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Project : 1

Abstract:

This report presents the implementation and analysis of an Orthogonal Frequency Division Multiplexing (OFDM) system and covers several key components:

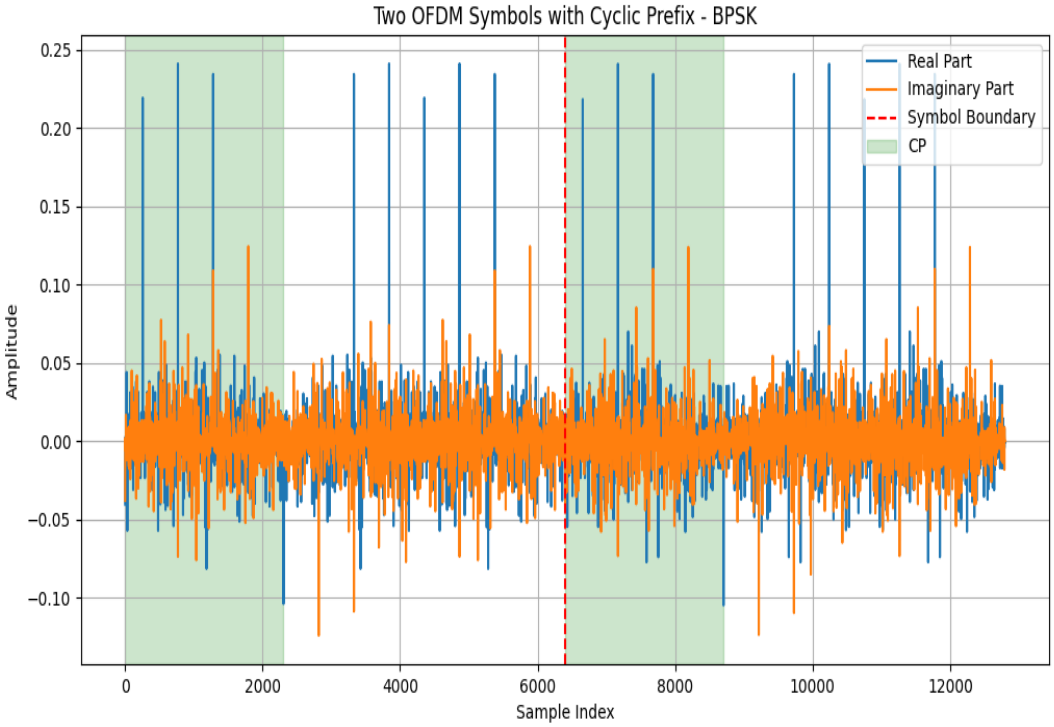
1. **Modulation Schemes**: Different modulation schemes such as BPSK, $\pi/2$-BPSK, QPSK, and 64-QAM are implemented in the `Modulators.py` file. These schemes are used to convert the input bit stream based off the 8-bit ASCII conversion of the string "WirelessCommunicationSystemsandSecurityJustinNgo" into suitable symbols ready for transmission.

