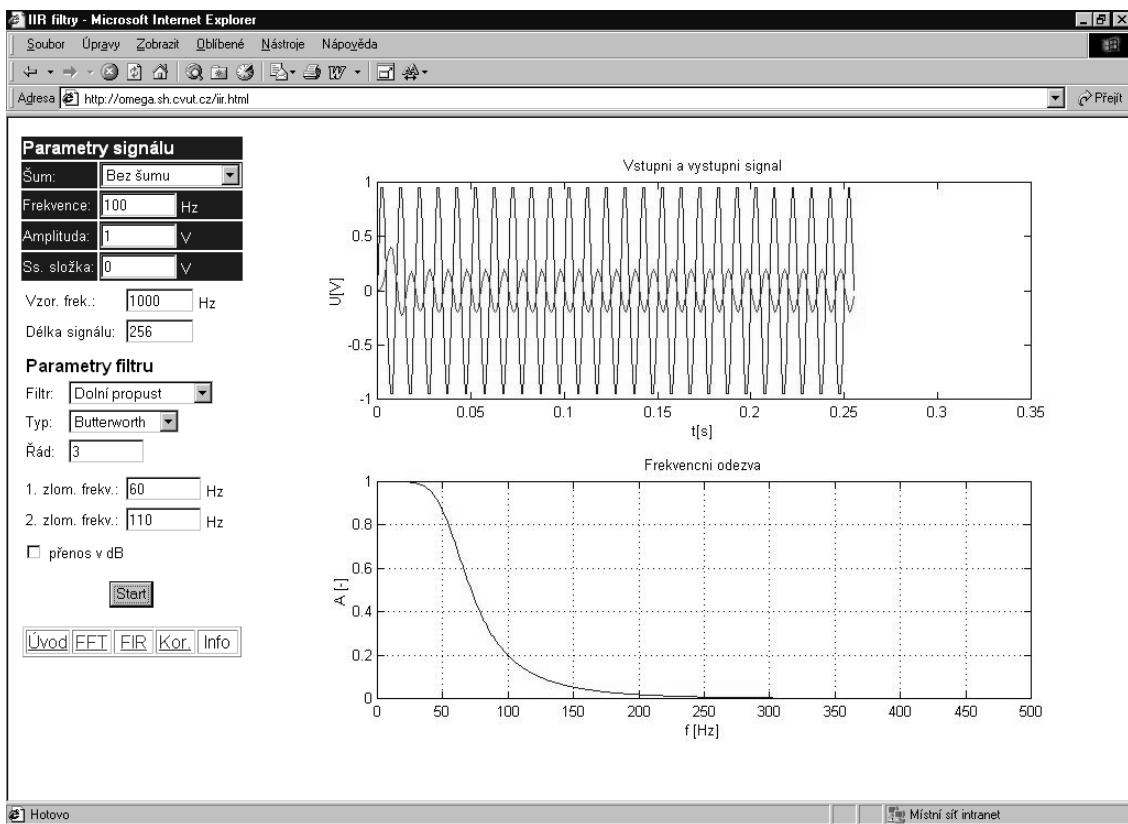


Fig. 4 Screen appearance of WWW browser for demonstration of design of a digital filter type IIR

3. Demonstration of correlation

Correlation algorithms are demonstrated in this task. The user can again choose signal characteristics as is frequency, amplitude, phase, type of additive noise and sampling rate. He then selects the time length of measurement (number of samples of the generated signals). It is possible also to select type of correlation function (autocorrelation of the first or of the second signal or cross-correlation of both signals). The results are waveform graphs of particular signals and the correlation graph.

