AUGMENTING PHYSICAL OBJECTS WITH MUSICAL ALGORITHMS AND ROBOTIC CONTROL

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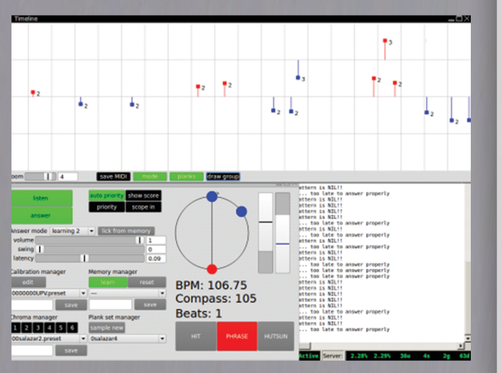
Abstract:
Computers can provide us with all the tools we need to compose and perform music, but artists and audiences may experience a feeling of disconnect between the physical action of mouse-clicking and the sounds being emitted. My aim was to design an interface that facilitates an interaction between the "real" world and the digital. Is it possible to control physical objects with digital algorithms? The interface allows real-time musical manipulation of electronic actuators that can be attached to a limitless number of surfaces, objects or musi cal instruments. A performer plays rhythms in real-time which are interpreted by a computer software, controlling the flow of current in a circuit. A contact microphone picks up surface vibration, creating an audio signal to connect to an amplifier or process on a computer, demonstrating a successful interplay of digital interfacing with acoustic sound.

Aims:
To explore new approaches to instrument design combining algorithmic musical processing with real-time input and acoustic sound.

To create a novel interface that facilitates an engaging physical interaction between digital technology and the physical world.

Devising an open-ended hardware/software package:
Early research was centred around building a digitally controlled circuit to control electromagnetic actuators called solenoids, for a single-purpose - to pluck strings. However, after experimentation, I found the solenoids gave fantastic results with a wide range of sound sources. This lead to the creation of a multi purpose interface DIY kit, inspired by the EBow. The kit is designed with inexpensive components and Open Source software, which will encourage a community of users to augment physical objects and instruments with digitally controlled robotics

International Conference on Live Interfaces (ICLI)
The first week of my project was spent working on the 2016 ICLI conference held at Sussex University. The conference promotes discussion on the role of the interface in creative expression in the arts. Here are some examples of work designed for interaction between human performers and digital processing.

