HARDWARE & PHYSICAL COMPUTING

P H O T O S O N I C   O F F I C E

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Artur, Femke & PJ

INITIAL PROPOSAL

Prototype — “Echo Chamber”

We initially wanted to set up the back partition of LMUY 04.28 to create an echo chamber where light would influence sound (see sketch of the original idea). We wanted to install four speakers which were constantly playing Arduino-produced sound in the corners, and relays, motors, and colour sensors would be spread across the room. Thus, the light that the participant feeds to the sensors causes the ‘echo’ in sound. The room itself had to be very dimly lit (or even dark) so as to not influence the colour sensors. The back partition of room 04.28 with a surface of about 3,5 x 5 m would therefore be perfect for our installation when closed off.

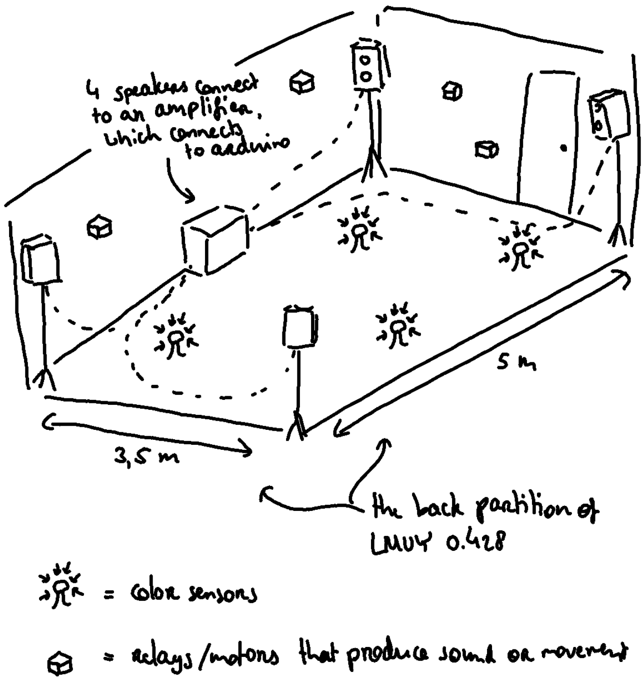

Fig 1: Sketch of the original idea.

Final version — “Photosonic Office”

We used the same space, but decided it would be more coherent if we concentrated the hardware. We also decided to use light sensors rather than colour sensors. We set up a dark office space for the participant to sit in; the space was ‘supervised’ by a masked figure that stood in the corner of the room. The arduino generated sound coming from four directions boxed in the participant like a cubicle. In front of the monitor, there were three photoresistors connected to a second arduino that reacted to glow sticks that the participant could move around. On top of the monitor there were two LEDs and one piezo covered by a box, each reacting to their respective photoresistor. The LEDs would blink when a glow stick was detected, and the piezo produced a continuous sound that would change pitch when detecting more light.

SCHEMATIC DIAGRAMS

We attach two diagrams of our circuits in attachments:

1) diagram of LED, photoresistor and piezo circuit,
2) diagram of Arduino synthesiser.

VISUAL DOCUMENTATION (PJ)

