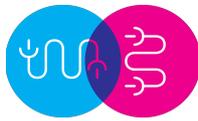


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D5.2 Final feedback on MusicBricks for creative applications

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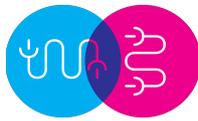


Authors:

Geoff Howse (STROMATOLITE); Andrew Dubber (STROMATOLITE); Michela Magas (STROMATOLITE); Thomas Lidy (TU WIEN), Jordi Janer (UPF), Sascha Grollmisch (Fraunhofer), Frederic Bevilacqua (Ircam), Emmanuel Flety (Ircam)



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The #MusicBricks project consortium is composed of:

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

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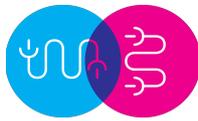
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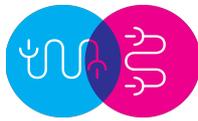
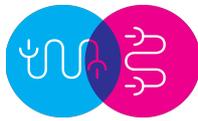


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Executive summary

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.

At each of the Creative Testbed events, #MusicBricks partners sought feedback on the usability, clarity and implementation of the tools in each of the projects in which they were used. The feedback took the form of feature requests, written feedback, observation of participant use of the technologies, addressing problems arising from the discussion with the users, and collaboration on projects in order to experience first hand the challenges and opportunities for improvement. In each case, the feedback on the #MusicBricks tools was positive, participants offered suggestions for further improvements both on documentation and functionality, and partners refined the tools in response to the user behaviours they observed.

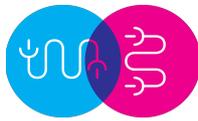
Some of the requested improvements were unfeasible: for instance, a reduction of processing time of a 3 minute audio track from 20 seconds down to just 1 second. However, refinements are being made that address user requests to the extent that they are technically possible.

Feedback highlighted the relative merits of online 'cloud-based' data libraries and services against locally stored ones, and participants reflected that each had advantages that made a dual offer the most flexible and therefore desirable offer.

Creative Testbed participants introduced unexpected challenges for the #MusicBricks partners in their approach as well as the variety of file formats they expected to work with. They also suggested output formats for data such as MIDI, which had not originally been conceived as part of the tools.

Through the observation of user behaviour, partners were able to learn from unanticipated tendencies and refine the documentation so as to avoid problems arising from expectations and assumptions by the users. For instance, users had come to rely on wireless connectivity for Internet access and so did not bring Ethernet adapters, which placed a greater burden on the data traffic on site. In addition, the R-IoT board's long battery life meant that users would often forget to check on the status of the charge, and the device would lose power at a critical moment. From this observation partners could include a simple warning to pay more attention to this fact, or develop a graphical display that alerts users of the battery status.

The live Testbed also provided a context for the usage of the tools in an environment with real world variables and challenges. In that respect, the tools performed well and feedback was very positive. The individual #MusicBricks tools were further developed in response to the feedback and real world experience afforded by the Creative Testbeds and in consultation with the successful projects that received incubation support.

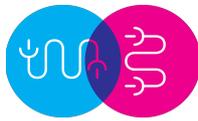


1. Introduction

This document provides an analysis of the feedback gathered from the teams of creative developers at the Creative Testbed events (details of which are outlined in D5.4). Feedback is detailed both in terms of qualitative feedback describing the participants' experience, and in terms of critical appraisal and suggested alterations to the #MusicBricks tools themselves. The document outlines the ways in which the feedback gathered about the tools and their use has contributed towards the continued development of all #MusicBricks components, their usability, capability and implementation.

The document begins by presenting direct feedback from Hackathon participants about the WP5 events, then outlines further feedback gathered at the Creative Testbeds relating to the use of the #MusicBricks tools and any resulting innovations as data was fed back into research. Conclusions are drawn from the analysis of all feedback gathered.

Some of the feedback that follows in this document has already been included in D5.1. However, in this report we add further final feedback as well as new information and results not available at the time of that Deliverable.



