Design and Implementation of Computer Assisted Instruction for Course of Signal and System Based on MATLAB

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Abstract

Signal and system is a professional foundation course in Electronics and Communications Engineering.With the development of communication technology and popularization in the society,its basic subject signal and system gradually reflected enormous effect. Under the guidance of the object-oriented design method,a GUI—based Signals and Systems teaching system is designed and implemented by using the hierarchical design．The system has Graphical User Interface(GUI)is achieved using GUIDE and it enables users to carry out dynamic simulation of the important teaching contents of Signals and Systems course interactively.The system mainly includes the following Fourier transform nature,signal time domain operation and conversion ,continuous signal frequency domain analysis,convolution etc., by entering their translation quantity or amplitude parameters such as amplitude, observe the change of the signal graph and establish corresponding relation between time domain and frequency domain signal.Meanwhile,classmates can understand better theoretical knowledge by vivid example demonstrating continuous signal convolution computational Process. The system has the advantage of friendly interface and is easy to use,parameter setting convenience and output result accuracy and perceptual intuition .Applying the platform to the teaching of Signals and Systems is helpful to deepen students' understanding and master of the course contents。stimulate their learning interest and improve the teaching efficiency and effect.

Keywords

Computer assisted instruction; Signal and system; Graphical User Interface(GUI).

1. Introduction

As the course of signal and system has the characteristics of strong theoretical content, concept abstraction and too many formulas, it is difficult to understand and master and feeled boring in learning for students. Making simulation of signal waveform using some kind of can solve these problems[1,2]. MATLAB, an internationally accepted scientific calculation software, has many merits ,such as efficient numerical calculation and symbol calculation function, complete graphics processing functions, friendly user interface , close to the mathematical expression of the natural language, feature-rich application toolbox, feature-rich application graphical user interface secondary development environment (GUIDE) and so on[3]. At the same time, the graphical user interface(GUI) of MATLAB has many advantages,i.e. strong interface, easy to operate, easy to modify the data and file preservation, high efficiency experiment, rich experimental content , intuitive and easy to understand results and so on. It is favored by many colleges and universities at home and abroad. MATLAB makes it possible for teachers of signal and system course that assist the students in completing the numerical calculation of the course, visual modeling and simulation debugging of signal and system analysis. In particular ,the signal processing toolbox including in the MATLAB is a powerful tool for learning and applying the methods and principles of signal and system[4].

In this paper, a auxiliary teaching system for signal and system was been designed using MATLAB. We made a visual graphical user interface. It includes the main interface, Fourier transform, the signal time domain operation and transformation, continuous signal frequency domain analysis, convolution

sub-interface, design interface layout, control properties and callback function preparation, debugging and operation . This system should be connected to the interface, so that the interface functions is improved and the operation is simple, while users can enter the function of the relevant parameters of the observed function characteristics, to achieve the interaction with the user. Callback function should be written with rigorous, simple statement.

2.   Course of Signal & System and Matlab Gui

2.1 Course of Signal & System

Signals and Systems is an introduction to analog and digital signal processing, a topic that forms an integral part of engineering systems in many diverse areas, including seismic data processing, communications, speech processing, image processing, defense electronics, consumer electronics, and consumer products[5].

The course presents and integrates the basic concepts for both continuous-time and discrete-time signals and systems. Signal and system representations are developed for both time and frequency domains. These representations are related through the Fourier transform and its generalizations, which are explored in detail. Filtering and filter design, modulation, and sampling for both analog and digital systems, as well as exposition and demonstration of the basic concepts of feedback systems for both analog and digital systems, are discussed and illustrated.

2.2 MATLAB Gui

 MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and fourth-generation programming language. A proprietary programming language developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, C#, Java, Fortran and Python.

Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing abilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems.

In 2004, MATLAB had around one million users across industry and academia. MATLAB users come from various backgrounds of engineering, science, and economics.

A graphical user interface (GUI) is a pictorial interface to a program[6]. A good GUI can make programs easier to use by providing them with a consistent appearance and with intuitive controls such as pushbuttons, edit boxes, list boxes, sliders, and menus. The GUI should behave in an understandable and predictable manner so that a user knows what to expect when he or she performs an action. For example, when a mouse click occurs on a pushbutton, the GUI should initiate the action described on the label of the button.

A graphical user interface provides the user with a familiar environment in which to work. It contains pushbuttons, toggle buttons, lists, menus, text boxes, and so forth, all of which are already familiar to the user, so that he or she can concentrate on the purpose of the application instead of the mechanics involved in doing things. However, GUIs are harder for the programmer, because a GUI-based program must be prepared for mouse clicks (or possibly keyboard input) for any GUI element at any time. Such inputs are known as events, and a program that responds to events is said to be event driven.

The three principal elements required to create a MATLAB graphical user interface are

(1) Components. Each item on a MATLAB GUI (pushbuttons, labels, edit boxes, etc.) is a graphical component. The types of components include graphical controls (pushbuttons, toggle buttons, edit boxes, lists, sliders, etc.) static elements (text boxes), menus, toolbars, and axes. Graphical controls and text boxes are created by the function uicontrol, and menus are created by the functions uimenu

and uicontextmenu. Toolbars are created by function uitoolbar. Axes, which are used to display graphical data, are created by the function axes.

