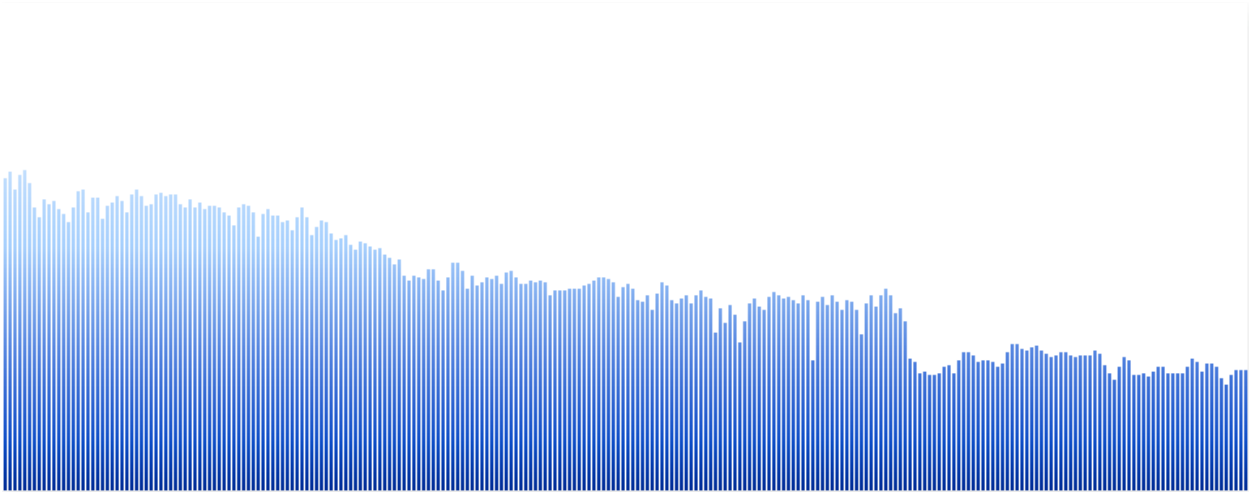
Audio Spectrum - FFT Spectrum of heart rate measured with a handmade piezoelectric device using python and pyaudio library



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1-Source Code

First of all I simply connect the piezo to the microphone of my laptop and put the device on a oneself chest to get the heartbeat.

- Reading data from microphone input:

```
CHUNK = 2*1024
FORMAT=pyaudio.paInt16
CHANNELS=1
RATE=44100

p = pyaudio.PyAudio()

stream=p.open(format=FORMAT,
              channels=CHANNELS,
              rate=RATE,
              input=True,
              output=True,
              frames_per_buffer=CHUNK
              )

```

- Drawing plot of spectrums with matplotlib library in python:

```


fig, (ax, ax2)=plt.subplots(2, figsize=(15, 8))
plt.ioff()

x=np.arange(0,2*CHUNK,2)
x_fft=np.linspace(0,RATE, CHUNK)

line,=ax.plot(x,np.random.rand(CHUNK), '-', lw=2)
line_fft,=ax2.semilogx(x_fft,np.random.rand(CHUNK), '-', lw=2)
ax.set_title('AUDIO WAVEFORM')
ax.set_xlabel('samples')
ax.set_ylabel('volume')
ax.set_ylim(0, 1024)
ax.set_xlim(0, 2 * CHUNK)
plt.setp(ax, xticks=[0, CHUNK, 2 * CHUNK], yticks=[0, 512, 1024])

ax2.set_xlim(20,RATE/2)

plt.show(block=False)

frame_count = 0
start_time = time.time()

```

- Analyzing the input audio:

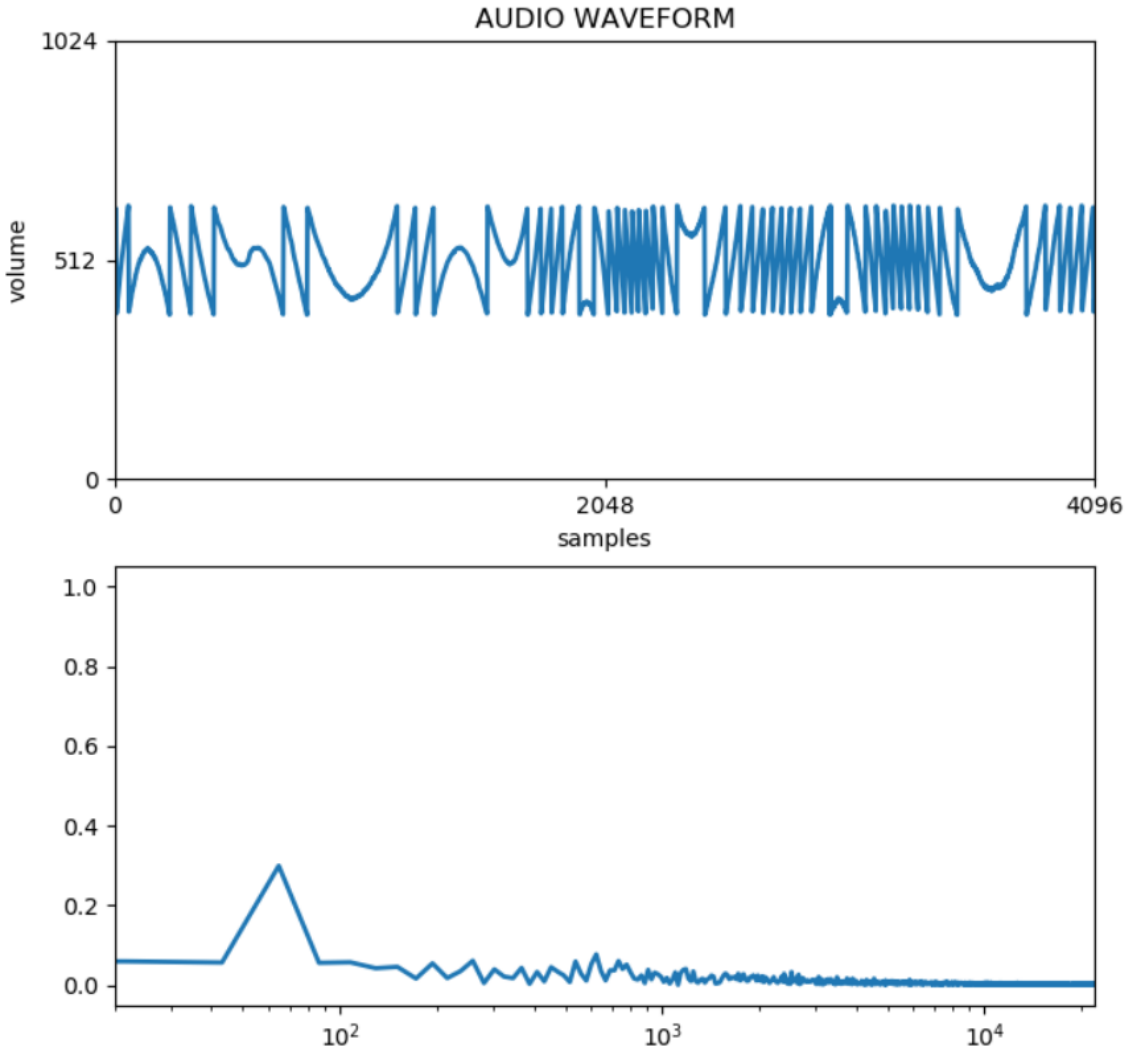
```
while True:
    data = stream.read(CHUNK)
    data_int = struct.unpack(str(2 * CHUNK) + 'B', data)
    data_np = np.array(data_int, dtype='b')[::2] + 512
    line.set_ydata(data_np)

    y_fft=fft(data_int)
    line_fft.set_ydata(np.abs(y_fft[0:CHUNK])*2/(512*CHUNK))


    try:
        fig.canvas.draw()
        fig.canvas.flush_events()
        frame_count += 1

    except TclError:

        # calculate average frame rate
        frame_rate = frame_count / (time.time() - start_time)

        print('stream stopped')
        print('average frame rate = {:.0f} FPS'.format(frame_rate))
        break
```

2-Output:

In following pages, we can compare the output, spectrums of three different person’s heartbeat:

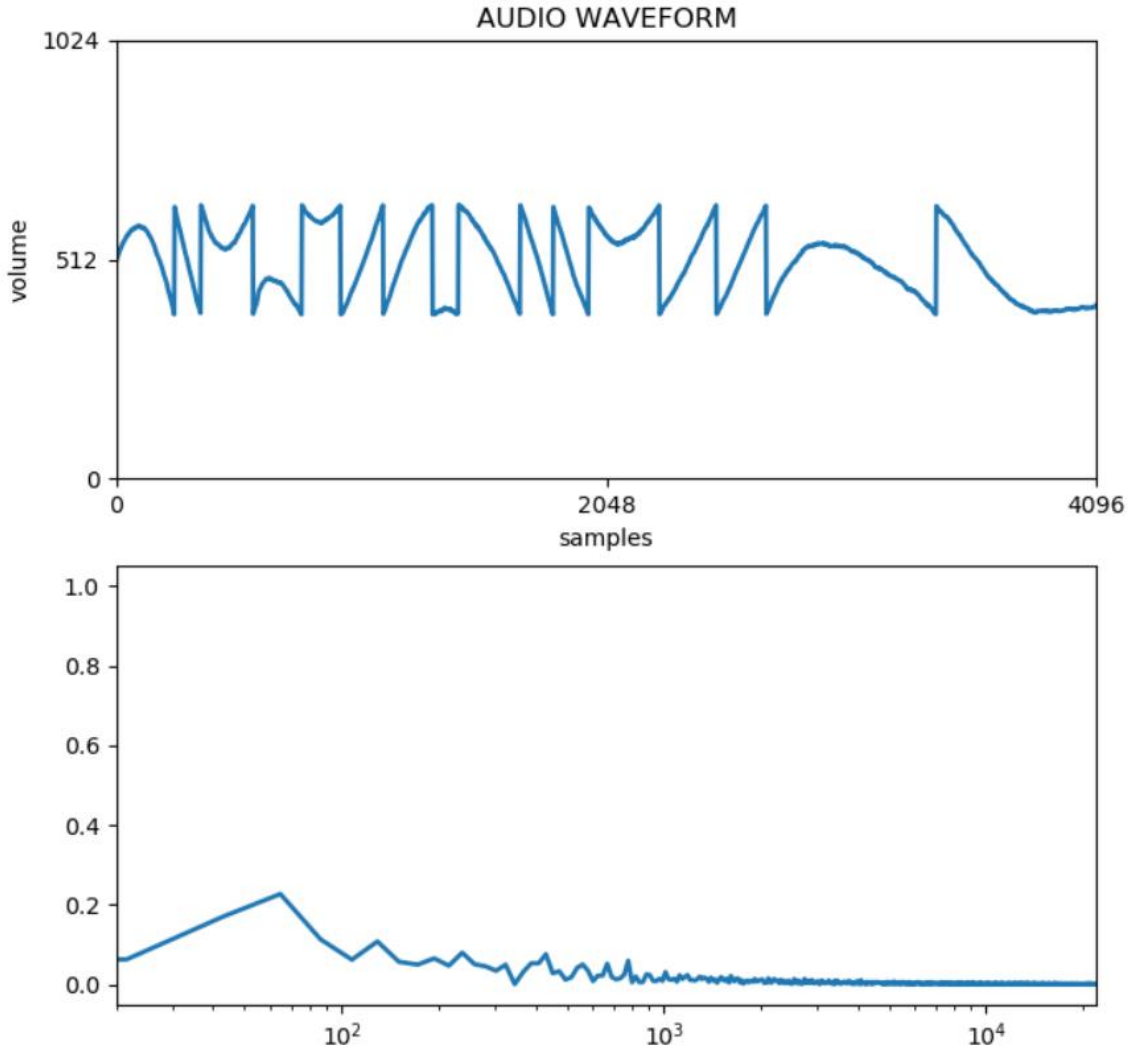
1- Fist one

-A 5 years old child



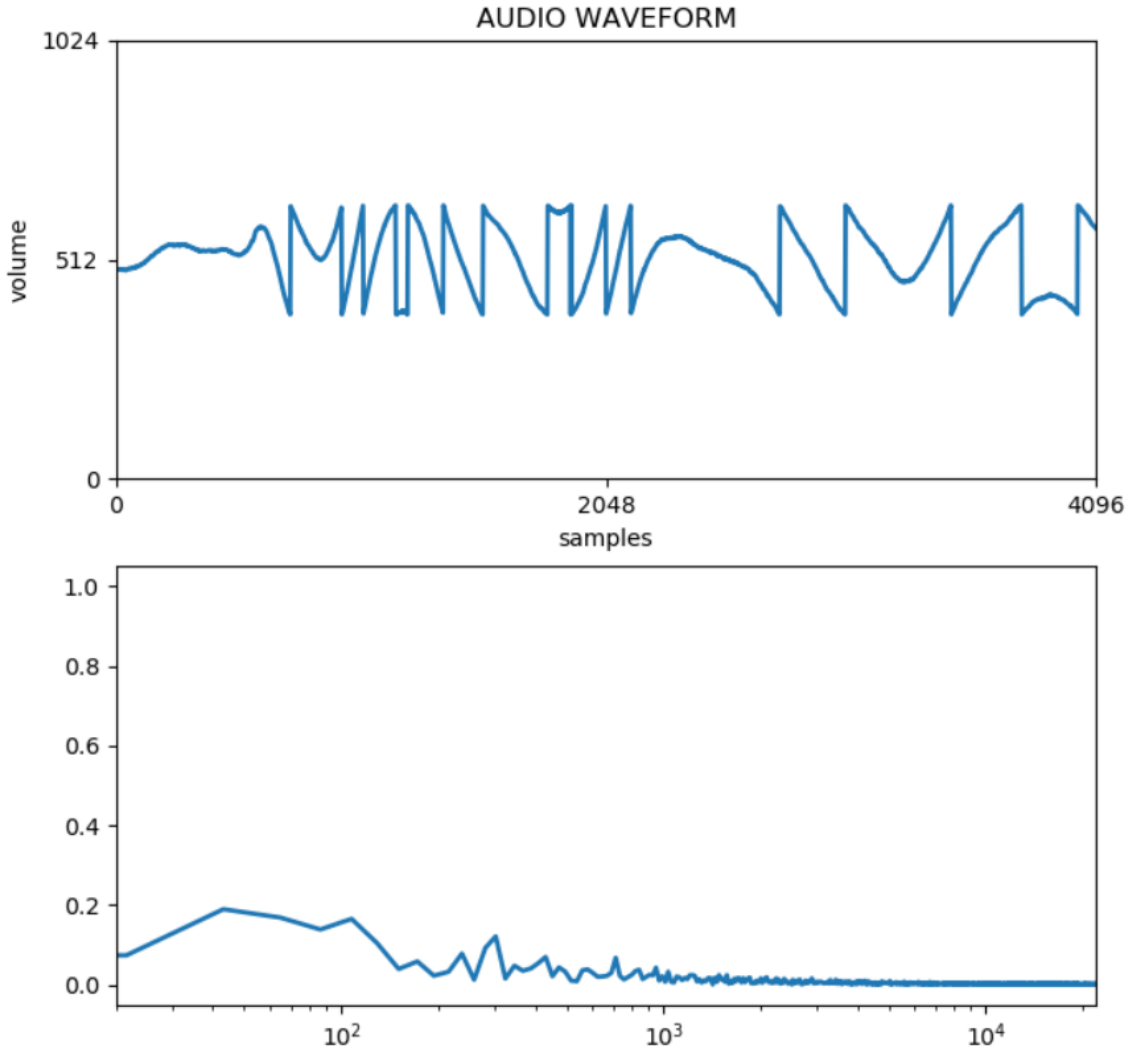
2- Second one:

-Twenty years old woman



3- Third one:

-thirty years old man



4- Visualization:

At the end, I used the amplitude of this signals as a parameter of some visual effects, simply I develop a sine wave, and I control the y value and the color of the wave with my signal's amplitude:

```
function setup() {
  createCanvas(710, 300);
  w = width + 16;
  dx = (TWO_PI / period) * xspacing;
  yvalues = new Array(floor(w / xspacing));
  amplitude = new p5.Amplitude();
  soundFile.loop();
}
```

```
function calcWave() {
  // Increment theta (try different values for
  // 'angular velocity' here)
  theta += 0.02;

  // For every x value, calculate a y value with sine function
  let x = theta;
  for (let i = 0; i < yvalues.length; i++) {
    yvalues[i] = sin(x) * size;
    x += dx;
  }
}
```

5- Sinewaves affected by amplitude:

The output turns out something like: