robotcowboy: 10 Years of Wearable Computer Rock

Dan Wilcox
Hertz-Lab
ZKM | Center for Art and Media Karlsruhe
Lorenzstr. 19, D-76135 Karlsruhe, Germany
dan.wilcox@zkm.de

ABSTRACT

This paper covers the technical and aesthetic development of *robotcowboy*, the author's ongoing human-computer wearable performance project. Conceived as an idiosyncratic manifesto on the embodiment of computational sound, the original *robotcowboy* system was built in 2006-2007 using an belt-mounted industrial wearable computer running GNU/Linux and Pure Data, external stereo USB audio/MIDI interfaces, HID gamepads, and guitar. Influenced by roadworthy analog gear, chief system requirements were mobility, plug-and-play, reliability, and low cost.

From 2007 to 2011, this first iteration *"Cabled Madness"* melded rock music with realtime algorithmic composition and revolved around cyborg human/system tension, aspects of improvisation, audience feedback, and an inherent capability of failure. The second iteration *"Onward to Mars"* explored storytelling from 2012-2015 through the one-way journey of the first human on Mars with the computing system adapted into a self-contained spacesuit backpack.

Now 10 years on, a new *"robotcowboy 2.0"* system powers a third iteration with only an iPhone and PdParty, the author's open-source iOS application which runs Pure Data patches and provides full duplex stereo audio, MIDI, HID game controller support, and Open Sound Control communication. The future is bright, do you have room to wiggle?

Author Keywords

wearable computing, mobile music, performance art, pure data

CCS Concepts

•**Applied computing** → **Performing arts;** *Sound and music computing;* •**Human-centered computing** → Ubiquitous and mobile computing;

1. INTRODUCTION

> *Art is the result of an allergic reaction to reality.*
> *- Los Carpinteros[5]*

In the spring of 2006, the author began development on a custom human-computer music performance system to solve a simple problem: he was not able to find people to form a new band. Before the rise of the consumer smartphone and embedded Linux device, the laptop computer was the main tool for electronic music performers. After initial experimentation in 2005, the author was unsatisfied with the laptop as stage partner for solo rock performance and the idioms of commercial composition software at the time.

With an informal college background playing in rock and punk bands, how does one approach performing with a computer in a similar manner? This question becomes one of human-computer interaction and performance methodologies where the presentation and compositional elements are as important as the algorithms and sound generation. For the author, the answer is found in the traditions of both the "one-man band" and musician-as-instrument-maker: fashioning an individual approach to instrumentality and the embodiment of computation for live performance. The computer is not merely a tool but an extension of the composer/performer and an active participant in the process.

The result of this concept and experimentation is *robotcowboy*, the author's wearable human-computer music performance system. The project is both a hardware/software platform and distinct iterations into different conceptual and aesthetic interests, allowing for continual growth in response to new technologies and approaches to music. At the time of writing, the project has been ongoing for 10 years and has entered it's third phase.

Figure 1: *robotcowboy: Cabled Madness* **at New Media Meeting 2009, Norrköping Sweden**

2. INFLUENCES

> *He also teaches the instrument the language it will speak which is, of course, the musicians own mother tongue. - African Music: A People's Art[2]*

Influences for the project range from popular musicians,

to experimentalists, to the old and new avant garde. An abridged listing follows.

From a musical and performance perspective, *robotcowboy* is inspired by DEVO's use of music and performance as a conceptual whole; the philosophical experimentalism of Sun Ra; Laurie Anderson's approach to narrative and storytelling; and the device art and playful use of "authority" utilized by the Japanese Maywa Denki "Corporation". African and alternative instrument making, Benoît Maubrey and Die Gruppe's long running *Audio Ballerinas* project[6], and Sergi Jordá's *Afasia* one-man-multimedia-band[3] show a path toward the realization of embodied performance through custom systems and musical languages. STEIM's Michel Waisviz' focus on touch and gesture[4] as exhibited by *The Hands* is a reminder that, as Richards states in *32kg: Performance Systems for a Post-Digital Age*, through the post-digital move toward re-experimentation of tools "ergonomics and biological condition have again become central to the idea of musical interface."[7]

robotcowboy strives to exist within the realm of "experimental pop", free to utilize familiar formal aspects within a non-formal context and act as a platform for the author's own expression. Many of the project's conceptual performance rules and conceits are directly derived from an experimentation and research period into early-moderism as well as the approaches of the digital and post-digital.

