Project Acronym: **MusicBricks**
Project Full Title: **Musical Building Blocks for Digital Makers and Content Creators**
Grant Agreement: **N°644871**
Project Duration: **18 months (Jan. 2015 - Dec. 2016)**

D4.1 Guidelines and specifications for low cost music TUI interfaces and mobile accessories

Deliverable Status: **Final**
File Name: **MusicBricks_D4.1.pdf**
Due Date: **Month 2015 (M3)**
Submission Date: **Month 2015 (M3)**
Dissemination Level: **Restricted**
Task Leader: **IRCAM**

Authors: **Frédéric Bevilacqua (IRCAM), Emmanuel Flety (IRCAM), Thomas Lidy (TU WIEN), Alexander Schindler (TU WIEN), Cyril Laurier (STROM)**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871

The MusicBricks project consortium is composed of:

SO	Sigma Orionis	France
STROMATOLITE	Stromatolite Ltd	United Kingdom
IRCAM	Institut de Recherche et de Coordination Acoustique Musique	France
UPF	Universitat Pompeu Fabra	Spain
Fraunhofer	Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung E.V	Germany
TU WIEN	Technische Universitaet Wien	Austria

Disclaimer

This deliverable dissemination level is restricted.

All MusicBricks consortium members are also committed to publish accurate and up to date information and take the greatest care to do so. However, the MusicBricks consortium members cannot accept liability for any inaccuracies or omissions nor do they accept liability for any direct, indirect, special, consequential or other losses or damages of any kind arising out of the use of this information.

The MusicBricks project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871

Revision Control

Version	Author	Date	Status
0.1	Frédéric Bevilacqua (IRCAM)	March 1, 2015	Initial Draft
0.2	Emmanuel Flety (IRCAM), Cyril Laurier (Stromatolite), Thomas Lidy (TU Wien)	March 28, 2015	Draft
0.3	Frédéric Bevilacqua (IRCAM), Cyril Laurier (Stromatolite), Alexander Schindler (TU Wien)	March 30, 2015	Quality Check
1.0	Marta Arniani (SIGMA)	March 31, 2015	Submission to the EC

The MusicBricks project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871

Table of Contents

1. Introduction 6

2. Current trends in tangible and gestural interfaces for music 6
 2.1 Sensors and computer interfaces 6
 2.2 Wireless communication in tangible musical interfaces 7
 2.3 Tablets and mobile phones (as gestural interfaces) 8

3. Technical Guidelines/Requirements 8
 3.1 Latency and jitter 8
 3.2 Bandwidth, parallel transmission and protocols 9
 3.3 Compactness 10
 3.4 Autonomy 10
 3.5 Easy and flexible setup 10
 3.6 Cost 10

4. Guidelines from user-centred perspective 11

5. Current trends in sensors processing and mapping tools 11
 5.1 Important tools from the state of the art 11
  5.1.1 Max extensions 11
  5.1.2 Standalone applications 11
  5.1.3 C++ API 12

6. Plan for sensors processing modules 12
 6.1 Calibration and normalisation 13
 6.2 Pre-processing 13
 6.3 Mediation/mapping 13
 6.4 Metaphors/playing techniques 13

7. Conclusions 14

8. References 15

The MusicBricks project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871

Executive summary

The present document is a deliverable of the MusicBricks project, funded by the European Commission's Directorate-General for Communications Networks, Content & Technology (DG CONNECT), under its Horizon 2020 research and innovation programme.

We first present current trends for the use of tangible interfaces used in music performance, including the use of wireless interfaces. We stress the fast evolution of the technologies, in part due to the development of Internet of Things, and the presence of wide DIY communities (Do It Yourself) that go beyond musical practices. Second, we present a series of guidelines/requirement that are specific for music performance, which have been formalised in the NIME communities (New Interfaces for Musical Expression). Third, we stress the need of sensor processing tools, and currently existing software. Finally, we summarized the current plan for a structured list of sensor processing modules.

The MusicBricks project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871

1. Introduction

Since 2000, there has been a significant increase of novel tangible interfaces for music performance. Several of them have been presented at the international conference for New Interfaces for Musical Expression (http://www.nime.org/), a leading interdisciplinary community of researchers and artists.

