

EE679 Assignment IB Report

Anugole Sai Gaurav, 170070008

1 Overview

The **main** file calls the functions (**rect_win.m**, **hamm_win.m**) for each window type and output DFT is plotted for each window length. The function file **f2_out.m** of assignment 1A is used again for generating /u/.

The DFT length used for each window length is varied accordingly to make the envelope of the DFT output look smooth. This doesn't affect the analysis to be done later. Also, the magnitude response is plotted from 0-4kHz only as the original formants are located up to 2kHz, and major effects are observed in this region.

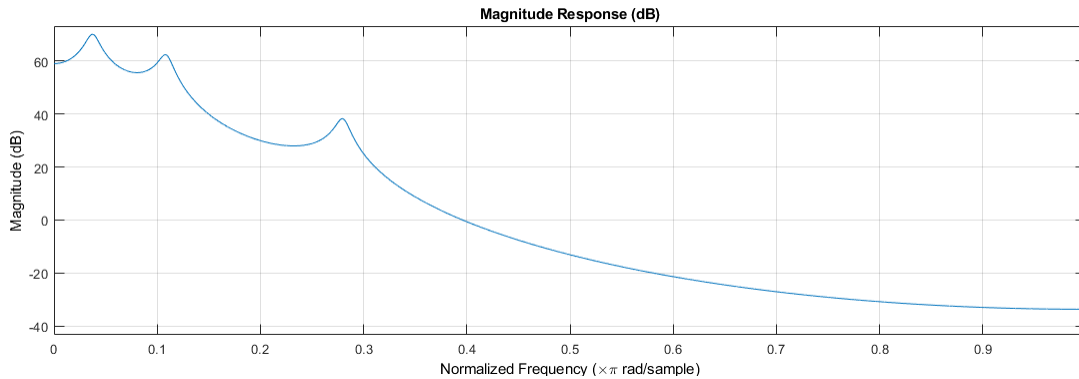


Figure 1: Original Magnitude Response of /u/

It can be clearly seen that the formants are located near 300Hz, 870Hz and 2240Hz after scaling the axis from 0-8kHz (sampling frequency used throughout is 16kHz).

For each of the following cases, the formant frequencies, from the output plots are measured at the points where the lobe peak values are relatively higher compared to the adjacent ones. These correspond to the main lobe widths of the window response with the heights being scale according to the magnitude of the original response.