3.   10 TENETS: A MANIFESTO

...the blind touch of a musician is still superior to the awkward musings of mouse man. - Norman, Waisvisz, and Ryan[1]

Before delving into the project as a whole, it is useful to examine the underlying concepts behind it's development. Inspired by early modern avant-garde manifestos such as *The Art of Noises*, the "10 tenets of robotcowboy" lay out a philosophy for the creation and performance of music with a computer.

1.   The cyborg embodies the computation: all of the gear must be worn on the body

The focus of the human-computer performance is to be returned to the body as opposed to the machine. This can be achieved through the modern "one-man band" as a cyborg entity who is a hybrid body extended through technology.

2. Plug and play: plug in the system, turn it on, it works

The computer processes should be enabling, not distracting, the performer should be able to focus on the performance, and the hardware should be reliable in a rough environment. The system should behave as guitar and amplifier: walk on stage, plug in, and play.

3. Human frailty: there must be room to fail

The digital process should not be perfect: playing live music should be walking a tightrope. There can be no proficiency of musicianship if there can be no failure.

4. Human energy: live sweat must be felt when listening to every song

The human half of the cyborg should infuse the performance with live energy: the sound should reflect an organic hybrid of man-machine.

5. Good with the bad: the human is enabling/disabling, the machine is enabling/disabling

The melding of man-machine should reflect the strengths and weaknesses of both. For instance, a long power/audio "umbilical cord" required by the machine which anchors the human performer to the performance area.

6. A real prototype: new ideas and gear must be tested in a real environment, risks must be taken

Live experimentation and iteration must be a part of the creation process. Hardware/software failures must be prepared for by making them part of the performance. Audience members will sometimes be required to break the fourth wall in order to help repair the machine half.

7. The non-recording artist: the performance is the commodity, recordings should be live

Escape the notion of recorded music as the musician's product. The hardware/software is designed so that all performances are recorded live. The songs are thus organic and no longer single, static recorded elements to be replayed over and over.

8. WY SEE IWYG: sound and action should be proportional

The digital instrumentation should be visually apparent. The timbre and loudness of the sound should be proportional to the action in "creating it" in a similar manner to more traditional instruments. Huge, disembodied sounds should be avoided.

9. WY HEAR IWYG: everything should be reproducible live

Avoid heavily produced, pre-recorded backing tracks. The sound should be minimal and focused on what instruments can be performed live.

10. Creative freedom: open source software should be used as much as possible

The software should be open, malleable, and adaptable to the performers needs. It should not be reliant upon a single system or vendor and all efforts should be made to make it "future resistant".

4.   CABLED MADNESS

Cabled Madness refers to both the initial development of the *robotcowboy* project in 2006-2007 as the author's M.S. thesis as well as it's first performance iteration which ran from 2007 to 2011.

4.1   System

The original system was built around a belt-worn Xybernaut MA V industrial wearable computer (500 MHz Pentium 3 with 256 MB RAM), USB hub, USB 1.1 sound interface, and direct box for pre-mixed stereo. Called the "robotcowboy unit", the computer ran Debian GNU/Linux with a custom kernel to achieve realtime audio performance on limited hardware and utilized Pure Data for DSP, effects, instrumentation, and control mappings. A main control patch handled I/O, transport, and playlist management for individual song patches. Plug-and-play USB HID gamepad events were provided by a custom daemon ("unit-daemon")
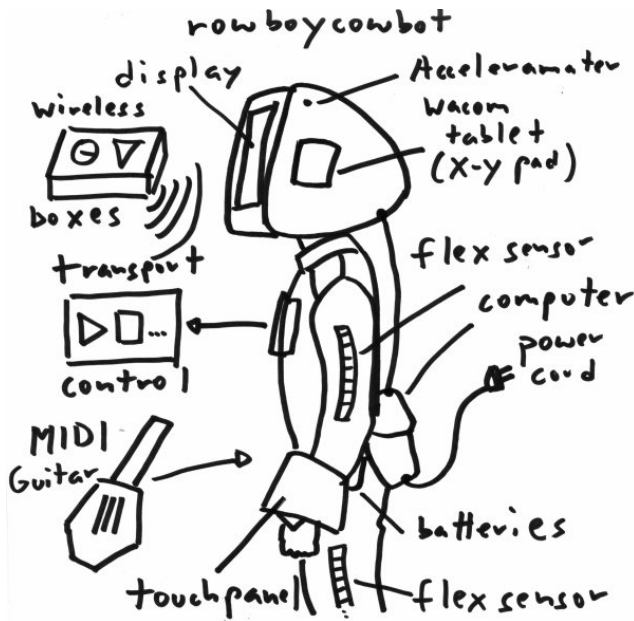
Figure 2: *robotcowboy* **design sketch 2006**

which communicated with Pure Data using OSC (Open Sound Control) messages. (Figure 2)

