

i-Maestro: Technology-Enhanced Learning and Teaching for Music

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ABSTRACT

This paper presents a project called i-Maestro (www.i-maestro.org) which develops interactive multimedia environments for technology enhanced music education. The project explores novel solutions for music training in both theory and performance, building on recent innovations resulting from the development of computer and information technologies, by exploiting new pedagogical paradigms with cooperative and interactive self-learning environments, gesture interfaces, and augmented instruments. This paper discusses the general context along with the background and current developments of the project, together with an overview of the framework and discussions on a number of selected tools to support technology-enhanced music learning and teaching.

Keywords

Music, education, technology-enhanced learning, motion, gesture, notation, sensor, augmented instrument, multimedia, interactive, interface, visualisation, sonification.

1. INTRODUCTION

The i-Maestro project [1, 12, 18, 19] aims to explore novel solutions for music training in both theory and performance, building on recent innovations in computer and information technologies. New pedagogical approaches are being studied with interactive cooperative and self-learning environments, and computer-assisted tuition in classrooms including gesture interfaces and augmented instruments. The project develops a technology-enhanced environment for aural and instrumental training both for individuals and ensembles, as well as tuition in musical analysis, theory, and composition.

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The project specifically addresses training support for string instruments and among the many challenging aspects of music education. The project is particularly interested in linking music practice and theory training.

2. I-MAESTRO

With an analysis of pedagogical needs, the project develops enabling technologies to support music performance and theory training, including tools based on augmented instruments, gesture analysis, audio analysis and processing, score following, symbolic music representation, cooperative support and exercise generation. The resulting i-Maestro framework for technology-enhanced music learning is designed to support the creation of flexible and personalisable e-learning courses, and aims to offer pedagogic solutions and tools to maximise efficiency, motivation, and interests in the learning processes and improve accessibility to musical knowledge.

A process of continuous user requirements analysis was started since the beginning forms the basis of the specification of a framework which includes enabling technologies, pedagogic tools and the production of content, and supportive pedagogical aspects, such as modelling and formalising educational models for music, courseware production tools. These include innovative aspects, such as models and support for cooperative training, interactive and creative interfaces with sensors, and gesture tracking, client tools for theory and play training, distribution and management tools for music lessons, and music exercise generation.

The outcomes are being validated by several European institutions including Accademia Nazionale di Santa Cecilia (Rome), the Fundación Albéniz (Madrid) and IRCAM (Paris).

2.1 Framework and Tools

The user requirements, and a set of pedagogical scenarios with use cases and test cases have been translated into specifications of the framework and tools. This section presents a diagram which depicts the overall framework (see Figure 1), and briefly describes a set of selected tools (in Section 2.2 to 2.5).

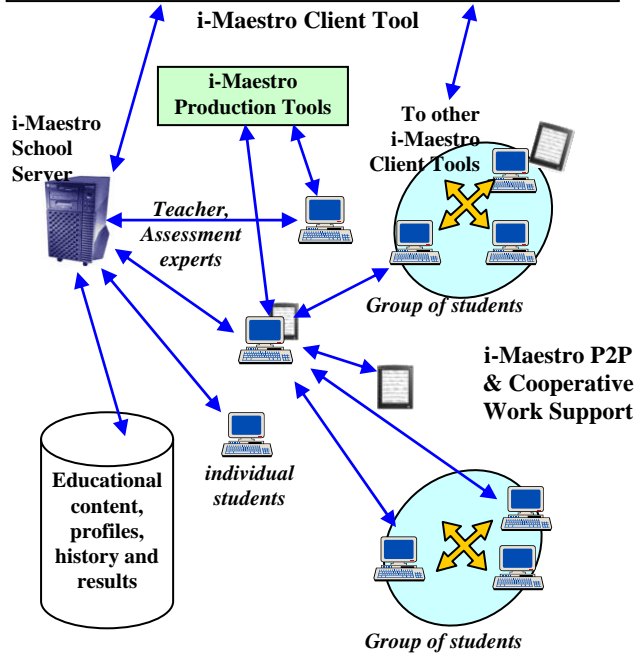


Figure 1. An overview of the i-Maestro architecture.

