The Hyper-Ney Technical Guide

This guide documents the technical specifications and assembly and connection instructions of the Hyper-Ney instrument.

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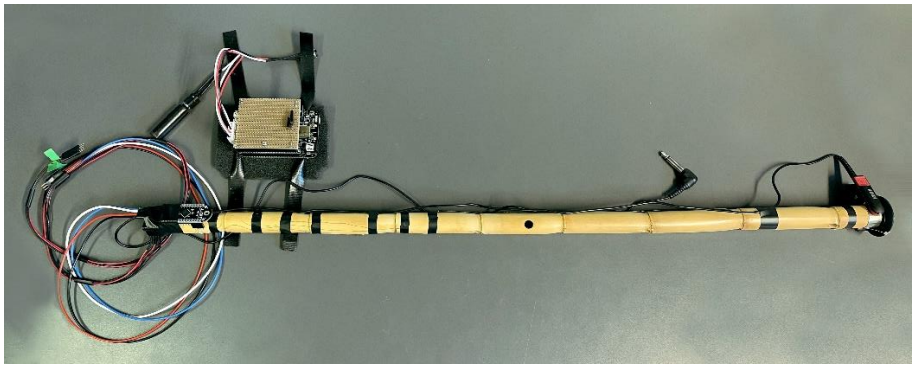
1. Introduction

The Hyper-Ney is an enhanced digital musical instrument built by integrating sensors to a traditional ney flute with a mouthpiece (*baspare*). This documentation is written for a "Mansur" size ney. However, the Hyper- Ney can be built for other sizes of ney. Please see for size reference: https://en.wikipedia.org/wiki/Ney.



2. Hardware

2.1. Required Material

The Hyper-Ney is built by integrating the following components:

- A ney flute with a mouthpiece (*baspare*)
- Aluminum tape or copper tape
- Copper strands (or similar conductive wires)
- Insulated wires
- Female and male header pins
- BeagleBone Black
- Bela
- Trill Craft
- SparkFun SEN-09269 Accelerometer (or a similar accelerometer with 3 axis)
- Contact Microphone
- Jack to mini-jack adapter
- 3.5mm audio jacks
- Perfoboard (suitable for the Bela)
- Electrical tape
- Soldering material
- Velcro straps
- Insulating foam
- Solid wires (for stabilizing the boards on arm)
- USB power source (for powering the BeagleBone Black)
- USB Barrel Cable
- USB A to USB B cable (for connecting the BeagleBone Black to the computer)

2.2. Design

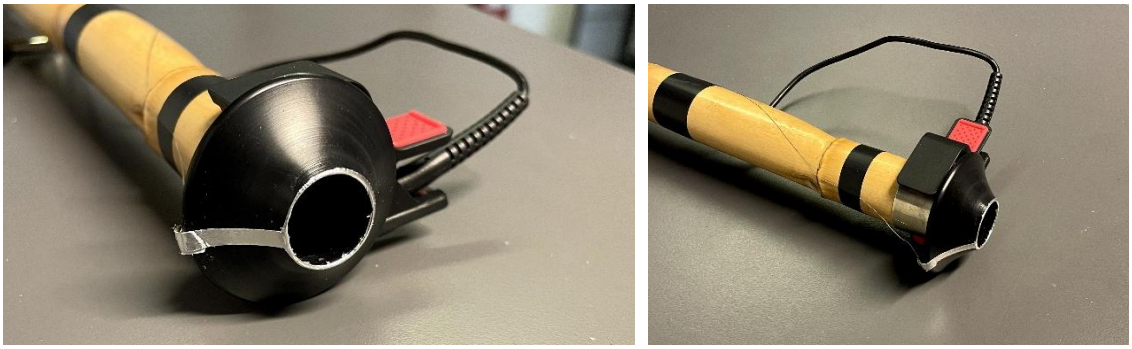
The Hyper-Ney is designed to be played very similarly to conventional playing techniques of the ney. The Hyper-Ney is built by integrating capacitive sensors to a ney's holes and at the mouthpiece. The sensors are placed on the ney in a way that they do not interfere with the traditional playing techniques. The Hyper-Ney is designed to be played in a sitting position. The sensors are connected to the Bela board, which is a low-latency audio processing platform. The Bela board is connected to the BeagleBone Black, which is a single-board computer. BeagleBone Black, Bela and the input and output jacks are designed to be worn on the player's arm. See the figure below showing the overall design of the Hyper-Ney.