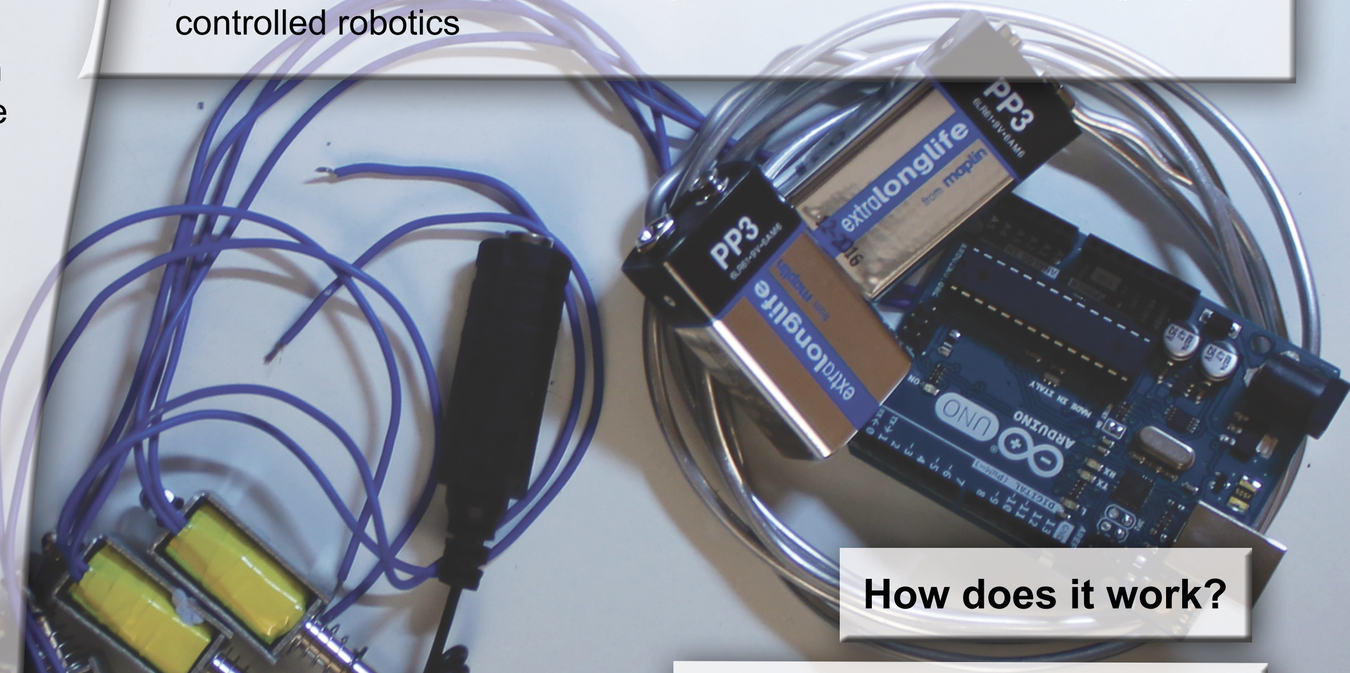


Alexander McPherson - *The Magnetic Resonator Piano*

This instrument uses electromagnetic actuators to enduce vibrations in the strings of a grand piano. A sensor reports the continuous position of each key, allowing a performer a greater range of timbre shaping affordances such as infinite sustain, note crescendos and harmonics. The sound generation is fully acoustic as it would be with an unmodified piano. This shows that digital code can not only be used to control the piano but to extend its functionality.

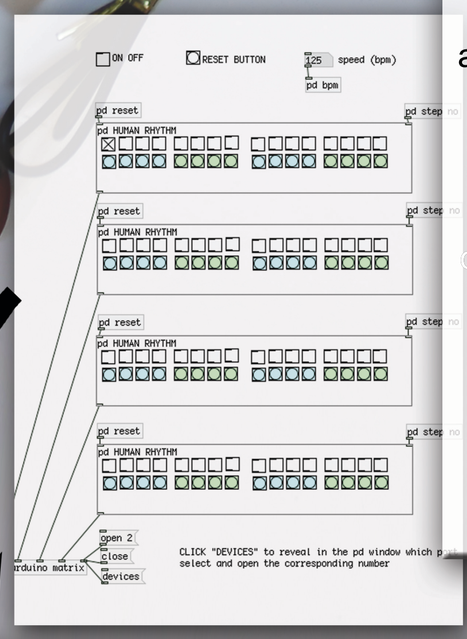
Enrike Hurtado - *Interfacing the Txalaparta*

The Txalaparta is a Basque percussion instrument for two performers, playing in call-and-response. Hurtado's interactive software reponds to a single player's improvisation. It analyses the actions of a single performer, using transients and pitch detection from the audio feed to interpret rhythmic patterns, tempo and note values. Responding in real-time, the software plays back recorded audio samples of Txalaparta hits according to the traditional playing rules of the instrument.

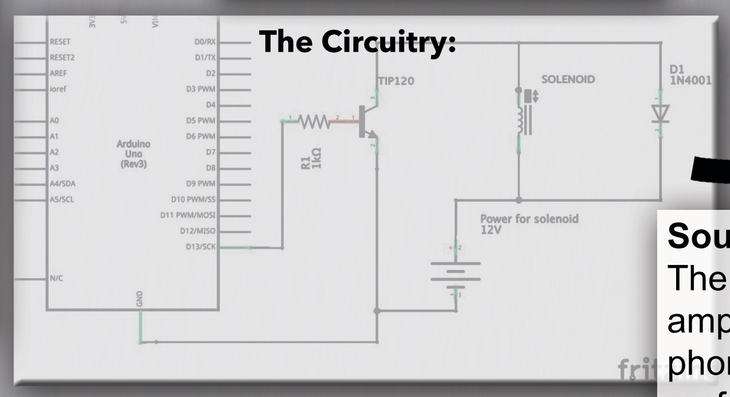


How does it work?

Digital Input & Mapping Stage:
Rhythms are performed in real-time on a drum pad. This information is analysed on the software (created on Pure Data) and quantised to a fixed tempo grid, sending messages of 1 (solenoid on) or 0 (solenoid off). The Pduino library is used for communication between Pure Data and an Arduino Uno, connected to the circuit via the digital output pins. When the current from the Arduino to the base pin of the transistor is high, the circuit between the power supply and the solenoid is complete.



The Circuitry:



Sound Generator:
The solenoids can be used without amplification but a contact microphone senses vibration from the surface itself, reducing the noise of the solenoids activating and highlighting minute acoustic detail.

Conclusion:
Inspired by contemporary research in the field of Music Technology, the proposed interface facilitates a meaningful interaction between the digital and the physical. It's captivating to play, with an tangible link between performed input and sonic output. There are a number of potential improvements to make the interface more expressive. A greater scope of performance dynamics, different time signatures, beat-detection and a setting free from quantisation would open up new possibilities for expressive control. Latency is also a problem when working with audio in Arduino, so the interface has been set for redesign on an ultra low latency Platform called *Bela,* eliminating the need for a computer to carry out the mapping, making the device more portable and user friendly.