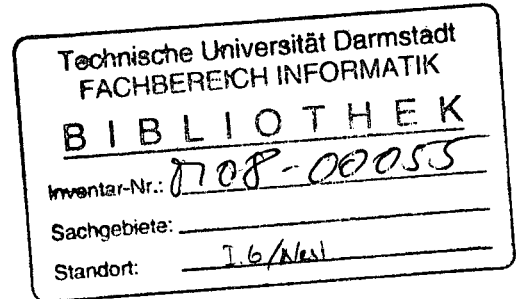


Interactive Multimedia Music Technologies

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Chapter I

Interactive Multimedia MUSICNETWORK: An Introduction / *Kia Ng and Paolo Nesi* 1

The MUSICNETWORK project was cosupported by the European Commission to bring music industry and related research areas into the interactive multimedia era. It represented a virtual Centre of Excellence during the period of the project, and today an international association where music content providers, cultural institutions, industry, and research institutions work together, drawing on their collective assets and mutual interests, to exploit the potential of multimedia music contents with new technologies, tools, products, formats, and models. Due to large gaps between needs and real products and solutions, many products in the market fail to exploit the potential of new multimedia technologies effectively. MUSICNETWORK helps research solutions to reach the market by seeking agreements between different actors and formats, by bringing together research institutions, industries, small and medium enterprises (SMEs), and experts to build the required momentum to study and define multimedia music modelling and coding for the new age. MUSICNETWORK activities, actions and services are provided through the project Web site, which can be found online at <http://www.interactivemusicnetwork.org>.

Chapter II

MPEG Symbolic Music Representation: A Solution for Multimedia Music Applications /
Pierfrancesco Bellini, Paolo Nesi, and Giorgio Zoia 12

The evolution of digital communication devices and formats has recently produced fundamental changes in the practical approach to music representation and notation, transforming them from a simple visual coding model for sheet music into a composite tool for modelling music in computer and multimedia applications in general. As a consequence, a multilayer model of music representation is needed for several purposes in addition to sheet music production or visual display, such as audio rendering, entertainment, music analysis, database query, music performance coding, music distance learning, and so forth.

The symbolic music representation is a standard for modelling music notations, proposed inside the MPEG multimedia framework. Symbolic music representation generalizes the main music notation

concepts to model the visual aspects of a music score, and audio information or annotations related to the music piece, allowing integration with other audiovisual elements by multimedia references. The Symbolic Music Representation standard overcomes the limitations of a widely accepted format like MIDI, which is in line with its main purpose to model music events, whereas it reveals important limitations in producing audio and visual representations with satisfactory results.

Chapter III

XML Music Notation Modelling for Multimedia: MPEG-SMR / *Pierfrancesco Bellini*..... 26

The evolution of information technology has changed the use of music representation and notation in software applications, transforming and extending them from a simple visual coding model for music scores into a tool for modelling music for computer programs and electronic devices in general (e.g., keyboards), to support the exploitation of the multimedia characteristics lying behind music notation and representation. The MPEG symbolic music representation (MPEG-SMR) is a new emerging standard for modelling music notation within the MPEG multimedia framework. MPEG-SMR provides an XML-based language to model most of the music notation in terms of the visual and audio aspects, as well as music score annotations. MPEG-SMR also provides a language to define the music score formatting rules, supporting personalisation for the score visual presentation, custom symbols, and control visual rendering of the common notation symbols.

Chapter IV

Optical Music Imaging: Music Document Digitisation, Recognition, Evaluation, and Restoration / *Graham Jones, Bee Ong, Ivan Bruno, and Kia Ng* 50

This chapter presents the applications and practices in the domain of music imaging for musical scores (music sheets and music manuscripts), which include music sheet digitisation, optical music recognition (OMR), and optical music restoration.

With a general background of optical music recognition (OMR), the chapter discusses typical obstacles in this domain, and reports currently available commercial OMR software. It reports hardware and software related to music imaging, discusses the SharpEye optical music recognition system, and provides an evaluation of a number of OMR systems.