2.3. Assembly Instructions

The assembly instructions are given in this section is based on a prototype on a *Mansur* size ney. However, the instructions can be adapted for other sizes of ney. The assembly instructions are given in the following steps:

1. Build the mouthpiece sensor.

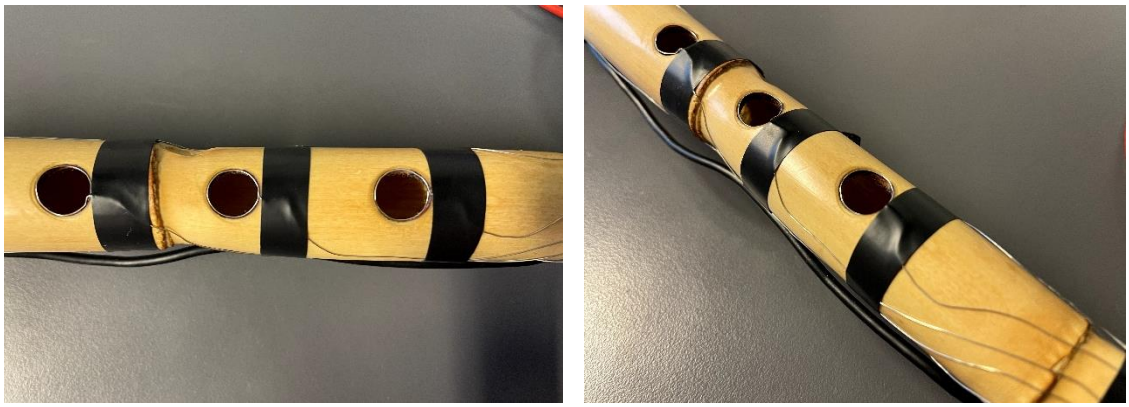
Cut a circle-shaped aluminum tape and carefully place it around the mouthpiece with a 1-2cm rectangle extension. The radius of the circle depends on your ney's mouthpiece size; however, the width of the tape shouldn't be wider than 3 mm as it may introduce too much conductance. See the figure below for reference. Solder a thin metal wire to extension of the aluminum tape on the mouthpiece. The thin metal wire should be long enough to reach the tail of the ney. Finally, slowly remove the cover on the back of the aluminum tape and tape the piece to the mouthpiece carefully.



Mouthpiece Capacitive Sensor

2. Build the hole sensors

For the 6 holes in the front face of the ney, prepare an encirculated thin metal wire specific to the size of each hole and tape it safely right outside of the hole. The encirculated thin metal wire at each hole should be placed around and slightly inside the hole to be able to touch entirely with the corresponding finger and partially-touch if wanted (e.g., half-holing). The tailing of the encirculated thin metal wire should be long enough to reach the tail of the ney and can be taped at intervals along the ney until slightly below the last hole. Make sure that the encirculated thin metal wire is efficiently placed around the holes and along the ney. The thin metal wires should be placed and taped on the ney in a way that they do not touch the fingers of the player while playing. See the figure below for reference.



Hole Capacitive Sensors

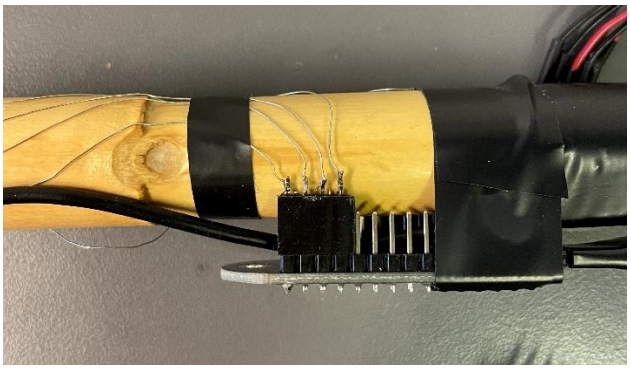
3. Build the on/off capacitive switch

The on/off capacitive switch is built by placing a spiral-shaped thin metal wire on the tail and front of the ney, below the lowest hole. Tape the on/off switch sensor with a small piece of tape securely.

