Feedback Mop Cello

Assembly Guide and Documentation

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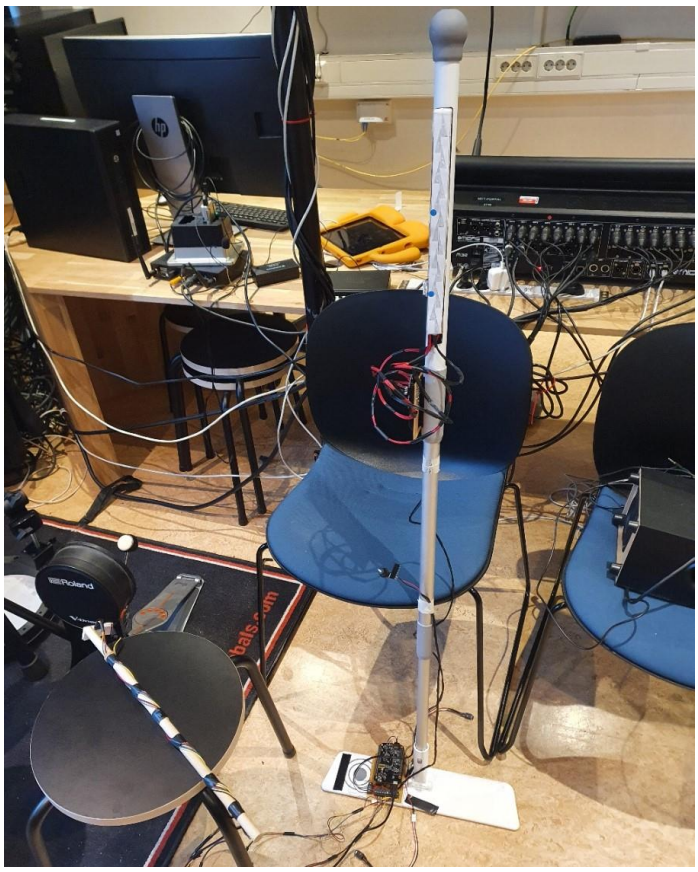

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The Feedback Mop Cello is an interactive music system that attempts to present interaction with acoustic feedback through a control interface grounded in a metaphor of the cello. This guide provides information on how to assemble a version of the instrument.

1. System Overview

The Feedback Mop Cello consists of two major components:

1. The Bow
2. The Body (the mop)

These two components are analogous in form and function to those of the cello.