Most of the commercialized interfaces/instruments, such as Reactable (http://www.reactable.com/), Tenori-on (http://www.global.yamaha.com/tenori-on/index.html), Monome (http://monome.org/), Karlax (http://www.dafact.com/) or very recently Phonotonic (http://www.phonotonic.net/), can be considered as "closed" interfaces, since the possibilities for modification by users are limited. Precisely, the gestural input has been predefined by the designers. We focus here in this document on tangible interfaces that can be highly customized based on highly modular architecture. Such a modular approach should allow for rapid experimentation by researchers, designers and performers to create novel tangible interfaces"from scratch". This approach corresponds to the methodology promoted in the MusicBricks project.

This document is structured as follows. First, we summarized current trends about modular sensing devices and sensor-computer interfaces. Second, we propose series of specifications and guidelines, with a particular attention towards wireless systems. Third, we present trends for motion analysis that add values to sensing technology. Finally, we present a summary of the current plan for the technology that will be made available in subsequent deliverables of workpackage 4.

2. Current trends in tangible and gestural interfaces for music

2.1 Sensors and computer interfaces

The principles for using sensors in Digital Musical Instruments have been described in length by Miranda and Wanderley almost ten years ago [Miranda and Wanderley, 2006]. This book summarizes the early effort of the NIME community (i.e. around the international conference series called New Interfaces for Musical Expression) to build music from basic sensors technology. The types of sensors they describe remains among the most popular today, to cite a few: pressure sensor (FSR - Force Sensitive Resistor), inertial measurement unit (accelerometer, gyroscope, magnetometer), proximity sensors, cameras and EMG (electromyography).

Nevertheless, important changes have appeared with the significant development of the so-called DIY communities (Do It Yourself) around sensors and computer interfaces. Music technologists represent only a fraction of these users, but these communities have a deep impact on musical communities interested in building and using tangible musical interfaces. In particular, three facts must be noted:

The increasing availability of sensors of various types and characteristics through "breakout boards" greatly facilitates soldering and the integration in sensing technology in DIY communities. Among major distributors: Sparkfun (https://www.sparkfun.com/), Adafruit (http://www.adafruit.com/), Mouser (http://www.mouser.com), Seeed Studio (http://www.seeedstudio.com).
Most of those designs, either breakout type boards, or complete designs, are sold and available as open source hardware, which allows a large freedom for customization to the project, and up to complete re-engineering.

The MusicBricks project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871

The availability of cheap sensor interfaces, from sensors to computer using either analog conversion or digital buses. The most popular platform is Arduino (http://www.arduino.cc/), which offers several models of various form factors and characteristics. An important advantage remains in the programming environment that offers a "low entry fee" for users not familiar with microcontroller programming, and that has been used by others (e.g. the microboard Teensy). Other specific interfaces have appeared for specific sensors, such as Bitalino (http://www.bitalino.com/) for biosignals (EMG, ECG), and Makey Makey for triggering events from various objects (http://makeymakey.com/)

The large availability of online documentation and tutorials provided by some platforms (e.g. Adafruit learning system), and widely completed by the DIY communities (e.g. http://bildr.org/, http://makezine.com/). This extends to major classic commercial distributors creating portals to emphasize collaboration and dialog with a community of users and DIYers along with providing free software tools and environments (Farnell's element14 (http://www.farnell.com/), Radiospares's Design Spark (http://www.rs-online.com/designspark/electronics/)).

Platforms often come with an Integrated Design Environment (IDE) for free, and with a toolchain that allows to quickly produce code and converge toward an actual result with the device. Selecting a popular platform ensures shared coding, firmware building and device flashing.

➔ Fast integration of new sensor technology in DIY maker communities, growing knowledge base. Strong connections with these communities are important. An open Hardware approach should be considered for reaching such communities.

2.2 Wireless communication in tangible musical interfaces

Most of the interfaces are based on wired serial connection using USB ports. Nevertheless, wireless communication has gained momentum. Basic systems using the Zigbee protocol (e.g. Xbee), bluetooth or Wifi can be used with general platforms such as Arduino. Other commercial boards have also appeared, such as

- x-io (http://www.x-io.co.uk/) that proposes inertial measurement unit and accessory analogue/digital port with bluetooth or Wi-Fi
- Spark, ARM Cortex M3 micro-controller with a Broadcom Wi-Fi chip, https://www.spark.io/
- Axivity, 9-Axis Bluetooth Streaming Intertial Measurement Unit (IMU), http://axivity.com/
- Redbear Lab Wi-Fi Arduino and Wi-Fi-mini (http://redbearlab.com)
- Shimmer, modular system for wireless sensors (http://www.shimmer-research.com)

Several other manufacturers could be mentioned as well, which provide solutions for high quality motion capture for industrial applications (medical, movies/gaming or military). Nevertheless, they remain at a significant high cost considering the music technology market. We restricted the list here to low-cost solutions.