On/off Capacitive Switch

4. Solder the thin metal wires to female header pins

Take two 4-pin-long female header pins and bend the pins slightly to the side. Plan the placing of the header pins as shown in the figure below to be able to fit the Trill Craft in in the next step. Solder all the thin metal wires to the pins making sure that they are not touching each other. See the connection diagram to see which thin metal wire is soldered to which pin. See the figure below for reference.



Female Headers Pins Connected to the Trill Craft

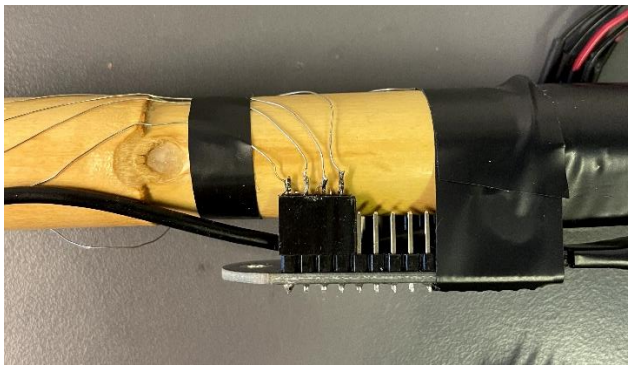
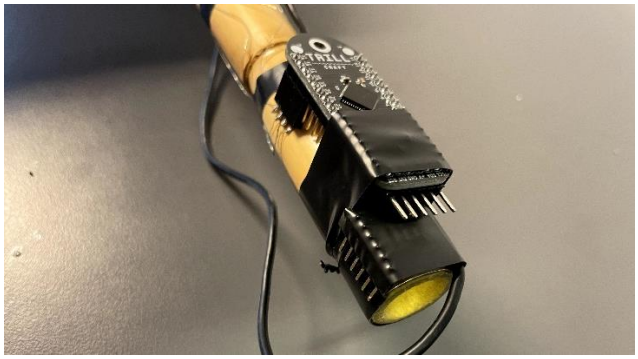
5. Attach the contact microphone

Attach the contact microphone close to the mouthpiece as shown in the figure below. Route it's cable along the ney until its tail.

Contact Microphone Attachment

6. Insert and place the Trill Craft

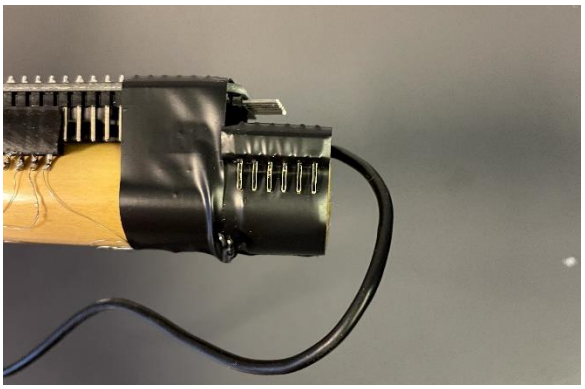
Insert the Trill Craft into the female header pins on the front face of the body, as shown in the figure below. Make sure that the pins are correctly inserted. Tape the lower half of the Trill Craft to the tail of the ney. Make sure that the pins that are for connecting to the Bela are not blocked and properly left outside of the Ney. See the figure below for reference.

Trill Craft Placement

7. Place the accelerometer

Place the accelerometer to the tail of the ney on the back of the ney. The x-axis should be parallel to the length of the Ney, while the Z-axis is coming out of the ney. Tape the accelerometer to the metal piece at the end of the ney to secure it. Make sure that the axes are perfectly aligned with the ney's faces and the pins are not blocked and properly left outside of the Ney. See the figure below for reference.

