MEK 4600 - Noiselab

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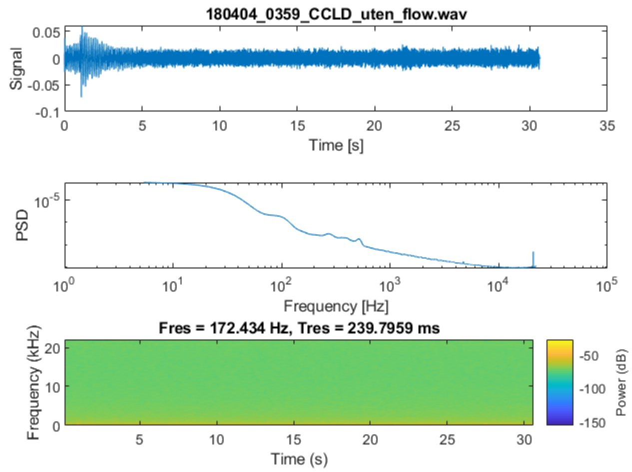
Introduction and set up

The purpose of this exercise is to identify the sounds of different flows through a pipe using a contact microphone. We will investigate whether we can identify when flow is turbulent by analysing signal and PSD. Beneath is a picture of the set up, where water flows from the jug through a tube

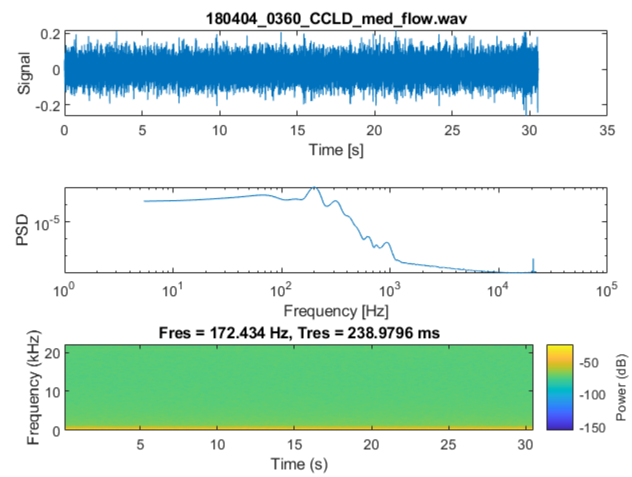
Figure 1: The experimental set up

Pre-lab activites

We were asked to analyse some existing sound files and compare them to the plots found on the exercise sheet (Noiselab.pdf). They behave the same way as on the sheet. We observe that the signal is higher on the recording with flow



(a) without flow



(b) with flow

Figure 2: Comparing sound of flow vs non flow through the tube

Main points

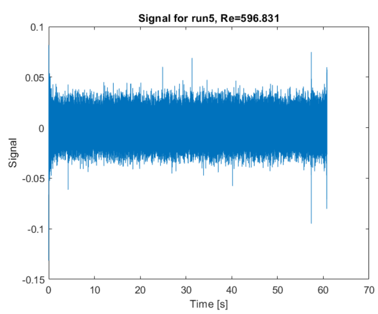
1. In fluid mechanics, turbulent flow is described by some characteristic traits rather than being defined concretely. One trait is that the fluid undergoes mixing, as opposed to laminar flow where the fluid particles moves in straight lines. Flow is characterised as turbulent by evaluating the Reynolds number. When Reynolds number (Re) is about 4000 or more we have turbulent flow. From around 2300-4000 we have what we call the transition fase, and at lower than 2300 we have laminar flow.

2. The microphone detects bla bla bla (continue here)

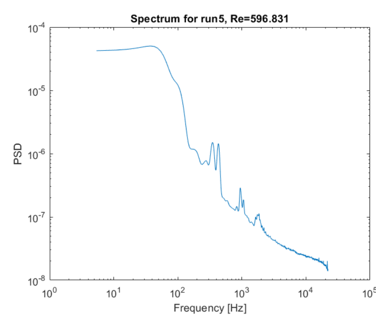
3.

4.

5. The recorded files lasts 60 seconds and the same procedure from the pre-lab activities are used. The figures for signal vs time and PSD (power spectral density) vs frequency are all saved. Beneath are plots for laminar, transitional and turbulent flow, respectively.