Performance interaction was built around physical controls, input, and audio feedback. A transport control box ("button box") worn either on the belt or the lapel provides song cue, next/previous, and voice communication "walkie-talkie" control events. The main input hardware was Playstation 2/PC gamepads, Casio DG-20 digital guitar MIDI, and two audio inputs: voice and (digital) guitar which were processed live by Pure Data. Important system status events were relayed to the performer via sound samples such as "bang" for new song load or "ooh" when a USB input device was inserted. Automatic stereo down mix recording to WAV files allowed for trouble-free documentation, whether good or bad. (Figure 3)
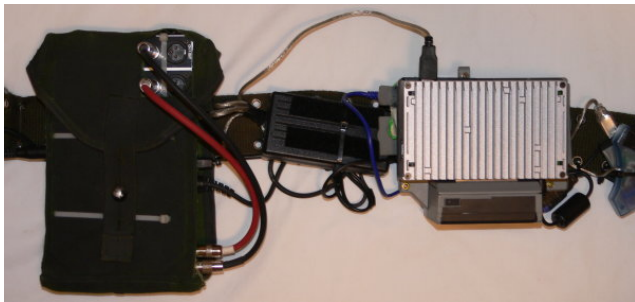

Figure 3: *robotcowboy* **belt hardware 2007 left: USB audio interface, right: Xybernaut MA V**

Optional performance visuals were provided by a custom program ("rc-visual") which bit blitted to the console framebuffer using the SDL (Simple Direct Media Layer) library, accepted scene description files, and communicated with Pure Data over OSC. These admittedly simple visual elements were focused on the display of realtime control using a low-resolution aesthetic. An integrated LCD monitor mask (the "robotcowboy helmet") invoked elements of African mask ritual for character transformation and was created as an integrated response to the "distraction visuals" employed by otherwise non-performative laptop musicians.

Weighing approximately 4 kilos, the helmet was driven by the wearable computer's VGA port, featured video camera and goggles, and went through 3 different screens over it's lifetime.

4.2 Performance Development

Musical experimentation began in 2006 resulting in a simple 3 song improvisational set running on the system in the summer of 2007. Thanks to a residency at STEIM in the fall[9], further songs utilizing the Casio digital MIDI guitar were developed for the January-February 2008 "Consoles Afire" US tour in collaboration with chip-tunes musician Laromlab. The project received abuse on the road through almost 40 dates, requiring only requisite soldering of USB ports, zip ties, and hot glue.

Expanded instrumentation experiments in 2008 branched into alternate interfaces (a trumpet sampler, throat microphone) and began integration of analog electric guitar for the adaptation of songs from a previous surf punk band of the author's, *7inchWave*. This led to a hybrid set between the original "digital improvisation" and a more sequenced "analog surf rock guitar" counterpoint to coincide with the helmet (machine) and non-helmet (man) portions of the show. This final *robotcowboy: Cabled Madness* performed in Europe from 2009-2010 through a small tour and at several festivals including STRP, Mapping, New Media Meeting. (Figure 1)

Figure 4: *Close Encounters of the Bit Kind* **at the Ars Electronica Festival 2009, note performer in lower center**

A special performance of the digital improv *Cabled Madness* songs was developed for the 2009 Ars Electronica Festival in Linz, Austria titled "Close Encounters of the Bit Kind." Utilizing a special version of rc-visual, the *robotcowboy* visuals were displayed on the Ars Electronica Center's 1048 panel LED facade. The performer was embedded within the audience and this special show involved interesting contrasts of scale between gamepad control movement, LCD helmet, and the 4 story building display. (Figure 4)

By 2011, however, the wearable computer had basically run it's course and became harder to maintain, leading to more frequent overheating and crashes on stage. Newer material involving expanded sequencing and synthesis elements were limited as they required more system resources than available. Last, the "robotcowboy helmet" was a useful visual tool but had become too much of a focus for the audience (and author) at the expense of continued musical exploration.