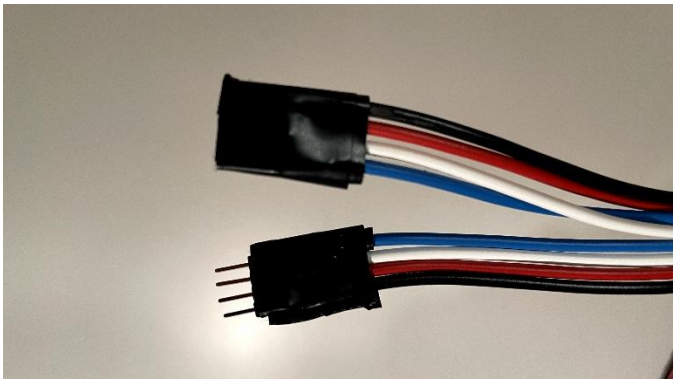


Accelerometer Placement

8. Prepare connection cables

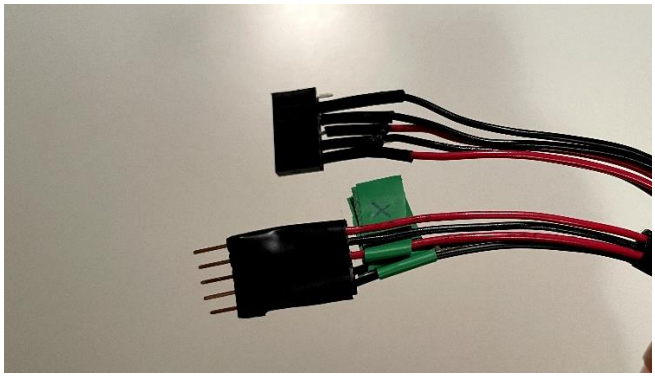
Two custom cables are needed to connect the Hyper-Ney body to the Bela.

a) Prepare a female to male cable using female and male header pins to connect the Trill Craft to the Bela. The cable should have 4 wires side-to-side and be long enough to reach the Bela. See the figure below for reference.



Connection Cable for the Trill Craft

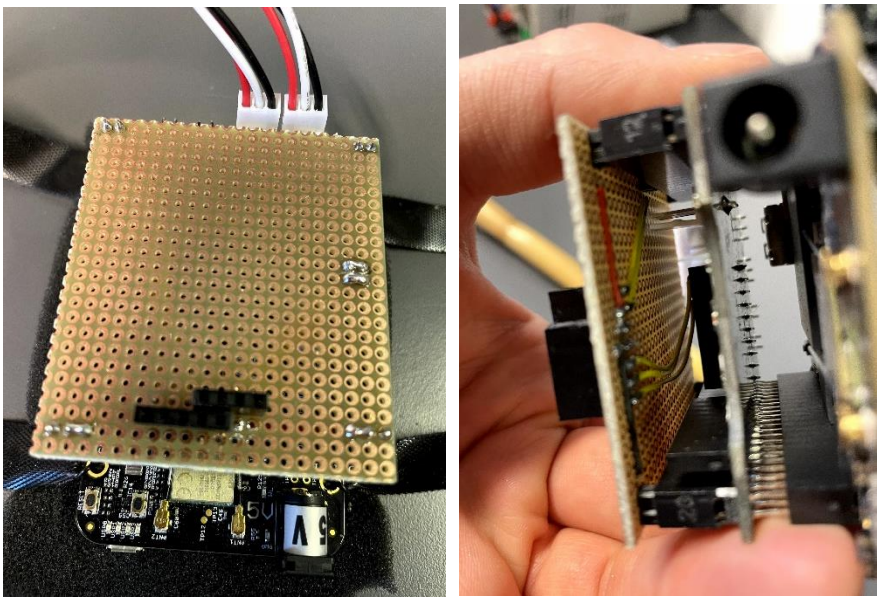
b) Prepare a female to male cable using female and male header pins to connect the accelerometer to the Bela. The cable should have 5 wires side-to-side and be long enough to reach the Bela. See the figure below for reference.



Connection Cable for the Accelerometer

9. Build the connection board

The connection board is built by soldering the two cables prepared in the previous step to a Perfoboard. The Perfoboard should be suitable for the Bela. The connection board is built to accommodate the necessary connection between the Trill Craft and accelerometer, and the Bela. The following figure is an example look to a Perfoboard with the two female header pins soldered to it and the cables connected to the pins, from up.



