Project 1: Analog Communication via Amplitude Modulation

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2021-11-02

I. Part II: Arduino

1)

$$y(t) = (A_m + m(t))cos(2\pi f_c t) \tag{1}$$

A should be chosen such that $A + m(t) >= 0$ is satisfied. The carrier frequency has to greater than upper and lower bandwidth of the message signal.

2) Arduino board ans DC bias circuit were set up, which can be seen in Fig. 1.

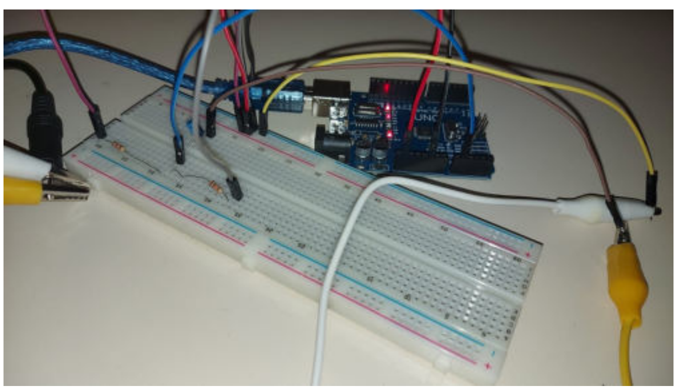

Fig. 1: Arduino Board and DC Bias Circuit

3) The arduino code has been compiled and uploaded to read data from analog pins.
4) The signal received from the serial port can be seen in Fig. 3.
5) Firstly, using a online tone generation tool, which can be seen in Fig. 2(a), generated wave passed through the system of DC bias and Arduino and to the computer. Then, in MATLAB, the received data is plotted as seen in Fig. 2(b). 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 $40 \times 224 = 8.96kHz$.

(a) The sine wave generated online (b) Received sine wave in MATLAB

Fig. 2: The process of finding the sampling frequency of MATLAB.

6) The received AM signal in MATLAB can be seen in Fig. 3.

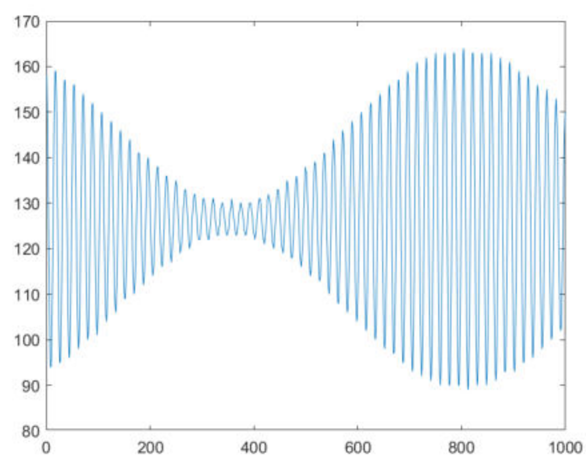

Fig. 3: Received AM Signal

7) Firstly, by dividing the t vector with the sampling frequency of MATLAB, which is 8980Hz, x axis is switched to time domain.
Then, mean of the signal is subtracted from the signal to block DC component. After that, the signal low-pass filtered with a cut-off frequency of 50 Hz. Lastly, the signal is dc-blocked again, and final signal is scaled to approximate the message signal.
8) Two signals are approximately the same signals but there is a phase shift between them, as can be seen in Fig. 4. The mean square error is 0.0974.

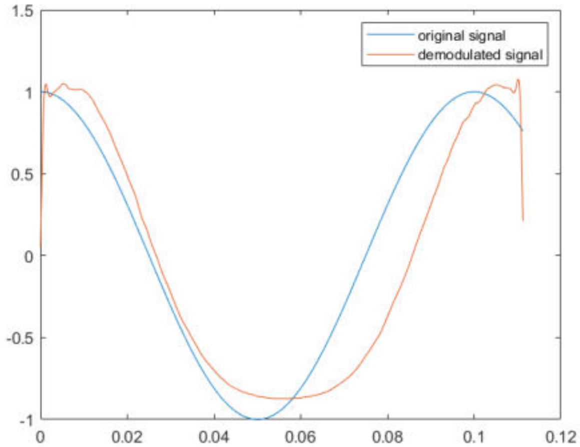

Fig. 4: The original and demodulated signal

9) For $P_n = 10^{-6}$, The mean square error is 0.1816. Both received and original waveforms can be seen in Fig. 5.

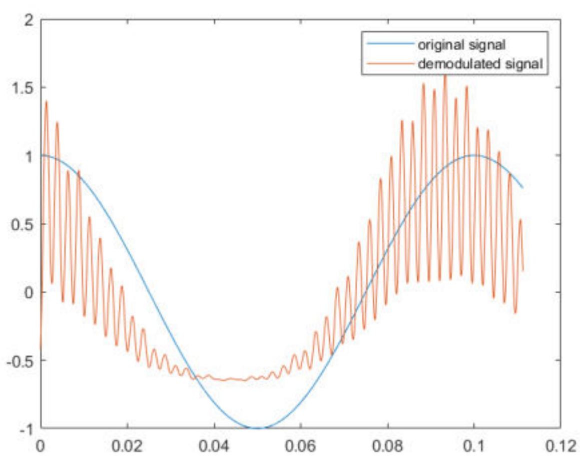

Fig. 5: The original and demodulated signal when $P_n = 10^{-6}$

For $P_n = 10^{-2}$, The mean square error is 0.2012. Both received and original waveforms can be seen in Fig. 6.

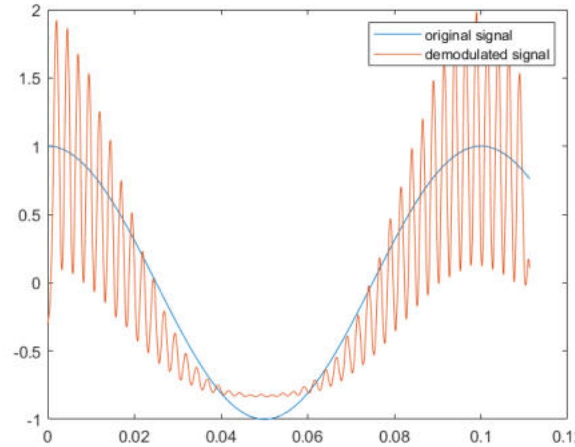

Fig. 6: The original and demodulated signal when $P_n = 10^{-2}$