

## Instructions for workshop on head-tracked HRTF spatialization

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In this workshop we will build a headphone-based spatialization system that tracks the position of the user's head and use those data to update the location of a virtual sound source so that it remains in the same location (i.e., independent from the movement of the user). In this case, we would be concerned only about changes of azimuth and elevation.

**NOTE:** This workshop must be finished before Aug. 2, 10:30.

### 1 Materials

#### ◇ Hardware



Figure 1: Bluetooth JY61 MPU6050 module and battery

- Bluetooth JY61 MPU6050 module angle output 6-axis Accelerometer Gyroscope Serial port
- Full charged LiPo battery (charger available on request)
- Cables, connectors, etc.
- Headphones (not provided)
- Mac computer

#### ◇ Software

- Pure-data modem (provided in Figure 2)
- hrir~ object and database (<http://onkyo.u-aizu.ac.jp/index.php/software/hrir/>)
- Spatialization program (not provided)

### 2 Procedure

- ◇ Make sure that there's only one `ttty.HC-06-DevB` in the `/dev` directory (delete any additional one). See Figure 3

- ◇ Carefully, connect VCC and GND terminals of the JY61 to the battery (use red cables for VCC and black for GND). Make sure that you're not reversing the polarity (mixing red with black). See Figure 1.
- ◇ If your sensor has a switch, make sure it's on its leftmost position. See Figure 1.
- ◇ Open bluetooth preferences and pair your sensor to your computer (make sure that you're connecting to the correct one). See Figure 4.
- ◇ Bluetooth will ask for a code to pair. Use: 1234
- ◇ Open `modem.pd` and connect to the sensor. Then, click the "open" button on the `pd parameters` box.
- ◇ Make sure that rotating the sensor around its different axes yield changes in the reported Roll, Pitch, and Yaw angles.
- ◇ Place the sensor over your head so that the 'x' arrow on the top of the sensor points to your right ear. See Figure 1.
- ◇ Create the spatialization program and use the outputs of the modem to compensate for rotations of the user's head.

### 3 Points to consider when creating the spatialization program

- ◇ You need to specify a sound source location (letting distance to be for example, 100 cm).
- ◇ The angles reported by the sensor are from  $[0^\circ \text{ to } 360^\circ]$  but the angles for elevation in `hrir~` are from  $[-40^\circ \text{ to } 90^\circ]$ . You need to adjust these values for the spatialization to work correctly.
- ◇ The user needs to manually specify the origin ( $\theta = 0^\circ, \phi = 0^\circ$ ). Hint: use a bang button to register the origin.
- ◇ The actual angle sent to the inputs of `hrir~` is the difference between the current angle reported by the sensor the the recorded origin value specified by the user.
- ◇ Add reverberation to improve the experience (you can use `[freeverb~]`).
- ◇ Use one of the short sounds from here: <http://onkyo.u-aizu.ac.jp/index.php/classes/3d-sound/ss/>

### 4 Report

- ◇ There's no need of written report
- ◇ Show your finished program to the instructor
- ◇ Answer these questions:
  1. How to change the data rate from the sensor?
  2. What could you do to improve the code?

**Extra point:** Using the acceleration output of the sensor, estimate distance changes.

### 5 References

High precision gyroscope module JY-61 Series User Manual: <http://onkyo.u-aizu.ac.jp/wp-content/uploads/2016/06/MPU6050-User-manual.pdf>

