% Note: Since the transmission is through an equivalent baseband channel, all signals, including channel

% noise and impulse response are, in general, complex-valued.

% Report: Summarize your finding in a report, consisting an abstract of 100 words or less, an introduction

% explaining how OFDM works (think of teaching one of your peers), two or three sections explaining your

% codes, and a conclusion of 100 words or less. The total length of your report should be limited to 3

% pages of double space text and as many figures as you wish. Keep text and figures in separate

% pages. Submit a pdf copy of your report along with your MATLAB codes all in a zip file with the name

% DigCom2022Project(your name).zip. Upload on canvas.

ABSTRACT

Orthogonal Frequency Division Multiplexing (OFDM) is a modern waveform approach utilizing orthogonal subcarrier sine/cosine waves to distribute transmission of data within a given bandwidth. Despite the computation complexity, OFDM utilizes Fast Fourier Transform and Inverse Fast Fourier Transform algorithms (FFT, IFFT) which simplify equalization. This simplification is the result of the flat gain profile of transmitting symbols on an approximately pure tones as the subcarriers. This approach is enabled by exploiting Nyquist Criterion and principles of orthogonal functions.

Introduction To OFDM Principles

For a student studying Digital Communications or even introductory signals courses, the response of an LTI system to sine/cosine waves should be intuitive. Given some passed through any arbitrary LTI system guarantees the following property:

This equation shows that given a pure tone of a certain amplitude, an LTI system will return that amplitude scaled by the system gain at that tone. Let us neglect the change in phase or delay of the cosine for this discussion and focus on amplitude. Given that amplitudes are often the mode of transmitting data, and that maintaining flat channel gain across a band is often challenging, pure or nearly pure tones virtually eliminate the flat channel gain issue.

Another important property utilized by OFDM is the principle of orthogonality particularly orthogonal functions. At the risk of delving too deeply into linear algebra principles, a student may remember or note that the dot product of two vectors can show these two vectors to be orthogonal and even that they may form a basis. This means that no linear combination of one basis vector can construct another member vector of that basis. This also applies to functions in the sense that one can show that a set of functions are orthogonal to each other and will not interfere with each other when multiplexed over a given time interval. Functions can be shown to be orthogonal as follows:

Additionally, given a function which incorporates Nyquist Criterion properties, one can show that we can sum two orthogonal Nyquist pulses in the time domain within a given symbol interval, transmit the multiplexed symbol and then extract information from a single component of the multiplexed symbol.

Diagram

Description automatically generated