Project 2: Analog Communication via Frequency Modulation

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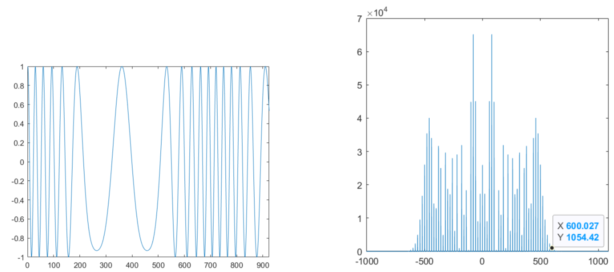
2021-11-16

I. Part II: Arduino

1) The values of k_f, the deviation constant, and f_c, the carrier frequency should be selected such that $\beta_f < 2pif_ct$ and $f_c << f_{sampling,MATLAB}$.
2) According to the Carson's rule:

$$B_T = 2(\beta_f + 1)W = 2(\frac{2\pi k_f}{2\pi 20} + 1)20 = 640 \quad (1)$$



(a) The time-domain

(b) The frequency-domain

Fig. 1: Plots of modulated signal

From Fig. 1(b), it can be seen that calculated and measured bandwidths are approximately equal.

3) The DC bias circuit setup can be seen in Fig. 2.

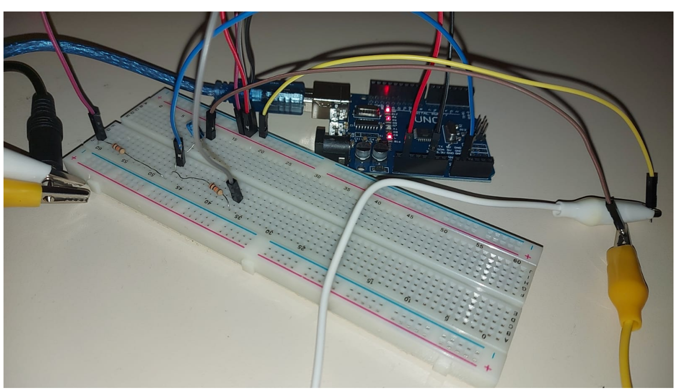


Fig. 2: DC Bias Circuit

4) The arduino code has verified and loaded into the board.
5) The FM signal has been read from the serial interface.
6) Generated tone has plotted in MATLAB. The total number of points in one period of wave should be calculated. In one period, 366-142=224 sample points has been observed. The generated wave frequency is 40, so, every second, it generates 40 periods. As a results, sampling rate of the arduino is approximately $40 \times 224 = 8.96kHz$.
7) The sampled received signal has been plotted in MATLAB, as can be seen in Fig. 3.

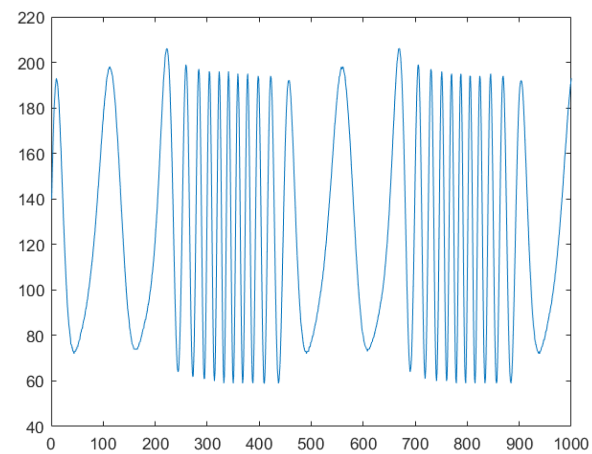


Fig. 3: Received FM signal

8) The received FM signal after the derivative operation can be seen in Fig. 4.

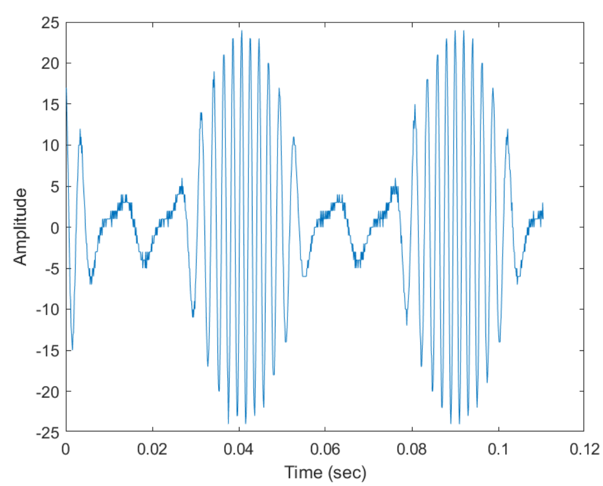


Fig. 4: FM signal after derivative operation.

9) The original and demodulated wave can be seen in

Fig. 5. Both of them seemed to be have approximately the same frequency. On the other hand, the very negative part of the demodulated signal seems to be recovered inefficiently. The Mean Square Error between the original signal and the received signal is 0.1359.

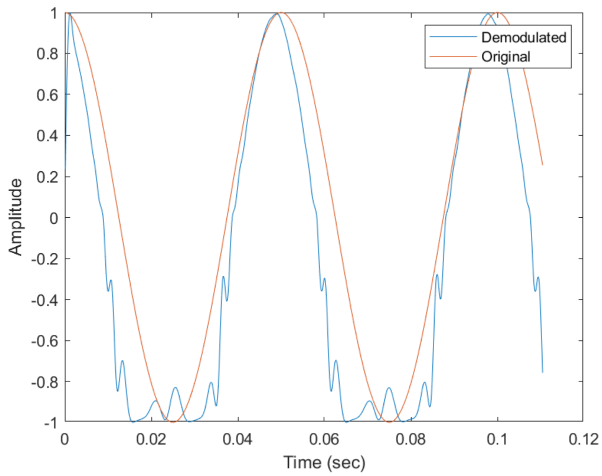


Fig. 5: The original and demodulated wave.