CMPEN 462
MP 1: Wireless Radio
Due 22 Feb 2022

Wireless Radio

In this MP, you will design a basic wireless receiver to decode a transmitted text message. The transmission occurs at a center frequency of $20Hz$. Your input is a 3000 sample long incoming signal at the antenna at $100Hz$ [1]. Although the antenna input is a continuous signal, in this MP, we will approximate this is a discrete signal of sampling rate $100Hz$. Assume there is no multipath and the channel $h = 1$. You need to implement the following steps to decode the transmitted message (block diagram in Figure 1).

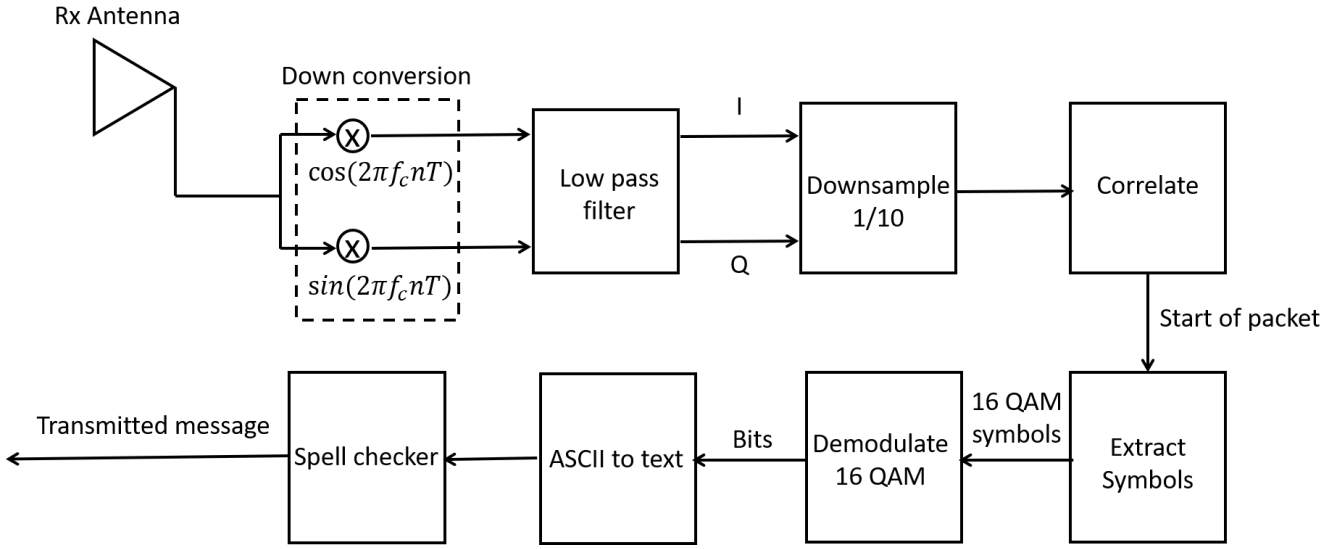

Figure 1: A basic wireless receiver

- **Downconvert:** Downconvert both I and Q to baseband by multiplying the input signal with 3000 sample long cos and sin functions (Both cos and sin start with a phase of zero. In other words, the first sample of the cos function will be 1 whereas the first sample of the sin function would be 0) of frequency 20 Hz (carrier frequency).
- **Filter:** Once downconverted, you need to compute the FFT (3000 point FFT) and eliminate all frequencies outside the range of -5.1 to $+5.1$ Hz by setting those frequency components to

zero. After computing the IFFT, you would only retain the baseband signal and eliminate high frequency components (Note: You might want to look at "FFT example.pdf" sent by Hao Zhou for an example on FFT output in Hz).

- **Downsample:** Since the transmitted symbol rate is $10Hz$, you need to downsample the filtered output to a sample rate $10Hz$. The input signal is 3000 samples long. You need to take every 10th sample starting from first (1st,11th,21st and so on). After this step, you would be left with 300 samples.
- **Correlate:** The first sample does not correspond to the first transmitted symbol. The transmitted symbols are preceded by a 50 sample preamble, as included in [2]. The I and Q components of preamble is represented in the file as a complex number $(I + jQ)$ Correlate with the known preamble and identify the start of the first symbol. After this discard all other samples that arrive before the first symbol. The last symbol is the last sample.
- **Demodulate:** Demodulate each symbol using 16QAM, the constellation of which is specified in Figure 2. Extract binary bits.

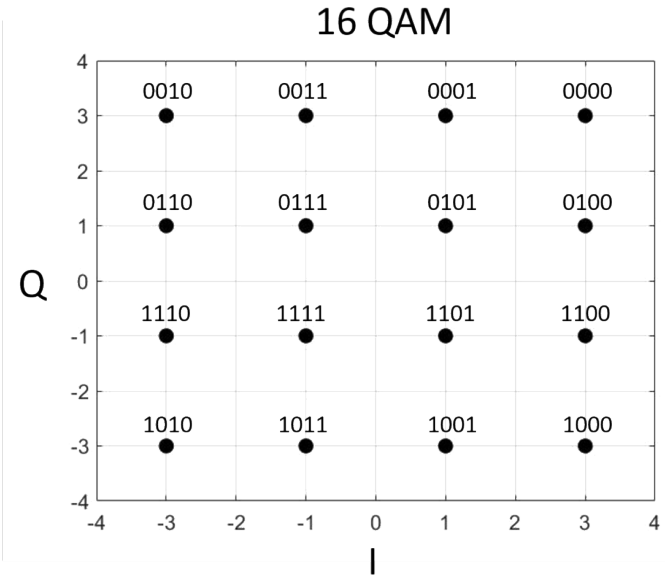

Figure 2: 16 QAM constellation diagram and symbol to bit mapping

- **ASCII to text:** Group 8 bits together and convert them into characters based on ASCII codes (E.g. if two symbols from previous step from 16QAM correspond to 0110 and 0001, then combine them into '01100001' to form a 8 bit string whose ascii conversion is the character 'a')
- **Error correction:** Your message is likely corrupted with noise. Can you use a spellchecker or your CMPEN 462 prior knowledge, to detect what the transmitted message was?

Submission Instructions

Your code need to take two files as input. One is the preamble signals, and the other is the input signal to the antenna. Use the same format as our input files [1,2]. The output must be the final text message

decoded (before error correction or spell checking). For the final submission, you need to upload four files on canvas: (i) The final decoded output for inputs specified in the question, (ii) your code, (iii) a 'readme.txt' file containing instructions for executing your code to generate the output, (iv) A video that shows the program running on your computer screen from start to end by following the instructions in your readme file. You are welcome to include your audio as well while you record the video to explain the steps you are undertaking. Your code would be tested for other 3000 sample inputs as well by your TAs.

References

[1] Input signal. `http://www.cse.psu.edu/~mkg31/teaching/cmpen_462_sp22/class_material/mp1/input.txt`.

[2] Preamble. `http://www.cse.psu.edu/~mkg31/teaching/cmpen_462_sp22/class_material/mp1/preamble.txt`.