Sunspeak: A Networked Solarpunk Performance

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Sunspeak is the outcome of an experimental research project conducted using discarded electronics, embedded microprocessors and photovoltaic (PV) cells to charge salvaged power cells. The components are retrofitted into a set of portable telecommunication handsets with additional inputs which send data via the OSC protocol over a local network to control granular synthesis and audio processing within software powered by Max/MSP. Each handset is powered by a re-chargeable battery cell taken from a discarded disposable vaporiser, running custom software on a Raspberry Pi Pico W written in C. The devices each display a unique text-based onboarding gameplay and graphical representation of user input, whilst transmitting OSC data via UDP using the boards integrated networking capabilities. The system is designed as a networked instrument to facilitate a collaborative improvised performance, that can be situated as a standalone performance or within a thematic solarpunk world building experience.

Keywords Solarpunk, Participatory Performance, Computing-within-limits, Improvisation, Embedded Systems.
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Description

Introduction

Configured as a solarpunk world building experience, *Sunspeak* invites five players to participate in an improvised collaborative performance. It uses networked portable wireless controllers that shape an immersive audio-visual performance. Exploring the nature of distributed and

consensus decision making, the piece requires collaboration between participants to guide the experience, with moments of discord and harmony emerging based on the agency of each player.

This work is inspired by and draws from the solarpunk genre as a space for eco-futurist fabulation and an approach to design. At a material level solarpunk focuses on critical engagement with technology, resource management, and collaborative work, rejecting the extractive conditions that 'technological solutionism' (Morozov 2012) has perpetuated under capitalism. Solarpunk looks to communal and collaborative infrastructure, envisioning techno-futures and knitting social alternatives that counter planetary scale computation with optimistic, local and often simpler, lower-tech solutions.

> *In a time where computing epitomizes industrial waste, permacomputing encourages the maximizing of hardware lifespans, minimizing energy use and focussing on the use of already available computational resources. (Viznut 2022)*

From a literary perspective the genre loosely defined as solarpunk has its roots nestled in the eco-feminist writings of Ursula K. Le Guin and Donna Haraway. These texts underpin a field of research collectively referred to as 'permacomputing', which brings together speculative-fiction with the critical theories of eco-futurism to form a critique of computational maximalism. It is within this context that the following work is situated.

In Sunspeak I attempt to bridge material considerations and speculative fiction approaches, entwining design methodologies with storytelling. The physical origins of the project respond to the repurposing of discarded single use and obsolete technologies to experiment with social infrastructure that encourages collaborative performance and storytelling through a low-power, solar-powered participatory communication network.

Telecommunication Handsets

The work is facilitated using a set of five handset controllers which are made up of retrofitted portable handheld televisions. I have stripped the original circuit boards and designed new internal electronics, which are networked with a Raspberry Pi Pico W microprocessor as the brain. Given that terrestrial broadcast signals have been gradually switched off internationally over recent years, these devices serve merely as relics of an analogue communication past; technological detritus that is widely available second-hand for little – if any – cost, otherwise fated to landfill.

I have made use of the exterior buttons originally used for tuning the device, but have rerouted them in the new circuit design and allocated new functions to them. They are now used to progress between pages on screen within the new software installed on the microprocessors. Additional user input is provided in the form of a potentiometer mounted through the original socket for an external antenna. The analogue potentiometer input is smoothed, mapped and sent wirelessly via the OSC protocol to a granular synthesiser programmed in gen~

within Max/MSP. Input data from each device is received and parsed in a max patch, and then routed to the main audio processing patch where it is mapped to a specific parameter, manipulating field recordings, some of which are made with a simple solar powered amplitude-modulation synthesiser.

Fig. 1. Two handsets refitted with Raspberry Pi Pico W and bespoke circuitry.

Fig. 2. Handset in use during performance.

In place of the original display, I have installed and mounted a 1.3” OLED screen which displays preliminary onboarding text and graphics to represent the input data from the potentiometer. The displays are mounted with a custom fabricated part that I designed and 3D printed with recycled PLA.