2 Low Pitch: 120Hz

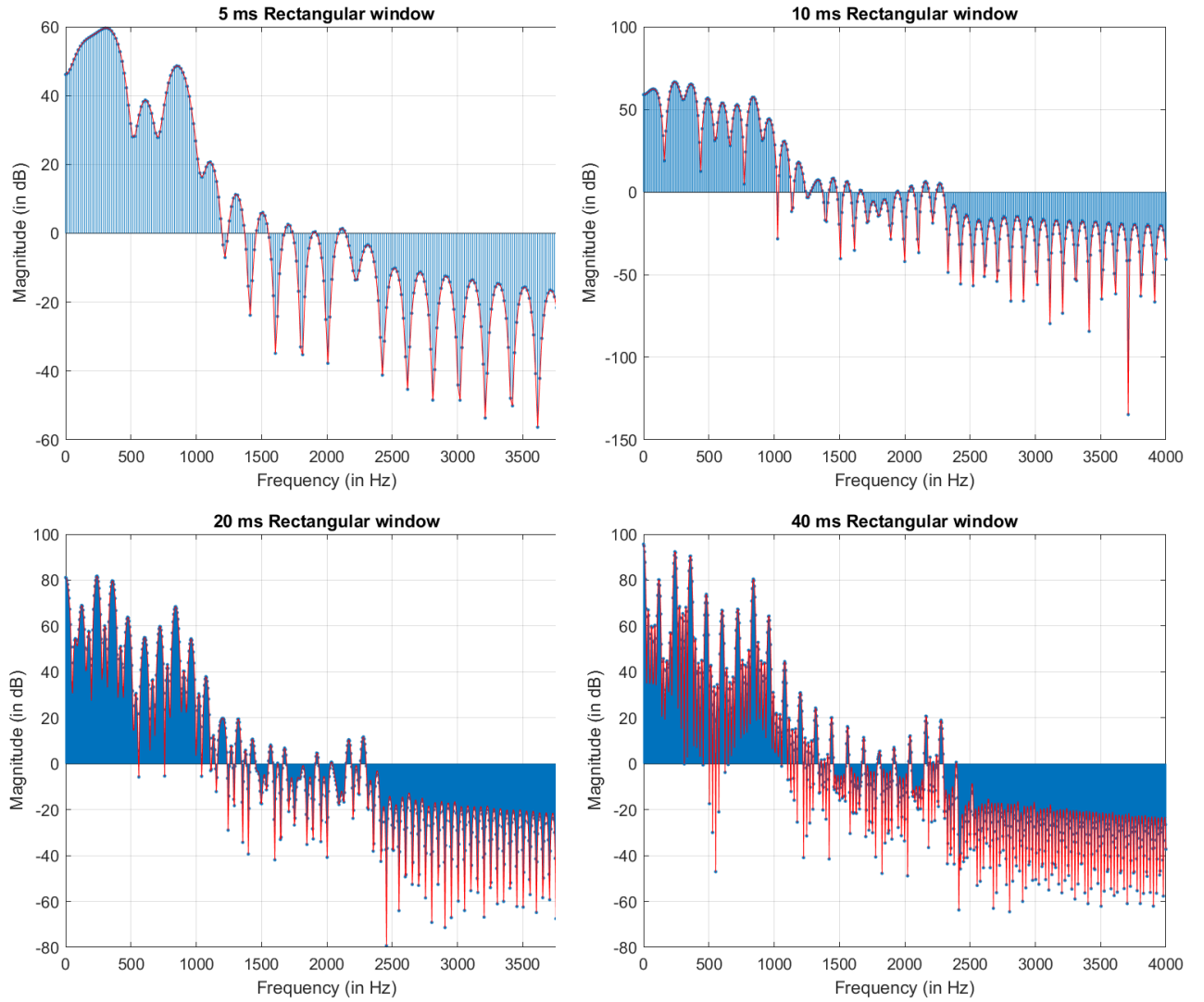


Figure 2: Magnitude responses for different Rectangular window lengths

Window length (ms)	f_1 (Hz)	f_2 (Hz)	f_3 (Hz)
5	321	851	2120
10	246	844	2160
20	243	838	2286
40	240	840	2166

Table 1: Observed formant frequencies for each window length

It can be seen that the approximate peak locations are the same as original, however disrupted by adjacent lobes in some cases due to higher original magnitude response and side-lobe in window response. Hence, first formant can be seen to deviate larger compared to

others. Also, the lobe width decreases with increasing window length as they are inversely proportional ($\frac{2\pi}{L}$).

