

A multimedia courseware on wavelets

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Abstract :

This article describes the design of a multimedia application for teaching wavelets theory and its applications in image processing. It is intended for engineers and students with a basic background in signal processing and mathematics. The issue was to teach abstract concepts poorly illustrated on paper. This courseware takes advantage of animation, graphics, written and spoken text and interactive simulations.

Keywords : multimedia, education, image processing.

Résumé :

Cet article décrit la conception d'une application multimédia pour enseigner la théorie et les applications des ondelettes en traitement d'image à des ingénieurs et des étudiants ayant des notions de base en traitement du signal et mathématique. Pour introduire des concepts abstraits difficilement illustrés sur papier, ce didacticiel met en œuvre des animations, des graphiques, des textes écrits et lus, et des simulations interactives.

Mots clés : multimédia, éducation, traitement d'image.

Introduction

Wavelets theory is based on advanced, abstract and rather complex mathematical concepts. Paper books can at best explain it with written text and static illustrations [1]. In contrast, multimedia allows enhanced communication and explanation means such as spoken comments played while displaying a figure, or interactive illustrations. For this reason, our purpose was *not* to develop an electronic copy of a paper book. We aimed at taking full pedagogical advantage of multimedia capabilities to make learning easier and more attractive.

Courseware description

Each part starts with an example of the addressed issue, the resolution of which is presented as a challenge. The mathematical theory is then introduced and illustrated with processed images. Finally, interactive simulations allow students to test their knowledge.

We tried to eliminate unnecessary words that could lead to confusions by using only short sentences elaborated to convey as much information as possible. Throughout the course, previously-introduced salient information is recalled, and complex points are explained several times in various ways. A great attention was paid to avoid any gap between successive parts.

Written explanations are supplemented by a voice that gives additional information. This allows to communicate with students having different preferred sense perception : images and written texts for those with easier visual perception, and spoken explanation for those preferring to listen.

Teaching efficiency is achieved by means of the following strategies [2, 3, 4].

- *Interest stimulation* : To capture students' attention, we try to face them with a challenge right at the beginning of each part of the course (fig. 1), and we give them some hints towards the solution.
- *Multilevel reading* : Detailed explanations can be obtained by clicking on a question mark icon (fig. 2). This allows users to focus on issues in which they have a particular interest.
- *Living presentations* : Complex equations and formulas are explained with animated illustrations built on simple examples. Mathematical algorithms with repeated operations can be easily explained by displaying the computation in progress along with spoken explanations (fig. 3).
- *Interactivity* : Students can change parameters in formulas and observe how the results are altered. A user friendly point-and-click graphical interface lets users control the many parameters of interactive simulations (fig. 4).

