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Mitigating the Effects of Intereference in a Multipath Prone Environment for a DVB-T Transmission

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ABSTRACT

This paper develops a novel simulation method that seeks to mitigate the effects of interference in a multipath prone environment for a DVB-T transmission by using the AWGN and the Multipath Rayleigh Fading Channel. The channel parameters were optimized until desired result was obtained. The reception performance of the DVB-T system shows that interference though not totally eliminated, can be minimized while transmitting in a multipath prone environment.

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1. INTRODUCTION

The Digital Video Broadcasting –Terrestrial (DVB-T) is a transmission method developed by the DVB group with a first broadcast made in 1998 in the UK. The method offers transmission with a wider coverage, better picture quality and possibility for multiplexing of signals. DVB-T uses Orthogonal Frequency Division Multiplexing (OFDM) as its modulation technique. The OFDM is an established and widely accepted technique for high rate data communications due to its numerous advantage especially its high robustness against severe channel conditions. The DVB-T system uses basically 2048 or 8192 carriers (mode 2k or 8k) [ETSI, 2008]. Each of (data) carriers is modulated by the same digital quadrature modulation: currently and typically, QPSK (4PSK), 16QAM, and 64QAM. Two error correction techniques have been shown to decrease error bit rate in DVB-T system – the first is the Reed-Solomon technique and secondly the convolution coding with Viterbi decoding [Kolawole, 2002]. A code rate is chosen from a set of 1/2, 2/3, 3/4, 5/6, and 7/8. Guard Interval *GI*—a cyclic prefix—is further inserted into the OFDM symbol to prevent influence of multipath transmission and facilitate easy synchronization and equalization [Karel, et.al, 2012]. The ratio between time of GI and time of useful part of symbol is chosen from a set of 1/4, 1/8, 1/16, and 1/32. The useful part of symbol length is 224μs in mode 2k and 896μs in mode 8k.

1.1. The Channels

Two channels are considered in this paper: an additive noise—which is assumed to be stationary and independent Gaussian random variable (AWGN), and *multipath Rayleigh fading*—due to structural obstructions in the propagation path(s) associated with Doppler shift due to the receiver moving away from or towards the transmitter.

Since noise power does not appear just at one frequency but over a range of frequencies, noise power density N_o is used, and the effect of noise in AGWN channel was observed as the noise level N_o increases relative to carrier-signal strength E_b.

2. RESEARCH METHOD

The Model parameters as listed in Table1.0 were used in designing the DVB-T System. The major source of interference was the Multipath Rayleigh Fading Channel.

Table 1. Model Parameters

Parameters	Modulation type: 2k 64-QAM
Subcarriers	2048
Puncture Vector	[1 1 0 1 1 0]
M-ary Number	64
Number of OFDM Symbols	6
QAM Symbols	1512
Zeros Added	536
Channel Model	AWGN & Rayleigh Fading Channel

The system was designed to observe the effect of interference and to determine a possible value for which a minimum error is obtainable in a DVB-T transmission for fixed or mobile reception. The Model, Fig. 1.0, shows the input data considered as any random integer that generates uniformly distributed random integers in the range [0, M-1] where M is the M-ary modulation value, which equates to $M=2^b$ where b is the bit-block [Kolawole, 2002]. Serial codes are generated by the encoder with the data sequence arranged and re-arranged by the outer and inner interleaver respectively to reduce the effect of burst errors while the first and second error level correction occurs at the outer and inner coder.

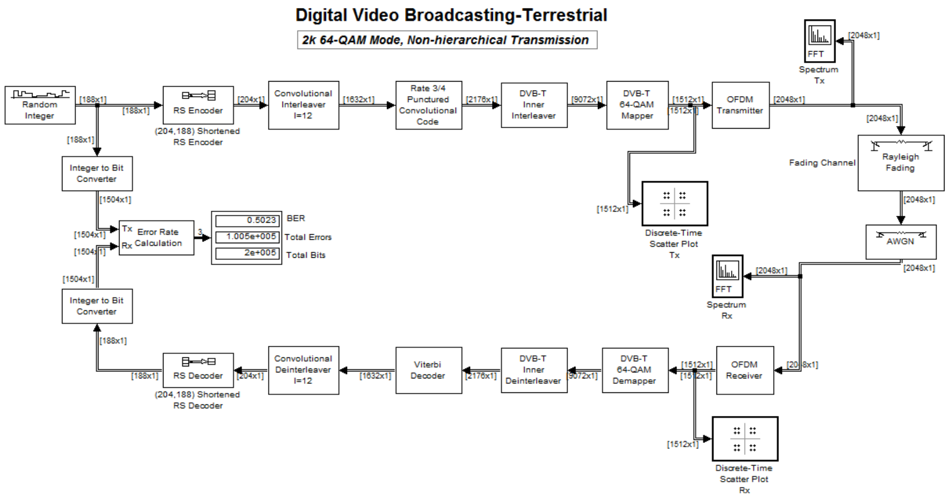

Figure 1. DVB-T Block Diagram Using SIMUINK

3. RESULTS AND ANALYSIS

The signal transmitted with no interference is seen in Figure 1.1(a) and 1.1(b) using the spectrum scope and signal constellation mapping, respectively.

