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Interactive Music Science Collaborative Activities

Team Teaching for STEAM Education

Deliverable 5.15
Final Gesture and VR tools for music interaction and co-creation

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Executive Summary

This deliverable reports on the final version of the Gesture and Virtual Reality (G-VR) tools for music interaction and co-creation. The demonstrated G-VR tools allow students to load a previously designed virtual instrument and perform it in the virtual 3D world. After recording the audio of performances, students can open these recordings in the Performance Sound Sampler (PSS) music co-creation tool, cut sample slices on the waveform of the performance, change the pitch of the selected samples, their activation times and collaborate with other students for making new music. The final versions of these AE include the following changes:

- Both AE now work over HTTPS, a secure protocol which uses certificates to validate server identity to avoid impersonation.
- There are several simplifications of the Gesture and Virtual Reality AE; the visualizations, the tools, and the selection of instrument/sensor/interaction menu have been removed.
- New 3D virtual instruments added along with their corresponding interaction methods.
- Overall performance improvements.
- Unification of the UI.
- Both AE are implemented to work integrated to the iMuSciCA workbench.

Links to demonstrators:

The links given below should be loaded from iMuscica workbench in order to be fully functional. Gesture Interactions AE won't produce any sound as standalone.

Note that the development of the activity environments continues, and the updated stable version of the environments can be accessed at https://workbench.imuscica.eu/ under the Music section (the four icons on the right).

Gesture Interactions:

https://athena.imuscica.eu/performance/v6/

Performance Sound Sampler:

https://athena.imuscica.eu/sampler/v6/

Version Log			
Date	Version No.	Author	Change
21/05/2019	0.1	Kosmas Kritsis (ATHENA)	Initial Content
22/05/2019	0.2	Maximos Kaliakatsos-Papakostas (ATHENA)	Added content / Adjustments
23/05/2019	0.2	Maximos Kaliakatsos-Papakostas (ATHENA)	Ready for review
10/06/2019	0.2	Maximos Kaliakatsos-Papakostas (ATHENA)	Address issues of reviewers
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LIST OF ABBREVIATIONS

Abbreviation	Description
G-VR	Gesture and Virtual Reality
MVC	Model-View-Controller
PSS	Performance Sample Sequencer
SPA	Single-Page Application
UI	User Interface
UX	User Experience
ATHENA	ATHENA RESEARCH AND INNOVATION CENTER IN INFORMATION COMMUNICATION & KNOWLEDGE TECHNOLOGIES
UCLL	UC LIMBURG
EA	ELLINOGERMANIKI AGOGI SCHOLI PANAGEA SAVVA AE
IRCAM	INSTITUT DE RECHERCHE ET DE COORDINATION ACOUSTIQUE MUSIQUE
LEOPOLY	3D FOR ALL SZAMITASTECHNIKAI FEJLESZTO KFT
CABRI	Cabrilog SAS
WIRIS	MATHS FOR MORE SL
UNIFRI	UNIVERSITE DE FRIBOURG
AE	Activity Environment

1. Introduction

This deliverable describes the final version of the Gesture and Virtual Reality (G-VR) Tools for Music Interaction and Co-creation that constitute of two Activity Environments (AEs): a) the Gesture and VR tools for music interaction and b) the Performance Sample Sequencer. We will describe the updates performed in the tool since D5.10-Intermediate Gesture and VR tools for music interaction and co-creation.

2. Installation and technical requirements

The Gesture and Virtual Reality (G-VR) environment and the Performance Sample Sequencer perform better on the Google Chrome web browser, however they are able to run on the Firefox web browser as well. Both environments should be used in a computer with speakers for listening the generated audio.

Both tools are intended to be included in the iMuSciCA workbench as an iframe element, similarly to the following code snippet example:

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
  "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html>
  <head>...</head>
  <body>
    <iframe src="https://athena.imuscica.eu/performance/v6/" frameborder="0"></iframe>
    <iframe src="https://athena.imuscica.eu/sampler/v6/" frameborder="0"></iframe>
  </body>
</html>
```

Specifically for the G-VR interaction, the Kinect and/or Leap Motion sensors are necessary for tracking the movement of the user in order to allow free and gesture-based interaction with the virtual instrument. Regarding the Leap Motion Sensor software requirements and installation instructions can be found in Section 2 of D4.1-First version of gesture and VR multimodal interaction interface. Regarding the Kinect-enabled environment, the executable can be found at the link included in the footnote[1] bellow. Download and unzip the corresponding file and run the "*KinectCoordinateMapping.exe*" program executable.

3. Description of new features demonstrator and user manual

In the following subsections the changes of the final versions of the G-VR interaction environment and the Performance Sample Sequencer are described.

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[1] https://athena.imuscica.eu/software/kinect/websocket/kinectImuscica.zip

3.1. Gesture and VR tools for music interaction

There are several changes made in the final version of the G-VR tools for music interaction Activity Environment (AE). The whole interface was greatly simplified and many of the operations (such as instrument selection and visualizations) can now be made externally from the workbench. Figure 3-1 depicts a screenshot of the final version of the AE.
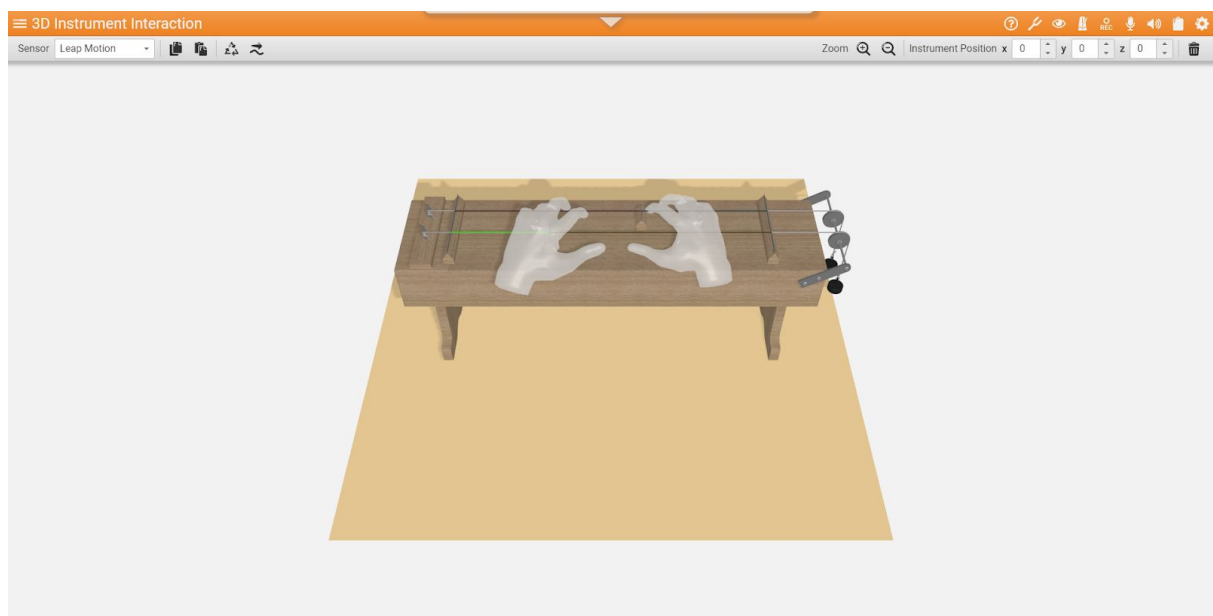
(a) Leap Motion-enabled web application
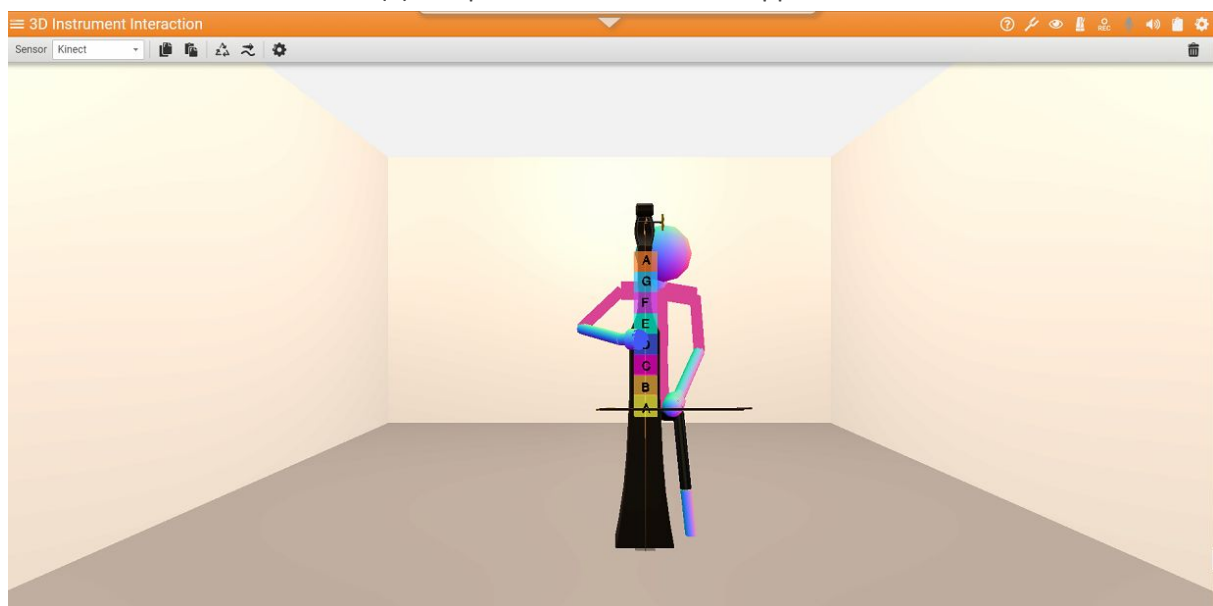
(b) Microsoft Kinect-enabled web application

Figure 3-1: The final version of the Gesture and VR tools for music interaction AE, as it is integrated in the iMuSciCA workbench: (a) Illustrates the Leap Motion-enabled interaction environment while (b) presents the Kinect-enabled interaction environment

The changes of the final version with respect to the intermediate version described in D5.10 are listed as follows:

- The parameters to the AE which are passed as URL parameters were reduced from 4 to 2, with remaining the selected language and the user id . The usage of the AE is:
https://athena.imuscica.eu/performance/v6/?lang=LANGl&id=UID
where:
  - ❖ LANG is the displayed language: en (English), fr (French), nl (Nederlands), el (Greek), es (Spanish).
  - ❖ UID is the username: default choice is the guest user, that is in cases of an empty or unknown UID.

- **User Interface updates:** The web interface was mainly updated to meet the uniform graphical requirements of workbench, especially regarding the functional objects like buttons, icons and input textboxes, as well as colors and the 3D scene lightning, so as to be in line with the rest of the AEs. In addition, the majority of the inter-environment options are now accessible via a toolbar placed in the top of the AE. Additionally, the Leap Motion and Kinect-enabled 3D interaction environments were unified under a common Activity Environment (AE).