Wireless communication remains an important issue for musical interfaces since it might limit the important specifications critical for music practice, such as latency, as discussed in the next section.

➔ Very fast evolution (and fast obsolescence) of wireless technology due to the development of IoT technology. This requires particular attention to the evolution of new wireless chips available.

The MusicBricks project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871

2.3 Tablets and mobile phones (as gestural interfaces)

Tablet and smartphone integrates nowadays various sensors and, in particular, inertial movement sensors. They represent, thus, platforms that are fully integrated in the sensing technology ecosystem. Their performance might be limited by the manufacturer's implementation whose requirements are not always aligned with ours for music performance. However their ubiquity make them interesting devices in some scenarios.

While they can be considered as low cost solution per se, they should still be considered as gestural interfaces in our scenarios since (almost) everyone has a smartphone nowadays. Even if the motion sensor may not match all the general requirements, other sensors like their integrated cameras can be used to detect and track physical objects converting them in tangible interfaces and allowing other types of applications.

➔ Mobile technology is now fully part of the "musical tangible interface ecosystem", yet the specifications of motion sensor might not meet our standards. Specific scenarios with mobile phones should still be considered.

3. Technical Guidelines/Requirements

The following points must be considered closely for music applications. We first review requirements valid for both wired and wireless interfaces. In the second part of this section, we review requirements that are more specific to wireless interfaces. These requirements are based on our previous experience in various projects (http://interlude.ircam.fr, http://legos.ircam.fr, http://cosima.ircam.fr) and general results established in the NIME community ([Fléty and Maestracci, 2011], [Schmeder et al., 2010], [Wessel and Wright, 2002], [Rasamimanana et al., 2011]).

3.1 Latency and jitter

Music practice typically requires a latency of less than **10 ms** to guarantee a sense of agency of the player (i.e. the perception that the player is in control of the instrument) [Wessel and Wright, 2002]. Importantly, the required latency for musical applications is typically lower than the latency guaranteed in Human-Computer Interaction applications. In this case, the interaction is generally designed with visual feedback, which can be efficient with a more relaxed latency (100 ms is generally acceptable).

With wired interfaces, latency is generally not an issue at the interface level. Nevertheless, wireless systems might cause latency larger than 10 ms, depending on the technology and protocols used. See Fléty ([Fléty and Maestracci, 2011]) for an example of protocol implementation and hardware development that satisfies latency of less than 10ms.

While latency defines a good indicator on the quality of an interaction with a device or system, the latency jitter is proven to be more disturbing than the latency itself ([Schmeder et al., 2010]). Therefore, an effort for reducing both the latency and its jitter is required; our experience being that it should be lower than 50% of the sampling period.
The latency jitter is highly correlated to the wireless transmission, which shares a radio channel with all (participating and non-participating) stations on the network, or simply being on the same frequency. The nature of the collision avoidance mechanism involved in the "listen-before-transmit" (CSMA/CA) principle

The MusicBricks project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871

adds by definition a statistical delay to avoid a locking phase of the transmission. Most wireless transmitters can be configured so that the delay remains low, usually accepting a higher packet loss (often called "favouring throughput")

Mobile devices are another case where the latency highly depends on manufacturers and OS, and might represent difficulties for musical performance (especially with Android).

➔ Latency and jitter must be < 10 m for regular musical performing (rhythmic playing). If not guaranteed, musical interaction must be designed accordingly focusing on non-rhythmic aspects.

3.2 Bandwidth, parallel transmission and protocols

Musical interfaces might require the use of several sensors in parallel. Music gestures generally imply a high degree of freedom (e.g. in capturing full body movement) and various modalities (body motion, touch, voice etc.). Moreover, musical practices generally also imply collective/social interaction. For example, the use of audience participation is an emerging use of tangible interfaces in musical experience.