Sweet, sweet (smelling) batteries

Noticing the vast number of discarded disposable flavoured vaporisers littering the streets, my investigations led me to dismantling the devices and testing the internal electronics. As it happens, the lithium-ion batteries installed to power the devices had the ability to be recharged safely countless times, with no loss of specified capacity after recharging at an optimal charge voltage. The vaporisers simply had no means of recharging the batteries, as the primary economic motives of the production of the devices was to sell as many disposable units as possible. The batteries I salvaged varied in capacity between the vapes that I pulled apart, but all had an operating voltage of 3.3 volts, which happens to sit within an appropriate voltage range to safely power a range of microprocessor boards.

I desoldered the cells, taking care not to short them, and re-soldered to modular JST connectors, which I then recharged with a 6 Watt photo-voltaic solar panel, using a voltage control TP4056 chip to regulate the incoming voltage from the solar panel and the outgoing charge to the battery. The energy stored by the battery is then used to power the networked handsets, which could last for several hours on a single charge. According to Alex Nathanson's top level descriptors of the three common designs of solar powered circuits, this approach could be classified as "long-term energy storage with batteries" (Nathanson 2021, 31) as it uses and stores PV energy for short term use. [1]

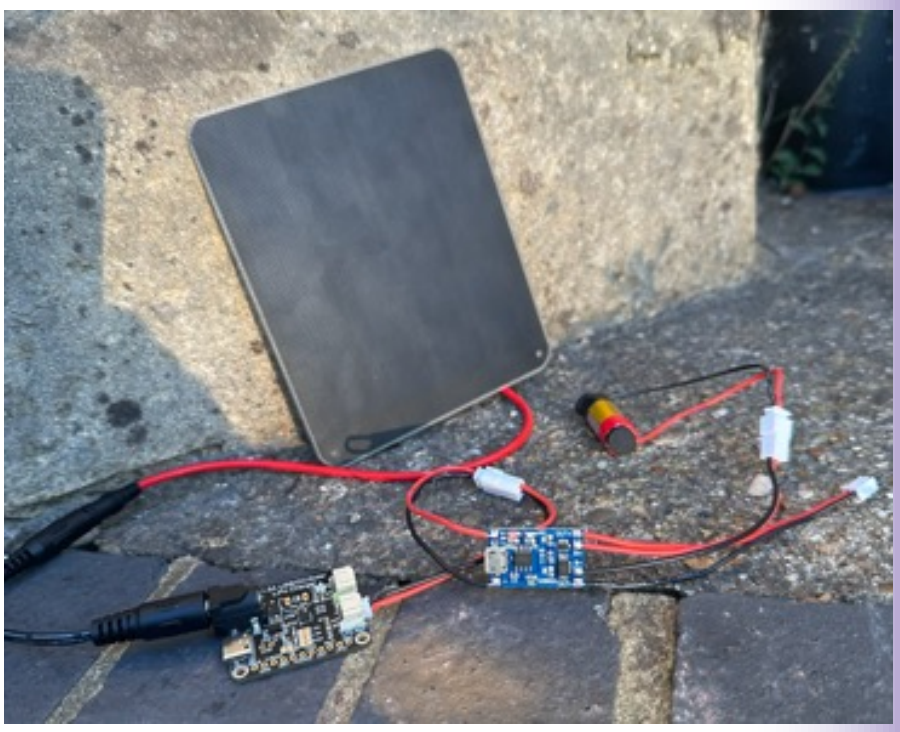

Fig. 3. 10V, 6W PV solar panel connected to TP4056 charge control chip, charging salvaged 500mAh cell.

