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_octave_conv.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.
τ 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:

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

$$Rk = Ak \circledast g \tag{2.0.2}$$

Where g_n is the set of tap weights given by:

$$g_n = \sum_{k=1}^{k} a_k \operatorname{sinc}\left(\frac{\tau_k}{t_s} - n\right) \tag{2.0.3}$$

$$-N_1 \le n \le N_2 \tag{2.0.4}$$

In the equations:
t_s is the input sample period to the channel
τ_k where $1 \le k \le K$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 $1 \le k \le K$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,

$$N_1 = N_2 = 800 \tag{2.0.5}$$

3 Parameters

The various parameters and their values used in the below code are listed in table I

```
./codes/LMS_octave_conv.m
```

Para.	Description	Val
Timeslot	Transmit time duration	0.002
SNR	Signal to noise ratio	18
Rsym	Input symbol rate	185000
Rbit	Input bit rate	556000
ts	Input sampling period	1/185000
htap	Channel taps	11
beta	Step size of LMS algo	0.001

Channel Parameters

Para.	Description	Val
ts	Input sampling period	1/185000
k	Rician K-factor	0.87/0.13
fd	Max. doppler shift(Hz)	0.1
fdLos	LOS doppler shift	0.07

TABLE I: Parameters and their values

4 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

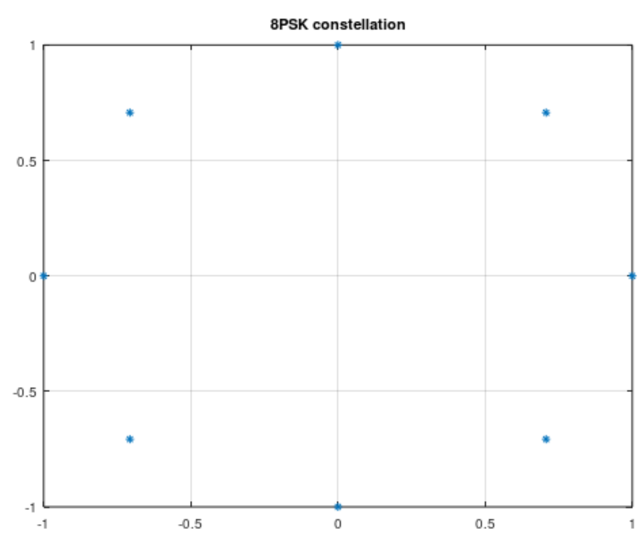

Fig. 1: 8-PSK constellation

Hence the code has been executed in octave.

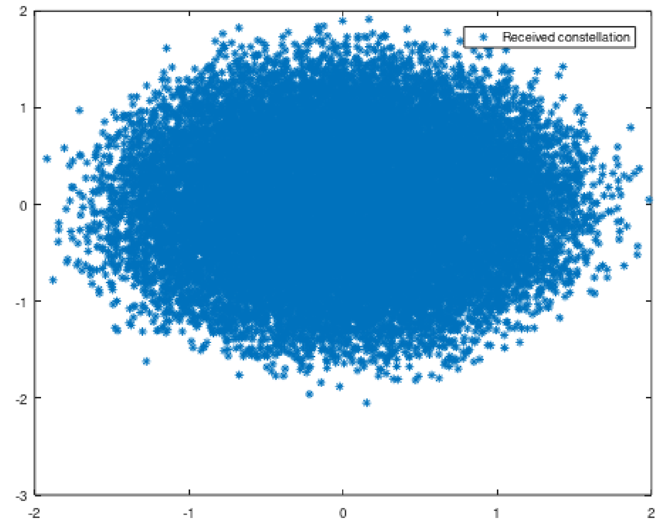

Fig. 2: Recieved constellation from the channel

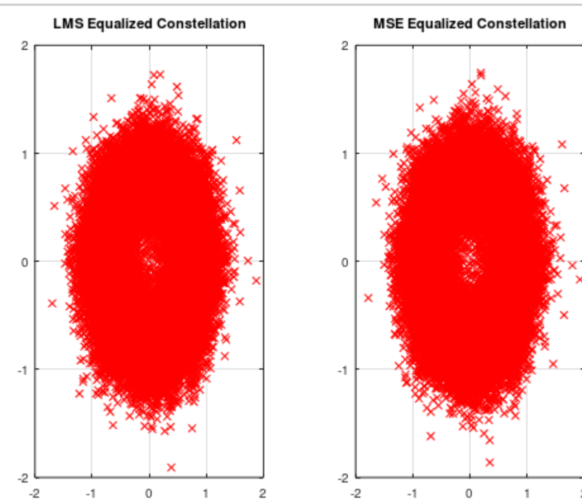

Fig. 3: LMS and MSE equalized constellation