Prynth

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Prynth is a technical framework for building self-contained programmable synthesizers, developed by Ivan Franco at the Input Devices and Music Interaction Lab (IDMIL) of McGill University. The goal of this new framework is to support the rapid development of a new breed of digital synthesizers and their respective interaction models.

Until recently, due to the rather limited processing power of micro-controllers, most digital music instruments have presented a configuration where an external physical controller is connected to a personal computer, with the need to perform several physical connections and complicated setups for the instrument to be operational. Contrarily, Prynth synthesizers use the Raspberry Pi single-board computer, coupled with custom electronics, to achieve an integration between physical interface and processing unit, resulting in much more compact, robust and easy-to-use digital synthesizers.

These digital synths retain the ability to be easily re-programmed through a set of web services that run constantly on the synthesizer itself. The result is a device that retains the advantages of both hardware synthesizer and their digital counterparts. Prynth has been released in the end of 2016 and has been received with enthusiasm by the community, with articles in relevant publications, such as Fact, Engadget or Synthopia. For more information consult the website at https://prynth.github.io/.

PROJECT OBJECTIVES

The main goal of this workshop is to have the participants build their own synthesizers under the supervision of Ivan Franco. The hands-on nature of this workshop will facilitate the sharing of conceptual and practical experiences, by promoting active discussion about this new type interactive device and its supporting architecture, and move forward conceptual studies, the continued technical improvement and the dissemination of the framework.

BACKGROUND INFORMATION

Sound synthesizers became popular in the market in the 80's, with the proliferation of commercial products like the Moog. These were very appealing to a public searching for a new music aesthetics, strongly influencing the music of that decade. Although generally available to the public, these devices were still somehow considered esoteric and represented a significant investment for the average musician, which was suddenly confronted with the purchase and learning of a new class of instrument. With the advance of computing came the virtualization of the recording studios and software instruments, through which the computer became a central piece of music production, offering several workflow conveniences and a much lower entry barrier. This fact led to the strong adoption of the computer as a tool for music and lead to the development of relevant computer music sub-genres like live coding.

Yet computers are still much more used in sound production on the studio and few musicians feel comfortable with the idea of laptop performances, where the immediate musical gesture has been substituted by a steering of prepared sound fragments or algorithms. The eventual solution for the limitations of gestural expressiveness came in the form of external controllers manipulated by the interpreter and sending control data to the computer for sound processing. Although this seemed like a promising future for the computer as an instrument, many players continued to prefer either traditional instruments or the more monolithic keyboard synthesizers, complaining about issues like robustness, longevity or complexity in software solutions. Furthermore, computers impose interaction modalities that use rely on different cognitive skills than those of the embodied activity of musical instrumentation.

Our framework facilitates the creation of synthesizer designs that combine the advantages of dedicated hardware with the flexibility of programming.

Suggested readings:

- E. R. Miranda and M. M. Wanderley. New Digital Musical Instruments: Control and Interaction Beyond the Keyboard. A-R Editions, Inc., 2006.
- Ryan, J.: Effort and Expression. In Proceedings of the International Computer Music Conference, pp. 414–414. San Jose, USA (1992)
- E. Berdahl and C. Chafe. Autonomous New Media Artefacts (AutoNMA). In Proceedings of the International Conference on New Interfaces for Musical Expression, pages 322–323, Oslo, Norway, 2011.

- Zappi, V., McPherson, A.:Design And Use Of A Hackable Digital Instrument. In: Proceedings of the International Conference on Live Interfaces, pp. 208-219. Lisbon, Portugal (2014)
- Franco, I., Wanderley, M. M.: Practical Evaluation of Synthesis Performance on the BeagleBone Black. In: Proceedings of the 2015 International Conference on New Interfaces for Musical Expression, pp. 223-226. Baton Rouge, USA (2015)
- Prynth, http://prynth.github.io
- SuperCollider, http://supercollider.github.io/

TECHNICAL DESCRIPTION

The Prynth framework uses the Raspberry Pi (RPi) for sound synthesis and the Teensy microcontroller for sensor signal acquisition. The Teensy communicates with the RPi through an add-on board, which in turn connects to up to 10 multiplexer boards for a total 80 sensor connections (analog resistors or switches).

With the Prynth framework, the RPi boots into a system that automatically runs a web service with a full code editor for the SuperCollider programing language. When powered the synthesizer will also automatically run the last edited program, autonomously reaching a ready-to-play state. The code editor also contains other convenient features, such as file managers, real-time system report and a SuperCollider debug window.

Currently the system is prepared to be connected to any Class-Compliant USB 2.0 Audio Card, which should work out-of-the-box.