Due to the nature of the original use, once I had extracted the battery cells from the vaporisers, they had a lingering smell of the fluid flavour from the device that they had ben pulled from. My workstation gave off the sweet scent of grape, mango, and cola. Interestingly, as I dismantled devices from each of the most well known competitive vape brands, I noticed that the battery cells used were wide ranging in manu-

1. Nathanson's other top-level descriptors are direct-drive design, which uses solar energy directly with no storage or power conditioning capabilities, and short-term energy storage that may or may not include power conditioning. An example of this would be a classic scientific calculator which is powered by a small PV cell and has very short term power conditioning.

facturer and capacity, even when from the same product line. Usually, these types of individual cells would be assembled together in series to form larger capacity 'batteries' for a wide range of consumer products. It was peculiar to find the individual cells fitted with such haphazard wiring as demonstrated in the devices I took apart. I can only assume that the li-ion cells used in the vaping devices were actually 'b-grade' cells that were rejected from the production lines of composite battery units. This suggests that the cheaply made vaporiser devices were themselves the bi-products of mass production manufacturing, in a way providing a first stage repurposing of materials.

Building a solar recharge station for these disposed cells is the most explicit result of my research into the solarpunk genre as an approach to design and infrastructure, by providing a means to explore the options for recycling and reusing discarded electronic materials within new design frameworks. Envisioning a more sustainable world that aims to reduce the discarding of technology requires an approach that engages critically with the status quo of contemporary manufacturing and explores design considerations with a material focus.

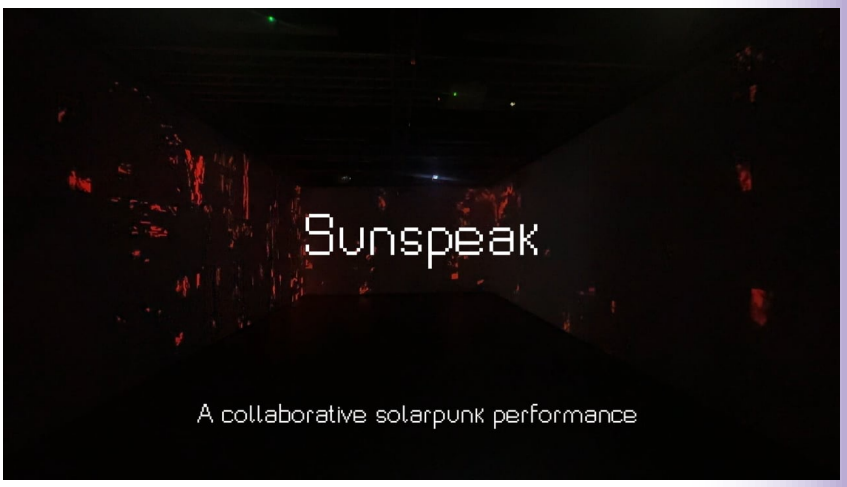

Fig. 4. Video documentation of performance (http://vimeo.com/862680790).

Emergent Performance

I devised this work as part of an MA programme in Computational Arts at Goldsmiths College, University of London, where I presented the first iteration of the piece as an improvised performance using multichannel sound and immersive visuals that were also mapped to the input of the handsets. During the course of a four day exhibition, I conducted the performance four times, each with a different set of participants who signed up on the day. I programmed each device with its own text-based narrative introduction and training game, which I used as an onboarding exercise for the participants to familiarise themselves with the devices and how they influence the networked instrument. Each performance began with a group read-through of the text, situated as a communication exercise in a sci-fi LARP (live-action-role-playing) experience. I took on the role of the dungeon-master to assist with the onboarding of performers, before taking a retreated position at the mixing desk to keep an eye on audio levels in the space.

As the performers took agency over the controls of the networked instrument, the performance unfolded as a unique improvised soundscape, with four completely different works emerging over the weekend. As an experimental participatory performance, I was interested in the dynamics that underpinned the collaborative workings of the performance. Much like traditional musical performance, the piece required each performer to listen closely and observe the unfolding work, and work with each other to shape the audio-visual journey.