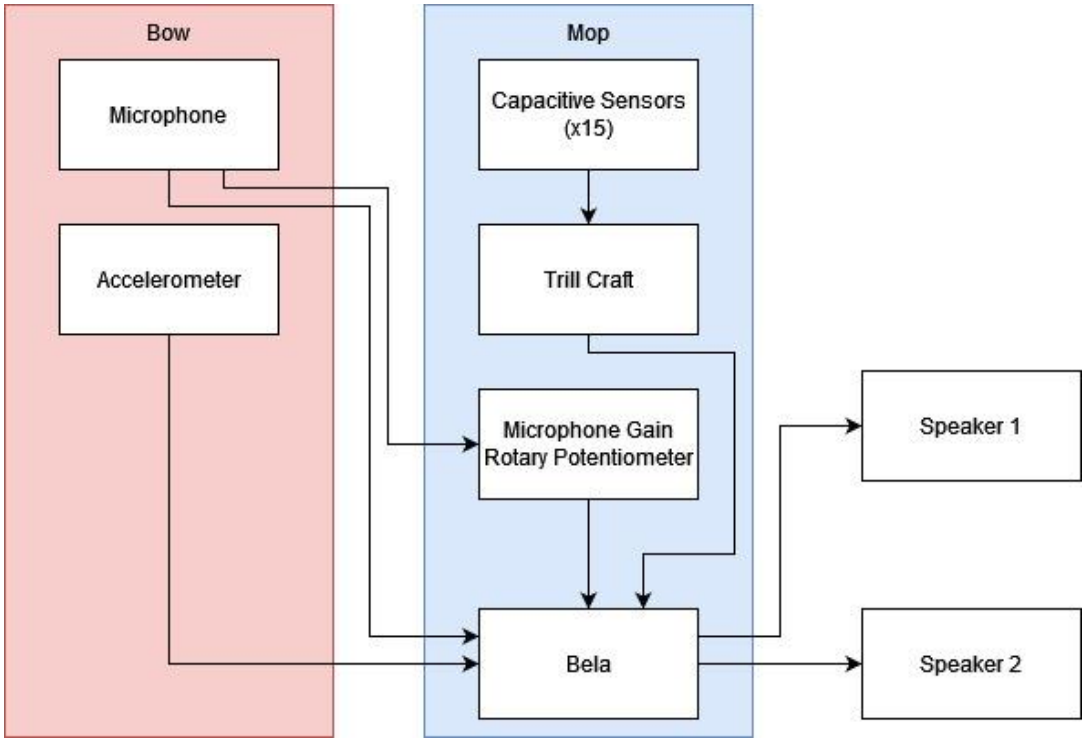

Figure 1.1 – A block diagram overview of the system components

Figure 1.1 and 1.2 show an overview of the system. Mounted upon the bow are two sensors: a microphone and an accelerometer. Mounted upon the body are a series of 15 capacitive sensors, the Trill Craft breakout board used to process the capacitive sensors, and the Bela board, as well as a rotary potentiometer used to set the gain of the microphone. There are two mini-jack outputs from the base of the body, the first of which outputs the unprocessed microphone signal and which should be connected to a speaker placed next to the performer and the second of which outputs the processed audio signal which should be connected to the front of house speaker system.