Figure 5: *robotcowboy: Onward to Mars* spacesuit in action.

5. ONWARD TO MARS

The development of the second iteration of *robotcowboy* coincided with the author's M.F.A studies from 2010-2013 and focused on establishing a more conceptual basis: individual and social aspects of contemporary humanity's journey to Mars. In the fall of 2011, the author conducted experiential background research at the Mars Society's MDRS (Mars Desert Research Station) in Utah[1] as the journalist for Crew 119. Throughout the 2 week crew rotation, daily reports were written about life in the Habitat, communicating with Mission Support, and exploring the high desert while wearing Martian analog "simsuits." The resulting text, photos, and notes were written from a "first landing" perspective and compiled into an a self-published book, *Heading to Mars*.[10] (Figure 6)

In 2013, the newly titled *Onward to Mars* was selected for the inaugural CSA (Community Supported Art) series at the New Hazlett Theater in Pittsburgh, PA USA[2]. Pitched as "Devo, Sun Ra, and Laurie Anderson meet Carl Sagan on the Red Planet," this iteration was developed toward a fixed show date and provided modest funding, production help, and working space at the theater. The overall set was organized around a spoken word narrative of the journey of the Astronaut on the first one-way trip to Mars.

Figure 6: *robotcowboy: Onward to Mars* MDRS research promo photos

5.1 PASS

A update of the *robotcowboy* hardware was required for the new show and utilized the existing software on updated hardware. A custom wearable system using an embedded UDOO board, large capacity battery, USB hub, USB audio interface, and direct box was built into the Astronaut's backpack. Called the PASS (Personal Audio Support System) this design was inspired by the NASA Apollo program's A7L spacesuit PLSS (Personal Life Support System) and included a built-in cooling fan for the suit's helmet. Although the physicality of this new system differed from that of *Cabled Madness*, the cyborg elements remained with the spacesuit acting conceptually as an integrated, portable environment required for exploration. (Figure 7)
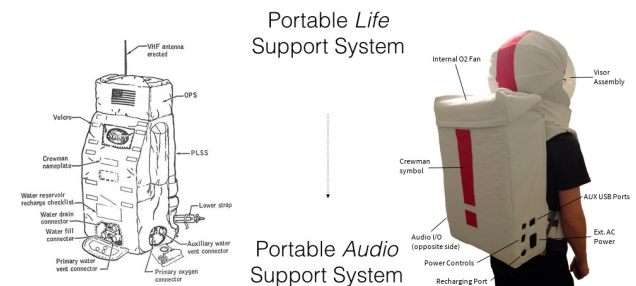

Figure 7: Apollo PLSS influence on the *robotcowboy* PASS backpack

5.2 Mars Show

For the CSA grant, *Onward to Mars* became a theatrical show and staging was developed using a 30x30 foot projection, overhead lighting, and custom mylar inflatable rocket and scene elements created by artist Anika Hirt[3]. (Figure 8) The rc-visual program was rewritten using the OpenFrameworks creative coding environment to support video, live scripting, and production control using a TouchOSC interface. New instrumentation included a NASA-branded Theremin and hacked Playstation 3 controllers embedded into mockups of geological measurement devices such as a soil penetration tester.

The February 2014 show date was a success and stripped down, off-stage follow-on performances took place in various venues in the Pittsburgh area including the 2015 Mars, PA USA New Year Celebration[4]. *Onward to Mars* development and research were also presented to the audience of professionals and space enthusiast at the 17th Annual Mars Society Convention in Houston, TX USA in 2014.[11][12] Further, this work became a major part of the author's 2015 M.F.A. thesis paper: "I'm Not An Astronaut but I Play One on TV."[13]

As compared to *Cabled Madness*, *Onward to Mars* was less satisfying for the author as it is felt too much time was spent developing story, costuming, and hardware at the expense of the music. Perhaps this is a result of a more codifies theater approach as opposed to looser, experimental iteration? The system hardware was in many ways not as stable or ideal with the backpack being too bulky, weighted incorrectly, and positioned so that it's I/O ports were almost impossible to reach while worn. The embedded UDOO board also ended up being difficult to tune for realtime performance and was less reliable than anticipated.

