

# **i-Maestro: Interactive Multimedia Environments for Music Education**

Bee Ong<sup>1</sup>, Kia Ng<sup>1</sup>, Nicola Mitolo<sup>2</sup>, Paolo Nesi<sup>2</sup>

<sup>1</sup> ICSRiM - University of Leeds, School of Computing & School of Music,  
Leeds LS2 9JT, UK

[kia@kcng.org](mailto:kia@kcng.org), [www.kcng.org](http://www.kcng.org), [www.icsrim.org.uk](http://www.icsrim.org.uk)

<sup>2</sup> DISIT-DSI, University of Florence,

Via S. Marta 3, 50139 Firenze, Italy

[nesi@dsi.unifi.it](mailto:nesi@dsi.unifi.it), [www.dsi.unifi.it/~nesi](http://www.dsi.unifi.it/~nesi)

[info@i-maestro.org](mailto:info@i-maestro.org), [www.i-maestro.org](http://www.i-maestro.org)

## **Abstract**

*The i-Maestro project is co-funded by the European Community under the IST Sixth Framework Programme to develop 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 exploration of 3D motion data for posture and gesture support to musical instrument learning and playing.*

## **1. Introduction**

This paper presents the i-Maestro project [12], which explores innovative solutions for music education and training in both theory and performance. The project is developing interactive multimedia environments for technology enhanced music education. It builds on recent innovations from the development of computer and information technologies, and exploits new pedagogical paradigms with cooperative and interactive self-learning environments. Additionally, the paper presents the developments of gesture-based interfaces to offer

technology-enhanced environments for music training such as instrumental playing with particular focus on the violin family.

i-Maestro is exploring music learning practices which have been developed over the course of the centuries by the European music educational institutions, and utilising technological advancements to enhance and amplify their qualities and propose possible new directions. Music educational institutions and other related actors can benefit from these new developments and solutions for increased efficiency, attractiveness, optimised learning outcomes and wider accessibilities, while reducing time and effort.

Music performance is not simply “to play the right note at the right time”. The i-Maestro project aims to study and explore many relevant aspects in order to produce methods and tools for music education with innovative pedagogical paradigms, taking into account key factors such as expressivity, interactivity, gesture controllability and cooperative-work among participants [1, 2, 5].

### **1.1. Main Technical Objectives**

The main technical objectives of the project includes basic research and development of new solutions and enabling technologies to support traditional pedagogical paradigms for music training, and novel pedagogical paradigms, such as cooperative-working, self-learning and class-studying, with particular focus on Theory Training paradigms and Practice Training paradigms for string instruments exploring interactive, gesture-based, and creative tools; and a framework for technology-enhanced music

educational models and tools to support the creation of flexible and personalisable e-learning courses to improve accessibility to the musical knowledge.

This paper presents an introduction to the i-Maestro project with general application scenarios for contextualisation together with the proposed architecture to support collaborative learning and teaching for music.

## 2. General Support and Architectural Overview

A framework such as i-Maestro can assist Teachers in following the progress of each Student and in evaluating their achievements with the support of innovative methods. Using the i-Maestro tools, Teachers will be able to create teaching material corresponding to the level of a Student or of a group of Students in a simple way, thus helping to personalise the tuition. The system also allows Teachers to monitor the Student's progress. In many teaching environments, physical contact and interaction with Students in classes is typically very limited in time and this can affect the quality of teaching. In this context, i-Maestro provides for the creation of an almost continuous interaction between Students and Teachers, improving teaching continuity, and accelerating the rate of improvement. i-Maestro can also be very useful for supporting those Students who may “lag” behind the class and need specific individual support.

The i-Maestro General Architecture is illustrated in Figure 1. It includes:

- **i-Maestro School Server:** An area for Lesson distribution, pedagogical material, history of Students pedagogical experiences, training material, tools for the Teachers, historical data collection and navigation, music school training management for the different scenarios.
- **i-Maestro Client Tools:** All of them have a similar structure. Several different Client Tools will be studied and developed, for Students, Teachers, conductors, impaired Students, assessment experts, etc. They will support different devices: PC and Tablet and simpler PDA tools for sharing information and Lessons.
- **i-Maestro Production Tools:** Music Exercise Authoring Tool, Music Exercise Generators, etc.
- **i-Maestro P2P and Cooperative Work Support:** for sharing content, supporting the cooperative work in classroom and among Students, stimulating collaboration and common experiences and setting up of groups for study,

class room group, practical or theory training, ensemble training and playing, etc.

