

VIRTUAL DSP SYSTEM DESIGN USING VISUAL STUDIO

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For the one who always stood by me through all the ups and downs

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ABSTRACT

DSP system is an essential tool in electronic engineering field. They serve as a tool to educate students to learn DSP in a simpler way. Although there is a lot of existing DSP systems in the market being used, the impression of new students from electronic engineering field still has a hard time comprehending the meaning of DSP.

Hence, the project objective is to develop a virtual DSP system using Visual Studio and Measurement Studio tools, where this system's functions includes digital signal processing with a selection of four types of algorithms. Tools will be used to provide input and output displays to let users of the system to visualize the inner process of DSP. The project scope will focus on using Visual Basic as the programming language and Measurement tools to display information data on the GUI.

There are some examples of literature review which includes a DSP system services provider from SIGNALogic. It has a problem for making the learning process of DSP become complicated and ineffective. It needs improvement on providing more tools to assist and communicate with the users of its system.

The development of this project is completed by using methodology modified from Object Oriented Analysis and Design. There are six phases in the Object Oriented Analysis and Design methodology which are the project initiation and planning phase, the system analysis phase, the system design, coding phase, and the implementation and testing phase.

Hence, this Virtual DSP System is a solution which consists of complexity features provided to assist users to learn and understand DSP in a more fun, effective way. In the nutshell, learning DSP will not be as complicated as before with the existence of this DSP system.

ABSTRAK

DSP sistem adalah satu keperluan dalam dunia elektronik kejuruteraan. Sistem ini digunakan sebagai bahan ajaran untuk belajar DSP dengan menggunakan cara yang baru. Walaupun terdapat banyak DSP sistem di pasaran, mahasiswa and mahasiswi dalam dunia elektronik kejuruteraan masih mempunyai masalah dalam pembelajaran DSP.

Jadi, arah rancangan projek ini adalah untuk membangunkan satu sistem DSP dengan menggunakan Visual Studio dan Measurement Studio tools, di mana fungsi sistem ini termasuk pemprosesan signal digital melalui empat pilihan algoritma. Tools akan digunakan untuk menunjukkan input dan output signal bagi pengguna sistem menggambarkan proses dalaman DSP. Skop projek ini akan menumpukan penggunaan Visual Basic sebagai bahasa program dan bahan Measurement Studio untuk menunjukkan data informasi di dalam GUI.

Terdapat contoh ulasan karya seperti SIGNALLogic yang member servis DSP. Akan tetapi, ia mempunyai masalah dalam penghantaran pembelajaran yang efektif kepada penggunanya. Pembelajaran melalui sistem ini menjadi susah dan sukar difahami.

Pembangunan sistem ini adalah menggunakan kaedah yang diubahsuai daripada Object Oriented Analysis dan Design (OOAD). Terdapat enam fasa dalam Object Oriented Analysis dan Design iaitu fasa permulaan projek dan fasa perancangan, fasa analisis sistem, reka bentuk sistem dan fasa pengekodan dan melaksanakan, dan fasa ujian.

Oleh itu, sistem DSP ini merupakan satu penyelesaian yang mempunyai pengkhususan untuk membenarkan pengguna sistem belajar DSP dalam cara yang efektif dan baru. Pembelajaran DSP tidak akan menjadi kompleks dan susah seperti dahulu dengan menggunakan sistem DSP ini.

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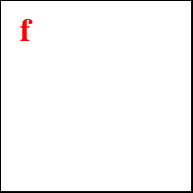
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NOMENCLATURE

DSP	-	Digital Signal Processing
VB	-	Visual Basic
OOAD	-	Object Oriented Analysis and Design
ERD	-	Entity-Relationship Diagram
RAM	-	Random Access Memory
DFT	-	Discrete Fourier Transform
FFT	-	Fast Fourier Transform
FIR	-	Finite Impulse Response
IIR	-	Infinite Impulse Response
GUI	-	Graphical User Interface
NI	-	National Instrument

CHAPTER 1

INTRODUCTION

1.1 Overview

Electronic learning (or e-Learning or eLearning) is a type of education where the medium of instruction is computer technology. It is so widely recognized and practiced as of today for its effectiveness in delivering the intended education to practitioner individuals. Currently, online education is fast adapting to ever-changing technology trends. E-Learning is a new way of doing business that involves openness, connectivity, and integration.

Generally e-learning is seen as offering solutions to several challenges currently facing HE. These include the move towards lifelong learning, with its ongoing demand for continuous professional development, and the drive to widen participation. These challenges come at a time of increasing pressure on resources, and the increasing diversity in the student population and their modes of attendance, including learning that is part-time, at a distance, open or flexible, and work based E-learning can improve the flexibility and quality of learning by:

- providing access to a range of resources and materials which may not otherwise be available or accessible, for example graphics, sound, animation, multimedia;
- giving control to students over when and where they study;
- allowing students to study at their own pace;

- providing a student centred learning environment which can be tailored to meet the learning needs of individual students;
- creating an environment that promotes an active approach to learning;
- supporting increased communications between staff and students, and amongst students;
- providing frequent and timely individual feedback, for example through computer assisted assessment, and positive reinforcement;
- motivating students through appropriate use of interactive courseware;
- supporting and encouraging collaborative learning;
- supporting economic reuse of high quality, expensive resources;
- encouraging students to take responsibility for their own learning.

