Baseband Wireless Channel Emulator

# Introduction

There are three types model in mobile radio propagation: Large Scale Path Loss, and Shading Losing, and Fading with Multipath (Referring Wireless Communications: Principles and Practice, T. S. Rappaport). We will build a wireless channel emulator on its tapping baseband model, and only Fading and Multipath is considered.

# Structure

In the block diagram, denotes the transmitted signal and denotes the received signal.

There are N taps in the channel emulator. In the k-th tap, the transmitted signal is delayed by first, then multiplied by power assignment weight , and at last faded by fading coefficient . Finally all results from the taps are summed up together and the Additive White Gaussian Noise is added to it.

All signals and coefficients except the power weight are complex numbers.



Figure (1) Block Diagram

The path delay are arbitrarily predetermined constants following the equation:

(1)

The power weight are predetermined constants following the equation:

(2)

The fading coefficient follows the Rayleigh distribution, and it can be computed by the following equation:

(3)

where , and are random variables uniformly distributed over for all and are mutually distributed, is maximum Doppler spread for the k-th path, is sampling period.

(Referring <http://www.gaussianwaves.com/2011/05/simulation-of-rayleigh-fading-clarkes-model-sum-of-sinusoids-method-2/> and <http://library.utem.edu.my/index2.php?option=com_docman&task=doc_view&gid=5459&Itemid=342> )

and are predetermined constants in the above Equation (3).

The received signal can be computed by the following equation:

(4)

Uniform random numbers are generated by the following equation:

(5)

Where，u is random numbers; n is a primer in format of 2k + 1; g is the minimum Primitive root modulo n; the initial value of u(0) and n should be relatively prime. For example, n = 216 +1 = 65537, g = 75 and u(0) = 4.

The random variables , and are computed by selecting the initial values respectively then recurrence by Equation (5). They also must be scaled to their range respectively.

The Additive White Gaussian Noise is generated by the following Equation (6) or Equation (7):

(6)

(7)

where and are independent random numbers distributed [uniformly](https://en.wikipedia.org/wiki/Uniform_distribution_(continuous)) on (0, 1), and is the mean square root of the noise.