- **Full Screen mode:** The full screen mode has been deactivated due to uniformity reasons across the various AEs.
- **Volume Control:** This functionality has been removed from the G-VR AE and became part of the iMuSciCA workbench in order to have a centralized control of the main audio volume output for all the AEs that produce audio context.
- **New instruments added**: In addition to the circular and square membranes that were introduced in the intermediate version, the final version of the G-VR got enriched with three more instruments: the guitar, the xylophone and the bowed monochord called Tromba Marina.
- **Instrument interactions**: Regarding the Leap Motion environment, new interactions were developed, by introducing the virtual 3D models of a set of mallets, drumsticks and a bow, in order to interact with the virtual xylophone, membranes and Tromba Marina respectively. Specifically, when the user selects to perform the xylophone or any of the two membranes, and places his hand within the Leap Motion Field-of-View, our system maps the palm position and its orientation to a virtual mallet (xylophone) or a virtual drumstick (membrane). On the other hand, performing the Tromba Marina entails a continuous interaction between the movement of the bow and the string of the instrument, thus requiring the user to perform a natural gesture as holding a real bow in order to control the horizontal movement of the virtual bow. The interactions designed for the Kinect-enabled environment can support both hands as primary, in addition to a virtual fretboard for selecting different chords when performing the guitar. As far as it concerns the xylophone and the circular membrane, the instruments appear in front of the player's avatar for facilitating the interaction which happens by using the hands as mallets. For the tromba marina, the performer uses her/his primary hand to control a virtual bow. Their non-primary hand controls whether a note is played, depending on its position compared to the virtual

fretboard. The velocity of the primary hand controls the amplitude of the note. Finally, 2-players performance is also supported.

- **Modalys**: All supported virtual instruments, excluding Tromba Marina, work with the "*trigger*" function of Modalys which is loaded from the workbench. This new function is much faster and more computationally efficient, thus consuming less resources from the user's computer and improving the overall user experience of the AE. Regarding Tromba Marina, it is a bowed instrument, thus requiring a continuous interaction approach for simulating the excitation of the string from the friction of the bow as it moves.
- **glTF 3D models support:** The overall backend of the web interface was refactored in order to support the GL Transmission Format (glTF) specifications which are used for the transmission and loading of the virtual instrument 3D models between the Instrument Design and G-VR AEs.
- **Kinect avatar improvements**: The Kinect skeletonized avatar is calculated using normalized body part lengths. This approach further reduces the browser latency, since it is not required to re-compute the 3D mesh geometry from scratch each time the application receives skeletal data from the Kinect websocket server.