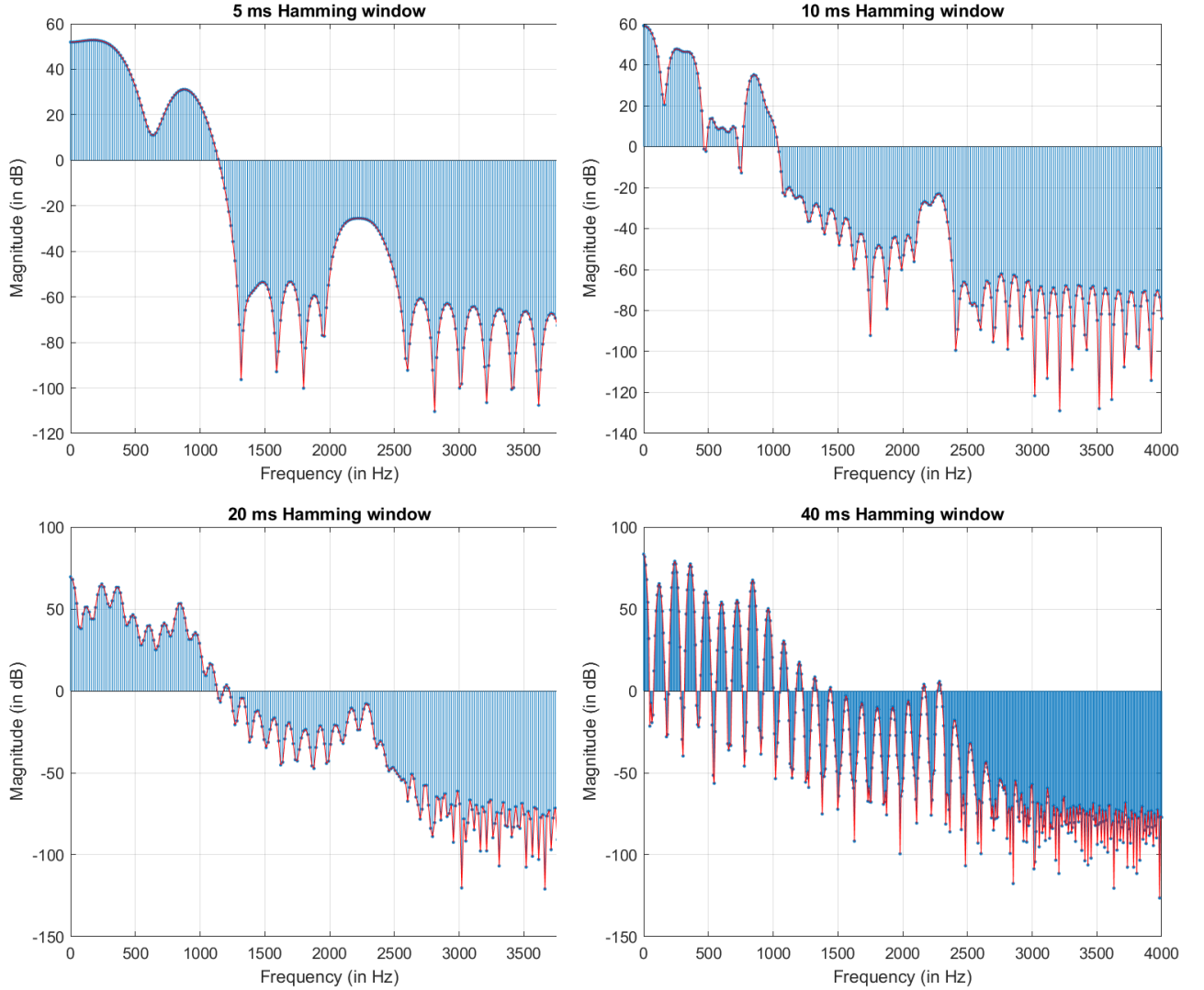


Figure 3: Magnitude responses for different Hamming window lengths

Window length (ms)	f_1 (Hz)	f_2 (Hz)	f_3 (Hz)
5	241	899	2233
10	257	851	2281
20	241	851	2297
40	240.5	841	2285

Table 2: Observed formant frequencies for each window length

The lobe widths can be seen to be larger than the rectangular window response. This is because, the main-lobe width of Hamming window is double that of rectangular. In both cases, with increasing window-length (or decreasing main lobe-width), the exact

location of formant frequencies tend to be observed more clearly and the envelope seems to form closer to the original magnitude response plotted before.

3 High Pitch: 220Hz

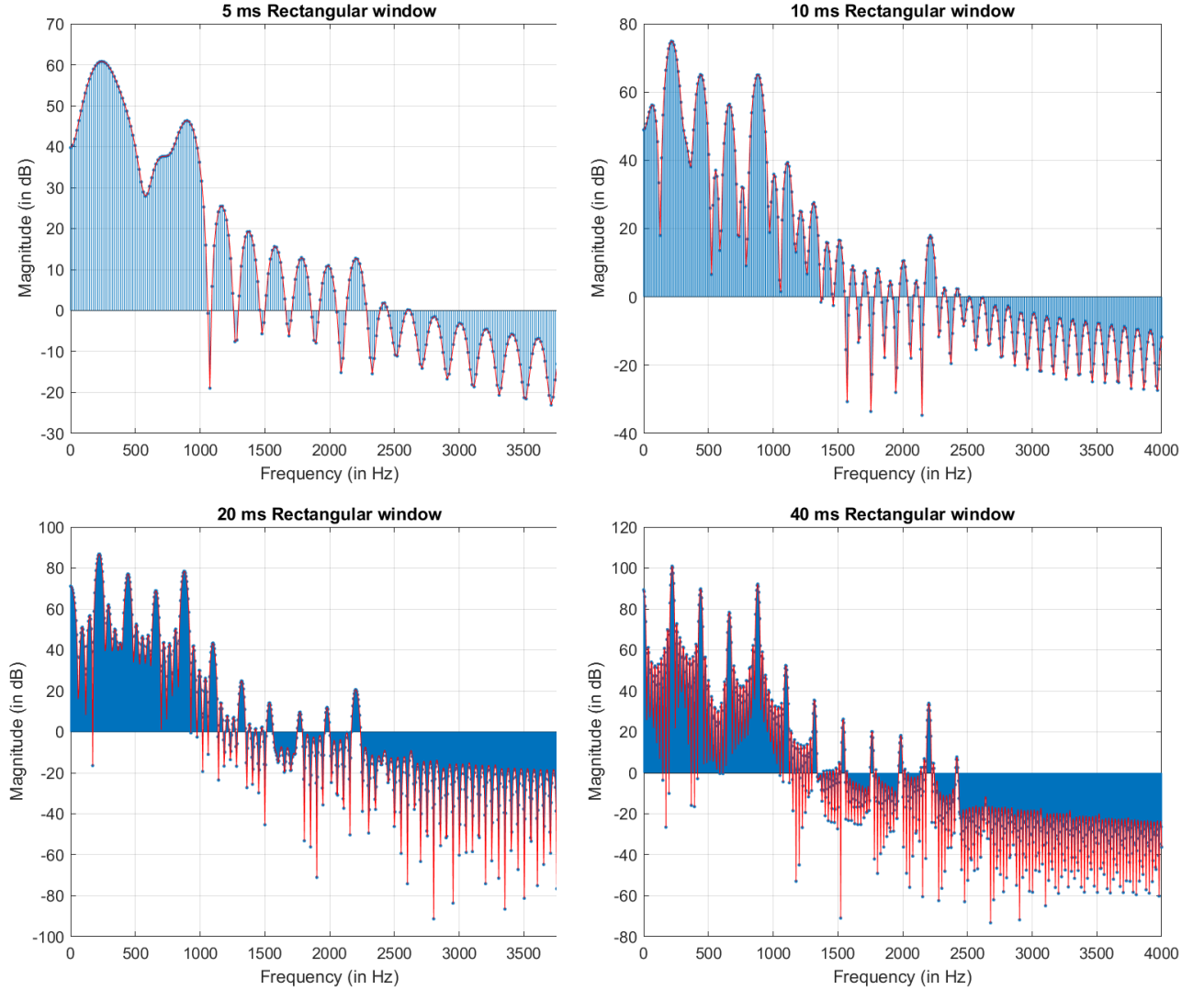


Figure 4: Magnitude responses for different Rectangular window lengths

Window length (ms)	f_1 (Hz)	f_2 (Hz)	f_3 (Hz)
5	257	899	2201
10	224	877	2214
20	219	881	2195
40	220	880	2202