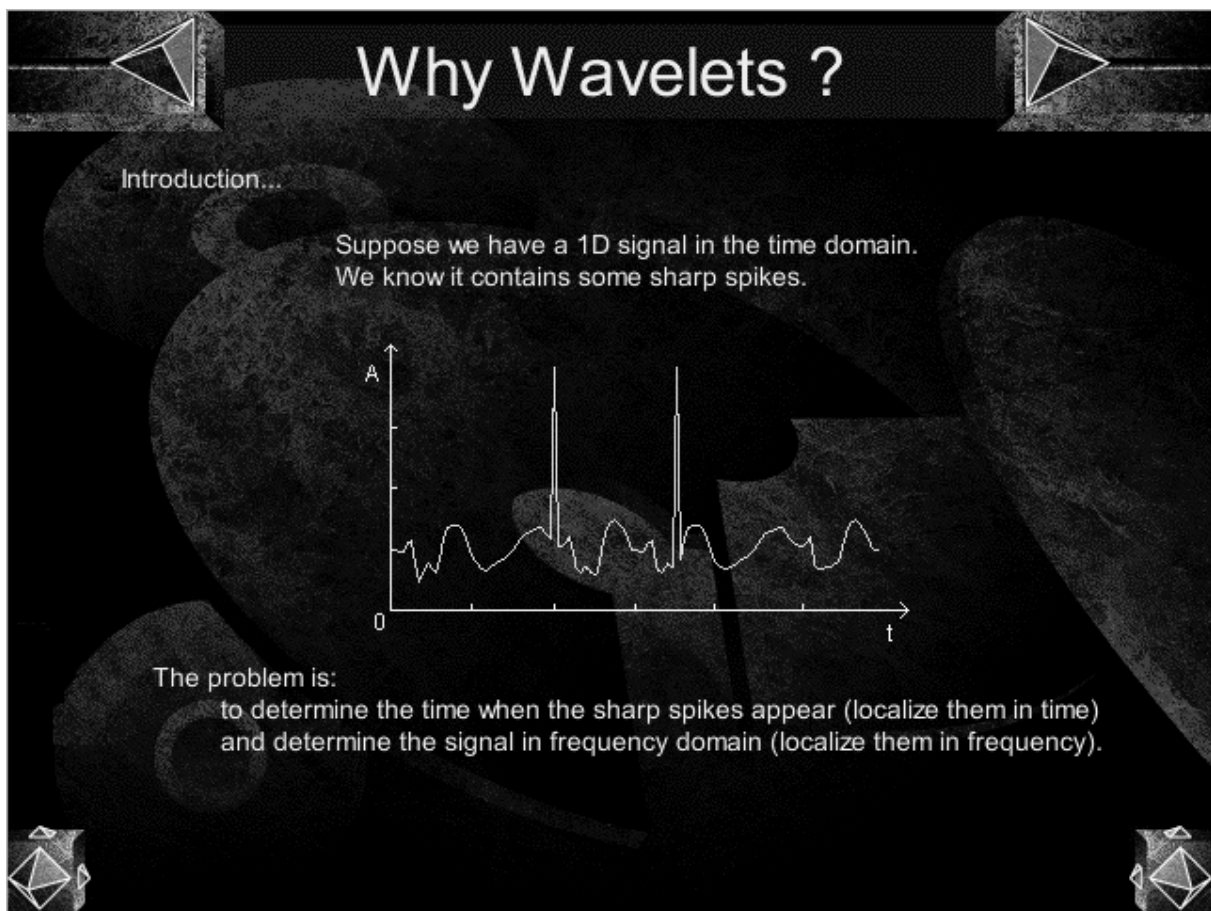


Fig. 1. Each part of the courseware starts with a challenge to be solved.

Development tools

This courseware was created with *Macromedia Director* [5]. Because it does not provide an efficient support for image processing, all the animated illustrations have been pre-computed for a limited number of parameter combinations. *Khoros* [6] and *Matlab* [7] have been used for this purpose.

This software requires Windows 95 / NT on a Pentium PC or OS-MAC on a PowerPC, SVGA, a sound card, and 70 Mb available on disk.