2.2 Music Training Supports

Prototypes for music training supports such as the score-follower (see Figures 3) [6, 7, 10], notation editor, client tools, gesture support and visualisation, and exercise generation are now available and continuously being enhanced and tested in pedagogical practice.

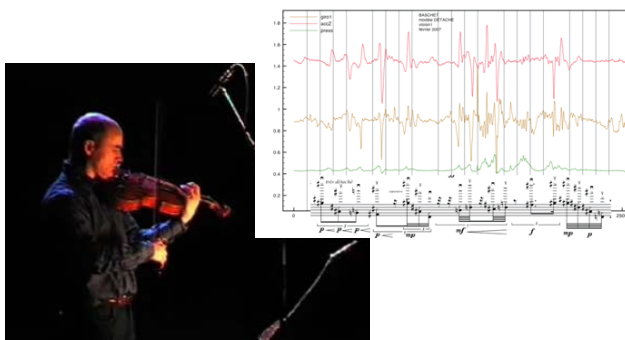


Figure 2. The Score Follower listens to the player and provide automated “page turning” and accompaniment.

Sensor interface and several pedagogical contexts have also been developed to support students to internalise key musical

concepts with the interactive tools. Figure 3 shows the wireless module and sensor setup to provide various feedbacks of the playing (augmented violin [7])

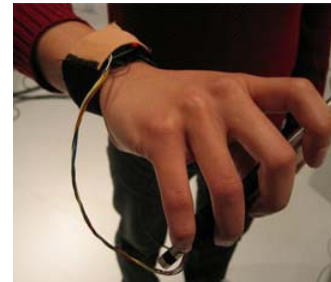


Figure 3. Wireless module and sensor.

3D motion capture technology is also being utilised. Figure 3 shows the 3D Augmented Mirror (AMIR) [11, 13, 14, 17, 18] captures and visualises the performance in 3D. It offers a number of different analyses to support the teaching and learning of bowing technique and body posture. Figure 5 shows the bowing tracking with automated bowing annotation on SMR

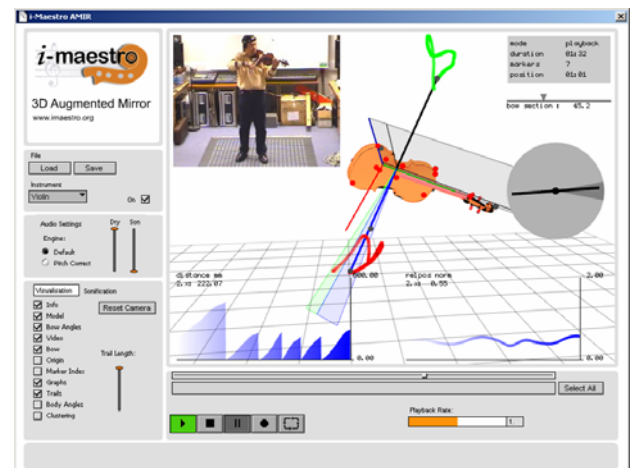


Figure 4. AMIR for 3D visualisation and sonification of a bowing exercise.

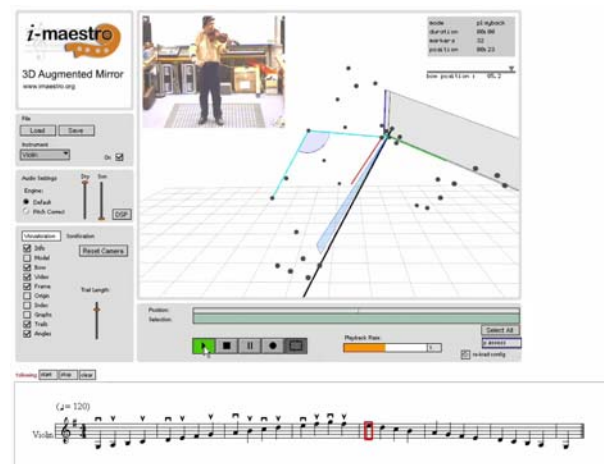


Figure 5. AMIR with automated bowing annotation.

