YARMI: an Augmented Reality Musical Instrument

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Abstract

In this paper, we present *YARMI*, a collaborative, networked, tangible, musical instrument. *YARMI* operates on augmented-reality space (shared between the performers and the public), presenting a multiple tabletop interface where several musical sequencers and real–time effects machines can be operated.

Keywords: Interactive music instruments, visual interfaces, visual feedback, tangible interfaces, augmented reality, collaborative music, networked musical instruments, real-time musical systems, musical sequencer.

1. Introduction

YARMI's idea (and its name) emerged from a discussion in our lab: which are the aspects that make an instrument truly *playable* and not Yet Another Ridiculous Musical Interface? What design patterns can be applied to achieve playability, engagement and musical sense? And also, if there is no social knowledge on the instruments' use, how can the public decode the performers' gestures?

In order to build an instrument that meets those expectations we decided to use two design patterns: mapping sound to physical objects, and music sequencers.

A rough division of computer music control, based on the immediacy of the sonic response to the interaction, can divide controllers in sequencers and continuous –gestural– controllers.

Both design patterns are extremely important. While sequencers are the traditional tools to construct digital music, direct manipulation approaches potentiate users' engagement and real-time expressiveness.

In addition, both sequencers and direct manipulation gestures can offer a very gentle learning curve while being able to be easily interpreted (that is, to establish a correspondence between the gestures and the produced music) by the audience during a performance.

In effect, musical sequencers are standards that do not pose a metaphor but constitute a recognizable interface themselves.

In the same vein, physically based direct manipulation interaction constitute an established paradigm in tangible user interfaces (with many successful examples like the *Reactable* [1]) that allow users to *feel* that they are operating directly with the objects presented to them [2], also allowing for an easy deconstruction of the performance from the audience.

2. The instrument

YARMI is a collaborative musical and –to a lesser extent– visual instrument being developed at the CECAL research group of the Instituto de Computación of the Universidad de la República of Uruguay.

2.1 Stations

YARMI is a multi-user, distributed instrument; or rather, an ensemble of synchronized instruments, operating under client-server architecture.

Each performer operates a *station* and *YARMI* is comprised of an arbitrary number of *stations* and one server.

A *station* consists of a table (or any flat surface) with a zenithal camera mounted on, and a visual projection showing the *screen-space*: an augmented version of the station's table.

On each *station*'s table, users can put tangibles –wooden tokens with fiducial markers–, which are recognized by the *station*.

2.2 Setup

Each station has its own visual representation showing the augmented surface, which we call *screen space*, but the table remains with no augmentation at all: for both the performer and the audience, it is just a flat surface with some wood pieces on it.

The locus of attention of both the performers and the public is the *screen space*. This real-time projection of the augmented surface shall be set up so that the audience stands between the performers and the images, visible by everyone and providing an explicit representation of the performers gesture and the different *stations'* visual feedback.

2.3 Interaction

Each station is divided into three different zones named, *track zone*, *effects zone* and *global zone*.

The *track zone* is an implementation of a multi-track sequencer, where users can create tracks and add samples and local effects to them.

To create a new track, the performer must add two tokens, one marking its beginning and one marking its end.

Once a track is created, users can add new tokens to it indicating samples to be played, or local effects to be applied.

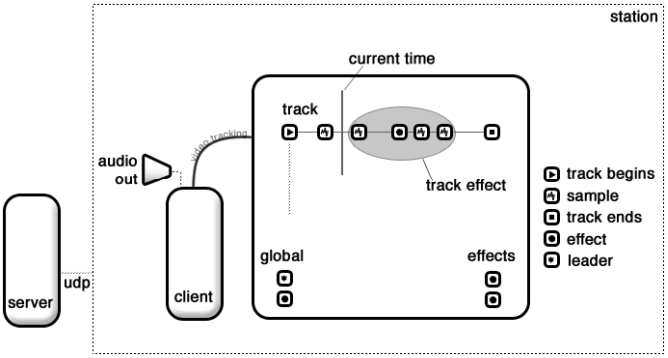

Figure 1 - The server and one *station* with some aspects of the screen space superimposed.

In every case, the rotation of the token controls the main parameter of the effect or the sample's pitch.

The *effects zone* presents the likes of a sound effects machine. Each token put on it triggers an immediate response.

If the performer adds a token representing a sample, the station plays it, looping it as long as the token is present (token rotation always controls the sample's pitch).

If a token representing an effect is added, the effect is applied immediately to the *station*'s output.

If many effects are added, they are applied respecting the order in which they were added to the zone.

Finally, the *global zone* is the *settings* zone, where users can add tokens that modify the *station* or the ensemble behavior.

2.4 In-*station* synchronization

Being a multi-track and multi-user instrument, synchronization between tracks and between stations is fundamental to produce coherent music.

Each track is automatically synchronized so they all start playing at the same time, but, as they can have different lengths, the first track that is created in the leader station (see next subsection) –called the main track– defines the main length (with its speed depending on what is set on the *global* zone).

If the performer creates a very short or very long track, for example one of approximately one quarter of the main track length, this is detected and then the track is played four times per bar.

2.5 *Leader station* and inter-*station* synchronization

To synchronize the different *stations*, we defined that one station is always acting as the *leader station*, and defines when the tracks begin to be played, the performance speed, the global volume, etc.

We use a token that, when added to the *global* zone of a *station*, sets it as the leader. This *station* sends its commands to the server, which, in turn, broadcasts them to all the *stations*.

3. Conclusions

Although *YARMI's* design is in a mature phase, and we have a working prototype, it is a project in development for which much work is yet to be done.

A major milestone yet to be reached is to test *YARMI* in a real performance setup, so far we have used it in our lab, in a controlled environment.

We believe that *YARMI* has some characteristics that can turn it into a capable, and interesting, musical instrument

Its networking approach, with many identical components that synchronize themselves automatically, allow for a confident use (delegating some of the cognitive work of the performance onto the system), while maintaining the performers engagement, independence and expressivity, which, in turn are levered with the inclusion of the *effects zone*.

We believe that the explicit representation of the instruments' feedback, together with the performance happening on a virtual space external to both the audience and the performers allow the public to decode some of the performance aspects re-installing the lost dimension of virtuosity into the performance.

Virtuosity has traditionally played an important role in live musical performances with an added aesthetic dimension of its own. However, for virtuosity to play that role, the performance details must be understood by the audience. With *YARMI*, the audience can enjoy not only the sonic output but also *how* music is created.

3.1 Future work

Besides improving the instrument's output, some paths appear worth to explore: the active inclusion of the audience, geographically distributed performances, more multimodal interaction, and the study of playability and delegation.

References

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