Figure 8: *robotcowboy: Onward to Mars* Act 1: Landing sequence

6. ELEMENTS

Figure 9: *robotcowboy* belt hardware 2017 left: USB audio interface, center: USB hub, right: iPhone

The current iteration of *robotcowboy* is, at the time of this writing, tentatively titled *Elements* and brings a return to the focus on songwriting and a simpler belt-based performance system using an iOS device. (Figure 9)

6.1 PdParty

With the 2011 release of the iPad 2 which brought USB audio and MIDI support to consumer mobile devices, the author saw an alternative to custom configured embedded computing and began the development of an open-source mobile application for use with *robotcowboy*. This work led to the author's involvement with the libpd embeddable Pure Data library project and, after years of on and off development, "PdParty" was released on the iOS App Store in the fall of 2016. PdParty provides an environment for running Pure Data patches on iOS devices and includes patch GUI emulation, sensor events, MIDI and wireless gamepad support, a built-in WebDAV server for patch management, and an OSC server for communication.[14]

With PdParty at it's core, the new *robotcowboy* system for *Elements* uses a hardware layout that is largely the same as that of the original *Cabled Madness* system with the industrial wearable now replaced by the modern consumer wearable, an iPhone. USB devices are connected through a powered USB hub and iOS compatible wireless gamepads form the basis for a new transport control box and performance hand held. Software-wise, almost all elements of the original design are integrated into PdParty and the original song patches have been adapted to support both desktop and mobile Pure Data environments. (Figure 10) The automatic stereo down-mix recording is maintained and resulting WAV files can be transferred off of the device via PdParty's internal WebDAV server.

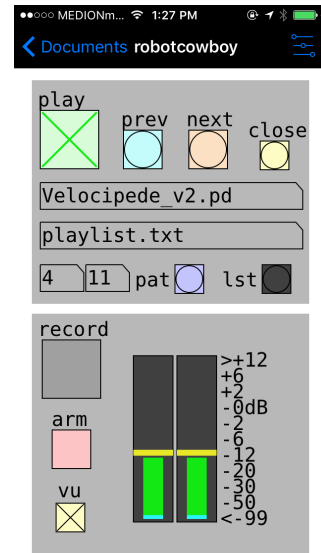The complete system was functional in the fall of 2017

Figure 10: Main *robotcowboy* Pure Data control patch running in PdParty on iOS

for a performance of the *Cabled Madness* set at the ZKM GigaHertz Festival in Karlsruhe, Germany. So far, the set up is very stable with iOS providing reliable low-latency and generous DSP overhead compared to previous systems. With this new development, *robotcowboy* now moves forward with a renewed emphasis on performance interaction and musical experimentation through near-scifi themes of nuclear energy, ballistic trajectories, space travel, medical imaging, and machine communication. (Figure 11)
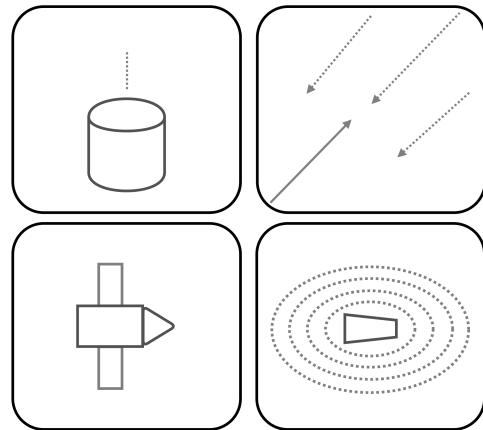