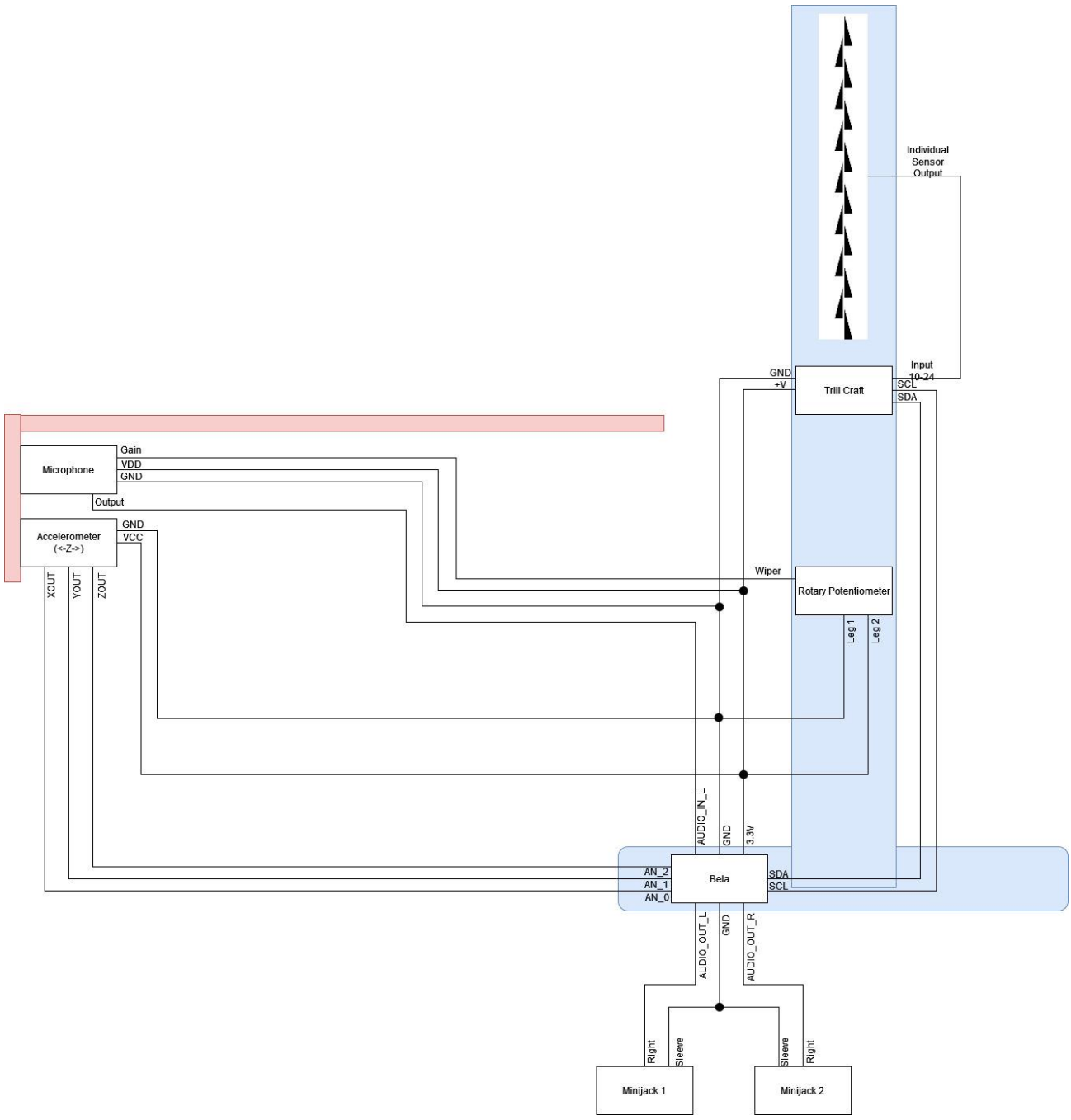

Figure 1.2 – A block diagram overview of the system components and their position on the two instrument components. Included are the electronic connections.

2. Hardware Construction

2.1. The Bow

2.1.1. You Will Need

1. A cylindrical stick of dimensions Length 450mm x Diameter 15mm. This can be of a material such as wood or plastic. Important is that at least one end is smooth upon which the front plate can be affixed.
2. A front plate of dimensions Width 25mm x Height 50mm. This can be of a material such as cardboard or wood.
3. A microphone with the following pins
    a. Signal Output
    b. Voltage
    c. Ground
    d. Gain
4. An accelerometer with the following pins
    a. X-Output
    b. Y-Output
    c. Z-Output
    d. Voltage
    e. Ground

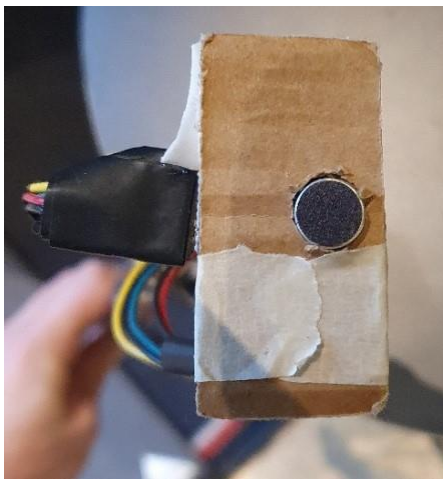

Figure 2.1 – How the microphone should be affixed to the front plate

2.1.2. Construction

1. Cut a hole towards the top of the front plate with a diameter of the microphone capsule.
2. Affix the microphone to the rear of the front plate with the capsule extending through the hole (figure 2.1).
3. Below the microphone affix the accelerometer (figure 2.2). Ensure that the Z-axis is pointing along the same axis as the microphone diaphragm.

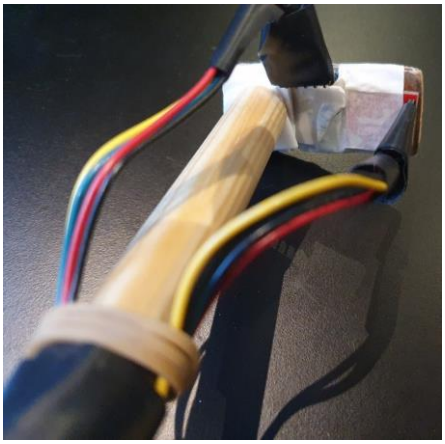

Figure 2.2 – Placement of the sensors. Left – microphone, Right – accelerometer.