DSP, or Digital Signal Processing, as the term suggests, is the processing of signals by digital means. Generally, a signal is a stream of information representing anything from stock prices to data from a remote-sensing satellite. The term "digital" comes from "digit", meaning a number (you count with your fingers - your digits), so "digital" literally means numerical; the French word for digital is *numerique*. A digital signal consists of a stream of numbers, usually (but not necessarily) in binary form. The processing of a digital signal is done by performing numerical calculations.

This project work towards producing a user friendly DSP system aimed at educating electronic engineering students to learn DSP in a new, different way. The overall system will be developed using Microsoft Visual Basic software. There are several algorithms that will be included, for example the DFT, FFT, FIR, and the IR filters. Besides that, virtual notes and experiments will be provided in this system as a reference to assist the learning process. In that way, learning DSP would be more interesting and fun as a standalone system compared to the availability of this concept as add-ons in other software at the current market. Smart and cool system software such as this will have the potential to be commercialized in the future.

The smart software will be uploaded to the World Wide Web to grant ease of access for respective students. In this case, the benefit of this concept can reach anyone interested in learning DSP with ease and convenience with just a click of the mouse at anywhere and anytime.

1.2 Project Objectives

To develop smart software as tools for electronic engineering students to learn DSP in a new way. This system will provide user friendly guides and illustrations to provide a better learning environment. The function of this system will develop algorithms such as the DFT, FFT, FIR, and IIR filter. Users who work with this system may come from a variety of background with, or without the upper hand knowledge of DSP techniques.

Virtual notes and experiments is one of the functions provided in this application software. Using these tools as assistance in an interesting GUI as the medium for the user to communicate with the smart software, learning DSP systems would be much more interesting and fun. Given the advantage of this virtual DSP system design project in so many ways, it will have the potential to be commercialized in the future.

1.3 Problem Statement

Problem: Current DSP systems that are add-ons in software are not user friendly

DSP systems that served as add-ons in software consist of dull illustrations for learning purposes. Learning DSP techniques became ineffective and complicated. An ignorant user who has never been exposed to DSP techniques before will have a hard time learning it in such inconvenience environment tool. A simple yet fun processing tool such a DSP will be labeled as complicated and boring by these users, therefore discouraging the awareness of the importance of this topic in the electronic engineering field.

In this project, a standalone system of the DSP system will be developed. Users can learn DSP in a whole new different way with more rich resources as virtual notes and experiments will be included in the system. A more interesting GUI that is user friendly can make learning more effective and interesting. A user who has never been exposed to DSP before can learn through this standalone system aimed at educating its user the concept of DSP in the current electronic engineering field.

1.4 Project Scope

The expected outcome of the project will produce an interesting standalone virtual DSP system that has its credibility in producing a new way of learning DSP techniques. A friendly GUI will be developed using Microsoft Visual Basic that consists of several functionality to assist its users to learn more effectively.

The project scope will focus on the following:

1.4.1 Involvement of Software and Hardware

The software and hardware used in this system are shown below:

VISUAL BASIC

Visual Basic (VB) is a third-generation event-driven programming language and associated development environment (IDE) from Microsoft for its COM programming model.

Like the BASIC programming language, Visual Basic was designed to be easy to learn and use. The language not only allows programmers to create simple GUI applications, but can also develop complex applications. Programming in VB is a combination of visually arranging components or controls on a form, specifying attributes and actions of those components, and writing additional lines of code for more functionality. Since default attributes and actions are defined for the components, a simple program can be created without the programmer having to write many lines of code.

MICROSOFT VISUAL STUDIO 2008

Microsoft Visual Studio is the main Integrated Development Environment (IDE) from Microsoft. It can be used to develop console and Graphical user interface applications along with Windows Forms applications, web sites, web applications, and web services in both native code together with managed code for all platforms supported by Microsoft Windows, Windows Mobile, .NET Framework, .NET Compact Framework and Microsoft Silverlight.

Visual Studio includes a code editor supporting IntelliSense as well as code refactoring. The integrated debugger works both as a source-level debugger and a machine-level debugger. Other built-in tools include a forms designer for building GUI applications, web designer, class designer, and database schema designer. It allows plug-ins to be added that enhance the functionality at almost every level –

including adding support for source control systems (like Subversion and Visual SourceSafe) to adding new toolsets like editors and visual designers for domain-specific languages or toolsets for other aspects of the software development lifecycle (like the Team Foundation Server client: Team Explorer).