The transmitted signal under the influence of varying channel interferences was observed with the listed effects very visible (see Figure1.2 and 1.3):

1. Multiple distortion and Fading
2. Loss of Orthogonality
3. Smearing of transmitted signal
4. Loss of transmitted signal
5. Signal/bits convergence

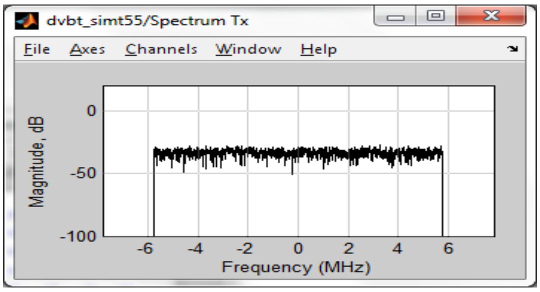

Figure 2.(a) Spectrum Scope of the Transmitted Signal

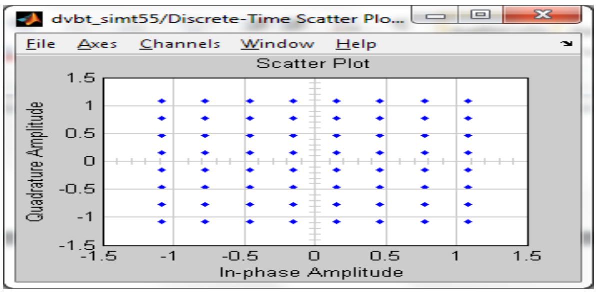

Figure 2.(b) Signal Constellation of Transmitted Signal

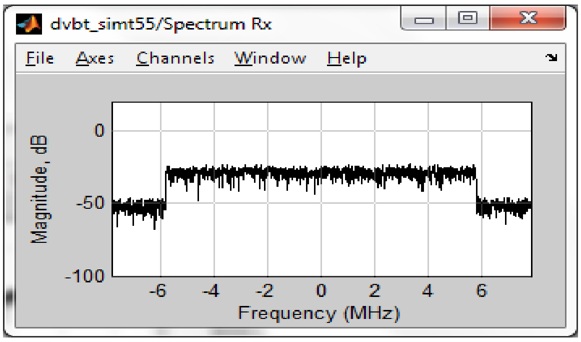

Figure 3 Spectrum Scope of the received signal at 5Hz

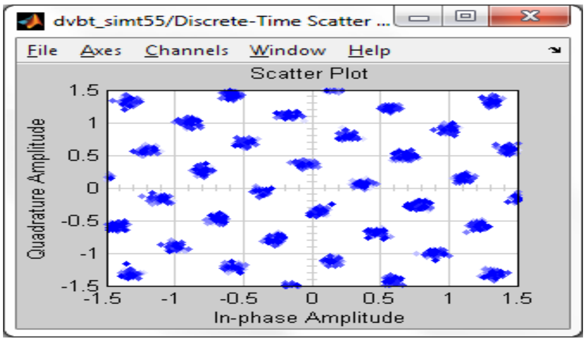

Figure 4 Signal Constellation received with less noise

To achieve minimum error transmission using both channels, the system parameter was optimized as follows:

1. Eb/No for AWGN - 30dB
2. Doppler Shift for Rayleigh - 50Hz
3. Delay Vector for Rayleigh - [0 1e-12]

Simulation result shows that lowest error, minimal BER and maximum number of bits transmitted, less fading and distortion are obtained with good signal constellation (Fig. 1.4). A further shift from these parameters show a very poor reception as shown in Fig. 1.5.

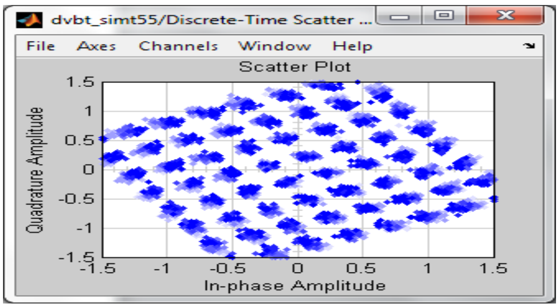

Figure 5. Signal Constellation received with fading at 50Hz

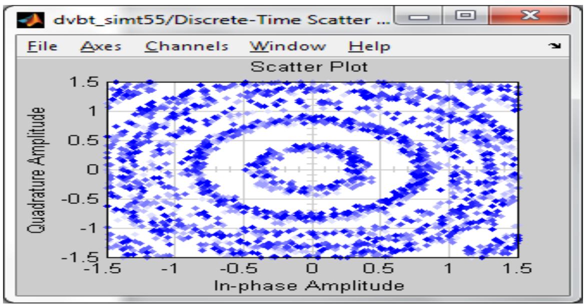

Figure 6. Signal Constellation using delay vector of [0 1e-9]

4. CONCLUSION

The combination of both the AWGN and Rayleigh Fading Channels has shown that transmission and reception in a multipath prone environment is possible with minimal effects of interference. The 2k carrier modulation has proven to enhance much robustness against Doppler frequency shifts as employed in this study.

The AWGN channel has also proven to be the best channel for DVB-T because it does not pose the challenge of multipath fading, distortion and loss of orthogonality of the system as seen in Rayleigh Multipath Fading Channel. This result is consistent with the results obtained by Aamir et.al. [2012].

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