Figure 2.3 – The bow with the wiring wrapped around the stick

4. Wire the connections of the microphone and accelerometer. The wiring can either be wrapped around the stick (figure 2.3), or a hole can be drilled along the length of the stick and the wiring passed through here. It is important that there is some physical resistance to the stick when bowing along the mop. The wiring can serve this purpose if wrapped around, but if the wiring is hidden then some material should be affixed along the length of the stick at evenly spaced intervals in order to provide physical resistance and haptic feedback when bowing.

2.2. The Body

2.2.1. You Will Need

1. A flat mop. This should be similar in form to the mop shown in figure 2.4. The mop fibre part should be removable, leaving the base flat. The handle should have two rotational degrees of freedom, allowing it to be at an angle to the base. An optional advantage is a telescopic handle so that the height of the mop can be adjusted for different performers, although this is not absolutely necessary.
2. A Bela board.
3. A Trill Craft breakout board.
4. A rotary potentiometer.
5. Two mini-jacks.
6. Aluminium tape.
7. Two back plates upon which to mount the capacitive sensors of dimensions Width 20mm x Height 250mm. This can be of material such as cardboard or wood.
8. Material for padding between the two back plate layers such as double-sided tape.
9. At least two printed copies of the capacitive sensor template. Two versions of the capacitive sensor design can be found. It is personal preference which to choose. When referring to the template what is meant is a single column of 15 individual sensors.

Figure 2.4 – The type of flat mop that should be used (Image from biltema.no)

2.2.2. Construction

2.2.2.1. Capacitive Sensors

1. Tape one of the sensor templates onto one of the back plates. This should be placed so that the row of 15 sensors is central upon the back plate.
2. Make a hole through the template and back plate at the centre of each individual sensor.
3. Pass a wire through each hole. The open end of the wire should lie flat against each sensor on the template on the front of the back plate and the rest of the wire should lie flat against the rear of the back plate.
4. Tape the second sensor template on top of a strip of aluminium tape.
5. Cut out each of the 15 individual sensors from the aluminium tape, following the template which is attached to the top.

6. Place each of the individual sensors that have been cut from the aluminium tape on top of the corresponding position on the template which has been taped to the back plate. Each of these should cover the open end of the wire.
7. Add the padding on top of the wires attached to the rear of the back plate. This could consist of several layers of double sided tape.
8. Affix the second back plate behind the padding. The result should resemble figure 2.5 and 2.6.
9. (Optional) Place thin cellotape over the top of the sensors in order to provide protection for the sensors.