2. Feedback on Creative Testbed Collaboration and Co-creation

The quality of the #MusicBricks seed ideas at the Creative Testbeds has been consistently high, and the attendees left the event inspired to continue to develop those projects and collaborations to a level of market prototype with full support from research partners and industry. The following feedback illustrates the industry partner experience of the Creative Testbeds, recorded at Music Tech Fest Central in Month 9 of the project:

- “#MTFCentral was an exceptional experience! I came to promote my vision as a musician/entrepreneur and ended up jamming with people who were, for years, great inspiration for me. MTF is quite unique in it’s experimental and productive vibe. While many festivals and conferences distinct between creators and audience MTF encourages the audience to take part and become creators. I find this approach inspiring and looking forward to the next event!” - **Roey Tsemah, Whitestone**
- "First timer for me at the MTF hackathon and we got completely immersed right off the bat! We were amazed about the high level of talent working with our Philips Hue system. Seeing them delve into the software, literally hacking it for the benefit of their own ideas was amazing. I hope this experience was just as great for all the amazing people we worked with. Cannot wait for the next one! :)" - **Tom Reinhoudt, Philips**

Feedback on the use of #MusicBricks tools

2.1.R-IoT Motion Sensing and Motion Analysis (IRCAM)

The basic functionality of R-IoT, i.e. providing low latency and 200 Hz motion parameter sampling, was readily grasped by participants during the Creative Hackathon events. The embedded data fusion algorithm providing absolute angle, and the possibility to use motion processing libraries (embedded or external) were also welcome by the participants. Users gave particularly positive feedback concerning the small size and form factor of the unit. The battery size remains the limiting factor of the size. A round battery was first selected in order to comply with aircraft safety regulations regarding li-ion batteries which had to remain removable from the device. A flat Lipo battery was found to be more appropriate, though the availability of these batteries is problematic. A reliable source of this type of battery is being sought.

Several groups requested multiple R-IoT boards for a given project. All R-IoT modules proved to provide robust wireless connection - no significant signal lost if remaining within 10 meters, despite the very high ambient RF "noise" and the high signal load at the hackathon events.

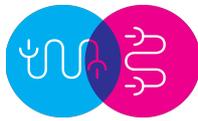
The hackathons at the Creative Testbeds were a good place to experiment with the various operating systems and hardware introduced by the participants. Some users requested that the configuration was adjusted to their setup, and this went smoothly in most cases except when the user preferred not to use the provided external Wi-Fi router and instead use a software enabled access point ('Soft AP') on their own computer, which made configuring their computer IP address cumbersome. Soft AP has been successfully tested on Windows PC using MyPublicWifi to enable a hotspot on the machine to which the R-IoT can connect.

Participants expressed positive feedback about the provided TP-link MR-3020 mini Wi-Fi router, citing its small size and the ability to power the module via USB as particularly advantageous.

Participants tended to overlook wired Ethernet and consider it to be 'old school'. As a result many users didn't bring a Thunderbolt to Ethernet adapter; newer Macbooks don't have a native ethernet plug. The user

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can still connect to the provided router using Wi-Fi, but the data flow quality isn't as good because it consumes radio bandwidth. It was observed that participants should be informed that they must bring an Ethernet adapter or a computer with a native port in order to fully benefit from the motion sensing module. A variant of the firmware that uses Wi-Fi-directly - a newer version of the former adhoc networks - is still to be developed.

During the initial creative hackathon event at the #MTFScandi Testbed, there was an issue when either flashing the firmware or developing on the R-IoT platform using the Mac operating system, due to an incomplete driver of the serial port USB chip used on the board. No answer was forthcoming from the manufacturer when asked to address this issue, and so the design of the board was changed to use another USB chip which was proven to work correctly, and this now allows R-IoT to be programmed by both PC and Mac, thereby becoming a real Arduino-like development platform.

In response to a request from a participant at the second Creative Testbed at MHD Barcelona, the current firmware was added to in order to support analog inputs of the module being exported in OSC just like the motion sensing data.