Besides the main focus on the transformation from images of music scores to symbolic format, this chapter also discusses optical music image restoration and the application of music imaging techniques for graphical preservation and potential applications for cross-media integration.

Chapter V

Optical Music Recognition: Architecture and Algorithms / *Pierfrancesco Bellini, Ivan Bruno, and Paolo Nesi*..... 80

Optical music recognition is a key problem for coding western music sheets in the digital world. This problem has been addressed in several manners, obtaining suitable results only when simple music con-

structs are processed. To this end, several different strategies have been followed to pass from the simple music sheet image to a complete and consistent representation of music notation symbols (symbolic music notation or representation). Typically, image processing, pattern recognition and symbolic reconstruction are the technologies that have to be considered and applied in several manners the architecture of the so-called OMR (optical music recognition) systems. In this chapter, the O³MR (object oriented optical music recognition) system is presented. It allows producing, from the image of a music sheet, the symbolic representation and save it in XML format (WEDELMUSIC XML and MUSICXML). The algorithms used in this process are those of the image processing, image segmentation, neural network pattern recognition, and symbolic reconstruction and reasoning. Most of the solutions can be applied in other fields of image understanding. The development of the O³MR solution with all its algorithms has been partially supported by the European Commission, in the IMUTUS Research and Development project, while the related music notation editor has been partially funded by the research and development WEDELMUSIC project of the European Commission. The chapter also includes a methodology for the assessment of other OMR systems. The set of metrics proposed has been used to assess the quality of results produce by the O³MR with respect to the best OMR on market.

Chapter VI

Challenges of Designing a Markup Language for Music / *Jacques Steyn* 111

XML-based languages for music have constraints not applicable to typical XML applications, such as for standard text documents or data sets. Music contains numerous simultaneous events across several dimensions, including time. The document model for a piece of music would thus look very different from serialised text documents. Most existing XML-based music markup languages mark music typography, following the print traditions of music scores. A general music markup language should include much more than mere print. Some of the challenges designing an XML-based markup language for music are considered. An SVG-based music symbol design grid is proposed to meet the challenge of music typography. An XML-based Music Symbol Language is used to design symbols on this grid. Resulting symbols are positioned in 3-D music space, which is introduced to address the challenge of topography.

Chapter VII

Alternative Design Goals for a General Music Markup Language / *Jacques Steyn*..... 133

Design goals determine the particular structure of a markup language, while the philosophy of what markup languages are about determine the framework within which its structure is developed. Most existing markup languages for music reflect low-level design strategies, compared to design that adheres to the high-level philosophy of markup languages. An approach to an XML-based music markup language from the perspective of SGML would differ from an approach from a markup language such as HTML. An ideal structure for a general markup language for music is proposed that follows a purist approach and that results in a different kind of XML-based music markup language than most present music markup languages offer.

Chapter VIII

Interactive Systems for Multimedia Opera / *Michael Oliva*..... 151

This chapter considers the development of systems to deliver multimedia content for new opera. After a short overview of the history of multimedia in opera, the specific requirements of opera are analysed, with emphasis on the fundamental musicality of operatic performance. Having considered the place of multimedia elements in the narrative and acting space, the relevance of previous practice in electroacoustic music and VJing is considered as a model for a working approach. Several software and hardware configurations explored, including the use of gestural control by the actors themselves. The creation of a keyboard based “video instrument” with a dedicated performer, capable of integration into the pre-existing musical ensemble, is recommended as the most effective and practical solution.

Chapter IX

Driving Sound Synthesis with a Live Audio Signal / *Cornelius Poepel*..... 167

An overview on problems and methods to map performers’ actions to a synthesized sound is presented. Approaches incorporating the audio signal are described, and a synthesis method called “audio signal driven sound synthesis” is introduced. It uses the raw audio signal of a traditional instrument to drive a synthesis algorithm. The system tries to support musicians with satisfying instrument-specific playability. In contrast to common methods that try to increase openness for the player’s input, openness of the system is achieved here by leaving essential playing parameters nonformalized as far as possible. Three implementations of the method and one application are described. An empirical study and experiences with users testing the system implemented for a bowed string instrument are presented. This implementation represents a specific case of a broader range of approaches to the treatment of user input, which has applications in a wide variety of contexts involving human-computer interaction.