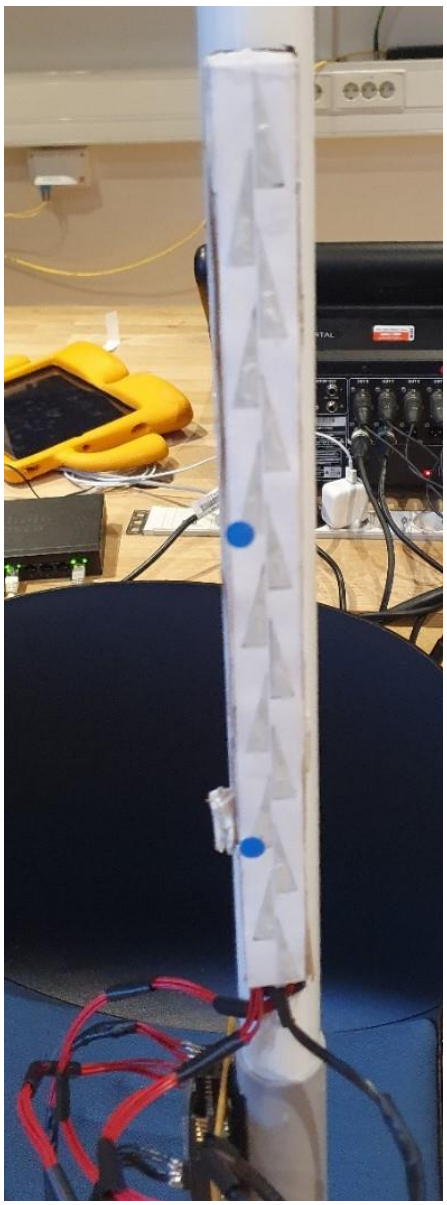

Figure 2.5 – The neck from the front

2.2.2.2. Rest of the Body

1. Affix the capacitive sensors towards the top of the mop handle (figure 2.7a). This should be at a level that is comfortable to play on, at around shoulder height.
2. Affix the Trill Craft below the capacitive sensors (figure 2.7b). This should be placed facing inwards, so that any wiring is not disturbed when playing the instrument.
3. Affix the rotary potentiometer towards the bottom of the mop handle (figure 2.7c). This should be at around knee level.
4. Affix the Bela board to one side of the base of the mop (figure 2.7d). If a prototype board is used to make the connections on the Bela, the prototype board can be attached instead, and the Bela placed upon this upside-down.
5. Tape each of the mini-jacks to the base of the mop (figure 2.7e/f). The mini-jack outputting the unprocessed signal should face outwards from the rear of the mop and the mini-jack outputting the processed signal should face towards the front.
6. Connect all wiring.