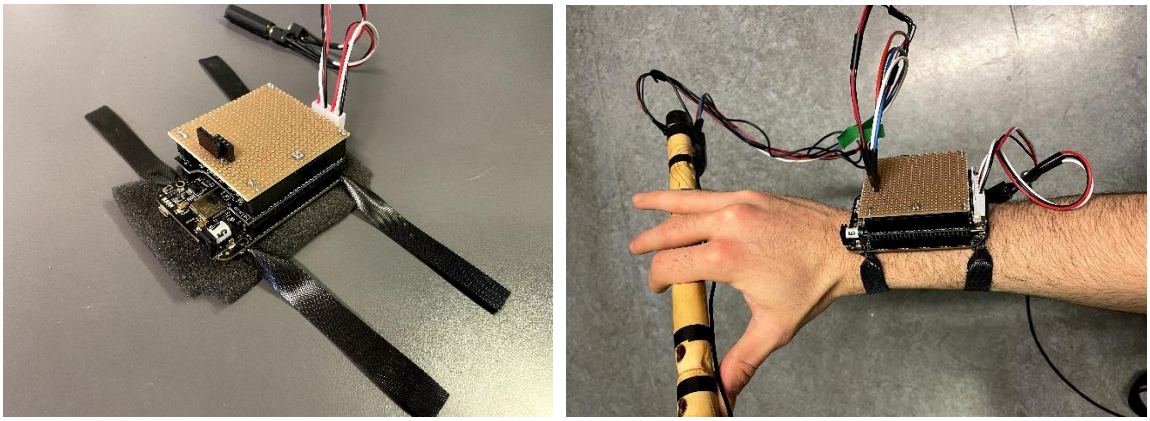
Perfoboard On Top of Bela

10. Connect the components

If not already connected, connect the Bela to the BeagleBone Black. Connect 3.55mm jack extensions as shown in the connection diagram. Connect the Hyper-Ney body to Bela using the custom cables prepared in the previous step. Connect the contact microphone jack to the 3.5mm input jack and use a jack to mini-jack adapter if needed. Please see the connection diagrams to connect the pieces correctly.

11. Stabilize the Boards and input jacks on the arm

The Bela, BeagleBone Black and the input jack are designed to be worn on the player's arm. The Bela and the BeagleBone Black are stabilized on the player's arm using Velcro straps. Place two straps underneath and along the short edge of the BeagleBone Black. Tie the straps to the four custom holes at the corners of the BeagleBone Black using solid wires. Place an insulating foam on your arm and place the boards on the foam and strap them around your arm. The input and output jacks are stabilized on the player's arm underneath the Velcro straps. See the figure below for reference.

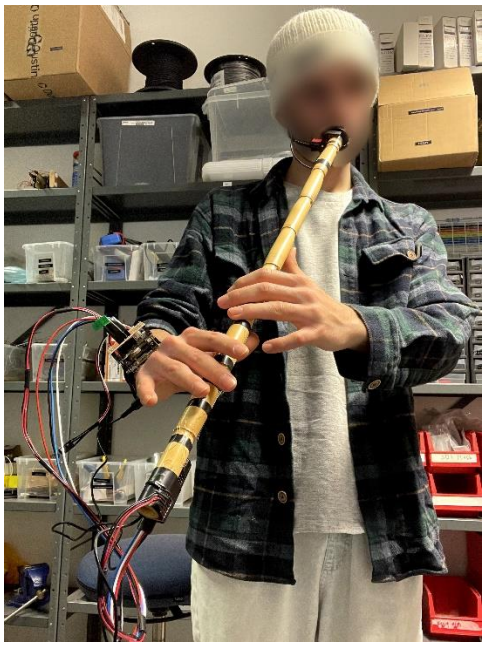


Stacked Boards with Velcro Straps and an Example Placement on the Arm

12. Power the BeagleBone Black

Connect the BeagleBone Black to a power source of 5 volts. The BeagleBone Black can be powered using a power bank or a computer. Please see the BeagleBone Black documentation for more information. Optionally, the power source can be stabilized on the player's arm underneath the Velcro straps.

