Five Robots Playing Pentatonic, Polyrhythmic Songs

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1 PROGRAM NOTES

Five robots playing five tuned bells by striking them with a mallet. Each robot is controlled by a minimalist, neurally inspired analogue oscillator. These oscillators are mutually connected and connected to a pacemaker oscillator, through network connectivity, they will synchronize at different ratios with the pacemaker. Slow-running analog oscillators of the same type switch on and off the connectivity and modulate the activation of the robots' oscillators. Only through these changing network configurations emerges a musical score that alternates between coordinated polyrhythms, random structure and moments of silence. The complex interaction between the analogue oscillators is visualized with a computer program that graphically displays the changing relations of the oscillators as multiple x-y plots.

2 PROJECT DESCRIPTION

The first documented robots and early automata were mostly self-playing music machines [1, 4]. Through complex mechanical clockworks, gears interlocking into each other, these automata drove mallets hitting on bells or hitting on tuning forks [2]. Later versions of musical automata encoded sequences of notes to be played on rotating cylinders, discs or punch cards. From that perspective, early musical automata may be considered predecessors for algorithmic computation. The five robots are in this tradition, but unlike their mechanical and mechanistic predecessors, they are not bound by the rigidity of mechanical connections. They are not bound by the rigidity of digital programming either; unlike the mechanistic and deterministic execution of scripted programs, these robots are controlled by a flexible and elastic network of neurally inspired analogue oscillators. These neuromorph oscillators provide the signals to drive gearbox motors equipped with mallets that hit on tuned RIN-bells (see Figure 4). [1]

Each oscillator by itself produces a beat, and the beat frequency of each oscillator is set by adjusting a variable resistor of a capacitor-resistor pair. Rhythmic structures arise when these five oscillators are coupled with a network of variable resistors. In mechanical or digital setups, these structures would be hard-coded into the ratio of different gears or into the sequencing of a digital program. In the installation variations are realized by having oscillators interact at different timescales: those at slower timescales modulate the connectivity of faster oscillators. How such network connectivity of simple neurally inspired oscillators can be used to create polyrhythmic structures is explained in detail in a previous paper [3]. Here, exactly the same network topology is used: a central pacemaking oscillator connects to

[1] The RIN-bells are manufactured by the Japanese instrument maker, Otsuka Factory.

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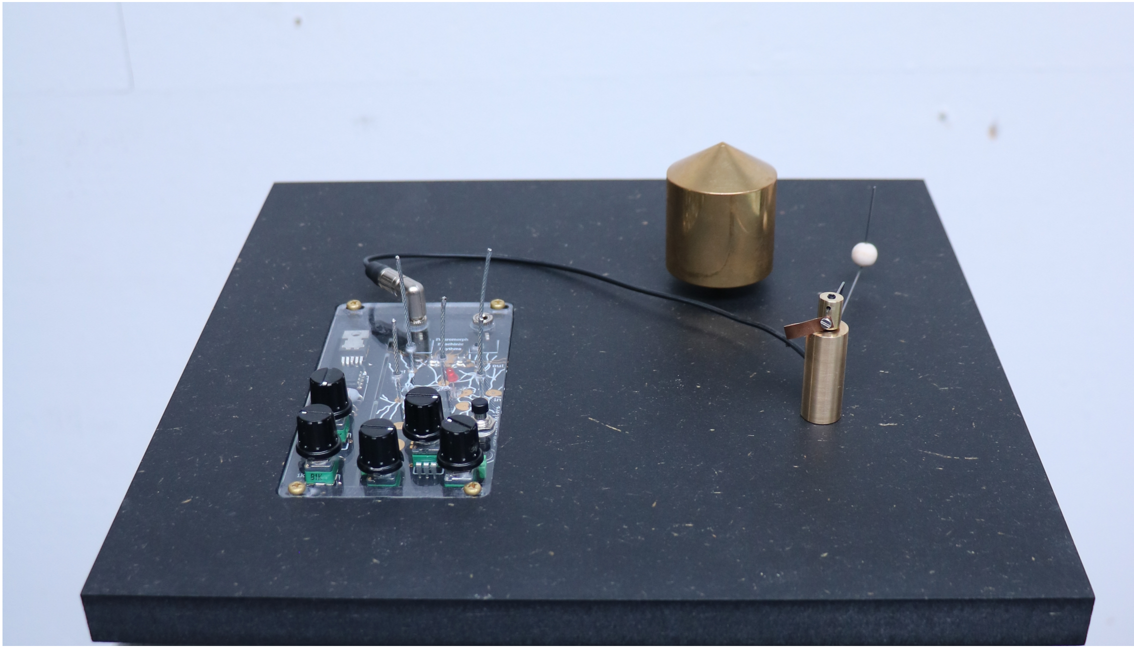

Fig. 1. One of the five robots and an oscillator circuit for hitting on a tuned bell.

the five oscillators, which are all set to different frequencies, but which match up at different fractions of the pacemaker, when connected. The pacemaker is set to an approximate frequency of 240 beats per minute (bpm), the first robot is set to a frequency of 120 bpm, a fraction of two, the second robot is set to 80 bpm, a fraction of 3, the third is set to 60 bpm a fraction of 4, the forth to 40 bpm, a fraction of 6 and the fifth to 30 bpm a fraction of 8. All settings are only approximate, but when the oscillators are connected they will go in sync with the pacemaker at the matching ratio, effectively creating the polyrhythm 2-3-4-6-8.

