Applied Mechanics and Materials Vols. 284-287 (2013) pp 2908-2912
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doi:10.4028/www.scientific.net/AMM.284-287.2908

Measurement and Simulation of System Performance of Digital Broadcasting System

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Keywords: Digital Video Broadcasting Terrestrial, Additive White Gaussian Noise, Bit Error Rate, Signal to Noise Ratio

Abstract. In this paper, we use MATLAB software to build the physical layer transceiver of the Digital Video Broadcasting Terrestrial System (DVB-T) and Additive White Gaussian Noise (AWGN) is added into the transmitted signal during its transmission. The transmitted signal passes through modulation, demodulation, encoding and decoding processes the resulting demodulated signal is compared with the transmitted signal to calculate its Bit Error Rate (BER). Three modulation formats, QPAK, 16-QAM and 64-QAM are simulated and through various Signal to Noise (SNR) ratio to evaluate the system performance. Various encoding techniques such as Reed Solomon Code, Convolutional Code and Viterbi Decoding [1-6] have been implemented and through simulation to make detailed system performance analysis and comparison. detailed system performance simulation, analysis and comparisons.

Introduction

In DVB-T transmission, system, it adopts MPEG-2 technique to encode video and audio information, in channel encoding it uses (2,1,6) Convolutional code with rate of 1/2, 2/3, 3/4,5/6 and 7/8, accommodating with Viterbi Decoding and (204,188,8) Reed Solomon code while it uses Coded Orthogonal Frequency Division Multiplexing (COFDM) to accomplish high data rate transmission. The modulation formats used are QPSK, 16-QAM and 64-QAM with bandwidths of 6 MHz, 7 MHz and 8 MHz.

ANALYSIS AND SIMULATION OF SYSTEM PERFORMANCE OF DVB-T SYSTEM

We use MATLAB to complete the design of DVB-T transceiver and then white Gaussian noise is added into the system, the bit error rates are then simulated when several modulation formats are implemented.

As shown in Fig. 1 is the simulation results by using MATLAB with coding rate of 5/6, 2K FFT points with three different kinds of modulation techniques are implemented. From this figure it appears that at the same bit error rate level with three modulation formats implemented the SNRs required to sustain this level of BER are in the order: 64 QAM, 16 QAM and QPSK. Also from this figure it depicts that the tolerable position deviation range of the QPSK is much larger than that of 64-QAM when the modulated data in its transmission has been affected by noisy interference but can be demodulated successfully at the receiver. We are in Table 1 in the bit error rate (BER) is the result of the consolidation under 10-3 coding gain.

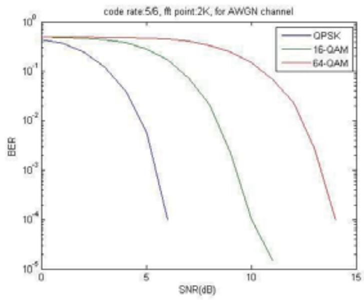

Fig. 1 BER of 2K FFT Points with Code Rate 5/6.

Table 1. BER=10-3 coding gain

	only a Convolutional code	only a Reed Solomon code	Reed Solomon code & Convolutional code
QPSK	5dB	1 dB	1dB
16-QAM	6dB	2 dB	1dB
64-QAM	6dB	1 dB	1dB

MEASUREMENT AND ANALYSIS OF DVB-H SYSTEM IN INDOOR ENVIRONMENT

Evaluation and Analysis of Measurement Data

It needs to have the indoor measurements to meet the DVB-H measurement specification [7-13] such as the specifications of IEC62002-1, MBRAI. The signals generated form the baseband signal generator to drive the test transmitter and then the RF signal is transmitted to the Device Under Test (DUT), the DUT signal is inputted to the baseband analyzer. The measurement test system has the set up as shown in Fig. 2. The transmission format can be changed with 2K, 4K or 8K FFT points or change other parameters or insert channel noise and insert signal fading to represent analog interference and utilizes bit error rate (BER) to test the receiver performance [14][15] . The BER test will demonstrate the receiver system has the capability to process these noises. For a receiving mobility test it needs to adopt channel analogy signal or fading analog signal to test the receiving performance at the receiver terminal.

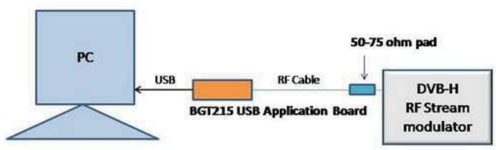

Fig. 2 Architecture of Measurement Test.

The evaluation method follows the CCIR Grading definition [16][17], it has grade 5 when it has perfect audio and video signals and the grade will zero if it has no video and no audio signals. In our measurements when the picture display is normal it has grade 4 and for those inferior picture the tester will grade them in 1-3 levels and determines its CCIR grade as:

「5」: Correct decoding video and audio signals, they are in normal operation with no any masks in the video picture and it is smooth in the pictures display. The video and audio signals must synchronize and the audio should not break, noisy and lose its fidelity.