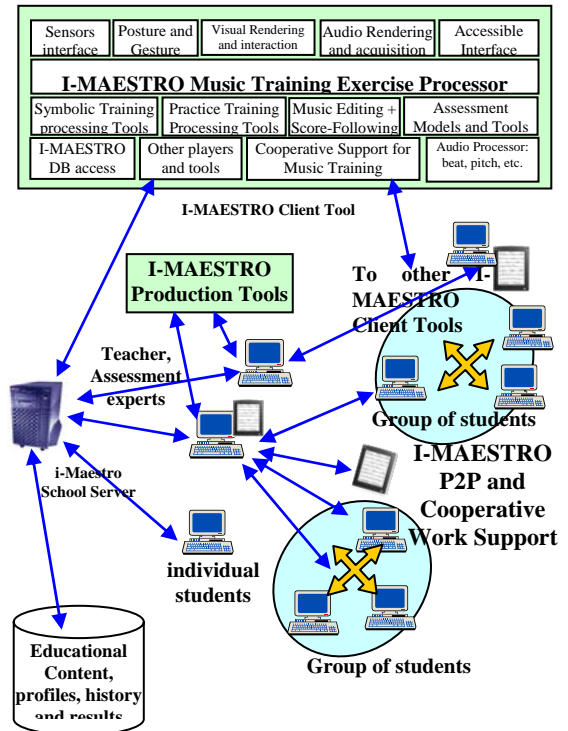


Figure 1. i-Maestro architecture

## 3. General Scenario

The main Actors using i-Maestro are music Teachers and Students. Using i-Maestro, a Teacher will have the possibility of using a set of tools for:

- Creating and editing music in MPEG ISO SMR (Symbolic Music Representation) format [9, 10, 11] or to import music scores in other formats (symbolic or images).
- Creating customised and personalisable Exercises using the Exercise Authoring Tool for theory and practice training.
- Creating Exercises using an Exercise Generator Tool using algorithms for automatic and semi-automatic generation of music Exercises.
- Creating Exercises that contain score, audio, video, annotation, etc.
- Assigning (and distributing) Lessons to Students.
- Supporting the establishing of groups for cooperative work and simple group lessons, allowing with P2P technology the creation of

communities working on the same lessons and tools.

- Following the progress of each Student, learning history, etc.
- Reviewing and assessing the Student work continuously.

The i-Maestro framework consists of an extensible set of tools for the users to:

- access Lessons, online or offline, according to the assignment
- create and complete Exercises and Lessons (as assigned) and saving the progress
- communicate with a Teacher or other Students, for example to share content or to compare notes, etc
- practise their music instrument and assess their performance, using creative interfaces with sensor and motion data for gesture and posture analysis
- practise the musical instrument more effectively with various supporting tools such as a metronome, a tuner, an auto accompaniment module, an auto page-turning module, etc.

#### 4. Posture and Gesture Support

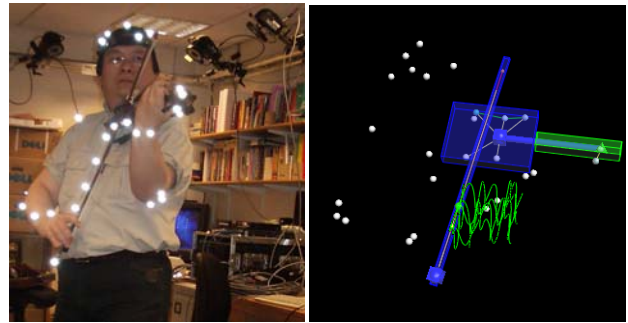
Playing an instrument is physical and requires careful coaching and training. In many ways, this can be studied in conjunction with sport sciences to enhance performance and to reduce self inflicted injuries.

Currently, Posture and Gesture support for training and learning are generally backed up by the use of images, drawings and/or video. However, this can be further extended with 3D visualisation to enable user controllable views beyond the limited 2D perspective projection.

Gesture is perhaps a very much misused term with a wide range of interpretation. For this paper, by gesture, we simply mean the physical motion of playing an instrument, involving one or more parts of the instrument and/or the body of the player.