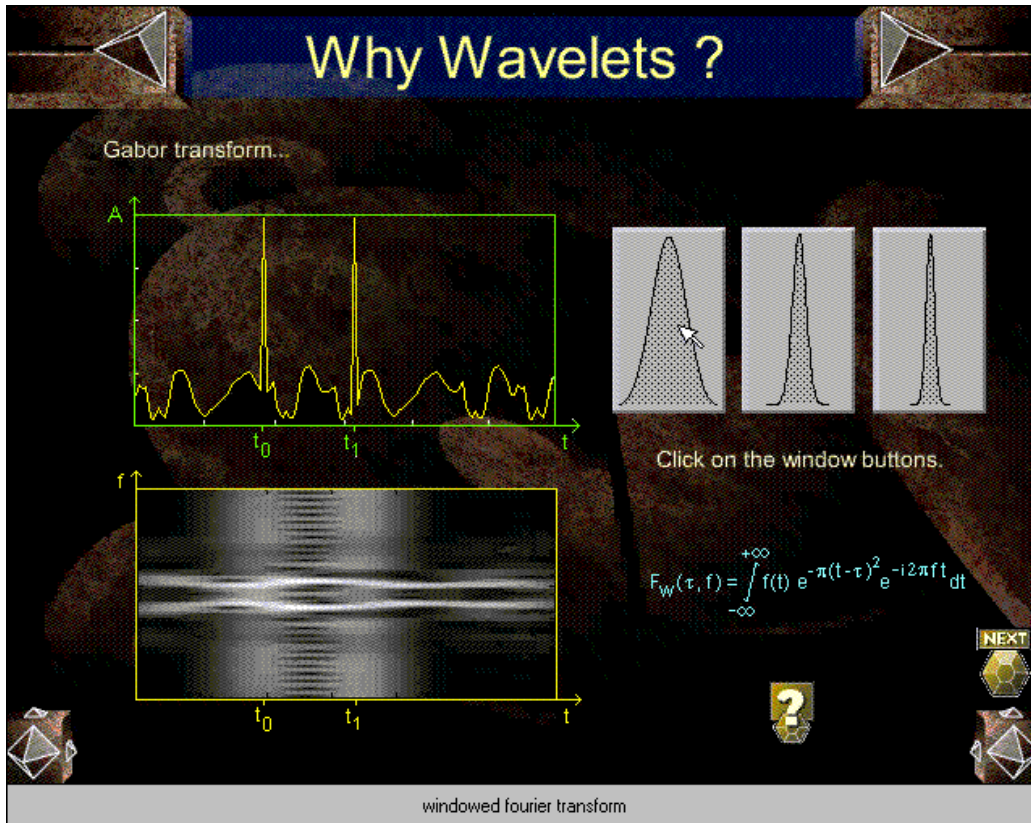


Fig. 2. Animated illustration of the windowed Fourier Transform. Parameters can be changed by a mouse click. The question mark gives access to detailed information.

To see the video you may double-click in the image.

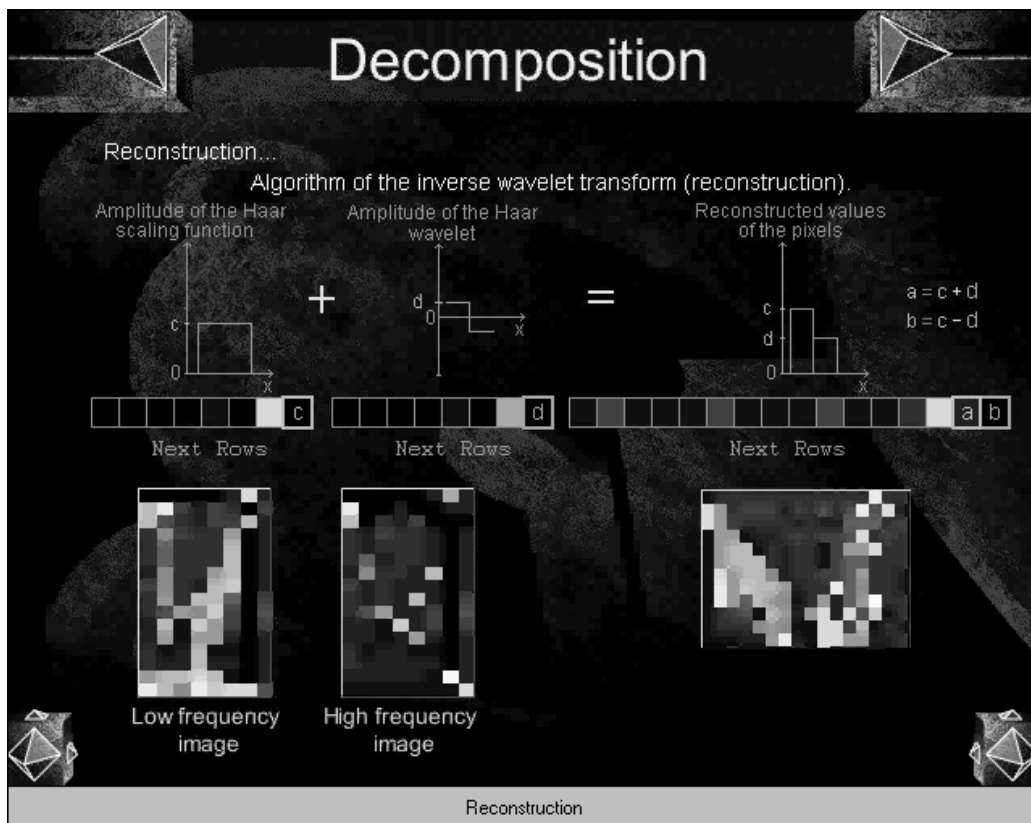


Fig. 3. Animated illustration of wavelet-based image reconstruction.