For wired connection, this requirement is easily taken care of by using network protocols, such as OpenSoundControl (http://opensoundcontrol.org/) based on internet protocol (generally UDP), **which is the standard we recommend**. This network protocol exists over wired Ethernet and Wi-Fi, which allows a great diversity and array of possibilities for the station to either broadcast directly to the recipient (sensor to tablet) or to a wireless router placed on stage during the performance, maximizing the wireless link with a short distance, then forwarding the sensors' data to a computer that may be located dozens of meters away, using a wired Ethernet connection.

For wireless communication, bandwidth is an issue closely linked with latency. It also depends on the network occupancy and interferences. This might have certainly limited wide use in digital musical instruments, where consistency and robustness are crucial.
With Wi-Fi, the lowest sampling period for an embedded unit is about 3 ms. Below this value, packet transmission will fight against the CSMA/CA statistical delay system and the bandwidth sharing with other stations. However, the packet transmission time ("over-the-air" duration) is much lower than this, and allows sending several hundreds of bytes in a single shot.
A trade-off must be found between the packet transmission time, the sampling/sending rate and the packet forging time. The forging duration includes sampling the sensors, the formatting time to comply with the protocol (Open Sound Control, for instance) and the physical access to the radio modem (PHY layer). We found that with such Wi-Fi systems present a packet forging time of 200-300 µs for a dozen of sampled and transmitted sensor values (16 bit each). Combined with the (very short) over-the-air time and, more importantly, the statistical delay (in the range of 2 to 2.5 ms), we obtain the 3 ms boundary exposed earlier.

From a power/runtime point of view, another physical wireless media is interesting: Bluetooth Low Energy (aka Bluetooth smart, Bluetooth 4 and BTLE). We have carefully considered this wireless solution due to its common use with mobile technology (tablets, smartphones). However, it lacks standardization on the recipient side: BTLE does not feature a single transmission profile like its former version 2.0 and 3.0. This means that the client side must implement a custom driver on each platform, which makes interoperability very difficult. Moreover, there is currently very little support of BTLE on computers, compared to Ethernet or Wi-Fi, which would limit the kind of platforms that could be used. Finally, the range and signal strength

The MusicBricks project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871

of Bluetooth is significantly lower than Wi-Fi, which generally remains a critical issue for concerts and live performances.

➔ We recommend the use of the OpenSoundMusic (OSC) protocol

➔ Wi-Fi is recommended over Bluetooth for best performance

3.3 Compactness

A small form factor can favour the implementation of wireless sensors in existing musical instruments (such as acoustic instruments) or generate novel use (e.g. implemented in clothes).

➔ As a rule of thumb, the module should be small enough to be inserted into objects that can be held in a hand or, worn on the wrist.

3.4 Autonomy

Wireless transmission might require relatively high battery consumption, which limits the system autonomy. At least a few hours of autonomy is necessary for a large acceptance in the performing arts.

➔ Three hours autonomy can be set as a standard minimum requirement since it matches a regular rehearsal/uninterrupted practice period of time. Ideally the device can be recharged in half of the runtime or less, to allow some easy rollover between devices. Three hours also covers twice the typical length of a show, providing thus an acceptable safety factor.

3.5 Easy and flexible setup

Robust wireless networks might require cumbersome setups (e.g. choosing less occupied RF channels), which might severely limit the system acceptance by non-specialist users. Potential interference with ambient wireless network occupancy might increase jitter and reduce latency, which severely limit the acceptance in music communities where these points are key issues.
We are targeting an easy setup system by connecting wirelessly to the unit, from a computer or a smartphone. Low-level configuration remains always feasible using a USB port, which also serves for charging the unit and uploading a new firmware.

3.6 Cost

Until recently, the cost has remained significantly higher than wired interfaces whose prices have dropped very significantly during the last five years. It often remained an obstacle for experimentation with a large number of users. However, the massive development of the Internet of Things (IoT) in the past two years brought various platforms for wireless communication, using either Bluetooth LE (low energy) or Wi-Fi, for a small fraction of the cost and size of what it was before. The new economy gravitating around the IoT will significantly drop the wireless technology cost, making it very affordable for the music market. The current

The MusicBricks project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871

availability of wireless technology is evolving extremely fast (new products appeared in the first three months of the project).

