# LMS equalizer

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***Abstract*—This document explains the modelling of Rician multipath fading channel channel in below octave code of an LMS equalizer**

```
./codes/LMS_equalizer_octave.m
```

Download the octave codes from

```
svn co https://github.com/krishnajakodali/
    summer20/trunk/LMS_equalizer_octave/codes
```

## 1 Introduction

Rician fading channel is one of the useful models of real-world phenomena in wireless communication.These phenomena include multipath scattering effects , time dispesion and doppler shifts that arise from relative motion between transmitter and reciever.
A channel filter applies path gains to the input signal. Path gains are configured based on settings chosen in fading channel object or block which are used to model fading channels.
The path gains are found using the matlab function ricianchan by running the code

```
./codes/LMS_equalizer_MATLAB.m
```

The channel specifications considered in the above code are as follows:

$$t_s = \frac{1}{185000} \tag{1.0.1}$$

$$fd = 0.1 \tag{1.0.2}$$

$$k = 0.87/0.13 \tag{1.0.3}$$

$$\tau = \begin{pmatrix} 0.0 & 0.2 & 0.4 & 0.6 & 0.8 \end{pmatrix} \times 10^{-5} \tag{1.0.4}$$

$$pdb = \begin{pmatrix} 0 & -2 & -10 & -20 & -22 \end{pmatrix} \tag{1.0.5}$$

$$fdLos = 0.7 * fd = 0.07 \tag{1.0.6}$$

Where $t_s$ is the sample time of the input signal, fd is the maximum doppler shift in hertz, k is the rician K-factor in linear scale,fdLos is the doppler shift of line of sight component.
$\tau$ is vector of path delays specified in seconds and pdb is the vector of average path gains specified in dB.

The path gains thus found are stored in the file

```
./codes/path_gains.dat
```

## 2 Equations

The multipath fading cahnnel is modelled as a linear finite impulse-reponse filter.
Let $s_i$ denote the set of samples at the input to the channel, Then samples $Rk_i$ at the output of the channel are related to $s_i$ through:

$$Rk_i = \sum_{n=-N_1}^{N2} s_{i-n} g_n \tag{2.0.1}$$

Where $g_n$ is the set of tap weights given by:

$$g_n = \sum_{k=1}^{k} a_k \operatorname{sinc}\left(\frac{\tau_k}{t_s} - n\right) \tag{2.0.2}$$

$$-N_1 \leq n \leq N_2 \tag{2.0.3}$$

In the equations:
$t_s$ is the input sample period to the channel
$\tau_k$ where $1 \leq k \leq K$is the set of path delays(pd).
K is the total number of paths in the multiple fading channel.Here, K=5
$a_k$ where $1 \leq k \leq K$is the set of complex path gains(pg). $N_1$ and $N_2$ are chosen so that $g_n$ is small when n is less than$-N_1$ and greater than $N_2$.In the given code,

$$N_1 = N_2 = 800 \tag{2.0.4}$$

## 3 Results

A path gain must be choosen by modifying the value of r in the command

```
pg = dlmread('path_gains.dat',',',[r,0,r,4])
```

Where r can be any value from 0 to 4.
For r=0, the following figures are obtained

Hence the code has been executed in octave.

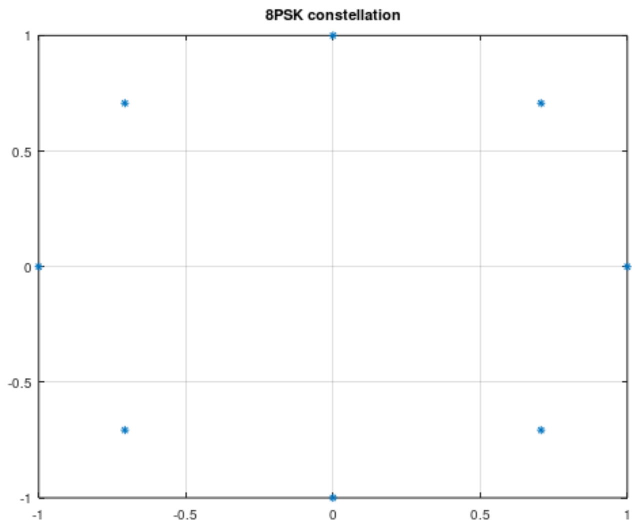


Fig. 1: 8-PSK constellation

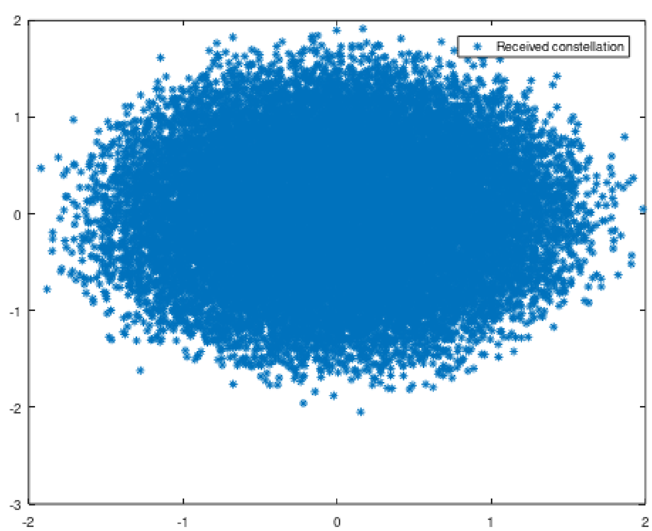


Fig. 2: Recieved constellation from the channel

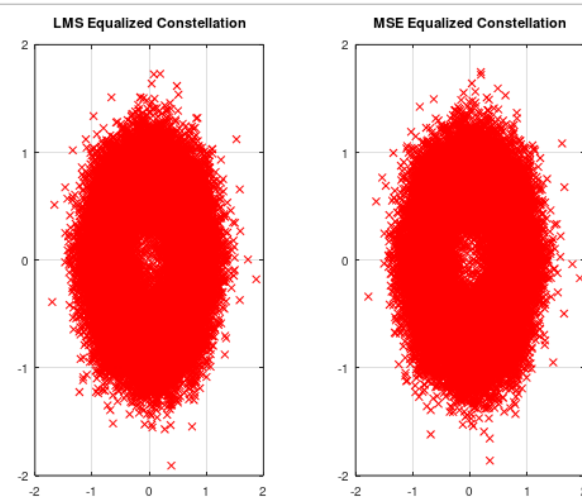


Fig. 3: LMS and MSE equalized constellation