- **User Tracking:** The GV-R AE informs the iMuSciCA server for every action performed by the user, such as the button clicks and instrument interaction events.
- **iMuSciCA Management Platform (IMP) load functionality**: The load functionality has been implemented for loading pre-saved virtual instruments from the 3D instrument design AE.
- **iMuSciCA Management Platform (IMP) snapshot functionality**: Workbench retains a snapshot of the last activity in the G-VR AE, including the currently loaded instrument and the guitar fingerings defined in the fretboard in the case of the Kinect environment, while being able to switch between the other AEs without losing the snapshot of the G-VR environment.
- **One-button switch:** This button allows immediate transition between the 3D instrument design environment and the G-VR environment, by automatically exchanging the current world content through clipboard, without leaving any data garbage that could possibly overflow the clipboard.

3.2. Description of the changes on the final version of the Performance Sample Sequencer

The final version of the Performance Sample Sequencer (PSS) has some significant adjustments on the user interface (UI) in comparison with the intermediate version, while on the backend it has been more integrated with the workbench and other tools. These adjustments resulted from feedback obtained from the usability tests. A screenshot of the new UI is illustrated in Figure 3-2. The new version includes the following modifications:

- The user has been given the ability to include up to four waveforms (instead of merely one in previous versions) and browse them using tabs (see 1 on Figure 3-2).
- Each of the four waveforms can be imported from recordings that are either stored and on user-accessible space on the workbench, or pasted from the clipboard. Point 2 on Figure 3-2 shows (from top to bottom) i) the "play" button for the currently selected waveform; ii) the "paste-from-clipboard" button for loading the currently selected waveform; and iii) the "load" button for loading a waveform from the user-accessible space on the workbench.

- The user can select the a row of sample cells that will correspond to the desired sample by clicking on or next to the desired row; this row appears highlighted (point 3 on Figure 3-2). When hovering the mouse over a row or next to it, the row gets highlighted, indicating that it can be clicked and selected.
- The PSS in its final version communicates with the workbench metronome for all its functionalities that concern timing. The following settings of the PSS can be changed through the workbench metronome: i) tempo; ii) time signature numerator and denominator; and iii) rhythm resolution. Additionally, the PSS gets the metronome pulse to change its current beat position when playing. Pressing the PSS play button (centre of the toolbar) the metronome is also activated in silent mode - metronome clicking can be enabled/disabled any time while the PSS is playing from the metronome's interface.
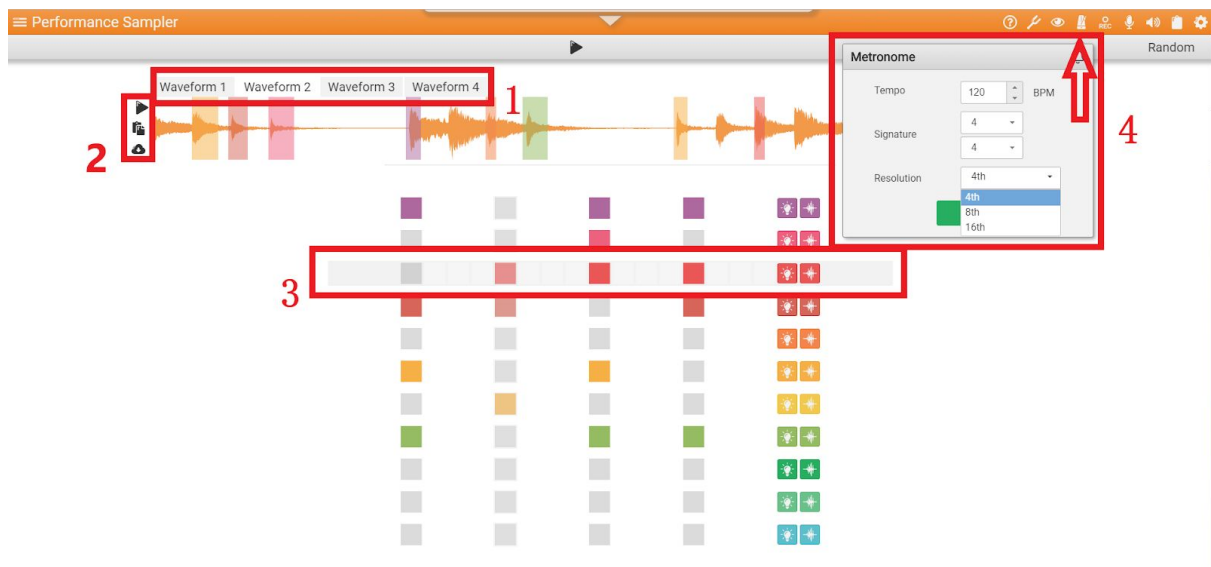

Figure 3-2: UI appearance of the final Performance Sample Sequencer activity environment, along with some annotations.