The decision to realize this installation with RIN-Bells came from a serendipitous encounter, by chance I got to know the producer of the RIN-Bells, who is the director of a Lathe-Company based in the north of Tokyo. For showcasing their ability of high precision lathe-tooling, they created the RIN-Bells with the aim to create a very long-lasting tuned tone. When he presented me the bells, I knew I wanted to make an installation using my robotic setup. He first borrowed and later presented me a set of bells. In the process of developing the installation, the RIN-Bells shaped all my aesthetic decisions. While I usually create works that are fragile, tinkered and that feature a do-it-yourself approach, the bells pushed me into another direction. I chose to use black MDF as support material and also used brass for the motor-holders and mallets.

The installation is an adaption and continuation of a work entitled *network effect* that has been shown as part of the sound art exhibition “on air sound as material – material as sound” at the Art Museum Krefeld (see Figure 2). The installation featured eight tuned bells and a table where visitors could interact with the installation by modifying the network structure. It also featured a two drawing machines and a projection visualizing the effects of network connectivity.

Fig. 2. installation view from the previous exhibition “network effect” at the Art Museum Krefeld.

For NIME I will bring a variant that will run fully autonomously without user interactions. Instead of visitors manipulating the network configuration, the installation will modify its own network structure by switching on and off small relays, that are either conducting or not, thus allowing the installation to go from a mode of connectivity where polyrhythmic structures emerge into a mode of disconnect where each robot is just following its own regime. This appearance of structure as an effect of network connectivity will be made visible through a projection of the mutual relations of oscillators driving the five robots (see Figure 3). In addition to the connectivity, slow-running oscillators also modulate the activation of individual oscillators. A subtle influence modifies the activation of the oscillator; the robot keeps on moving but, under that influence, does not move its mallet far enough to strike the bell. As a matter of fact, sequences of silence are introduced, yet there is never a standstill but always movement within the installation, just periods without bells being stroked. The setup of the installation for NIME will be site-specific; the robots may be placed on one or more tables instead of pedestals. The oscillators to modulate activations and network connectivity will not be mounted on a table as in the previous installation, but instead they will be mounted into an eurorack case for modular synthesizers.

3 PERFORMANCE NOTES

The setup of the installation is quite flexible, the robots can be mounted on pedestals or on tables. The central pacemaker and the modulating oscillators will be mounted into a modular synthesizer eurorack that can be placed on a table. For connecting all the cables, I will need one day on site, if possible. I can add a motion-detection sensor, so that the installation only turn active when visitors are present. Ideally, it should be installed in a separate room. A projector and a screen to project on (can be a white wall) should be provided.