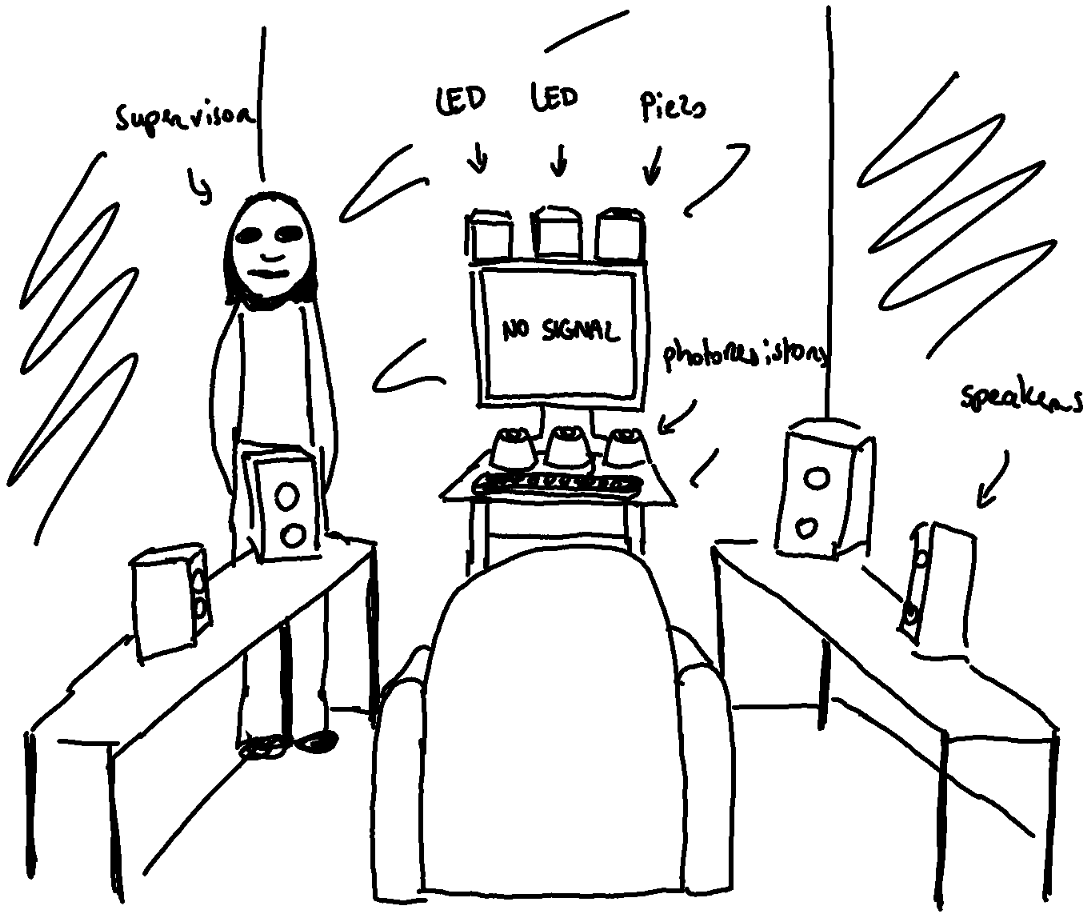

Fig. 2: Sketch of the exhibition.

Image 1: Preparing the room for the installation. The entrance to the room is behind the photographer. The room was secluded from the exteriors by setting up the sliding wall (left).

Image 2, 3 and 4: Documentation of the exhibition Photosonic Office, showcasing visitors interacting with the installation.

Images 1 to 4 depict the space in which the exhibition took place. For the installation a small section of the lecture room was curated in the form of an office-like setting. Using the existing elements of the space i.e a computer and its table, two tables and an armchair were used. A path was created using glow sticks on the floor as the room was darkened to allow effective navigation through the room.

ROLES OF THE TEAMMATES

1) Artur

I was responsible for the audio domain of the exhibition. The Arduino sketch I provided turns the board into a simple polyphonic synthesiser with DCO-based voices (digital controlled oscillator).. The code allows for an arbitrary amount of voices (each getting one digital pin out as “audio output”), however we used only four. A pin outputs a square wave at the audio rate. The sketch adjust the frequencies of each oscillator according to the “squared” rules of Renaissance classical counterpoint (“Palestrinian”), thus aiming at providing consonant intervals at the strong beat of each bar. The melodies’ pitches and rhythms are procedurally generated.

I was also responsible for setting up the speakers and connecting Arduino to them.
During the opening of the exhibition, I stayed there in a mask in the corner of the room, fulfilling the role of a “supervisor”, observing every participant approaching the installation.

2) Femke

Together with PJ, I created a setup with two LEDs and a piezo which would each react to a photoresistor (see diagram and code included). As the room was dark, these photoresistors reacted to the glowsticks that participants would hold to the photoresistors. To cover the LEDs and hold up the photoresistors, I designed and 3D printed these parts (see stl files included).

3) PJ
My contribution involved the development of the concept and documentation, soldering hardware and presentation. Initially the idea was to incorporate servo motors to place the glow sticks on them. I supplied and coded the servos and the presentation material for them were designed and 3D printed by Femke. However, approaching the presentation day, the servos were unresponsive as they broke down during the prototyping phase for the presentation therefore we needed to leave them out of the presentation.