In this context, the i-Maestro framework is developing several related software modules for posture and gesture support. With these modules, a Teacher can set up (by recording or from some predefined Gesture library of motion data) certain Gesture and Posture 3D graphics to support a particular training or specific Exercise. It is recommended that this is done during a Lesson when

the Teacher can access the Student's physical conditions and capabilities.



**Figure 2. 3D motion capture and visualisation**

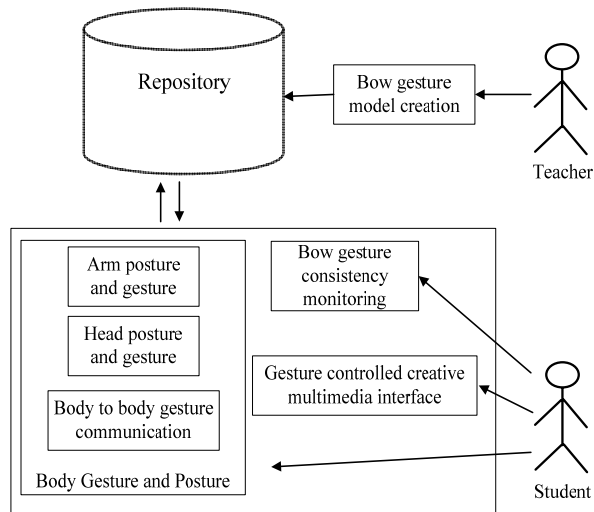
During practice, using the above mentioned tool, a Student can view the Posture and Gesture sequences (3D rendering of the recorded motion data) as prepared by the Teacher, selecting viewpoints and studying the recording without the limitation of a normal 2D video (see Figure 6). A Student can also make use of the i-Maestro systems to capture and study their own Posture and Gesture, or to compare them with some selected models.

Current works in hand for i-Maestro gesture-based supporting tools can be categorised into (i) Instrument (bow and the main body of the instrument); (ii) Arm gesture (with respect to the instrument and upper body); (iii) Body (head and upper body); and (iv) Overall motion (including body to body gesture communication).

The main functionalities of these tools are to provide automated analysis of the playing. For example, to analyse the regularity of a bow stroke exercise using the 3D motion data. These tools are not to support direct "cloning" of the playing gesture since playing gesture is player dependent and a result of personal interpretation. They analyse the playing gesture to provide information on the relationship between the player and the instruments and the bow and the instruments, such as joint angles, space, flow, etc., acting as a 3D digital "enhanced mirror" that can reconstruct the playing to facilitate further the understanding of the relationship between physical and musical gesture. Other features include informative 3D path trajectory visualisation to depict shapes and patterns of certain motion, e.g. for specific bowing-technique as illustrated in Figure 2.

Based on the analysis of 3D motion data, creative interfaces can be created by utilising several i-Maestro

tools to provide Gesture-controlled performance for motivating music learning at an early stage and also to support casual interests. Gesture mapping using these technologies can be adopted to map different input for multimedia controls providing accessibilities to all [3, 4, 6, 7, 8].



**Figure 3. Posture and Gesture support**

## 5. Conclusion

This paper discussed the i-Maestro project and presented its basic aims and objectives. With a short introduction, the paper provided general context and application scenarios for the framework. The paper also highlighted the gesture-based analysis area. It discussed the role of gesture and posture in music playing and explained the advantages of using 3D visualisations of motion data.

i-Maestro utilises and improves the current standards related to music education exploiting the capabilities of a set of enabling technologies related to multimedia, interactivity, computer supported cooperative support and gesture and posture analysis. The project is exploring a unified educational model integrating theory and practice to maximise efficiency, motivation and interests in the learning process. It is also focusing on the production of guidelines on how the music tuition courseware can be implemented in standard tools and models for distance learning.

The outcomes will be validated through a set of tools and methodologies including (i) tools and methods for music courseware production; (ii)

interactive and creative tools for instrumental training in different environments such as classrooms and cooperative work, on different devices such as PC and Tablet-PC; and (iii) assessment and pedagogical models for music training.

The project includes demonstration and validation activities, which will be conducted by major European institutions such as Accademia Nazionale di Santa Cecilia (Rome), the Fundación Albéniz (Madrid) and IRCAM (Paris). The final results of the project will be incorporated in various products and services that will be made available to the public and to educational establishments.

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