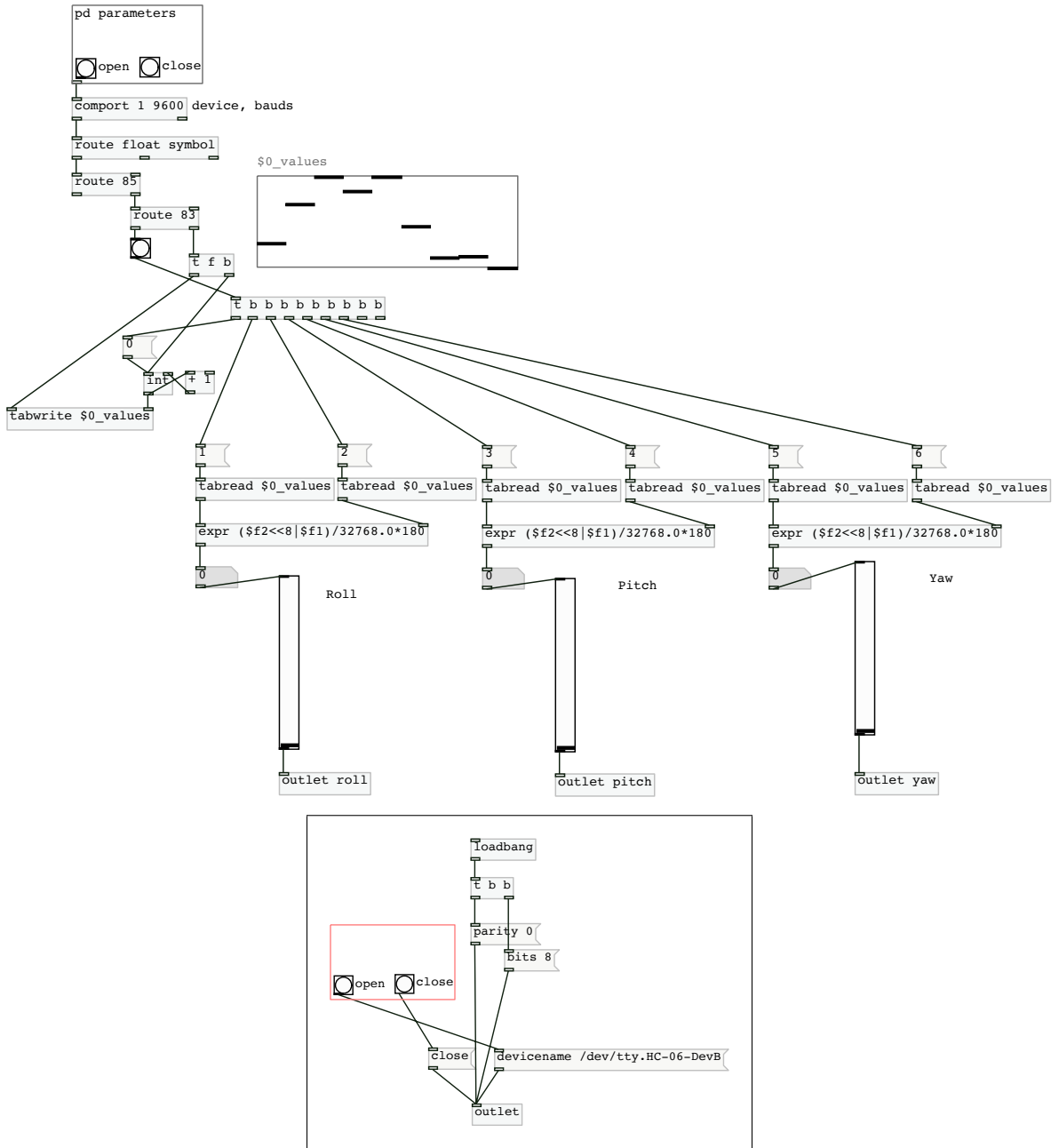


Figure 2: modem.pd and the contents of the 'parameters' sub-patch

```
sinister:osc julian$ ls /dev/tty
Display all 136 possibilities? (y or n)
tty          ttyq9
tty.Bluetooth-Incoming-Port  ttyqa
tty.HC-06-DevB  ttyqb
ttyp0        ttyqc
ttyp1        ttyqd
ttyp2        ttyqe
ttyp3        ttyqf
ttyp4        ttyr0
ttyp5        ttyr1
ttyp6        ttyr2
ttyp7        ttyr3
ttyp8        ttyr4
```

Figure 3: /dev directory with a single HC-06 modem

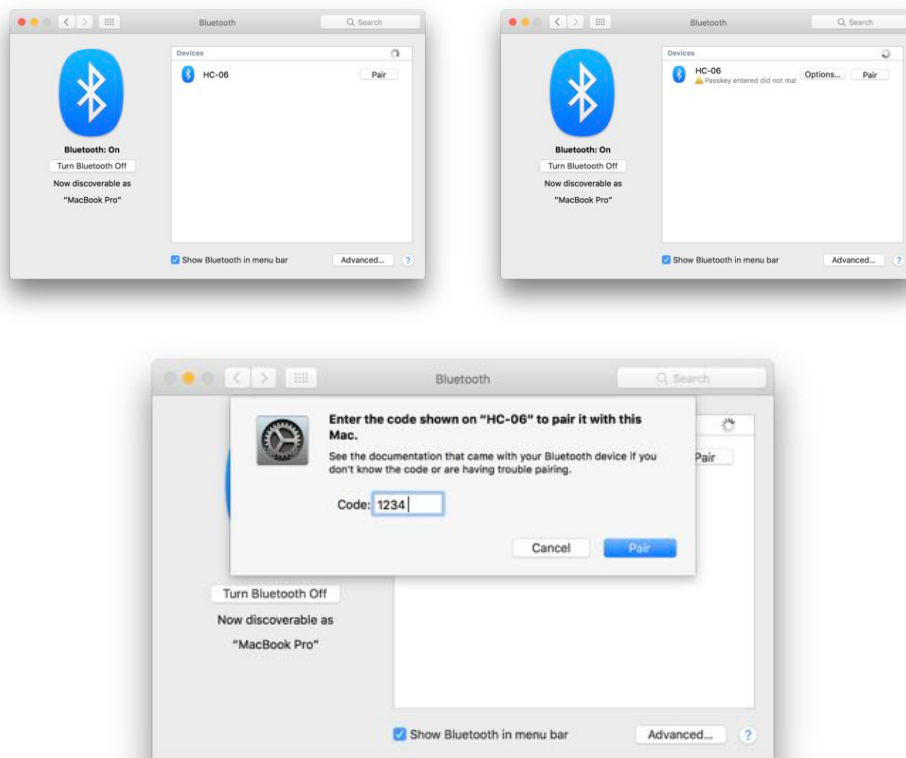


Figure 4: Pairing Bluetooth with JY61 module