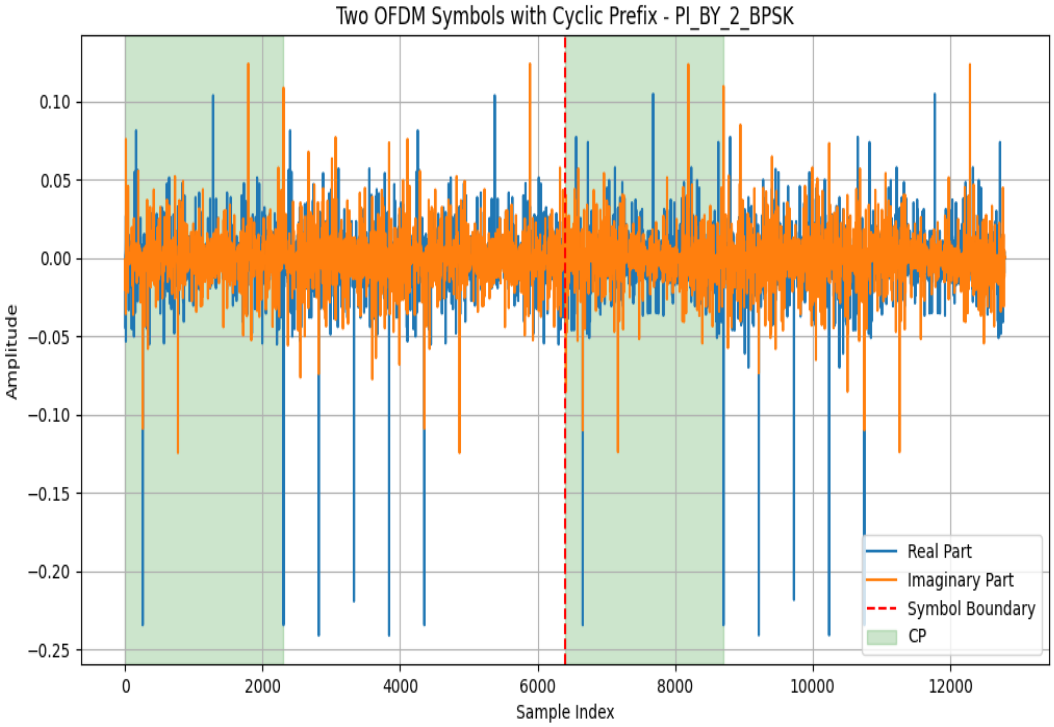
2. **OFDM Processing**: The `OFDM.py` file houses all the relevant functions used to produce an OFDM output, and handles the bulk of the processing. The OFDM function is responsible for running the serial-to-parallel conversion, Inverse Fast Fourier Transform (IFFT), cyclic prefix insertion, and also graphs the output.

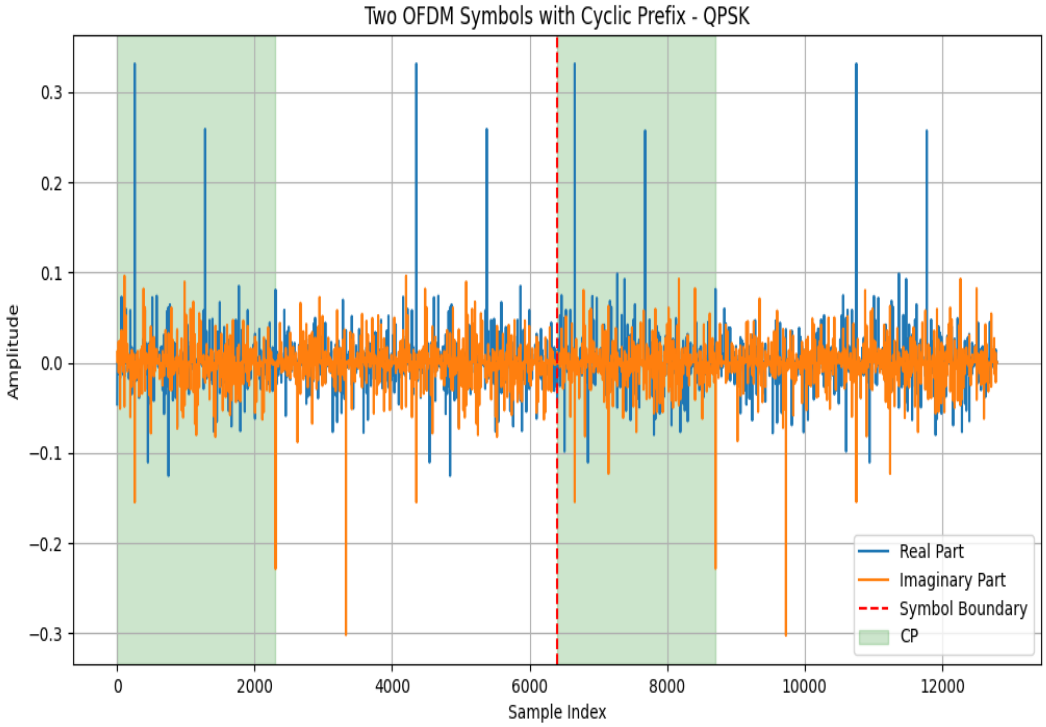
3. **Main Execution**: The `main.py` file generates the bit stream used for processing from the aforementioned phrase and is where the OFDM function is called to run the system for each modulation scheme.

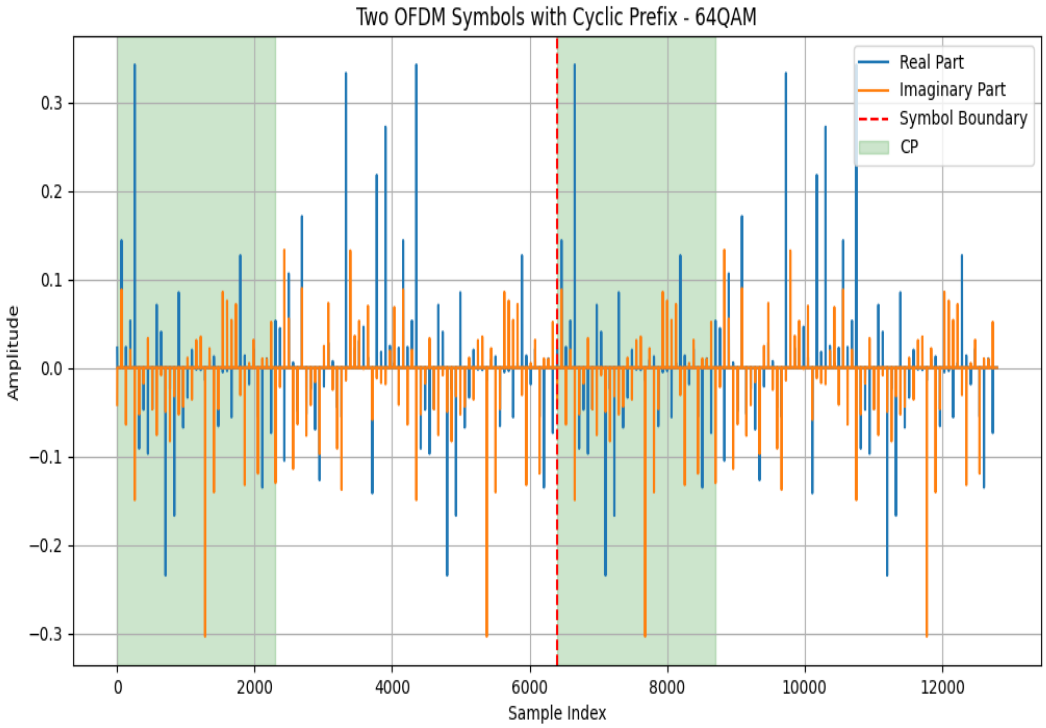
4. **Visualization**: A sample of 2 symbols generated from the OFDM system is plotted for visualization and highlights the cyclic prefix and symbol boundaries.

Generated Waveforms:






Two OFDM Symbols with Cyclic Prefix - QPSK
Amplitude
Sample Index
Real Part
Imaginary Part
Symbol Boundary
CP


Two OFDM Symbols with Cyclic Prefix - 64QAM
Amplitude
Sample Index
Real Part
Imaginary Part
Symbol Boundary
CP

Flow Diagram:

1. **Bit Stream Generation**: The input bit stream is generated from the ASCII conversion of the phrase "WirelessCommunicationSystemsandSecurityJustinNgo" and is repeated to ensure a minimum length of 1 slot using the `64QAM` modulation scheme, since that requires the most bits per symbol.

2. **Modulation**: Depending on the modulation scheme passed into the `OFDM` function, the input bits are mapped to a constellation based off of figure 5.2 from the book, that was provided in the lecture slides. The formulas I used were approximations of what were provided on the 3GPP TS 38.211 pdf.

3. **Serial to Parallel Conversion**: After modulation, the bits are passed into the `s2p` function which converts the serial input into a parallel output before running the IFFT

4. **IFFT**: The `IFFT` is run immediately after the bits are reorganized within the `s2p` function, and is the final output from `s2p`

5. **Cyclic Prefix Insertion**: The 2d array that's returned as the IFFT from `s2p` is then passed into `cyc_pref`, where each symbol is prepended with the last $2034T_c$ of it's output

6. **Steps That Weren't Modeled**:

   (a) **Parallel to Serial Conversion**: The parallel output of the Prefix Insertions would then be flattened into a serialized output for processing at the DAC

   (b) **DAC**: The DAC would convert the digital signal into an analog signal for transmission

   (c) **RF Modulation**: The analog signal would then be modulated with the carrier frequency to boost the signal before being broadcasted by the antenna