The absolute angles computation was found initially to be drifting, and significant improvements were obtained after each Creative Testbed event. In particular, using an efficient calibration procedure, the angle computation has now been made reliable and allows the module to be used as a head tracker.

It was observed that users should be warned more about the need to recharge the R-IoT module's battery using the provided USB cable. Because of the long runtime (6 hours), many users tended to forget about checking the battery level (provided as a Voltage, which could be improved with a graphical feedback), and as a result the battery ended up being totally depleted in the last (critical) part of the hackathon during which the system needed to be operational.

It was also found that proposing the motion recognition patches & objects in MaxMSP received good feedback. Nevertheless, there was also a demand to have those ported to other environments such as Pure Data (Pd).

2.2.RP extract: Rhythmic and Timbral Audio Feature Extraction (TU Wien)

The Rhythmic and Timbral Audio Feature Extraction library (#RhythmTimbre) was used in one winning project each of MTF Scandinavia and MHD Barcelona events. The following feedback was gathered and acted upon as follows:

Feedback: The installation requirements (Python dependencies) have been more complex than expected.

Action: The provided tutorial has already been updated to better outline all needed prerequisites.

Feedback: There was an issue reading 24 bit WAV audio files.

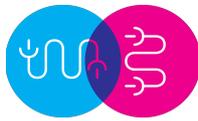
Action: As a result of the hackers using 24 bit WAV files, an issue with normalisation of the audio has been resolved. This was improved live in response to feedback during the #MTFScandi testbed, providing the participants with an updated version in time to use it in their winning prototype presented at the final session (Airstument project).

Feedback: Improved Error handling required: When problems with an audio file (reading, decoding) arise, the library would stop the analysis of further files.

Action: This will be improved to continue and write an informational log entry instead. Specifically: proper Exception handling (already improved during MHD Barcelona); adding Logging capabilities; adding Error for wave data of insufficient length (requires a minimum of 5.94 sec of audio data)

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Feedback: A feature request of returning not only aggregate audio features for a song, but also detailed segment level features has been received.

Action: This has been implemented and added as a new capability of the library during MHD Barcelona. The #RhythmTimbre library now returns segment features, returns timestamps and sample positions of the segments, and is able to return individual segment's audio data and optionally export it. This enables a more accurate search of similar audio in a longer audio stream.

Feedback: When exporting features to a CSV file, there has been a problem with long filenames containing special characters such as “, ‘ and ,

Action: This has been improved, and a CSV read function added that is capable of handling all filenames with these special characters has been implemented.

Several testbed project teams at the Creative Testbeds discussed the pros and cons of an offline library such as #RhythmTimbre being integrated into its own source code project as an online API, as is the case with Search by Sound (2.2.3 above). Although an online API has the advantage that nothing needs to be installed and it can be immediately addressed using the simple REST protocol, both *Airstrument* and *Sound In Translation* preferred to use the offline library because of the greater flexibility it offers.

There is a balance between quick and easy integration and flexibility. By making both options available, users can choose between the two.

2.3.Melody & Bass Transcription, Beat & Key & Tempo Detection API (Fraunhofer)

The #MusicBricks Transcriber, and in particular the beat tracking functionality, was used in the *Sound in Translation* project, one of the winning hackathon entries at MHD Barcelona. The Transcriber is also used for main melody and BPM (beats per minute) extraction by *Airstrument* which won at #MTFScandi. From the feedback gathered during the hands-on workshop, the participants had no problems running the tool, which was provided as an executable for different platforms such as Windows, Linux, and Mac OSX. One of the participants made the suggestion of supporting 24 bit WAV files and the feature was added after the event.

