Dimensionless Velocity Experiment

Fernando Hurtado

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1 Introduction

2 Experiment Conducted

Two different experiments were conducted. The first one consisted on setting the distance from the lips to the labium (W) fixed and varying the mass flow rate from 0 SLPM to 30 SLPM in 15 seconds and then back to 0 SLPM in 15 seconds. This was repeated for 13 values of W, from 6 mm to 9 mm every 0.25 mm. The second experiment consisted on setting the mass flow rate fixed and varying W from 5.5 mm to 9.5 mm in 15 seconds and then back to 5.5 mm in 15 seconds. This was repeated for 23 values of mass flow rate, from 8 SLMP to 30 SLPM every 1 SLPM. In both cases the fingering corresponded to a G3 ($f_1 = 392$ Hz).

3 Information Available

From the experiment and with the sensors used, it is obtained the following information as a function of time on each repetition:

- Pitch: calculated in real time using the YIN algorithm
- Temperature of the jet
- Mass flow rate
- Volume flow rate
- Mouth gauge pressure
- X position
- Z position
- α position
- W: distance from the lips to the labium calculated transforming X, Z and α.
- θ_j: incidence angle of the jet to the labium calculated transforming X, Z and α.
- Offset of the jet with respect to the labium, calculated transforming X, Z and α.
- Position reference
- Mass flow reference

As well as a `.wav` file with the recorded sound.

4 Additional Calculations

Assuming a constant shape of the mouth outlet, approximated by the function:

$$h \cos^2 \left(\frac{\pi x}{w_m} \right) \tag{1}$$

Where $h = 4.5$ [mm] and $w_m = 12$ [mm], and $x \in [-6, 6]$. The surface obtained integrating this function is:

$$S = \int_{-6}^{6} 4.5 \cos^2 \left(\frac{\pi x}{12} \right) \mathrm{d}x = 27 \tag{2}$$

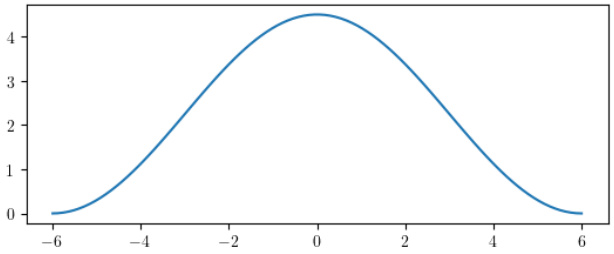

Figure 1: Shape of the mouth outlet approximation

Which can be used to calculate the average flow velocity of the jet at the outlet, assuming the air as incompressible, with the function:

$$\bar{u} = \frac{Q}{S} \tag{3}$$

Where Q is the volume flow rate measured during the experiment. As Q is in liters per minute, and S in mm^2, it is necessary to multiply by 1000000/60000, in order to express u in m/s.

Finally the reduced jet velocity is calculated as:

$$\theta = \frac{u}{W f_1} \tag{4}$$

Where W should be expressed in m.

5 Results

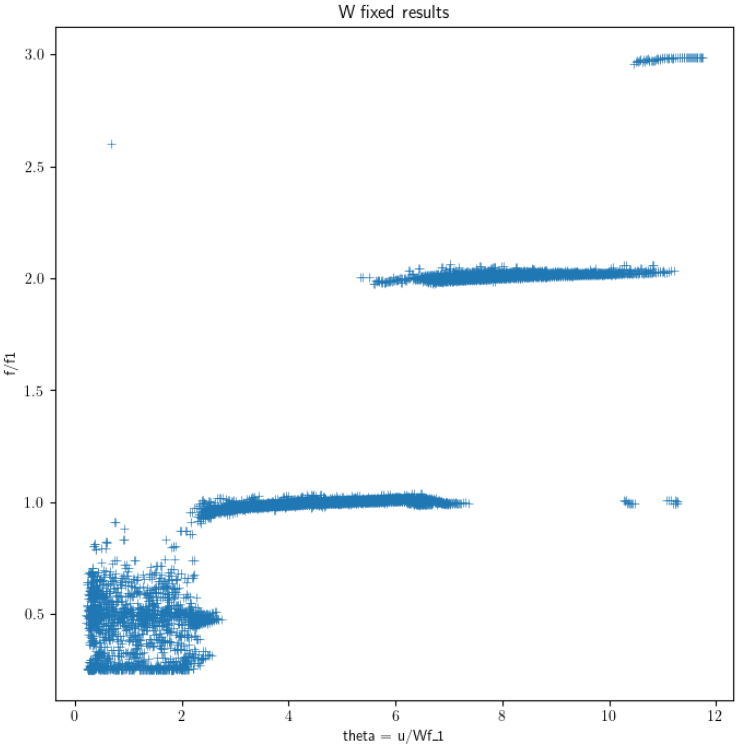

Figure 2: Results of the first experiment

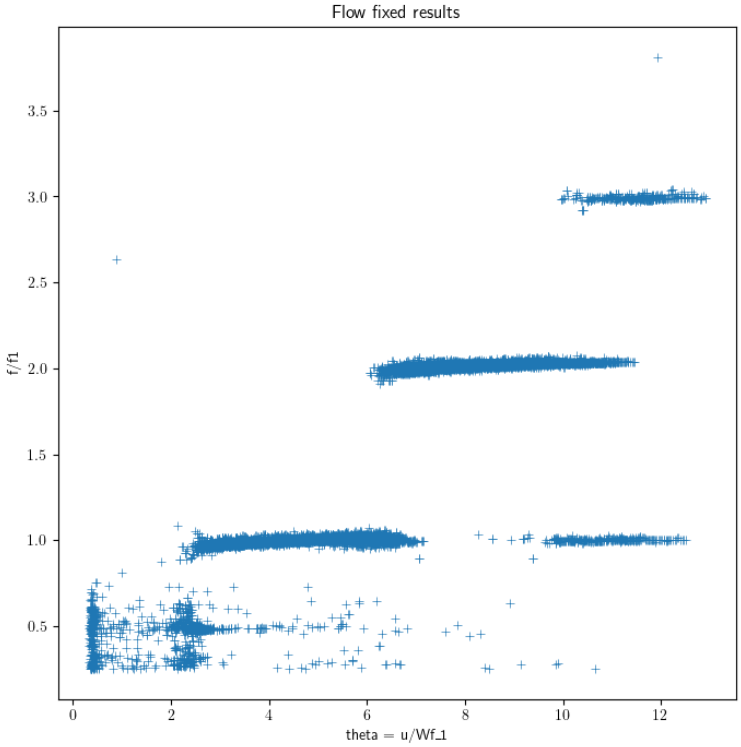

Figure 3: Results of the second experiment

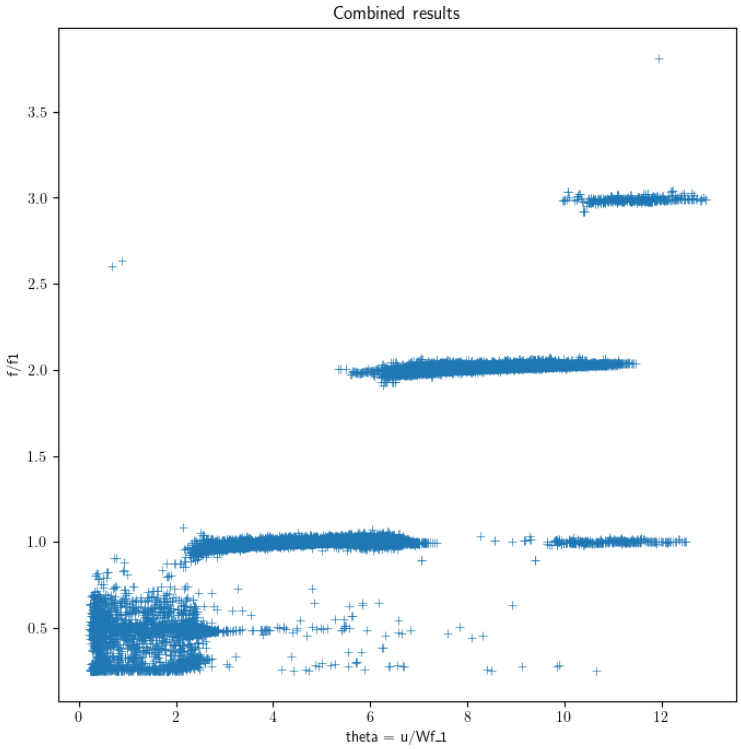

Figure 4: Combined results