For more information consult: https://prynth.github.io/create/framework.html

Features

- PCBs with mostly through-hole components (easy to manufacture and solder).
- Ready-to-use Linux distribution with minimal configuration necessary.
- Web-based code editor with debugger.
- Patch and sample management.
- System Status panel.

Required Resources

Facility

- Multimedia projector.
- Audio system with audio mixer with no less than 8 channels.
- Tables and chairs.
- Good lighting.
- Power outlets for each participant table
- Mechanical workshop for wood, acrylic and metal (adapted to host facilities).

NOTE: If possible, the workshop would gain from the access to a workshop prepared for heavier duty work, such as cutting/drilling and other similar tasks related to the construction and assembly of synthesizer enclosures. Ideally this would include access to a laser cutter.

Equipment

- Table (with enough room electronics assembly).
- Soldering station and the basic electronics tools with cutter, tweezer, multimeter, etc - ideally for each participant.
- Audio cabling.
- Internet router with full access by the instructor.

- Bill of materials for each synthesizer unit, provided by the organization or brought by participant, with a total estimated average value of about 150 Euros:
    - Raspberry Pi (2 or 3).
    - Teensy micro-controller (3.1 or 3.2).
    - Class-compliant USB 2.0 audio card.
    - Prynth electronics boards (provided by organization).
    - 4051 8-channel analog multiplexers.
    - Micro SD Card (at least 4 Gb, class 10 preferred).
    - 2 x 20 female GPIO header.
    - Male and female headers 0.1’’.
    - Female jumper wire.
    - Analog variable resistors or switches (depending on the user's design).
    - Micro-USB power supply with 2.4 A.
    - Miscellaneous electronics components.
- Personal computer (either MacOS, Windows or Linux).

Software

- All the required software is freely distributed.
- Requirements: SuperCollider, Arduino IDE, Teensyduino Library, POSIX terminal, Inkscape, Apple Pi Baker or Win32 Disk Imager, IPv4 network scanner software.

Staff

- Although not mandatory it would be good to have an assistant familiarized with electronics development and/or programming, to help those participants who might be slower or have more difficulties with activities such as soldering or programming.

WORK PLAN

The proposed workshop will include both practical and theoretical components. The practical component is essentially related to the construction and programming of a synthesizer, individually or in groups. The theoretical component is related to an understanding of the state-of-the-art and the conduction of user studies based on these novel devices.

There is an encouragement to work towards dissemination through academic publication. After building the devices we will conduct formal and informal assessments in the form of questionnaires, interviews, and group discussions. The results will be compiled and used to elaborate a report about the workshop activities and other papers regarding new findings on this research topic.

The activities are planned as a 2-week workshop and divided into the following self-explanatory work packages (detailed schedule in fig.1):

- Introduction to digital music instruments (DMIs).
- Introduction to the concept of self-contained DMIs.
- The Prynth technical framework.
- Conceptual planning of new synthesizers.
- Assembly of synthesizer electronics.
- Small introduction to SuperCollider.
- Sound synthesis and mapping in Prynth.
- Work on projects.
- Preparation of evaluation studies.
- Evaluation experiments.
- Result analysis and discussion.
- Planning of publications and technical contributions.
- Public presentation and informal networking.

<table>
<tr><th></th><th>Monday, 03</th><th>Tuesday, 04</th><th>Wednesday, 05</th><th>Thursday, 06</th><th>Friday, 07</th><th>Saturday, 08</th><th>Sunday, 09</th><th>Monday, 10</th><th>Tuesday, 11</th><th>Wednesday, 12</th><th>Thursday, 13</th><th>Friday, 14</th></tr>
<tr><td>9:00</td><td rowspan="9">Registration, Opening ceremony, project presentations, Teams gathering and installation</td><td>Welcome</td><td rowspan="2">Keynote session 1</td><td rowspan="2">Introduction to SuperCollider</td><td rowspan="4">Work on Synths</td><td rowspan="9">Social Activity</td><td rowspan="9">Free day</td><td>Status Report</td><td>Status Report</td><td>Status Report</td><td rowspan="4">Evaluation experiments</td><td rowspan="4">Planning of publications & technical contributions and remote work</td></tr>
<tr><td>10:00</td><td>Introduction to DMIs</td><td rowspan="3">Work on Synths</td><td rowspan="3">Work on Synths</td><td rowspan="3">Work on Synths</td></tr>
<tr><td>11:00</td><td rowspan="2">The Concept of self-contained DMIs</td><td rowspan="2">Electronics assembly 1</td><td rowspan="2">Sound Synthesis and Mapping in Prynth</td></tr>
<tr><td>12:00</td></tr>
<tr><td>13:00</td><td colspan="4">Lunch</td><td colspan="5">Lunch</td></tr>
<tr><td>14:00</td><td rowspan="2">The Prynth framework</td><td rowspan="4">Electronics assembly 2</td><td rowspan="4">Work on Synths</td><td rowspan="4">Work on Synths</td><td rowspan="4">Work on Synths</td><td rowspan="4">Work on Synths</td><td rowspan="4">Preparation of evaluation studies</td><td rowspan="4">Result Analysis</td><td rowspan="4">Final presentation</td></tr>
<tr><td>15:00</td></tr>
<tr><td>16:00</td><td rowspan="2">Conceptual and technical planning of new synthesizers</td></tr>
<tr><td>17:00</td></tr>
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Fig. 1 – Detailed schedule.