Table 3: Observed formant frequencies for each window length

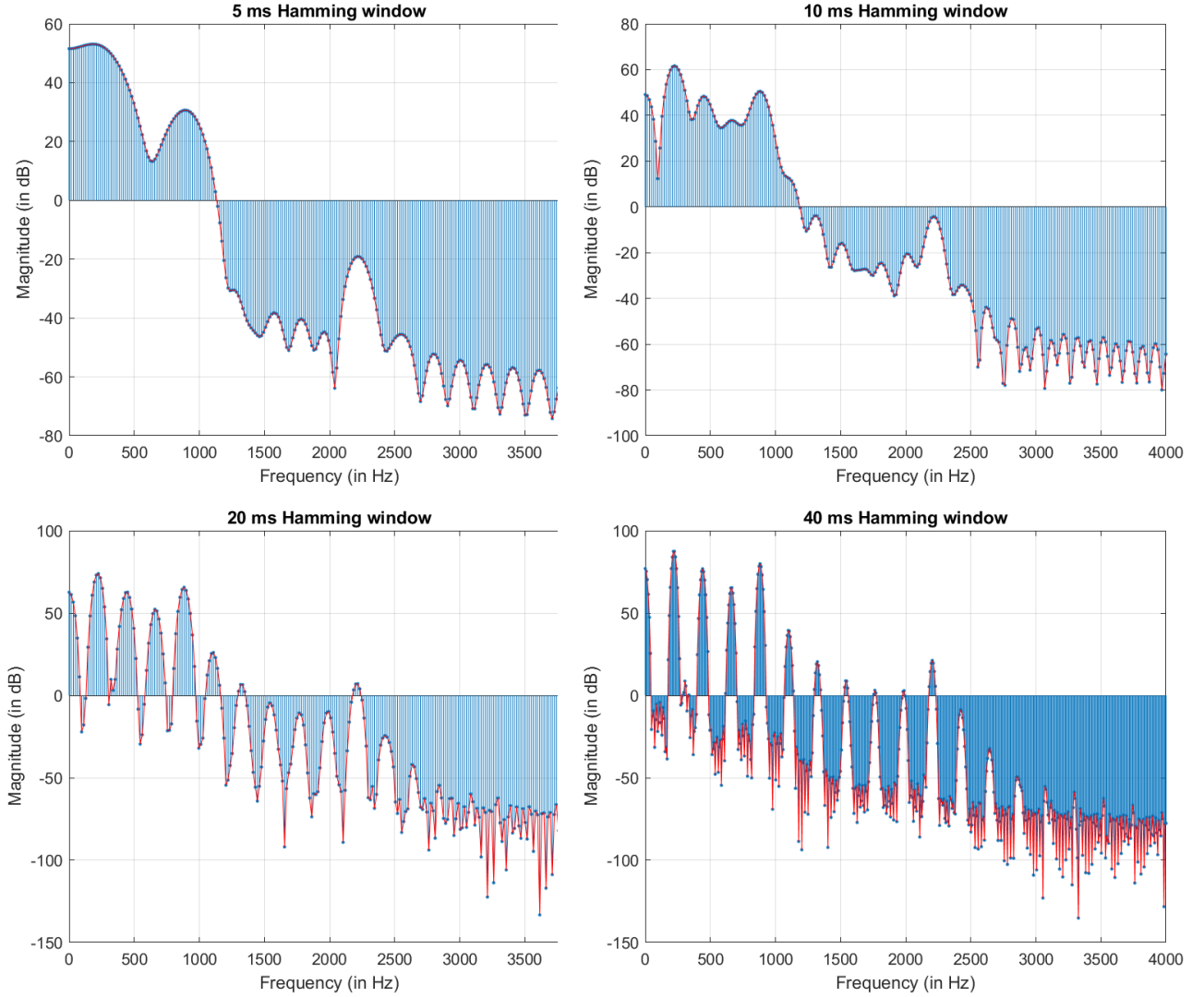


Figure 5: Magnitude responses for different Hamming window lengths

Window length (ms)	f_1 (Hz)	f_2 (Hz)	f_3 (Hz)
5	257	883	2217
10	241	883	2217
20	224	883	2217
40	224	881	2204

Table 4: Observed formant frequencies for each window length

The observations with respect to window type and varying window lengths are similar to the lower pitch case. With increasing pitch, the number of lobes(peaks) in a given range has decreased. The previous case seems to be a better approximation to the actual magnitude response with windowing operation. In this case, the overall envelope to be traced isn't very clear and formant locations not so precise compared to the lower pitch response.