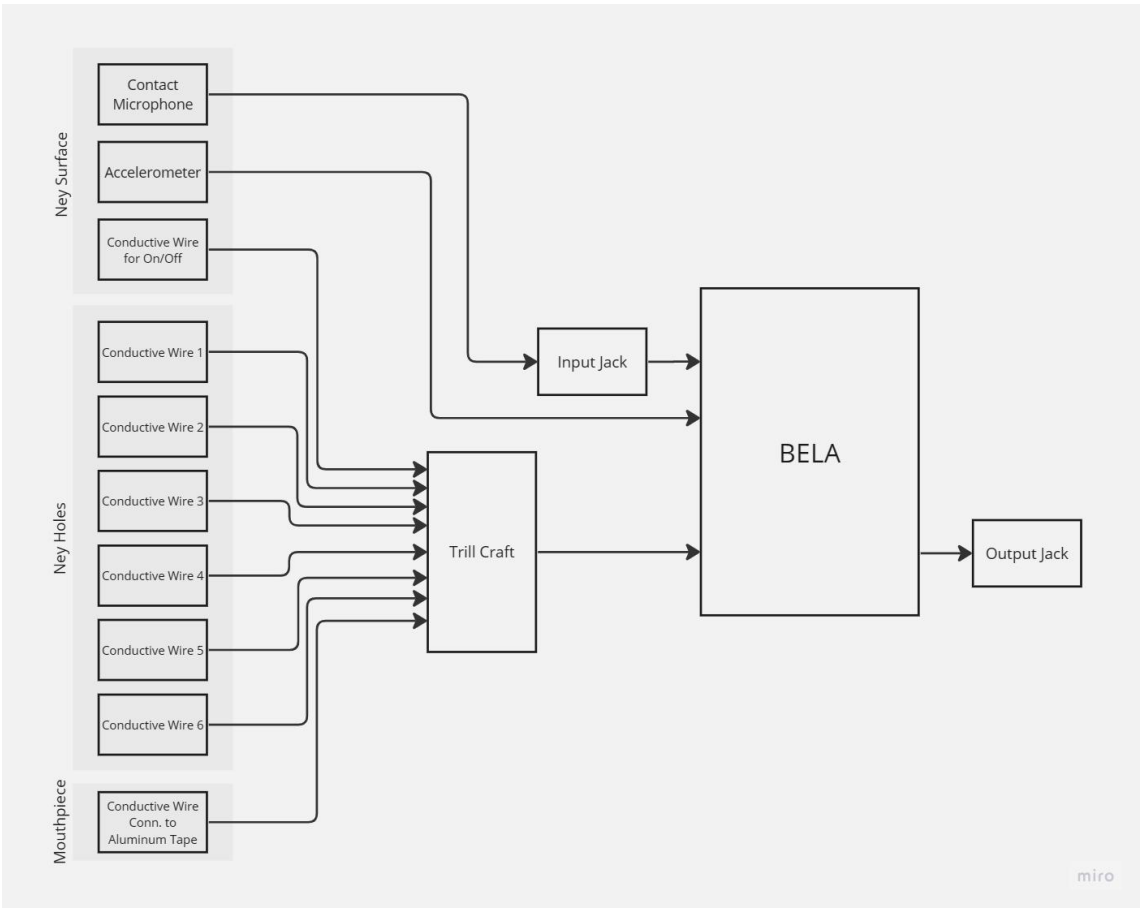
The following figure shows the completed assembly of the Hyper-Ney.