Figure 2.5 – The neck from the side

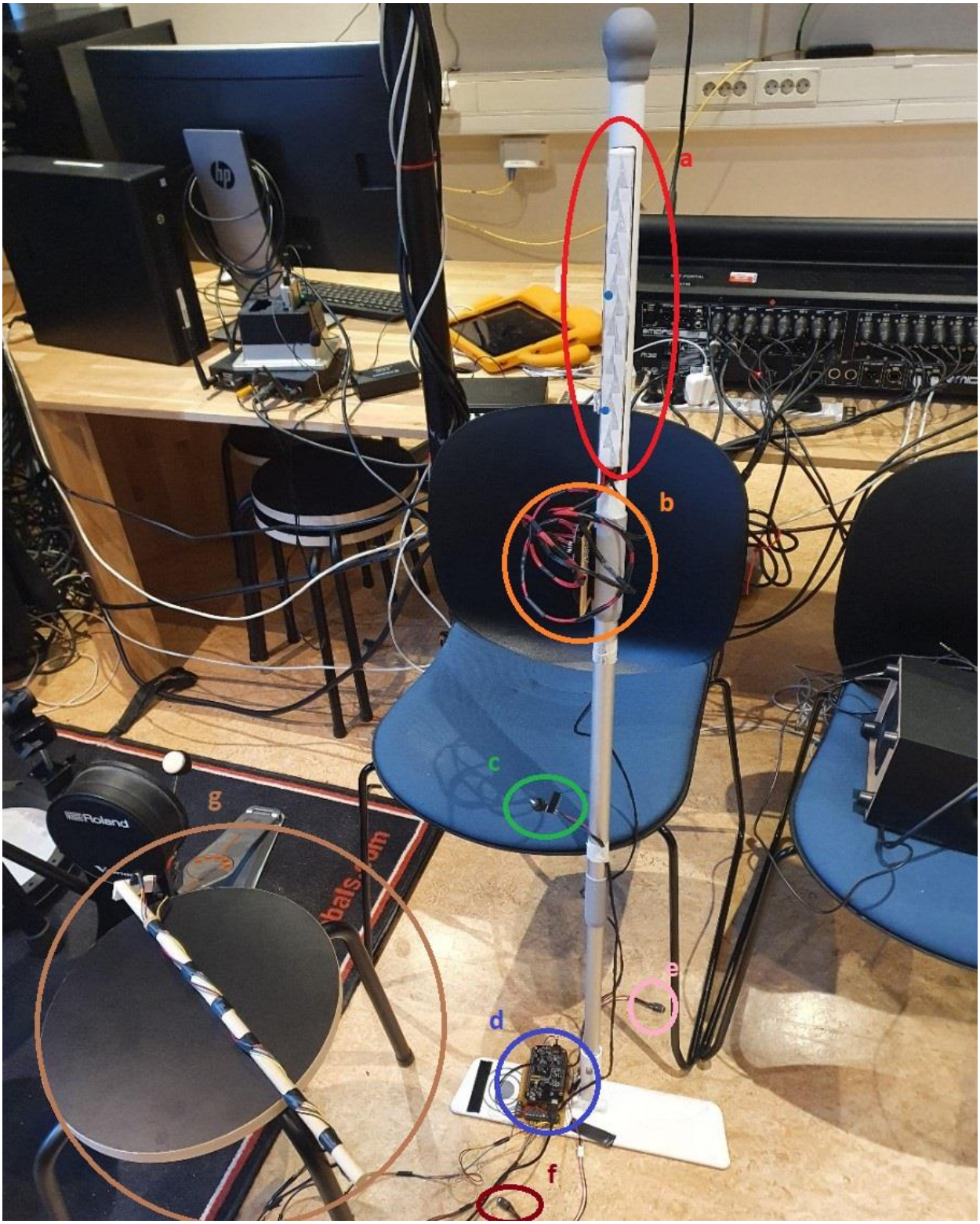

Figure 2.7 – a) Placement of the neck b) Placement of the Trill Craft c) Placement of the Rotary Potentiometer d) Placement of the Bela board e) Placement of the non-processed mini-jack output f) Placement of the processed mini-jack output g) The bow

3. Electronics

Figure 3.1 shows the electronics schematics for the system and figure 3.2 shows a matrix of component connections.