Figure 11: *Elements* song design sketches

7. OPEN TOOLS

As *robotcowboy* is built upon free software and artistic tools, it's important to note that, similarly to PdParty, the various component tools used within the project have been continually developed and released. The original unit-deamon HID gamepad to OSC message software has been renamed "joyosc" and updated to include cross platform support as well as more flexible button and axis event remapping.[5] The Pure Data patch library used for song creation is available as the "rc-patches" including both original abstractions
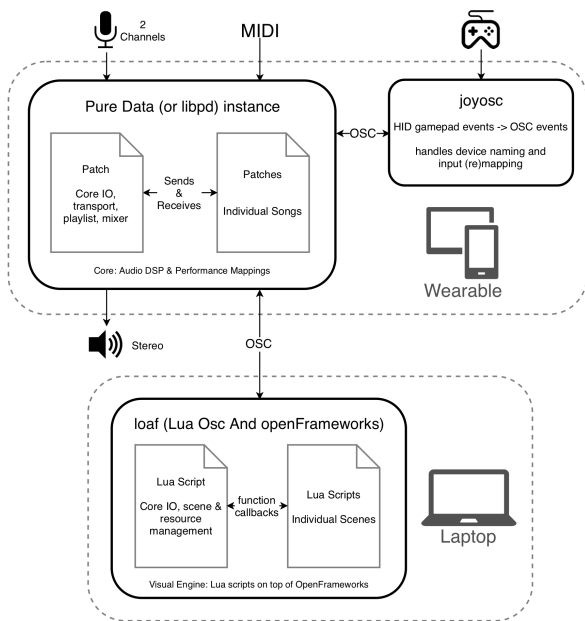
---

[5] https://github.com/danomatika/joyosc

Figure 12: *robotcowboy* **system diagram**

and new versions which use only Pure Data "vanilla" objects for portability.[6] The rc-visual application has been through 4 iterations in total and is now written in Lua using the author's open-source Lua interpreter for the Open-Frameworks creative coding toolkit: *loaf* (**L**ua **O**sc **A**nd open**F**rameworks).[7]

8. FUTURE

robotcowboy was always designed to be a platform for experimentation and evolving phases are a natural course of it's development. Through 10 years of hardware and software changes, conceptual expansion, and new approaches, the core focus on embodiment and performance methodologies links it's iterations and, as this repertory grows, the performer can mix and match these various styles into new shows and artistic territory. Thanks to libpd, Pure Data will continue to act as a ubiquitous platform for computer music within the project for the foreseeable future with the reality of modern mobile computing becoming a realization of the 2007 *robotcowboy* M.S. thesis abstract:

> *It is hoped that the concept of "wearable music computer" can one day become as ubiquitous as that of "laptop musician" in a return to the fragility and excitement of live music.[8]*

Grab your gamepad and guitar. The future is bright, do you have room to wiggle?

10. REFERENCES

[1] Touchstone. `http://steim.org/archive/steim/texts.php?id=2`, 1998. Essay for 1st STEIM Touch Festival; Online; accessed Apr 2018.

[2] F. Bebey. *African Music: A People's Art.* Lawrence Hill, Westport, CT, 1975.

[3] S. Jordá. Afasia: The ultimate homeric one-man-multimedia-band. In *Proceedings of NIME-02*, Dublin, Ireland, May 2002.

[4] V. Krefeld. Biography of Michel Waisvisz. `http://www.crackle.org/short%20biography.htm`, 2004.

[5] Los Carpinteros. *From an Artist's Perspective: 13 Questions - 51 Interviews.* Kerber Verlag, Bielefeld DE, 2009.

[6] B. Maubrey and D. A. Gruppe. Performances with electroacoustic clothes: Audio ballerinas. `http://soundartarchive.net/articles/Maubrey-1989-audioballerinas.pdf`, 2005.

[7] J. Richards. 32kg: Performance Systems for a Post-digital Age. In *NIME-06*, Paris, France, 2006.

[8] D. Wilcox. robotcowboy: A One Man Band Musical Cyborg. Master's thesis, Chalmers University of Technology, 2007.

[9] D. Wilcox. robotcowboy song structure pd patches and wiimote experiments. `http://steim.org/projectblog/2007/10/20/dan-wilcox/`, 2007. Online; accessed Jan 2018.

[10] D. Wilcox. Heading to Mars. self published, 2013. Digital copy available at `http://danomatika.com/projects/heading-to-mars`.

[11] D. Wilcox. Heading to Mars: MDRS Field Journal, Crew 119. In *17th Annual Mars Society Convention*, Houston TX, 2014.

[12] D. Wilcox. robotcowboy: Onward to Mars, A One Astronaut Space Rock Opera. In *17th Annual Mars Society Convention*, Houston TX, 2014.

[13] D. Wilcox. I'm Not An Astronaut But I Play One On TV. Master's thesis, Carnegie Mellon University, 2015.

[14] D. Wilcox. PdParty: An iOS Computer Music Platform using libpd. In *PdCon2016* , New York NY, 2016.

---

[6] `https://github.com/danomatika/rc-patches`
[7] `http://danomatika.com/code/loaf`