2.3 Symbolic Music Representation

Music notation is one of the fundamentals in music education. i-Maestro is promoting MPEG Symbolic Music Representation (SMR), an ISO standard for the representation of music notation with enhanced multimedia features [3, 4, 8, 9, 15]. Cooperative work is another key area of music education. It allows different components of the i-Maestro framework to be used across a network. Other tools include the Exercise Generator, which supports (semi-)automated creation of exercises and the School Server offers online access to stored lesson material for sharing learning material at home and in the classroom.

Figure 5 shows an MPEG SMR player/decoder within the IM1 MPEG-4 reference software. The MPEG-SMR has been accepted as an ISO standard under MPEG-4.

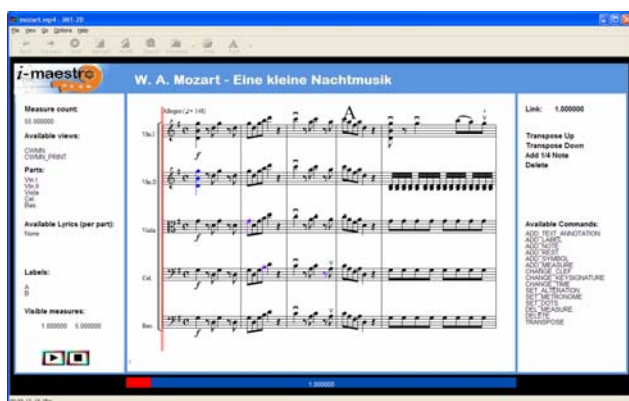


Figure 6. An MPEG SMR player/decoder.

2.4 Notation, Annotation and Representation

For annotation of audio recordings and notation, an adaptation of the SDIF format has been developed to represent sensor, motion, and analysis data, raising interest from practitioners of the domain. The partners continued research and development, extensions, and refining models and tools in light of the responses and feedbacks from User Group and contacts. The individual tools are brought together for integration, linking them into the overall framework.

2.5 Integration

The combination of tools leads to new functionality, e.g. the automatic annotation of a score with bowing symbols in real time while a musician is playing, which is reached by combining, score follower, motion capture and SMR support. An application (called the i-Maestro Start) has been created to offer students and teachers a unique tool to start all the tools offered by i-Maestro. With the tools and results available, validation activities have been started with teachers in music schools and conservatories.

3. Reflections and Next Steps

The project has worked on pedagogical aspects, enabling technologies, i-Maestro software components, and started validation activities. In addition, guidelines for accessibility in technology-enhanced music training have been developed [2, 5].

An overarching pedagogical approach and model [16] for technology-enhanced teaching and learning has been developed. On this basis, a set of detailed pedagogical scenarios related to the use of the i-Maestro tools has been created.

This paper presented a brief overview of the i-Maestro project. With the introduction, the paper presented the overall framework design and introduced several tools to support music learning and teaching including MPEG SMR for theory training, gesture analysis for performance training.

The final results are expected to consist of a framework for technology-enhanced music training, that combines proven and novel pedagogical models with technological tools such as collaborative work support, symbolic music processing, audio processing, and gesture interfaces. Offering accessible tools for music performance and theory training as well as for authoring lessons and exercises will ensure wide participation.

Many prototype tools available are expected to be incorporated in various new products and services, which will be made available to both the general public and educational establishments. These are in the process of being validated and refined and the project is inviting music teachers and students to take part in the testing phase the i-Maestro software. We are particularly interested in testing the system in real pedagogical situations to see how teachers and students interact with the technology. At the ICSRiM - University of Leeds (UK), open lab sessions are being organised for people to come and try out the i-Maestro 3D augmented mirror system with a 12-camera motion capture system.

4. ACKNOWLEDGMENTS

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