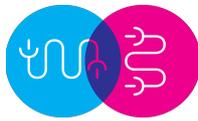
The received feedback enabled improvement of the computational performance time for some bricks (e.g. #MusicBricks Transcriber for offline music transcription). The *LightBeat* team asked if the performance of the #MusicBricks Transcriber (processing 3 minutes of audio in 20 seconds) can be further improved. The project team worked with the Transcriber to detect audio beats as a source for controlling Philips Hue lights. They found difficulties with the time delay between the beat detection and controlling the lights. This however was more due to the lag in the control of the Philips lights than in the audio processing of the #MusicBrick. They came up with a creative solution of preprocessing the audio, so it could be (adaptively) synced with the lag of the light device so as to control the lights in time with the beats. Their feedback to the #MusicBricks Transcriber tools is that they would have liked it to process in real-time (with a delay as low as possible). Other than that, they were very happy with the results of the Transcriber tool. Although we have already started optimising the algorithms, their requested processing time of 1 second (for 3 minutes of audio) is unfortunately not feasible.

In response to a request made during a hackathon, chord transcription was added to the Transcriber brick. The technology was available but not initially as a #MusicBricks component. One participant in Barcelona wanted to create some visualisation of harmonic content and asked that the algorithm be included.

Following a query from a hacker at #MTFScandi, new output formats were added (ABC notation, zipped MusicXML). The hacker was checking which annotation formats were available and suggested both formats, so they were included.

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It was observed during the hackathons that no tool for time-stretching & pitch-shifting was available, but could be very useful for some projects, and so both were added as new #MusicBricks components at the end of 2015.

The Goatify demo application was added to illustrate to the hackers how they might combine #MusicBricks (in this case: Goatify and Freesound) into a new application. This offers the possibility of replacing the main melody in a song with an user-selected sample that will be pitched according to melody. Full details on Goatify can be found in D3.3.

2.4. Realtime Monophonic & Polyphonic Pitch Detection API (Fraunhofer)

The Realtime Pitch Detection library was used in at least one project during the MHD Barcelona, which involved an Android app for real-time transcription of hummed melodies and sending the transcription results as MIDI signals to a remote synthesiser app.

One of the developers initially had problems referencing the library for the Android app using the JUICE framework. The issue was resolved quickly after sending him a complete Android project as an example.

Feedback was received from some workshop participants that providing sample projects for different platforms such as iOS, Android, and Mac OSX was a good starting point when getting to grips with the technology and thinking about ways it might be possible to integrate the Pitch Detection Library into projects.

Several MHD Barcelona and #MTFScandi participants that were interested in the #MusicBricks tools were asked for their feedback on the general clarity and comprehensibility of the tools. The participants responded that all of the interfaces and documentation were clearly expressed and well understood.

2.5. “Search by Sound” Music Similarity Retrieval API (TU Wien / Spectralmind)

The Search by Sound API was used by several teams throughout the hackathons of the Creative Testbed. As a result, it was possible to gather insight on what the extended needs of the API might be in terms of processing audio and hosting metadata online or “in the cloud”.

The feedback received indicates that the ability to use music analysis without the need to install any libraries or dependencies and instead manage the process through a web server doing the audio analysis using a simple REST API is appreciated by developers. However, there is an expectation of greater flexibility in terms of the variety of audio signals that can be processed, for instance MP3, WAV and other file formats, or the audio from Youtube videos, and also in terms of the results returned from the API. For now, Search by Sound returns matching similar song IDs together with the degree of similarity, expressed in terms of “distances”.

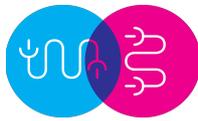
Respondents stated that they would like the API to deliver both the full audio and the full metadata, whether stored internally or from external services. This would potentially raise intellectual property rights issues to be resolved, but a link to an audiofile on a free authorised web resource such as freemusicarchive.org could be provided.

2.6. Melody Extraction API (UPF)

This API was presented in a workshop session that explored Melody Analysis from music signals. Many participants appreciated the general explanations of the different approaches to melody description (predominant, monophonic, polyphonic), as well as the more conceptual insights beyond the technical documentation of the API. The following feedback was gathered from participants:

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MIDI support could be a useful addition to the API. The current Melody Extraction algorithms only output pitch values per frame. Converting the output to a note segmentation can increase its integration in creative applications such as controlling a MIDI synthesiser.