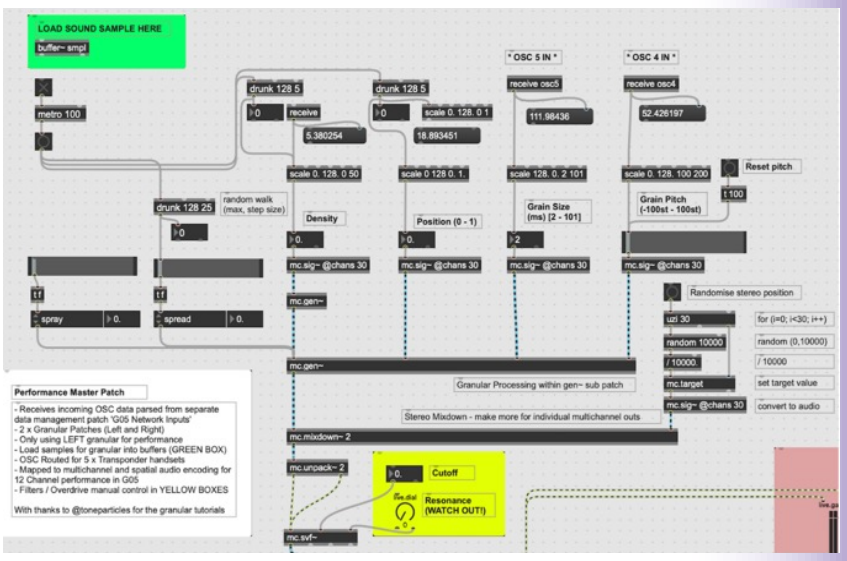

Fig. 5. Granular synthesis patch in MaxMSP, a section of a larger patch in which all audio processing for the project takes place. OSC control is mapped to two parameters of the unit; 'Grain Size' and 'Grain Pitch'.

Technical Details

The initial run of performances made use of open source ambisonic external devices from ICST to control some simple spatialisation within the main max patch, with surround panning controlled by one of the handsets introducing a distinct spatial element to the work to increase the level of immersion during the performances.

The first iteration of the work was presented in a specialist room with almost fully-surrounding projection screens, which was utilised for the performances, parsing handset data back out from max into a generative TouchDesigner composition. The projection spanned 9600 x 1080 pixels and was output via NDI to Resolume Arena where it was mapped for projection across the 5 channel projection array. For this setup, potentiometer data from each of the handsets was carefully mapped to a different parameters within the composition to influence the visual output in relationship to the audio output.

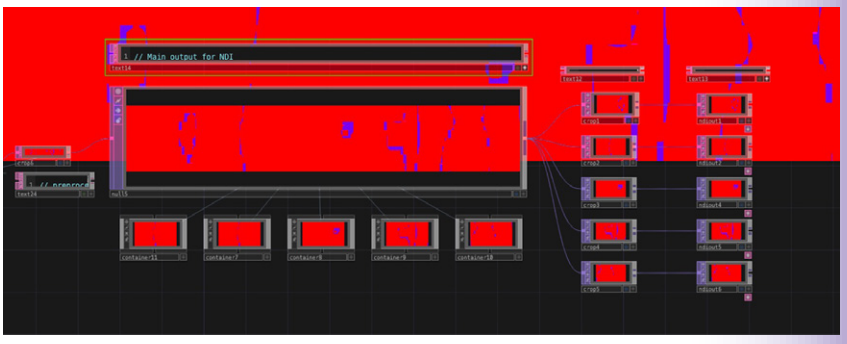

Fig. 6. Network view in TouchDesigner: breaking down a 9600 x 1080 image into 5 component images to send out via NDI outputs to be received and mapped for projection.

Whilst this approach utilised a range of computationally demanding audio-visual processing hardware and software, I opted to use them in conjunction with the repurposed handsets to demonstrate how low-power electronics can be merged within contemporary audio-visual solutions. In the time since initially presenting the piece, I have been developing a supplementary device in order for the work to be run as a standalone set of tools that do not require media servers or even a laptop to be performed, integrating the granular synthesis into an embedded device using an ElectroSmith Daisy Seed microprocessor and solar powered dub pedal to granulate and process the audio.

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