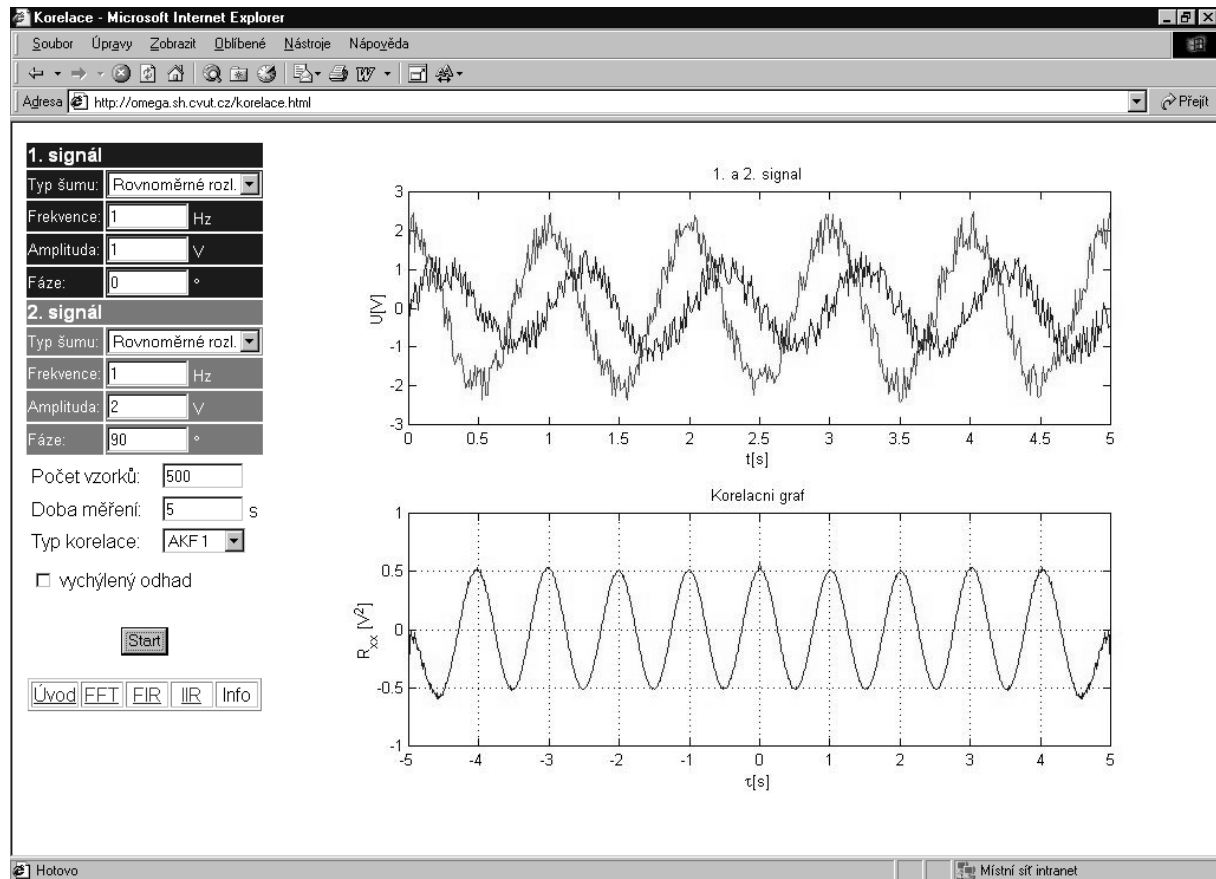


Fig. 5 Screen appearance of WWW browser for demonstration of correlation techniques

Conclusion

For the creation of a MATLAB Web Server application it is necessary to have the elementary knowledge of the HTML and of programming in MATLAB. That means that creation of applications or their modification is not too time-consuming but nevertheless the resulting effect is indisputable. Our system will be firstly used in October 2001 in full of classwork. Present experience and perceptions reflect its advantages: availability by the help of Internet and WWW browser, simple control from environment WWW browser, high-speed response of MATLAB, and last but not least also financial savings for hardware.

Acknowledgement

This work has been supported by the research program No. 23-21034/338 FRVS (sponsored by the Ministry of Education, Youth and Sports of the Czech Republic).

References

- [1] The MathWorks, Inc.: Matlab Web Server – Users Guide, 1999
- [2] <http://ladis.ssesvdf.cz>: Introduction to HTML