This API requires the installation of the Essentia Library (<http://essentia.upf.edu/>). The Essentia installation worked well for most participants. The process consists of several steps and involves installing additional libraries to the system. Some participants experienced problems compiling if they did not follow the installation steps exactly, but our support staff was able to help.

This API is non-realtime. Some participants were concerned that for many hack ideas, the non-realtime implementations had limitations, especially for creating novel musical instruments. Some algorithms integrated into this API (in particular, Melodia) do not allow for real-time implementation due to their internal structure. However, for batch analysis projects such as music recommendation, these extraction algorithms yield good results.

This API offers Python bindings, enabling participants to code in Python directly and access the Melody Extraction algorithms in this way. There was a problem in the latest release of the Python bindings that was solved during the workshop thanks to feedback received.

As a result of this feedback UPF is further developing the audio processing library Essentia (<http://essentia.upf.edu/>), and has taken actions from the feedback received from creative users. These efforts are found in EssentiaRT~ (<http://mtg.upf.edu/technologies/EssentiaRT~/>), a real-time subset of the Essentia library implemented as an external for Pd (Pure Data) and Max/MSP. The development plan of EssentiaRT~ is to extend the number of algorithms that are available as real-time processing modules.

MIDI support has also been developed but is still under testing. The team plans to integrate this in a future release of the Essentia library.

2.7. Onset Description (UPF)

This #MusicBricks tool is part of the Real-time implementation of the MTG's Essentia Library. It contains a subset of algorithms available as Pure Data and MaxMSP objects. The feedback received was very positive because of its real-time functionalities and off-the-shelf usage in Pd.

Specific improvements requested by participants were related to the online documentation, which consists of a Tutorial Patch, and the object help. Further information is planned about the functionality of "Onset Description" from a more general perspective.

Onset Description is a component of EssentiaRT~, and in response to this feedback, the website (<http://www.mtg.upf.edu/technologies/EssentiaRT~/>) has been updated with more detailed information.

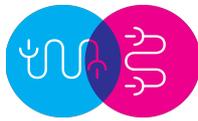
2.8. Freesound 2.0 Web API (UPF)

Freesound was used during the Creative Testbeds for some of the projects, however most of those usages were using content from FreeSound, rather than explicitly using the web API in their projects.

Fostering the use of the FreeSound API is planned in coming events, by showing 'Drum Machine', a demo application that combines Ircam's Gesture Sensor and a Web application. This DrumMachine demo was built and fully documented in deliverable D3.3. The prototype will be shown at the "Music and HCI" workshop that forms part of the large CHI Conference in May 2016. The source code is available in Github <https://github.com/MTG/hands-free-sound-machine>

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3. Conclusions

The intention at the Music Tech Fest Hack Camp has always been to encourage the creation of projects which have a life beyond the end of the festival. Following the integration of the #MusicBricks project this ambition has now been given a sustainable structure, and has enabled both researchers and developers to progress with improving their components and products.

The feedback gathered has been overwhelmingly positive. Stakeholders found the wealth of partner support on the ground to be highly beneficial and the resulting knowledge transfer has been of great benefit to hackers and the partner teams alike.

Invaluable feedback has been gathered on potential improvements to the tools, which has resulted in enhancements such as improved cross-platform compatibility, better documentation, #MusicBricks project examples and greater real-time compatibility. By having the developers of the #MusicBricks tools participating in the Creative Testbeds, partners were able to respond quickly to feedback that participants raised, and in many cases, made adjustments and alterations to the tools that enabled innovation and unanticipated functionality within product prototype developments that used the toolkit.

The Creative Testbeds attract participants of a very high calibre - many of which are postgraduate or postdoctoral level computer scientists, professional designers and musicians, and all of whom bring a level of experience and expertise. The feedback from these engaged and critical users has made a significant difference to the design cycle of the #MusicBricks tools, and the development and implementation process through this series of Testbeds has provided a platform for a rapid iterative process of improvement and enhanced functionality.