To see the video you may double-click in the image.

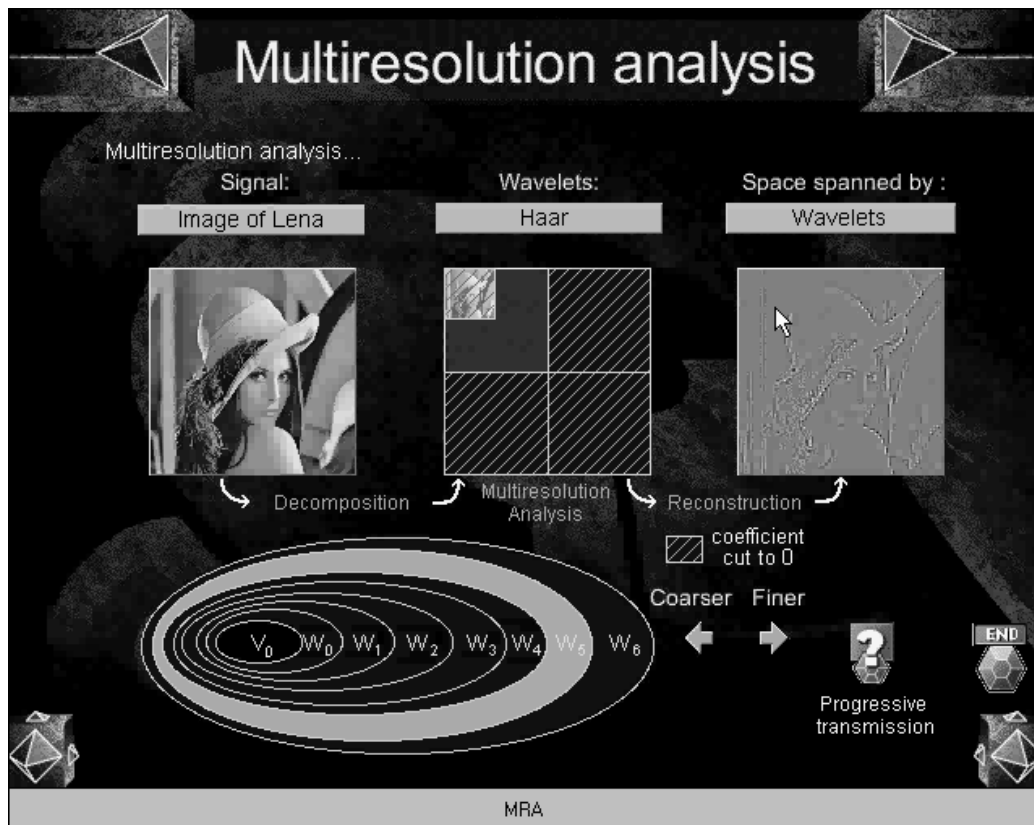


Fig. 4. Interactive simulation of progressive transmission. The transmitted image shows more details as the user expands the coefficient subspaces.

To see the video you may double-click in the image.

Perspectives

This courseware is being extended with simulations written in Java. Java applets can be run on many different platforms, either locally or over a network link. Most importantly, Java programs allow some data processing in real time, which removes the limitation on the number of combinations of parameters in simulations.

The software could be distributed as a part of a course on picture processing on CDROM or be made accessible via Internet using a standard WWW browser with the *Macromedia Shockwave* plug-in.

Acknowledgment

This courseware has been developed in the framework of the ERNEST project [8] of the *Groupe des Ecoles des Télécommunications*. The graphical background was taken from the PRISMEO project.

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