(2) Containers. The components of a GUI must be arranged within a container,which is a window on the computer screen. The most common container is a figure. A figure is a window on the computer screen that has a title bar along the top and that can optionally have menus attached. In the past, figures have been created automatically whenever we plotted data.However, empty figures can be created with the function figure, and they can be used to hold any combination of components and other containers.The other types of containers are panels (created by the function uipanel) and button groups (created by the function uibuttongroup).Panels can contain components or other containers, but they do not have a title bar and cannot have menus attached. Button groups are special panels that can manage groups of radio buttons or toggle buttons to ensure that no more than one button in the group is on at any time.

(3) Callbacks. Finally, there must be some way to perform an action if a user clicks a mouse on a button or types information on a keyboard. A mouse click or a key press is an event, and the MATLAB program must respond to each event if the program is to perform its function. For example, if a user clicks on a button, then that event must cause the MATLAB code that implements the function of the button to be executed. The code executed in response to an event is known as a callback. There must be a callback to implement the function of each graphical component on the GUI.

3. System Master Planning And Design Steps
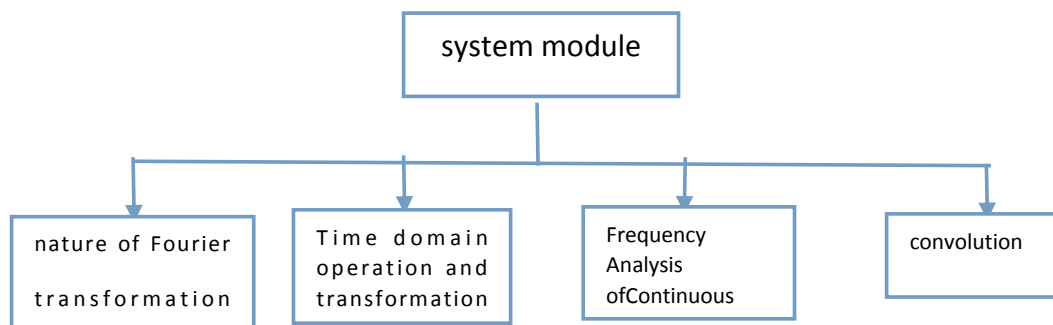
3.1 System Modul

Fig.1 Total System Module

Before designing the GUI, the first step is to determine the structure of the entire system. The main goal of the system is to provide an interactive graphical user interface for the teaching of signal and system courses, and to dynamically simulate the important contents of the signal and system courses to help students understand the physical concepts and physical processes of these contents deeply. According to this requirement, combined with the course of "signal and system" materials ,we determine the structure of the whole system shown in Figure 1. The system consists of Fourier transform, convolution and other four basic modules, basically covering the signal and system courses, the main teaching content. In order to simplify the design of each basic module, the system adopts the hierarchical design method to decompose the basic module into several sub-modules.
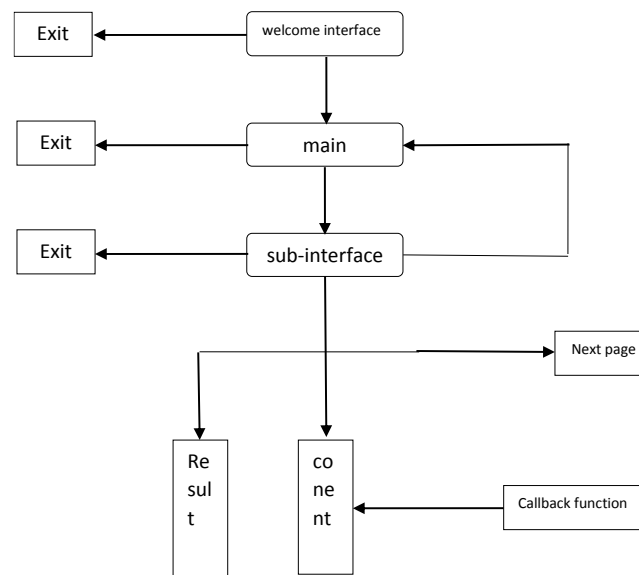
3.2 System Flowchart

Fig.2 System flowchart

3.3 Design steps of Callback function

The design of the system follows the steps of the flow chart. Firstly, we design the system into the interface, and then design the main interface of the system. Finally, we design the various sub-interface. The sub-interface includes controls such as buttons, axes, static text boxes, edit text boxes, pop-up menus, and so on. When interface design is completed, it is just some static screen, and cannot run. We must edit M file. Calling a series of programs with the help of the callback function, it allows the interface to run and act as a demonstration. Callback function controls must be written separately, then each step debugging control it properly. The specific operation of the design steps are as follows.

(1)Design the entire system GUI interface, demonstration of the main interface and the various sub-interface, using the MATLAB graphical user interface development environment GUIDE.

(2)Write each sub-interface of the control object of the callback function to achieve the control of the corresponding control function.

(3)Run the GUI interface to check whether the controls are running properly and whether the presentation results are set. And then debug the program according to the results of the demonstration until a satisfactory result is achieved.

4. Conclusion

Nowadays, with the rapid development of social information technology, the emergence of new theories and new technologies, teacher of the signal and system courses must keep pace with the times, constantly update teaching methods and deepen the teaching reform. By auxiliary teaching system of signals and systems based on MATLAB, students can intuitively understand and appreciate the textbook abstract content and increase interest in learning. It can also can enhance understanding of the nature of the problem, strengthen innovative thinking, and improve the quality of teaching.

Acknowledgements

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