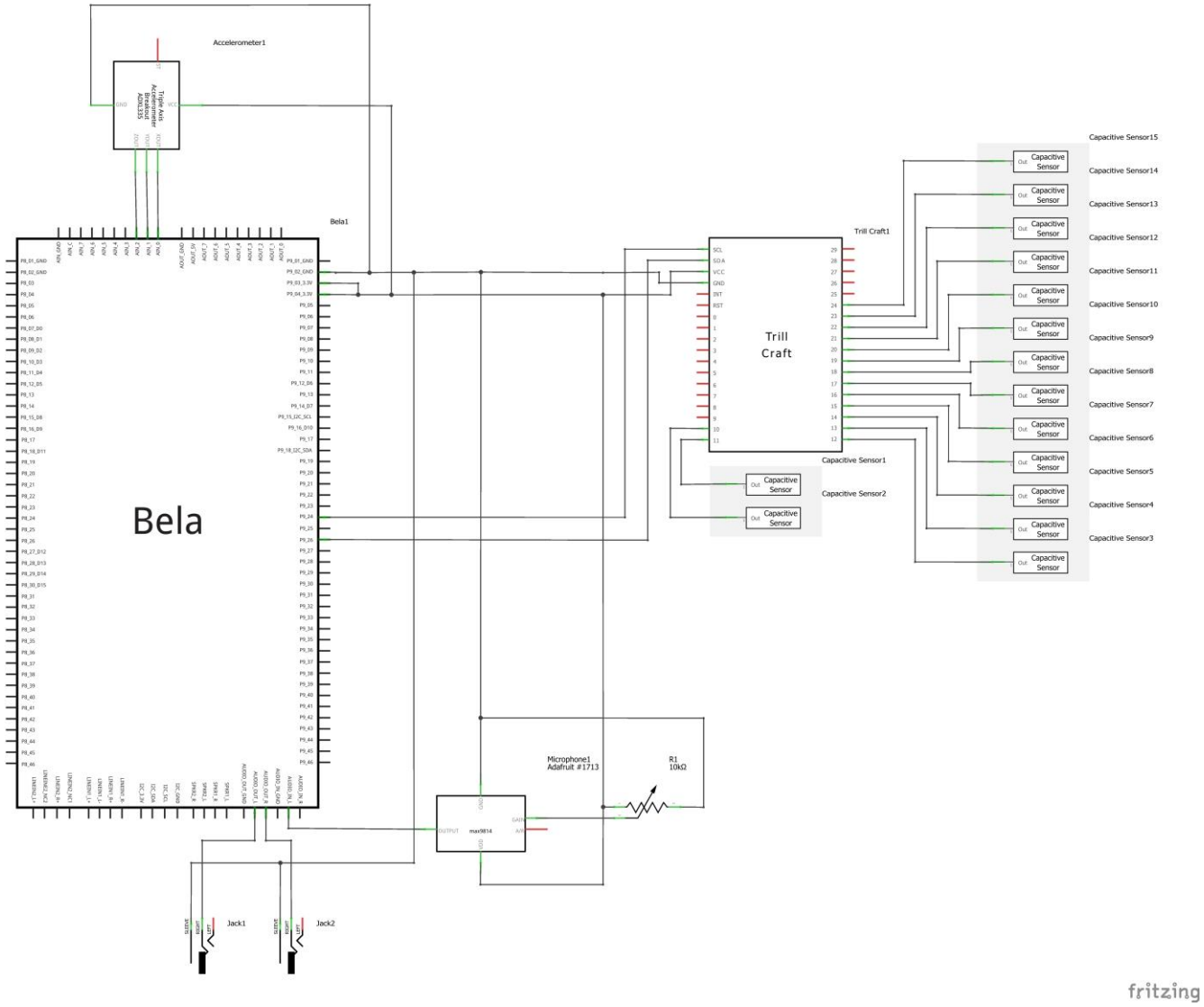

Figure 3.1 – Electronics Schematic

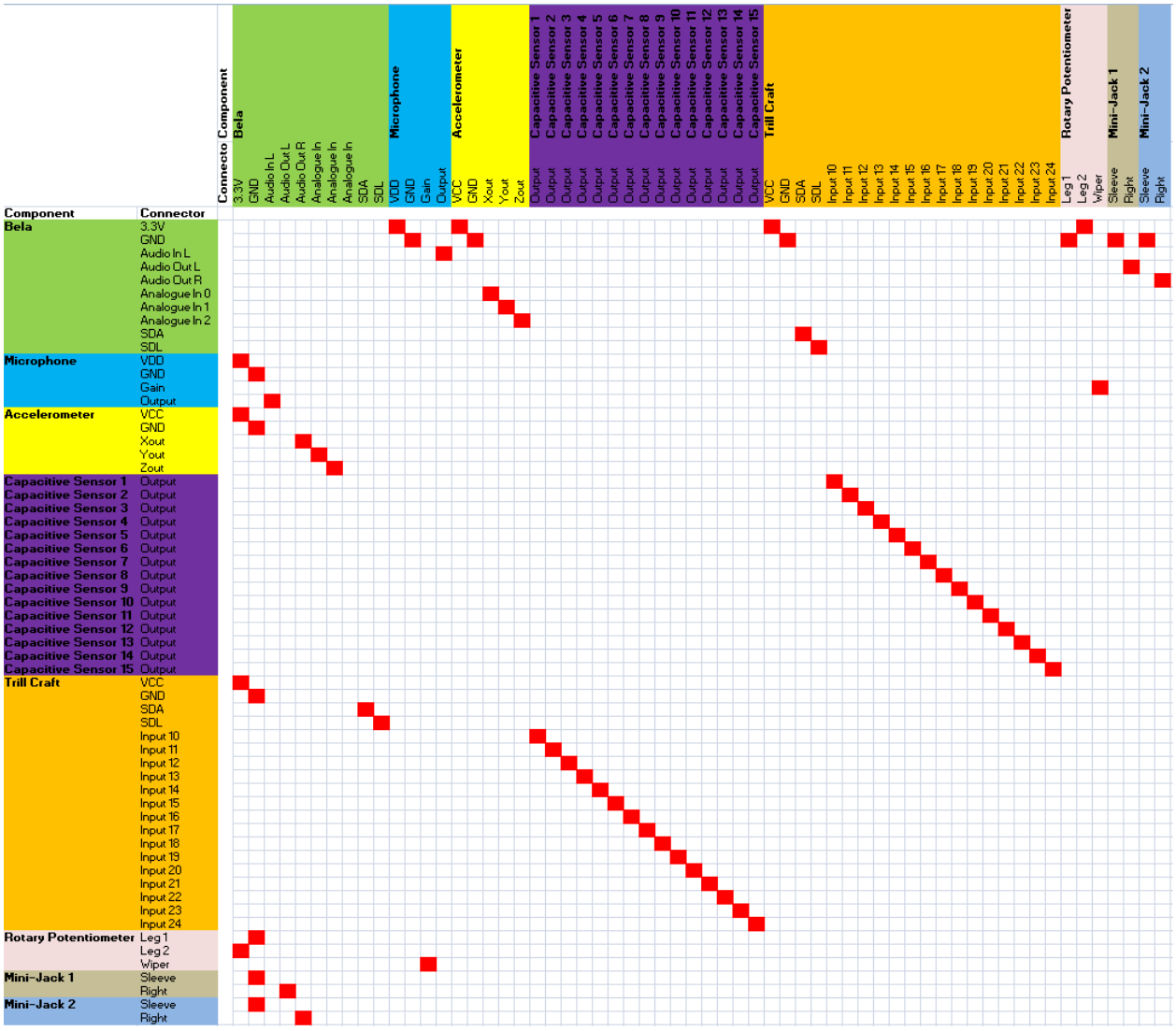

Figure 3.2 – Electronics Connection Matrix

4. Software

4.1. Bela Settings

The system only requires 3 analogue inputs, so can be run at a sample rate of 44100Hz. It runs without any dropped blocks at a block size of 128. At 64 there is very occasionally a dropped block, but this is very rare and has no perceptible effect when playing the system. 64 seems to be the lower boundary, as running the patch at 32 blocks results in constant and consistent dropped blocks.

It is worth experimenting with the microphone input gain as well. Slightly clipping the input signal provides a sound more resembling a string instrument, and heavily clipping it provides the system with a very different feeling. By default the input gain is set to +7dB.

4.2. Pure Data

The following abstractions are required to run the Pure Data patch:

1. trill_init.pd
2. trill_input.pd
3. acc_magnitude~
4. string_position_v2.pd
5. vibrato.pd
6. bowing.pd
7. deltasig~.pd
8. pitchshifting.pd
9. pitchshifter~.pd
10. scalelin.pd
11. output.pd
12. ghost_sensor.pd
13. scalesiglin~.pd
14. adc_input.pd

deltasig~.pd and scalesiglin~.pd are both from Stefano Fasciani's sfalib library, and scalelin.pd is an adaptation of scalesiglin~.pd to work with control signals. pitchshifter~.pd is an expansion of help patch G09.pitchshift.pd and was found at: http://www.pdpatchrepo.info/hurleur/pitchshifter~.pd

Comments within the patch explain the functionality and mappings.

5. Playing the Feedback Mop Cello

The system should be played sitting, with the mop placed between the legs. A foot should be placed upon the side of the base on which the Bela is not mounted in order to keep it stable. The speaker connected to mini-jack one should be placed to the side. Figure 5.1 shows the conventional setup for playing with the system.

The conventional method of playing is to bow across the mop back and forth towards the speaker, however there are many methods with which one can create sounds with the system. Mini-jack two should be connected to the front of house speakers, but can also be used to generate feedback. A good starting point is to set the output volume level of the front of house speakers so that when the microphone gain is at a minimum, no feedback from the front of house speakers is generated, and when the microphone gain is at a maximum, feedback is generated from the front of house speakers.

The system is suitable for use by both left- and right-handed performers.

Figure 5.1 – Playing Position