Chapter X

How Technology Can Support Culture and Learning / *David Luigi Fuschi, Bee Ong, and David Crombie*..... 195

From the authors’ perspective, technology is both a tool and a developing factor that can foster culture and learning development. This chapter focuses on the interrelations that interleave education, technology, content accessibility, and intercultural issues. With an introduction and related background, language learning is used as an example further to explain these issues. This chapter then discusses authoring and content development for e-learning applications (including authoring tools, virtual communities, and forums), and examines technology and accessibility issues in this context. The current state of e-learning is introduced along with a description of different tools and approaches. The chapter concludes with an overview of e-learning and the marketplace.

Chapter XI

Web-Based Music Intelligent Tutoring Systems / *Somnuk Phon-Amnuaisuk
and Chee Keh Siong*..... 231

Our work bridges two interesting topics: the research in the area of Web-based applications and the area of learning technologies. We give an overall picture of the current development in Web-based music intelligent tutoring system (WMITS). The term WMITS is coined by us to describe the two main areas in our focus. In this chapter, we address the following issues: (i) the pedagogical aspect of teaching and learning music, (ii) the background of music intelligent tutoring system, and (iii) our WMITS system for teaching music theories. A Web-based environment offers strengths in terms of accessibility and self-paced learning. However, the environment has a great drawback in terms of interactivities between the users and the system. Our design addresses this issue by developing a specialised client tool. The client tool provides an interactive environment for score editing, which is crucial for learning music theories. The system incorporates three major inference techniques (i.e., deductive, inductive, and Bayesian inference) in dealing with music theories and uncertain knowledge such as students' understanding.

Chapter XII

Digital Rights Management Technologies and Standards / *Jaime Delgado
and Eva Rodriguez*..... 249

This chapter discusses technologies and standards related to digital rights management (DRM). Firstly, it presents DRM systems that are multimedia information management systems that take into account digital rights and protection. These systems enable the controlled distribution and use of multimedia content through the digital value chain. Then, this chapter presents current initiatives, standard and proprietary, that specify a DRM system. It focuses in the MPEG-21 standard initiative, mainly in the parts of this standard that normatively specify the different pieces and formats needed by a complete DRM system. Finally, this chapter presents one of the key components of DRM systems, rights expression languages (RELs), that have been defined to express content usage rules.

Chapter XIII

Possibilities, Limitations, and the Future of Audiovisual Content Protection /
Martin Schmucker..... 283

This chapter explains the fundamental principles of audiovisual content protection. It explains the basic knowledge that is needed to understand the fundamentals of digital rights management (DRM) systems and their problems. Starting with a general introduction about copyright and content protection, available protection technologies are described and analyzed. The basic concepts of DRM solutions are explained and problems discussed. Potentials and practical limitations are analysed based on the digital music industry value chain. An outlook is given on solutions that are under development and that stronger consider the needs of the customers. In the conclusion, future solutions are discussed.

Chapter XIV

Online Music Distribution / <i>Francesco Spadoni</i>	325
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This chapter analyses multiple aspects of online music distribution, investigating the major problems, the different approaches and business models, considering the different points of view and perspectives, presenting the emerging technologies and digital rights management standards, analysing issues for rights clearing, intellectual property protection, content retrieval, and metadata management.

The chapter presents the structure of the developing market of digital music and multimedia content distribution, considering all the stakeholders and their mutual relationships, as well as the legal framework. It highlights the importance of the needs of end-users and consumers of music when considering the major problems, as well as the new behaviours and possibilities originated by the availability of music in digital form

This chapter is aimed at many different audiences, from policy makers to music end-users and consumers, to content creators, publishers, and distributors, as well as technology providers, and in general, to all the players in the digital music content value chain.

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