「4」: Correct decoding video and audio signals, they are in normal operation with no any masks in the video picture. The video and audio signals must synchronize and the audio should not break, noisy and lose its fidelity.

「3」: Correct decoding video and audio signals, they are in normal operation with mask in the video picture once for a while. The synchronizations of video and audio signals are in acceptable range (< 100ms) and the audio should not break, noisy.

「2」: Correct decoding video and audio signals, they are in normal operation, some fragmentations and partially masked in video pictures. It is unable to get synchronization in the video and audio signals (< 1000ms) and the audio signal may have discontinuous and broken noise.

「1」: Video and audio signals could not get correct decoding, they are not in normal operation, almost all pictures are masked. It is unable to get synchronization in the video and audio signals (>1000ms) and the audio signal in un-discernable.

「0」: It is impossible to perform the demodulation process and no video and audio outputs.

Analysis of the Measurement Data

In the indoor measurements the system has the test results shown in Table 2. In wireless broadcasting it often incurs the problem of rain fading, the more rain fall the worse of the signal reception. Generally in the mid-level of rain fall (3-15 mm/h) it will interfere with the picture reception or in the worst situation the picture will be masked. The reception will be interrupted when it is in heavy rain (15-60 mm/h) or in storm (above 60 mm/h) situation. Taiwan is located in the rain affluent and typhoon area therefore our main test and measurement are made in the situation when it is in heavy rain and incurring rain fading phenomena. When it is nice day the indoor has CCIR grading 4 in its reception however it has grade 2 when it is a rainy day. In the consideration of bad receiver reception due to rain fade, it needs first to consider the effect of rain on the signal transmitted from the transmitter. Generally in Taiwan the transmitters are installed in the mountains, because they are located in the high altitude the clouds and fogs will have effect on the transmitted signal. The transmitted signal will be attenuated due to the rain fade and then another factor is that the higher the transmitting frequency the higher possible signal attenuation. When the signal is transmitted over the sky the cloud or the rains attenuate the signal transmission and this effect is called rain fade. It has two reasons for the generating the rain fade, the first is the loss due to the transmitted electromagnetic wave been absorbed due to the rain and cloud and another is the loss due to scattering of the rain and cloud on the transmitted signal. In the high frequency transmission its wavelength is shorter then it is not easy to penetrate through the clouds and the rain drops. If the cloud is thick or it is heavy rain the receing signal will be greatly degraded.

Table 2. Measured Receiver Input Signal Level (8MHz).

Receiver Input Signal Level Test Result (8MHz)				
Indoor		the Public Television Laboratories		
parameter		Failure criterion ref BER $2*10^{-4}$ CCIR grading: 3-4 Test parameter: signal power level dBm, power lose at pad (7.5dB)		
Mode DVB-H setting	Frequency RF/Channel	FFT	Minimum (dBm)	Maximum (dBm)
8MHz Bandwidth QPSK CR 1/2 GI 1/8	474MHz (CH21)	2K	-95.6	-16.5
		4K	-95.7	-16.4
		8K	-95.8	-16.4
	666MHz (CH45)	2K	-95.1	-16.9
		4K	-95.2	-16.8
		8K	-95.3	-16.8
	818MHz (CH64)	2K	-94.6	-16.7
		4K	-94.7	-16.4
		8K	-94.7	-16.2

THE RESULTS AND ANALYSIS OF DVB-H OUTDOOR MEASUREMENT

In the outdoor measurements it mainly uses the CCIR grading system to decide the receiving picture quality and to find the received signal strength that is expressed in percentage (%). The picture signal quality is in the 1-4 range and the received signal strength is in 10 – 40%.

In the high speed train test when the speed is below 100 km/h the signal reception is in the acceptable ranges. However when the train speed is above 100 km/h the signal strength attenuates quite fast and when it is above 160 km/h no signal is received at the receiver terminal, its RSSI percentage drops below 30%, it has masks in the pictures. The test results with high speed train are shown in Fig. 3.

In the freeway measurement it does not find the transmitted signal reception been interrupted when the vehicle speed is in accelerating or decelerating stage as found in the test of high speed train. It may be due to in the acceleration or deceleration of freeway test the vehicle could not be accelerated or decelerated as quickly as the high speed train. But the received signal strength in the freeway measurement will be affected when it has other vehicles passing by especially when it has large size vehicle passing by. The picture will be lightly affected. In the high speed measurements the electrical filed coverage of the picture reception is the same as the transmitting waves. In the fringe coverage area it is found that the RF coverage area of Taiwan DVB-H signal is not uniform, it has worse reception coverage in some mountain areas comparing with the reception in the plain area and in the high speed train test the receiving signal strength is quite weak at 130 km/h, it could not reach the high speed range as experienced in Europe test.