4. Guidelines from a user-centred perspective

The appropriation of the tangible interfaces by users does not depend solely on their technical specifications, but also highly depends on their ease of use. Moreover, the musical applications must be "agnostic" to sensors' particularities, in order to guarantee the continuation through the fast sensor evolutions. We note the following points:

➔ Calibration and pre-processing is necessary to avoid strong dependencies on sensors particularities

➔ Straightforward and fast setup ("plug and play") is necessary to guarantee wide acceptance

➔ Visualization and "intuitiveness" of sensors

These points lead to the fact that appropriate **analysis and mapping tools should be developed at higher levels of readiness (from TRL4 to TRL7).** Moreover, in order to guarantee some level of scalability in the number of sensors usable in one setup, some processing might be embedded in sensor microcontrollers. Processing tools are described in the next two sections.

5. Current trends in sensor processing and mapping tools

5.1 Important tools from the state of the art

5.1.1 Max extensions

- The MuBu multi-buffer is a multi-track container for sound description and motion capture data. We are currently developing a set of Max/MSP externals for content-based real-time interactive audio processing around the MuBu container.
    - The MuBu environment contains several objects for sensor analysis (http://ismm.ircam.fr/mubu/)
    - PiPo, Programming Interface for (Afferent Stream) Processing Objects
    - Gesture Follower, Real-time following and recognition of time profiles
    - XMM, Probabilistic Models for Motion Recognition and Mapping (https://github.com/Ircam-RnD/xmm)

  This collection of Max objects should replace FTM's most important features (http://ismm.ircam.fr/ftmco/) for mapping sensors to musical processes (using the MnM library)

- *Musical Gestures Toolbox*, which is a collection of modules and abstractions developed in and for the graphical programming environment Max. The toolbox is currently being developed within the Jamoma open platform for interactive art-based research and performance (http://www.uio.no/english/research/groups/fourms/software/musicalgesturestoolbox/)

5.1.2 Standalone applications

- *Eyesweb* (http://www.infomus.org/eyesweb_ita.php)

The MusicBricks project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871

- The *Wekinator*: Software for using machine learning to build real-time interactive systems (http://wekinator.cs.princeton.edu/)

5.1.3 C++ API

- The *Gesture Recognition Toolkit* (GRT) is a cross-platform, open-source, C++ machine-learning library that has been specifically designed for real-time gesture recognition http://www.nickgillian.com/software/grt). In addition to a comprehensive C++ API, the GRT now also includes an easy-to-use graphical user interface:
- *Libmapper*. This library is a system for representing input and output signals on a network and allowing arbitrary "mappings" to be dynamically created between them (http://idmil.org/software/libmapper).

6. Plan for sensors processing modules

From a user perspective, we can distinguish two categories of gesture-sensing technology. First, for some sensors the output data is directly exploitable by the users because the data are related to physical quantities that the users are familiar with. Typical examples are buttons, sliders, distance/proximity sensors, pressure and bending sensors. For this category of sensors, the difficulty of use might arise from **calibration** issues and **managing a high number of sensors**.

Second, another category of sensors requires pre-processing to extract meaningful data from the user perspective [Bevilacqua et al., 2010]. Accelerometers represent a typical example. In this case, the raw data is difficult to apprehend due to two factors: 1) Raw data depends on two different physical quantities, the orientation to gravity (so-called static acceleration) and 2) dynamic acceleration. Dynamic acceleration in itself is not a physical application that we are familiar with in our day life, being more used to spatial and velocities quantities.

Third, the user should be able to deal with meaningful concepts (see [Bevilacqua et al., 2013], [Caramiaux et al., 2014], [Françoise et al., 2013], [Rasamimanana et al., 2011], [Schnell et al., 2011], [Zamborlin et al., 2012]). We need to provide metaphors and playing techniques which give a meaningful signification and define usage templates of the sensor data. This involves a semantic with commonly understandable gesture terms such as "shaking", "throwing" or "tilting" to name a few.

Finally, it is important to design proper graphical user interfaces (GUIs) to simplify the interaction with sensor data at all levels. Calibration, normalisation and pre-processing are likely to be illustrated with curves of the incoming data before and after the data is transformed and mapped. Playing techniques could be displayed when triggered and would give visual feedbacks to users to train themselves to control them. Moreover the output of the processed data, at all levels, should be made available using the recommended protocols.

➔ From a user perspective, we need to provide three types of sensor processing:

1. Calibration and normalization
2. Pre-processing
3. Metaphors/playing techniques

The MusicBricks project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871

6.1 Calibration and normalisation

This step should allow to easily change sensors while minimizing the impact of the general behaviour of the musical system.

