

ECE/CS 439
MP 1: Wireless Radio
Due 13 October 2017

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 as 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).

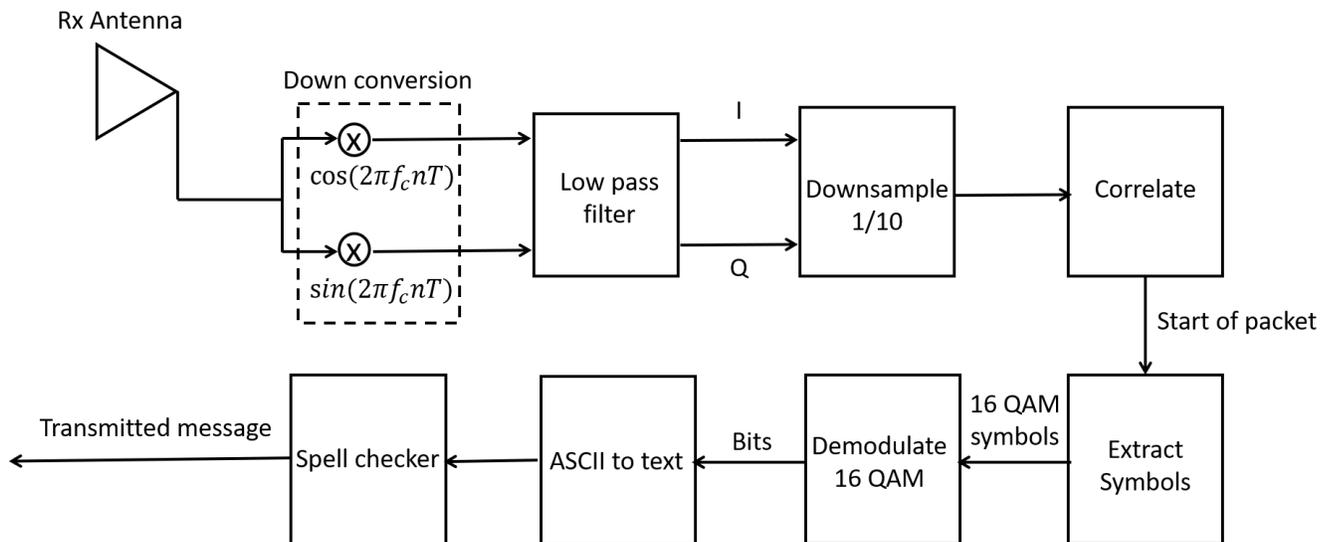


Figure 1: A basic wireless receiver

- **Downconvert:** Downconvert both I and Q to baseband by multiplying the input signal with 3000 sample long cos and sin functions 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 $+5.1\text{ Hz}$ by setting those frequency components to zero. After computing the IFFT, you would only retain the baseband signal and eliminate high frequency components.

- **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.

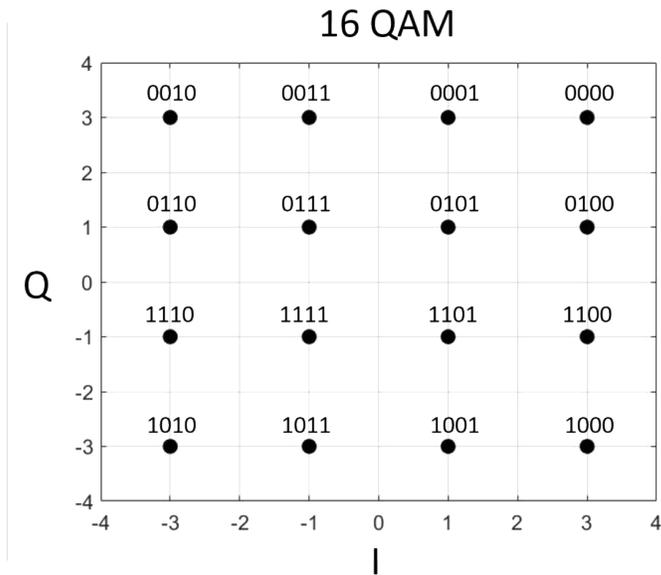


Figure 2: 16 QAM constellation diagram and symbol to bit mapping

- **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 ECE 439 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 three files on compass. The final decoded output, your code, and a 'readme.txt' file containing instructions

for executing your code to generate the output. Your code would be tested for other 3000 sample inputs as well.

References

- [1] Input signal. <https://courses.engr.illinois.edu/ece439/fa2017/mp/input.txt>.
- [2] Preamble. <https://courses.engr.illinois.edu/ece439/fa2017/mp/preamble.txt>.