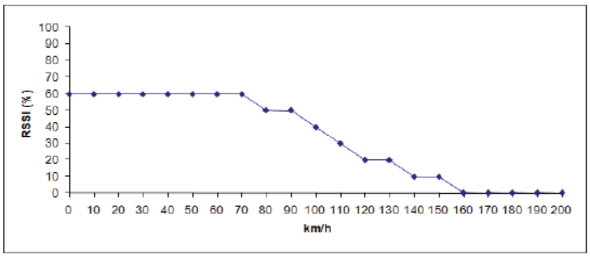

Fig. 3 Measurement of High Speed Train Mobility.

Summary

In the DVB-H indoor measurement, the reception at the near-by windows has better performance than the reception in the room it is due to the blockage of the signal and also in the higher floor of high rise building it has better reception than that in the lower floors. Finally the main reason to affect the DVB-H signal reception is the blockage of the neighboring high rise buildings and the rain fade situation.

In outdoor high speed train and freeway DVT-H measurement, the high speed reception capability could not meet the DVB-H specifications; however, the receiver modules considered in the measurement test of this paper met the MABRAI specifications but in our test it failed to meet the specifications. The main reason for this failure is because in Taiwan the installation is based on single frequency network set up and with the single frequency network installation it will generate time delay between the transmitted and received signals and consequently at the receiver terminal the orthogonal property between OFDM carriers are no longer valid, this time delay exceeds the pre-set guard interval facilitated at the transmitted signal. The guard interval for DVB-H in Taiwan is at 1/8; then when the time delay in the single frequency network exceeds this interval it will have problem in the signal reception. The transmitter electrical field coverage in Taiwan is not perfect and also in Taiwan it has more mountain areas than plain areas; it is not easy to have a complete electrical filed coverage it may use gap filter to provide electrical filed to cover the dead angle areas and then use extra power to compensate for this required power used in the dead angle areas coverage. However it still does not have any service provider to consider this extra power facilitation, it does not have any fee charge mechanism in digital television broadcast and they try to save this kind of service cost. Furthermore Taiwan is a developed country, it has many high buildings in metropolitan areas, it has many rainy days and many storms that result in multipath transmission and rain fade and consequently the transmitting signal is fade and interference easily. On the other hand the DVB-H system is quite popular in Europe; it is easy to develop ground broadcasting system since it has plain terrains and environment. In Taiwan the common family gets used to use cable to receive television broadcast and it needs to conquer these problems when it is in the future to consider the development of outdoor ground digital broadcasting system.

Acknowledgments

The authors would like to express their thanks to Mr. Cheng-Tai Shih for his helpful discussions. This study was support from the National Science Council, ROC under contracts NSC 100-2221-E-032-031.

References

[1] TR 101 211, Digital Video Broadcasting (DVB); Guidelines on Implementation and Usage of Service Information (SI), ETSI, (2004).

[2] ETSI TR 102 401Digital Video Broadcasting (DVB): Transmission to Handheld Terminals (DVB-H) Validation Task Force Report, (2004).

[3] ETSI EN 301 192 Digital Video Broadcasting (DVB): specification for data broadcasting, (2005).

[4] IPDC Forum Broadcast Media in Mobile Workshop Presentations London, (2004).

[5] DVB A098, Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Architecture, (2005).

[6] DVB A097, Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Use Cases and Services, (2005).

[7] EN 300 744, Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television, ETSI, (2004).

[8] IETF RFC 2327, SDP- Session Description Protocol, (1998).

[9] DVB TM 3095. IPDC in DVB-H: Technical Requirements.

[10]TR 101 202, Digital Video Broadcasting (DVB); Implementation Guidelines for Data Broadcasting, (2003).

[11] NorDig, Unified Requirements for Integrated Receiver Decoders for use in cable, terrestrial, satellite and IP-based networks, ver 1.0.2., (2005).

[12] IEC 62002-2 EICTA MBRAI 2.0; Mobile And Portable DVB-T/H Radio Access –Part 2 Interface conformance testing, (2005).

[13] IEC 62001-1 EICTA MBRAI 2.0; Mobile and Portable DVB-T/H Radio Access –Part 1: Interface specification, (2005).

[14] D Book Digital Terrestrial Television, Requirements for Interoperability, Digital Television Group (1999).

[15] DVB-Technical Module Ad-Hoc Group DVB-UMTS: Technical aspects in spectrum allocation for DVB-UMTS convergence terminals, (2002).

[16] York,Kuan, Technical Development Technical Development of Mobile TV and The Trial result of PTS consortium, (2006).

[17] Subjective assessment of the quality of television picture: CCIR Grade Plenary Assembly Dubrovnik, (1992).