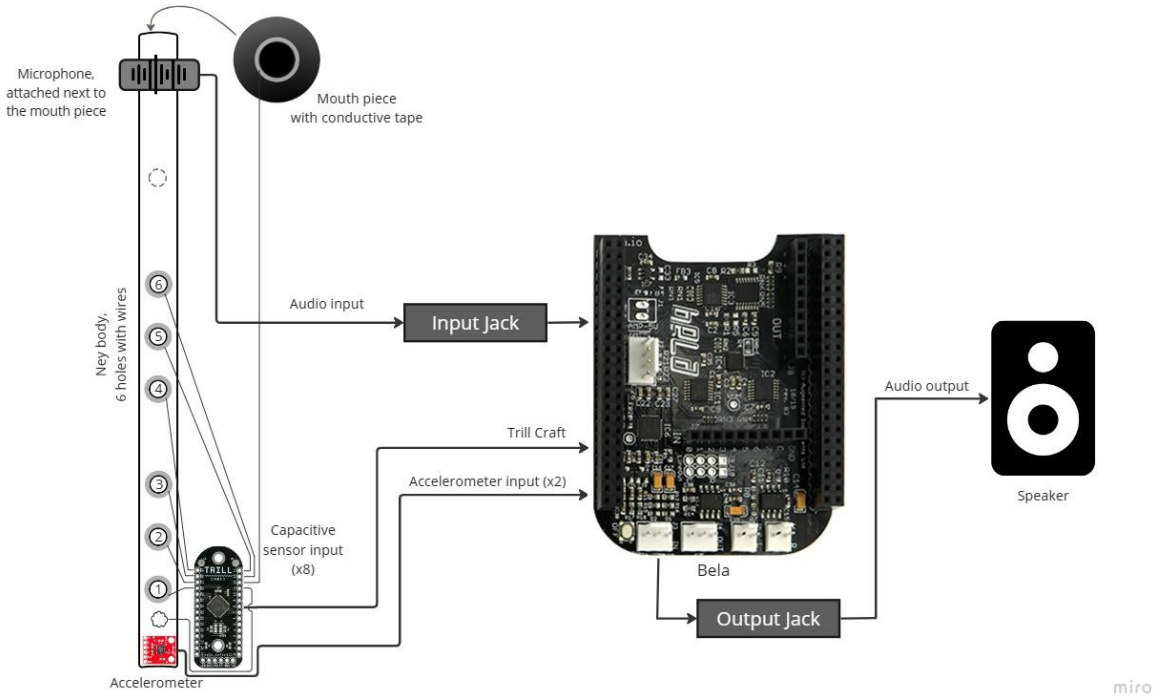
Full Assembly of the Hyper-Ney

2.4. Diagrams

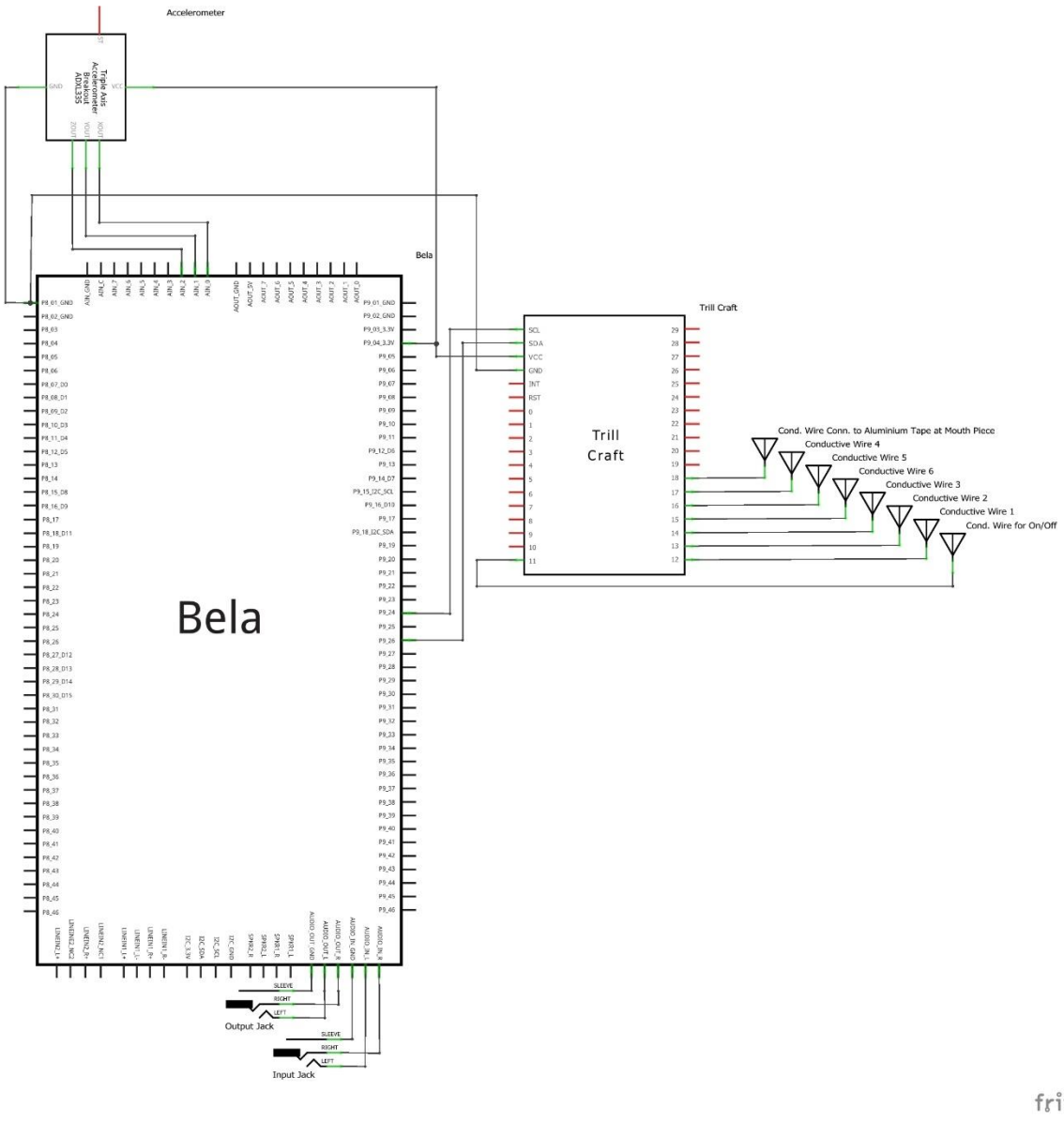
2.4.1. Hardware Block Diagram


Ney Surface
Contact Microphone
Accelerometer
Conductive Wire for On/Off
Ney Holes
Conductive Wire 1
Conductive Wire 2
Conductive Wire 3
Conductive Wire 4
Conductive Wire 5
Conductive Wire 6
Mouthpiece
Conductive Wire Conn. to Aluminum Tape
Input Jack
Trill Craft
BELA
Output Jack
miro

2.4.2. Hardware Illustrations



2.4.3. Schematics



3. Software

3.1. Required Software and Dependencies

To modify and synthesize sound, Hyper-Ney uses Pure Data which is an open-source visual programming language. The Hyper-Ney uses the Bela platform for low-latency audio processing and typically, Bela already comes with Pure Data installed. Please make sure that the following dependencies are installed on the Bela in order to start the Hyper-Ney successfully:

- cyclone
- sfapdlib

3.2. Bela Configuration

To configure the Bela for the Hyper-Ney, access the Bela IDE and follow the steps below:

1. Create a new project for the Hyper-Ney
2. Upload all the necessary Pure Data files included in the deliverables to the project folder.
3. Go to the settings tab and configure the following settings:
    3.1. Set the “Run project on boot” to the project that is created in the previous step.
    3.2. Set the audio block size to 1024.
    3.3. Set the number of analog channels to 4.
    3.4. Set the sample rate to 22050.
    3.5. Set “Use Digital” to False.
    3.6. Set the “Headphone Left Level (dB)” to -16.
    3.7. Set the “Headphone Right Level (dB)” to -16.
    3.8. Set the “Input Left Gain (dB)” to 10.
    3.9. Set the “Input Right Gain (dB)” to 10.
4. Safely shutdown the Bela to run on boot later.

4. Safety and Limitations

The Hyper-Ney described in this document is a prototype. Remember that the sensors on the Hyper-Ney are sensitive and prone to break. Please do not apply too much force to the sensors. The wires around the holes and the wire connected to the mouthpiece can get off easily and may need to be placed back using precise equipment. Remember the safety concerns and limitations while playing, storing, and carrying the Hyper-Ney.