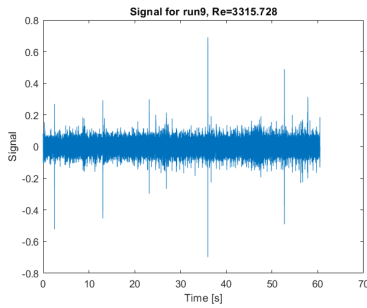


(a) Signal plot, laminar

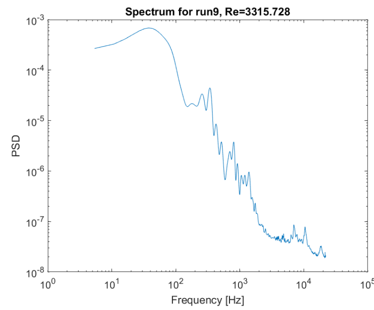


(b) PSD, laminar

Figure 3: Signal vs time and PSD vs frequency for laminar flow

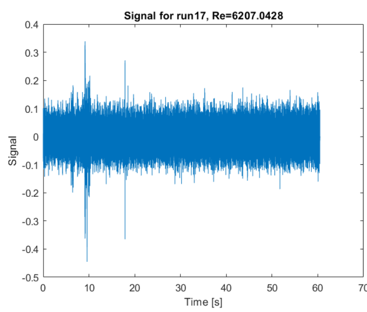


(a) Signal plot, transitional

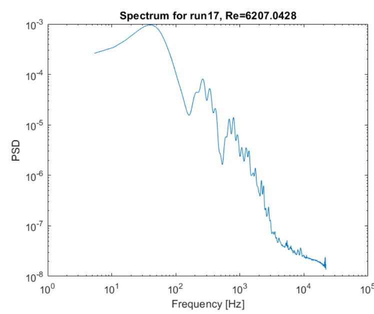


(b) PSD, transitional

Figure 4: Signal vs time and PSD vs frequency for transitional flow



(a) Signal plot, turbulent



(b) PSD, turbulent

Figure 5: Signal vs time and PSD vs frequency for turbulent flow

6. Frequencies at 10 and 100 Hz are detected on every example, and from there we can see a gradual decrease. Our strategy for denoising will be to use the PSD spectrum and manually remove those frequencies below a certain PSD threshold. For these figures PSD-values beneath 10^{-5} for the laminar flow seems reasonable. For non-laminar we set 10^{-4} as a threshold. From reading up on the literature the turbulent spectra is the fluctuating PSD signals and the corresponding frequencies.

7. By using fast Fourier transform (fft) we detect frequencies, zeroing out "unwanted" frequencies, and then using reverse fft to get the cleaned up signal. Below are the results for the same three runs as before.

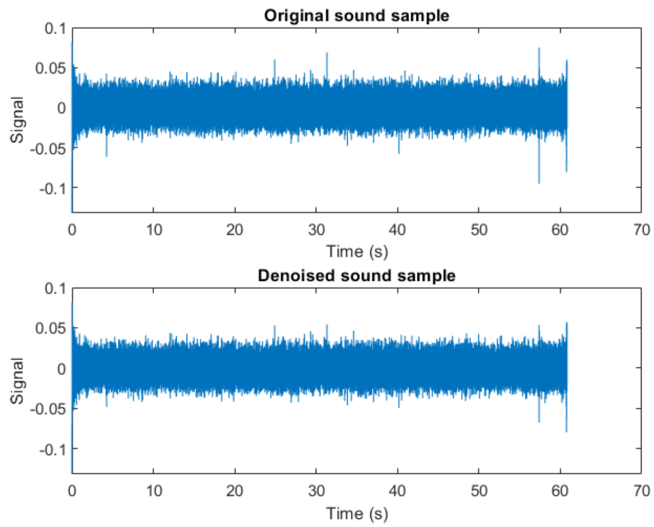


Figure 6: Original vs filtered audio sample, run 5

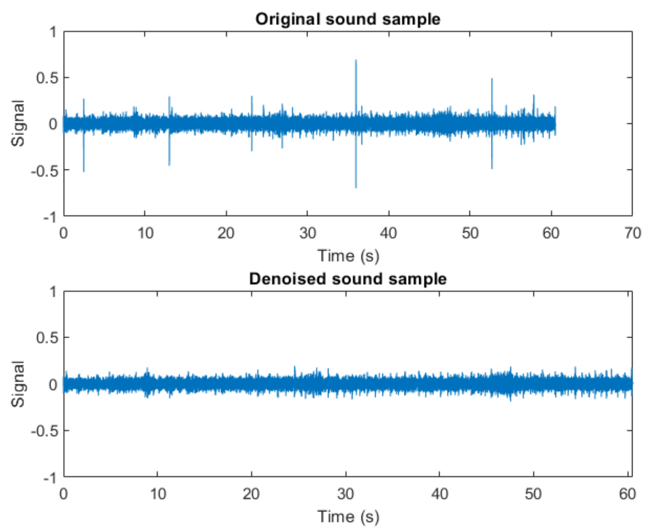


Figure 7: Original vs filtered audio sample, run 9

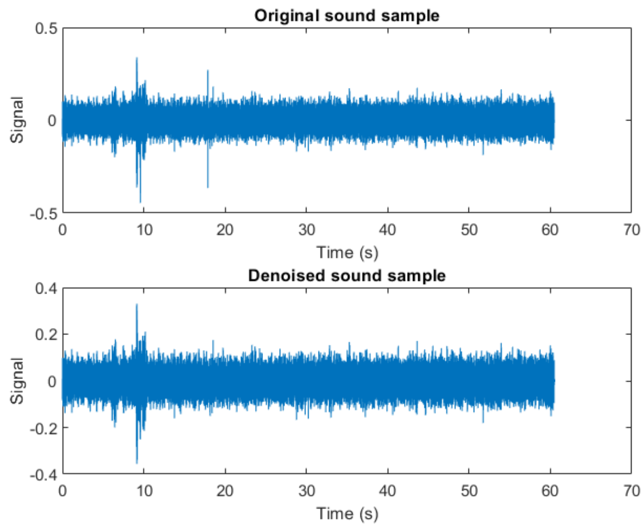


Figure 8: Original vs filtered audio sample, run 17

Conclusion