Student: Garrett Nadauld

Course: ECE 5210

Subject: Lab 1, Signal Distortion

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1   Introduction

In lab 1, we looked into signal distortion which is commonly used in audio effects like guitar distortion pedals and audio tube amplifiers. In this lab we were tasked with implementing soft-clipping.

2   Theory

This lab did not require any calculations, the only nuance was the denormalization of the equation given by

$$y[n] = \begin{cases} -\frac{2}{3} & x[n] \le -1 \\ x[n] - \frac{x[n]^3}{3} & -1 < x[n] < 1 \\ \frac{2}{3} & 1 < x[n] \end{cases} \tag{1}$$

Instead of denormalizing this equation I just normalized the incoming sample and denormalized the processed sample by dividing by the limit and multiplying by the limit respectively.

3   Results

Once the C code was working correctly the oscilloscope produced both a sine wave and a sine wave where the peaks and valleys were soft clipped. This matched our expectations. Fig. 1 shows our processed signal plotted against our input signal. We can see the soft clipping that occurs as the input signal increases.

4   Discussion and Conclusions

As mentioned in the results section our plots from the implemented code matches the goal for this lab although it only shows the right side of the figure provided in lab.

The system given to us is not linear, it is however time-invariant. The system is not causal because it has nonzero values on the left side of the x-axis. The system is memoryless because current values do not require previous values to be calculated. The system is also stable because it has a bounded output given a bounded input.

For the listening test I used Setting Forth by Eddie Vedder as well as the original given limit of 4500. At these settings it was difficult to detect the distortion until I played both the original and modified version at once. At this point the difference was very clear. When I changed the limit to a higher number such as 6000 or even 10000 I thought that the difference was very minuscule and had a hard time differentiating them from the 4500 limit test. When I changed the limit to 1000 the change was very noticeable, instead of mainly the guitar being distorted the singers voice started being distorted as well. This is expected because as the limit increases the signal will be clipped less and when the limit is decreased the signal will experience greater clipping.
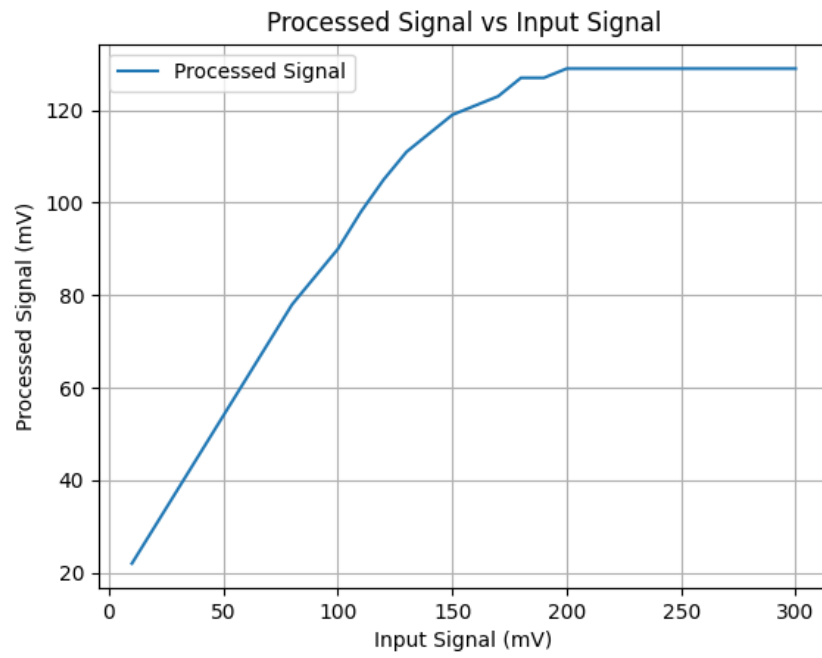
Figure 1: Processed signal plotted against the input signal showing the soft clipping on the upper bound.