# MATLAB Optical Transmission Simulation Code

## Description

This code simulates an optical transmission system using various functions such as laser modulation, amplification, and filtering. It uses a Pulse Amplitude Modulation (PAM) or Quadrature Amplitude Modulation (QAM) schemes and analyzes the performance in terms of Bit Error Rate (BER) and Optical Signal-to-Noise Ratio (OSNR). In the case of QAM transmission, self-coherent detections is made with the utilization of a partially modulated carrier. The system involves signal transmission through single mode fiber and simulated recursive optical MZDI filters with detuning, bandwidth optimization, feedback strength adjustment, and delay loops, followed by photodetection, demodulation, linear equalization through ridge regression and bit-error analysis. The main purpose is the investigation of the best MZDI parameters for equalization in different link cases.

### Prerequisites

1. \*\*MATLAB\*\* (preferably R2020b or higher)

2. \*\*MATLAB Toolboxes\*\* (required)

- \*\*Signal Processing Toolbox\*\*

- \*\*Communications System Toolbox\*\*

3. \*\*Other dependencies:\*\*

- Simple functions (e.g., `Laser`, `PAM\_transmitter`, `transmission\_parameters`, `MZDI`, etc.) are provided separately in the repository, are custom made and can be replaced by any type of readily available functions of other similar software.

All these functions are uploaded in the repository along with the main scripts.

### Steps to Set Up

1. \*\*Clone this repository\*\* or download the code files to your local machine.

2. \*\*Add the functions to MATLAB Path:\*\*

Ensure all functions used in the script (e.g., `Laser.m`, `PAM\_transmitter.m`, etc.) are either included in the repository or available on your local MATLAB path.

3. \*\*Run the Code:\*\*

- Open the MATLAB environment.

- Navigate to the folder where the code is stored.

- Execute the script by typing the script's name in the command window.

4. \*\*Check Results:\*\*

- The simulation will produce several figures as outputs, including the frequency domain plots, Bit Error Rate (BER) results, and other key performance metrics.

- You can modify the script for more specific output formats or results as needed.

## Dependencies

This code requires the following dependencies:

1. \*\*MATLAB Toolboxes\*\*:

- Signal Processing Toolbox

- Communications System Toolbox

2. \*\*Functions\*\*:

- `Laser.m` (Generates laser output with specific properties)

- `PAM\_transmitter.m` (Transmits signals with a specific modulation scheme)

- `transmission\_parameters.m` (Defines the parameters for the transmission medium)

- `MZDI.m` (Mach-Zehnder Delayed Interferometer, simulation block)

- Other custom functions related to the simulation.

## Usage

### Inputs:

- \*\*PowdBm\*\*: Power in dBm (default: `3` dBm).

- \*\*Symbol\_rate\*\*: Symbol rate of the transmission (default: `112e9` symbols per second).

- \*\*samples\_symbol\*\*: Number of samples per symbol (default: `32` samples per symbol).

- \*\*Nt\*\*: Number of samples in the transmission (default: `2^21` samples).

### Outputs:

- \*\*BER (Bit Error Rate)\*\*: This is calculated after the simulation and is a measure of the transmission quality.

- \*\*OSNR (Optical Signal-to-Noise Ratio)\*\*: A measure of the noise level in the system.

-\*\*Electrical spectra of the back-to-back input and each output.

## Example Output

You can expect to see plots of:

- Frequency domain analysis of the transmitted and received signals.

- BER performance graphs (eyediagrams, scatterplots for QAM).

- OSNR and Received Optical Power (ROP) comparison for different simulation configurations and parameters.

System Toolboxes for enabling advanced processing.

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