BENEFITS OF THE RESEARCH

This workshop is intended to gather a group of multidisciplinary researchers and artists in the fields of electronic music performance, human-computer interaction and computer science. We believe that the proposed structure is a good balance between scientific and artistic practices. According to each of the individual interests and skills, we'll try to harmonize effort between these two types of work.

The benefits from this research will be:

- Introduction to synthesizer building.
  - The participants will be quickly exposed to the construction of digital synthesizers, through a practical and contextualized learning of the involved electronics and programming.

- Construction of custom synths for personal use.
  - In the end of the workshop each participant will have a synthesizer, bringing home a device that lends itself to a continued artistic and scientific exploration.

- Academic Publication.
  - This academic field has had a relevant publication in the last twenty years. We believe that the field of electronic arts performance is also a very relevant testbed for new concepts of interactivity and human-computer interaction. In this workshop we will work towards academic publication and the advance of group and individual research.

- Feedback for conceptual and technical improvements.
  - The Prynth framework is freely available to the public. The possibility of having a focus group concentrate on this work will result in important discussions for the improvement of this framework, which is in use outside the context of this particular workshop.

- Establishment of a research network.

  We will also work towards recruiting researchers that are interested in continuing work on these topics and particularly on the use, improvement and dissemination of the framework.

- Awareness.

  We intend to heavily document the various phases of the workshop and use the results for public dissemination and knowledge growth about the involved institutions, the individual participants and the conducted research.

PROFILE TEAM

Leader

Ivan Franco started is research path by 1995 at GASA, an environmental research group dedicated to VR and computer simulations. During this time he also cultivated his passion for music, playing drums in several rock bands. From the combination of these two interests he began a self-taught exploration of computer music. Frustrated with the lack of physical engagement, he turned to HCI studies to rethink physical interfaces in media art performances, later pursuing his Master in Digital Arts at Pompeu Fabra University, where he developed his own electronic music instruments and presented work at relevant electronic art festivals.

In 2002 he was invited to join YDreams to manage the company's Research and Development lab, where he would further explore is knowledge in the areas of user interface design and ubiquitous computing. During this time YDreams became one of the most notorious award-winning Portuguese tech companies, featured in Wired, CNBC and The Economist. He won several awards and has been an invited speaker in many universities, corporate events and media festivals. Currently he is pursuing his PhD in Music Technology at IDMIL / McGill University.

Experience:
- R&D Director, YDreams, 2003 - 2013: technical and scientific planning, execution management, licensing, partnerships, IP management, co-inventor of numerous patents.
- Research Associate, YDreams, 2002 - 2003: lead in interaction design and natural user interfaces, R&D and innovation strategist.
- Researcher, Music Technology Group (MTG), Universitat Pompeu Fabra, 1999 - 2001: interactive systems for music performance.
- Researcher, Gabinete de Análise de Sistemas Ambientais (GASA), New University of Lisbon, 1997 - 1999: virtual reality simulation.

Education:
- McGill University, PhD Candidate, Music Technology, 2013 - ongoing.
- Universitat Pompeu Fabra, Msc, Digital Arts, 1999 - 2001.
- Universidade Nova de Lisboa, BSc, Engineering, 1993 – 1998.

Awards:
- "Personality of the Year 2010", APMP, 2010.
- "Touching AR", Auggies Award, ARE 2010.
- "Lively Dreams", Entertainment Award, APMP, 2009.
- “Ernesto de Sousa Scollarship” honorific mention, FLAD/Gulbenkian, 2005.

Scholarships:
- Fundação para a Ciência e a Tecnologia, PhD, 2015 - ongoing.
- Pompeu Fabra University, Research, 2000 - 2001.
- Fundação para a Ciência e a Tecnologia, MSc, 1999 - 2001.
- CNIG, Research, 1998-1999.

Other researchers needed

- Human-Computer Interaction researchers.
- Cognitive Science researchers.
- Electronic Music performers.

Other information

It would be important to find a way for the participant to own his/her synthesizer after the workshop. Considering the need for significant material sourcing investment, we should work towards the best budgeting model between Enterface 2017 and participants.

An important consideration when selecting participants is that this is an intermediate/advanced workshop and not suitable for people that have little experience with electronics and programming.