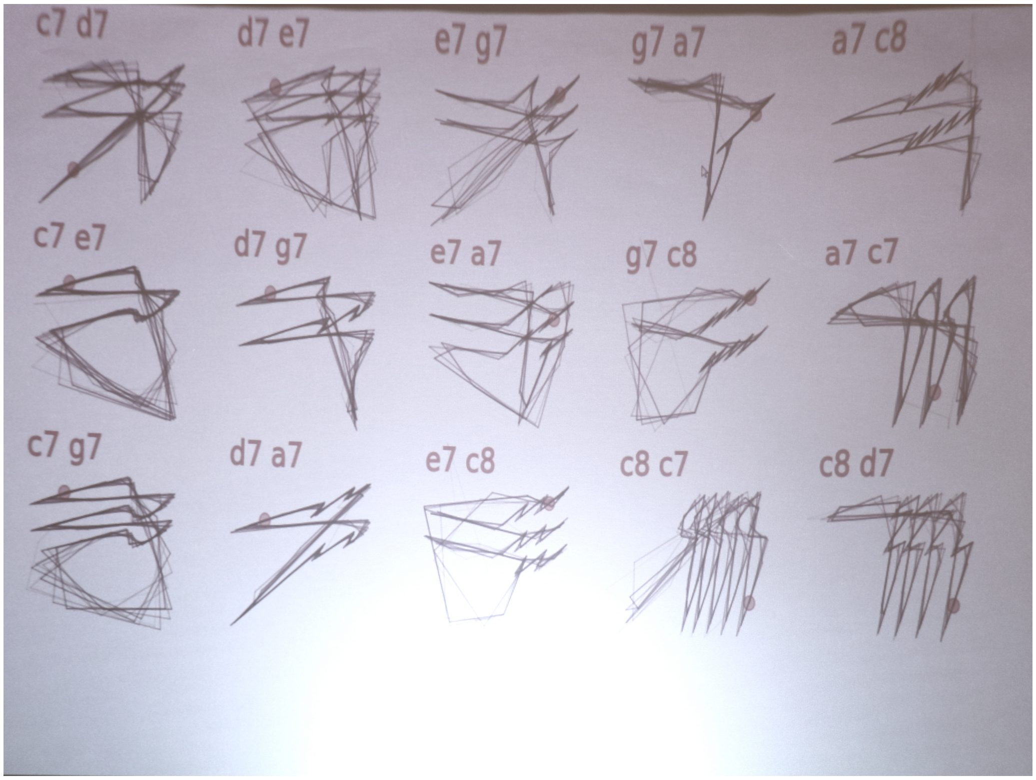

Fig. 3. Photo of the projection of the x-y plots of multiple oscillators

4 MEDIA LINKS

- Video: https://vimeo.com/912950719
- Audio: https://tanukitunes.com/library/tracks/124672/

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REFERENCES

[1] Herbert Bruderer. 2020. Historical Automatons and Robots. *Milestones in Analog and Digital Computing* (2020), 593–735.

[2] Yu-Hsun Chen, Marco Ceccarelli, and Hong-Sen Yan. 2018. A historical study and mechanical classification of ancient music-playing automata. *Mechanism and Machine Theory* 121 (2018), 273–285.

[3] Christian Faubel. 2021. Emergent Polyrhythmic Patterns with a Neuromorph Electronic Network. In *NIME 2021*. https://nime.pubpub.org/pub/g04egsqn.

[4] Elizabeth Stephens and Tara Heffernan. 2016. We have always been robots: The history of robots and art. *Robots and art: Exploring an unlikely symbiosis* (2016), 29–45.

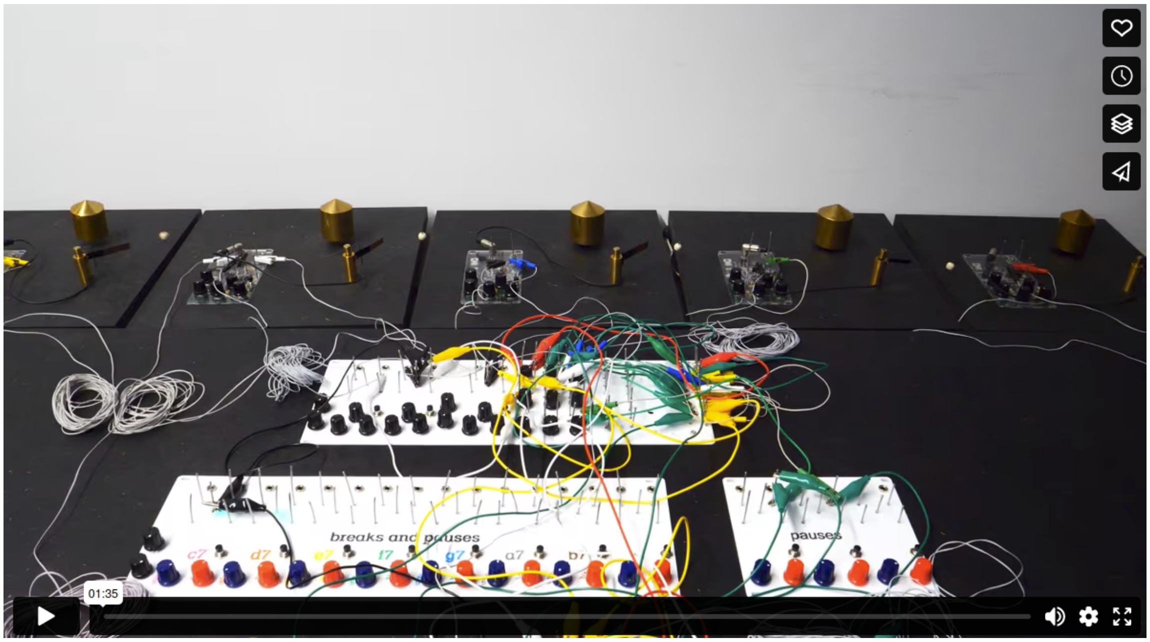

Fig. 4. links to online media, a video and a example recording of the sound of the installation: https://vimeo.com/945804194 https://tanukitunes.com/library/tracks/126337/