Supporting DSP Education Using Java

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Overview

This research is concerned with the design, development and evaluation of Java-based tools for Digital Signal Processing (DSP) education. The tools are designed for use by lecturers and tutors as teaching aids and by students as learning and study aids.

Issues and Requirements

Users

-Educators already have a variety of teaching aids - books, slides, boards.
-Students have competing courses making demands on their time.
-People do not learn to use tools for the sake of it.
-Users of software systems are not inclined to read documentation.

-Provide features that traditional teaching aids do not creating an incentive for their uptake by educators.
-Exploit dynamic visualisation / animation wherever appropriate to demonstrate and impart certain concepts in ways not possible using traditional teaching materials.
-Ensure the tools are easy to learn and intuitive to use.

Task

-Different educators will teach the same concepts in different ways.
-Educators should not have to change their courses to be able to use a tool.
-Animation and movies can support learning by observation.
-Learning by experimentation or doing can lead to an enhanced experience facilitating experimentation with textbook or lecture examples and the use of the tools in exploring solutions to course-work.

-The tools should allow educators to have control over their content.
-Allow students to view the effect of altering key parameters.
-Allow students to provide their own data and to manipulate this dynamically.

Technology

-Java runs on multiple platforms under multiple web-browsers.
-Web-browsers exist in varying versions differing in the support available for different Java flavours.
-Users will have access to a varying range of display sizes.
-Browsers impose further constraints on the available display space.

-The tools should be compatible with a wide range of platforms and browsers.
-The requirement for users - especially students - to download additional plug-ins should be kept to a minimum.
-The tools should be configurable by the users to suit their available display space.
-Use of the tools should not be denied to those with minimal 640x480 displays.

Environment

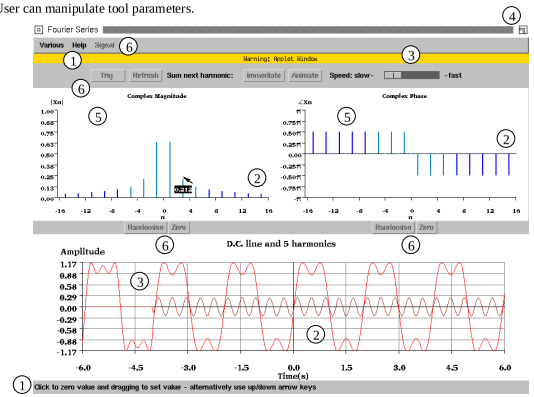
-Data projectors used in lecture rooms vary in their ability to present graphical information clearly - some colour schemes work better than others.
-Contrasting facilities can be provided both between departments of an institution and between institutions.
-In addition, students may own their own computers.

-Support user customisation of colour schemes to yield an effective and clear presentation when using a data projector.
-The tools should be compatible with multiple platforms allowing use in the widest range of available environments.

Meeting the Requirements

Java Tools for DSP Education

1-Both menu-accessed and context-sensitive help systems.
2-Colour schemes fully customisable by the user.
3-Exploitation of animation where appropriate - for example summing harmonics to construct a signal.
4-Compatible with 640x480 and larger screen sizes via a fully re-scalable interface.
5-Users can provide their own data - for example magnitude and phase - via simple graph-sketching facilities.
6-User can manipulate tool parameters.



-Java 1.1 compatible - compatible with Netscape 4.6 and Internet Explorer 4.
-Compatible with UNIX workstation, PC and Macintosh.
-Standard Mozilla Java Plug-in only required for Macintosh Netscape users.
-Can be run as stand-alone applications within a suitable Java environment.
-Tools currently available for Fourier transforms, Fourier series, discrete Fourier transforms, windowing functions, power spectral density, convolution (continuous and discrete), correlation, FIR filters, rotating phasors, and discrete wavelet transforms.

Multi-platform capability
+
Configurability
=
Flexibility

Tool-dependant Configuration Files

```
Coefficient colour = blue
Background colour = white
Number of Coefficients = 17
Number of Periods = 6

Name: Square wave 3 (Figure 1.6)
Period: 1
Magnitude: harmonic == 0 : 2 / 5 ;
           otherwise: abs((2 / 5) * sinc((harmonic * PI) / 5))
Phase: harmonic == 0 : 0 ;
       otherwise: ((harmonic / 5) % 2) * -PI
```

Assessing Educational Impact

Positive Anecdotal Evidence

A student comments that using the tools can enhance their understanding:

> *I think that this abstract topic was made a lot easier by the "hands-on" software where I can try what I think the behaviour should be and by that get a better understanding.*

A lecturer notes this also:

> *I have noticed that I am asked less questions on the topics covered by the applets. When using the applets in a one-to-one tutorial basis problems in understanding are more quickly resolved, and students more confident than previously when only paper-based approaches were used. In fact, students are more likely to ask more in-depth questions than those required for surface learning.*

Evaluation Questions

-Does the use of the tools lead to an increase in understanding of DSP concepts by students?
  o When used by the students as a learning and study aid?
  o When used by the lecturers as a teaching and demonstrating aid?
-If such an increase in understanding arises then, why, and if not, why not?
-How easy is it for lecturers to integrate the tools into their own courses?
-How might the tools be more effectively integrated into a course as a whole?
-In what way can the tools be improved: to support students; to support lecturers?

Interpretive Evaluation

-On-line forms, student-evaluator dialogue, and interviews with educators.
-Collect the perceptions of educators and students as to the usability and utility of the tools.
-Record comments, perceptions, views, suggestions and complaints.
-Form descriptions of users' experiences and behaviour.
-Yields qualitative information from students themselves as to how they feel the tools improve, or, indeed, hinder, their understanding.
-Educators can assess whether the reasons given are credible based on their understandings of the subject, course, and student behaviour and learning.
-Can elicit information as to why any problems arise:
  o low-level interface design problems, or,
  o fundamental problems concerning how the tool imparts information about a concept.

Conclusion

Responses from both students and lecturers to early versions of the tools has proven positive and there has been an increase in uptake ofthe tools by lecturers at Edinburgh during the 2000 / 2001 session. The interpretive evaluation is now underway and the authors look forward to reporting the results of this evaluation.

The WebEng Project

-Web-based Procedures, Tools and Strategies for Internet-based Engineering Education
-Development of a unified, on-line, web-based learning and teaching environment for DSP education.
-Departments of Electronics and Electrical Engineering at the Universities of Strathclyde and Edinburgh.

www.webeng.org

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