CHALLENGES & APPROACHES

1. Sound synthesis

The Arduino ecosystem already possesses some libraries related to audio (like “Mozzi”). For this project however, I decided to find my own way to use my board as a synthesiser. I managed to create an oscillator by changing the state of a digital pin on and off periodically, turning it into a square-wave digital controlled oscillator (DCO).

Although I began to implement PWM waveshaping as well as a digital LFO and a simple gate (for envelope), I couldn’t refine it on time and I decided not to use them in the final presentation.

The result was a satisfying 4-part polyphony of independent voices, forming a continuous stream of consonant music thanks to the algorithm choosing pitches and rhythms (understood here as time taken for the pitch to change) in a manner resembling rules of the Renaissance classical (“Palestrinina”) counterpoint.

2. Renaissance Counterpoint Arduino Sketch

The rhythmic contours of classical Renaissance melodies were convincingly reproduced by an algorithm, which included various choices for the next rhythmic value on the basis of a randomness factor limited by analysis of the current beat position (strong or weak).

From the other hand, the domain of pitch – although mostly achieving consonant “feel” – drifted away from the style of Palestrina more noticeably. Choosing the next pitch interval turned out to be not enough: a lack of well-defined rules regarding contours and architecture of climactic points of the melody rendered the result much more amorphous.

Implementation of the rests (pauses in sound generation) stumbled upon an unexpected obstacle. When one voice pauses, the whole sounding pitch lifts up and the tempo accelerates. This is due to a sudden simplification of pitch and rhythm calculation, which when paused, increased the absolute clock rate of the unit.

The resulting polyphony — played in the office environment — was pleasingly disturbing, misfitting the whole setting. I am looking forward to implementing my algorithm in a more music-purposed environment like PureData soon.

3. Speaker setup

The direct output of Arduino’s digital pin is 5V, making it too “hot” for the speaker system. Thus, the signal of each pin was attenuated by the potentionemer’s 10kΩ capacitor, allowing the direct connection to the speaker. The quality of the signal itself — raw as it was — turned out to be acoustically pleasing and warm and didn’t require more waveshaping.

4. Colour or Light Detection

At first, we wanted to use colour sensors that reacted to RGB LED strips. However, these sensors were very expensive and the sensor that we had did not react well to coloured light. Therefore, we decided to use photoresistors and glow sticks instead.

5. **Servos**

We initially wanted to use servos that were influenced by photoresistors instead of the LEDs and piezo, but we had trouble programming them and connecting them to a proper power supply and eventually fried them. When this happened, we decided to change our approach but re-use the boxes that we made.

6. **Communication Between Arduinos**

In our original idea, we wanted to let the light influence the sound by communicating a value generated from the photoresistors to the arduino that was producing the sound. However, because we had a few hiccups along the way (colour sensor not working as we had hoped and frying the servos) we did not have time to dive into communication protocols. We finally decided to keep the two arduinos separate; one creating the ambiance, the other creating the interaction.

RESULTS

"**Photosonic Office**" introduces a sense of transmaterial experience by producing a light and sound interactive exhibition or installation. We are constantly buried in photosonic fiction as the echoes of technology instil a mechanical and robotic dimension to our everyday way of being. The work invites the visitor to experience an unconventional (cyber-punkish) professional space while wearing the glow sticks provided. The goal is to disconnect from traditional forms of professionalism and experience the transformation of special hues of light that transport us back to our childhood and even beyond, to the disembodied synthetic sounds of procedurally generated pseudo-ecclesiastic counterpoint (so sounds that are normally not heard often in the official spaces around us anymore). This materialised juxtaposition of light, sound, and space will be exhibited in the back partition of LMUY 04.28.

In the framework of the hardware, four speakers, three LEDs, a piezo and two arduinos were used. For the development of the entire installation, the backside of LMUY 04.28 was curated in an office setting to emphasise and bring across the theme of the installation. As an addition to the exhibition glow sticks were used for navigation as well as interactive purposes as they served as the input 'devices' that were provided to the visitors to interact with the installation.

LICENSING

CODE

We attach the arduino sketch files (.ino) in the attachments:
1) AUDIO_SquareWaveGenerator.ino (synthesiser)
2) hpc_piezoandleds.ino (handling piezos and light sensor)

ACKNOWLEDGEMENTS

The mount for the boxes was based on the Printables design ‘servo stand’ by Gabe9000.

The other .STL files used for 3D printing are of Femke’s original design.