Visual Studio supports languages by means of language services, which allow any programming language to be supported (to varying degrees) by the code editor and debugger, provided a language-specific service has been authored. Built-in languages include C/C++ (via Visual C++), VB.NET (via Visual Basic .NET), and C# (via Visual C#). Support for other languages such as Chrome, F#, Python, and Ruby among others has been made available via language services which are to be installed separately. It also supports XML/XSLT, HTML/XHTML, JavaScript and CSS. Language-specific versions of Visual Studio also exist which provide more limited language services to the user. These individual packages are called Microsoft Visual Basic, Visual J#, Visual C#, and Visual C++.

MEASUREMENT STUDIO 8.5

Measurement Studio provides a collection of managed NET controls tightly integrated within the Visual Studio 2008/2005/.NET 2003 environments that are designed specifically for engineers and scientists building virtual instrumentation systems. With Measurement Studio, you can configure plug-in data acquisition devices, GPIB instruments, and serial devices from interactive wizards that also generate Visual Basic .NET or Visual C# .NET source code. With scientific user interface controls for Web and Windows Forms, you can interactively configure graphs, knobs, meters, gauges, dials, tanks, thermometers, binary switches, and LEDs from property pages or collection editors. In addition, Measurement Studio delivers powerful networking components so you can easily share live measurement data between applications via the Internet.

Hardware Requirement

The hardware requirements for the DSP system are:

- Windows XP Service Pack 2
- Intel Pentium4, CPU 1.72 GHz or above
- 512MB RAM at least
- 10/100 Mb Network Card
- 40 GB Hard Disk, DVD Combo Drive

1.4.2 Types of Algorithms and Features

In electronics, computer science and mathematics, a digital filter is a system that performs mathematical operations on a sampling, discrete-time signal to reduce or enhance certain aspects of that signal. This is in contrast to the other major type of electronic filter, the analog filter, which is an electronic circuit operating on continuous-time analog signals. An analog signal may be processed by a digital filter by first being digitized and represented as a sequence of numbers, then manipulated mathematically, and then reconstructed as a new analog signal (digital signal processing). In an analog filter, the input signal is "directly" manipulated by the circuit. Software running on the microprocessor can implement the digital filter by performing the necessary mathematical operations on the numbers received from the ADC.

A digital filter system usually consists of an analog-to-digital converter (to sample the input signal), a microprocessor (often a specialized digital signal processor), and a digital-to-analog converter. In this project, 4 types of algorithms is available for digital signal processing purpose.

1.4.2.1 Algorithm applications in DSP System

Four Algorithms that will be implemented in this project would be the following:

- FFT (Fast Fourier Transform)
- DFT (Discrete Fourier Transform)
- FIR (Finite Impulse Response)
- IIR (Infinite Impulse Response)

Filter parameters that are related to the calculations of the output are provided as well.

The element features for this category is the following:

Filter Parameters

- Filter Type – Lowpass, Highpass, Bandpass, Bandstop
- Filter Design – Butterworth, Chebyshev
- Ripple
- Attenuation
- Order
- Lower Cutoff
- Upper Cutoff

To successfully process the input signal by DSP means, the following information stated above must be provided to assist the calculations related to the algorithm chosen in the system.

1.4.2.2 Range of Signals

The input signal used in this system will be generated by the system. There are two ways of producing input signal in this system. The input can be generated using the signal generator or randomly generating a noise signal. Using the signal generator, specific parameters information regarding the input signal must be provided to successfully generate the desired input signal. To generate the noise signal, no parameters information is required as all of its required information is generated by the system internally.

Signal Generator

The range of signals that will be used in this system is the following:

- Frequency: 1 Hz – 100M Hz
- Sampling Rate: 1 – 100M Samples
- Number of Samples: 1 – 100M Samples
- Signal Amplitude: 0.1 – 100

Noise Signal

A randomly generated noise signal can be produced in the system for processing means. White noise will be used in this feature hence the noise signal generated will be random each time. Processing this signal using DSP algorithms will show significant fine tuning results to the output signal.

CHAPTER 2

LITERATURE REVIEW

2.1 Background Study of DSP

Just a decade and a half ago, digital signal processing was more theory than practice. The only systems capable of doing signal processing were massive mainframes and supercomputers and even then, much of the processing was done not in real time, but off-line in batches. For example, seismic data was collected in the field, stored on magnetic tapes and then taken to a computing center, where a mainframe might take hours or days to digest the information.

The first practical real-time DSP systems emerged in the late 1970s and used bipolar "bit-slice" components. Large quantities of these building-block chips were needed to design a system, at considerable effort and expense. Uses were limited to esoteric high-end technology, such as military and space systems.

The economics began to change in the early 80s with the advent of single-chip MOS (Metal-Oxide Semiconductor) DSPs. Cheaper and easier to design-in than building blocks, these "monolithic" processors meant that digital signal processing could be cost-effectively integrated into an array of ordinary products. The early single-chip processors were relatively simple 16-bit devices, which, teamed with 8- or 10-bit ADCs, were suitable for low-speed applications, general-purpose coders such as