Generic

- normalisation (min/max, mean/stddev)
- sampling rate conversion (resampling)
- visualization (sliding window and level meter)

IMU specific

- IMU calibration

6.2 Pre-processing

Generic

- scaling (static/adaptive)
- filtering + visualisation (combining different filtering techniques, moving average, median, low pass, high pass)
- energy (combining several sensors)
- strike detections
- motion components

IMU specific

- acceleration (including and excluding gravity)
- rotation rate
- orientation

6.3 Mediation/mapping

- generative motion models
- smart mapping

6.4 Metaphors/playing techniques

- striking (intensity, direction)
- shaking (intensity, frequency, jerkiness)
- throwing (intensity, direction, rotation, duration)
- falling (rotation, duration)
- spinning (intensity, direction)
- waving (intensity, frequency, jerkiness)
- tilting/steering (direction, velocity)
- music conducting (tempo, phase, intensity)

The MusicBricks project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871

7. Conclusions

In this document we described two complementary aspects for the development of tangible interfaces for musical applications: technical guidelines for the physical interfaces and the need for specific software tools: graphical interfaces, visualization, and sensor processing tools.

The MusicBricks project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871

8. References

1. [Bevilacqua et al., 2013] Bevilacqua, F., Schnell, N., Rasamimanana, N., Bloit, J., Fléty, E., Caramiaux, B., Françoise, J., and Boyer, E. (2013). De-MO : Designing Action-Sound Relationships with the MO Interfaces. In CHI '13 Extended Abstracts on Human Factors in Computing Systems, Paris, France.
2. [Bevilacqua et al., 2010] Bevilacqua, F., Zamborlin, B., Sypniewski, A., Schnell, N., Guedy, F., and Rasamimanana, N. (2010). Continuous realtime gesture following and recognition. In Lecture Notes in Computer Science, (5934): 73–84. Springer.
3. [Caramiaux et al., 2014] Caramiaux, B., Schnell, N., Françoise, J., and Bevilacqua, F. (2014). Mapping through listening. Computer Music Journal (38): 34-48.
4. [Fléty and Maestracci, 2011] Fléty, E. and Maestracci, C. (2011). Latency improvement in sensor wireless transmission using IEEE 802.15.4. In Proceedings of the International Conference on New Interfaces for Musical Expression: 409–412.
5. [Françoise et al., 2013] Françoise, J., Schnell, N., and Bevilacqua, F. (2013). A Multimodal Probabilistic Model for Gesture–based Control of Sound Synthesis. In Proceedings of the 21st ACM international conference on Multimedia (MM'13): 705–708, Barcelona, Spain.
6. [Miranda and Wanderley, 2006] Miranda, E. and Wanderley, M. (2006). New Digital Musical Instruments: Control and Interaction beyond the Keyboard. A-R Editions.
7. [Rasamimanana et al., 2011] Rasamimanana, N., Bevilacqua, F., Schnell, N., Guedy, F., Maestracci, C., Zamborlin, B., Frechin, J., and Petrevski, U. (2011). Modular Musical Objects Towards Embodied Control Of Digital Music. In Proceedings of the Tangible Embedded and Embodied Interaction Conference (TEI): 9–12.
8. [Schmeder et al., 2010] Schmeder, A., Freed, A., and Wessel, D. (2010). Best practices for open sound control. In Linux Audio Conference (10).
9. [Schnell et al., 2011] Schnell, N., Bevilacqua, F., Rasamimana, N., Bloit, J., Guedy, F., and Fléty, E. (2011). Playing the "MO" - Gestural Control and Re-Embodiment of Recorded Sound and Music. In Proceedings of the International Conference on New Interfaces for Musical Expression: 535–536, Oslo, Norway.
10. [Wessel and Wright, 2002] Wessel, D. and Wright, M. (2002). Problems and prospects for intimate musical control of computers. The Computer Music Journal, 26(3): 11–22.
11. [Zamborlin et al., 2012] Zamborlin, B., Bevilacqua, F., Gillies, M., and d'Inverno, M. (2012). Fluid gesture interaction design: applications of continuous recognition for the design of modern gestural interfaces. ACM Transactions on Interactive Intelligent Systems (TiiS), 3(4): 22.

The MusicBricks project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°644871