International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 09 Issue 10 ǁ 2021 ǁ PP. 65-68

A Review on Modulation and Interleaving Schemes in Digital Video Broadcasting – Cable

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Abstract- *DVB-C is the most widely used standard for interactive television. DVB-C uses the MPEG-2 standard for coding the data, as well as Forward Error Coding, Reed Solomon Coding and Convolutional coding to make the signal robust against the high amount of error that comes with transmission. It also uses QPSK to modulate the signal, which makes the information be encoded in the phase instead of the amplitude, which also helps with making the signal robust enough for the channel. But due to increase in number of users and changing needs of users in the field of communications and entertainment, there are new challenges that the currents standards are not able to satisfy. So as the number of users increases the system complexity and interference also increases. The communication channel is not free from the effects of channel impairments such as noise, interference and fading. These channel impairments caused signal distortion and signal to ratio (SNR) degradation. This problem can be overcome by implementing the system with different modulation and error detection and correction schemes. So first design a DVB-C system with Rectangular 64-QAM Modulator and Reed-Solomon Encoder. Then analyze this system with different interleaving schemes such as convolutional, helical, matrix, block and random interleaving and find the best suited interleaving scheme with lowest bit error rate.*

Keywords- *DVB-C, Modulation, Interleaving, BER.*

Date of Submission: 28-09-2021 Date of acceptance: 11-10-2021

I. INTRODUCTION

Digital Video Broadcasting - Cable is the DVB European consortium standard for the broadcast transmission of digital television over cable. This system transmits an MPEG-2 or MPEG-4 family digital audio/digital video stream, using a QAM modulation with channel coding. The standard was first published by the ETSI in 1994, and subsequently became the most widely used transmission system for digital cable television in Europe, Asia and South America. It is deployed worldwide in systems ranging from the larger cable television networks (CATV) down to smaller satellite master antenna TV (SMATV) systems.

Digital video broadcasting cable (DVB-C) refers a digital broadcast standard that cable as the transmission medium. DVB-C is one of the digital video broadcasting standards used in different scenarios of television and video transmission. The DVB standards vary in regards to requirements, performance and accessibility.

Cable media is very successful at delivering high-quality video and the latest multimedia features. Fiber optics is a type of high-speed cable medium with more bandwidth and higher quality digital video. Fiber optics also has fewer issues with packet loss, which allows the best quality possible. Coaxial is the alternate cable medium; it is cost effective for service providers compared to fiber optics and is still a good choice if the service provider is only looking to provide an mpeg-2 quality digital video. However, fiber optics is a better choice when providing Internet, TV and telephone services through a single medium.

Development in digital video has brought new features like digital video recording, video on demand and 3D video. These features require more bandwidth to provide the required performance and experience to the user. DVB-C transmission systems consider all the analog and digital requirements and is designed to provide the best services in this regard. DVB-C2 is the upgraded version of DVB-C.

II. LITERATURE REVIEW

Drakshayini et. al. (2019) presented that DAB system is one of the high - definition radio with the ability to provide high audio quality and data - based services for stationary and mobile receivers. Digital Video Broadcasting (DVB) is the popular broadcasting standards that enable handheld receivers to receive high definition digital television transmissions. Orthogonal Frequency Division Multiplexing (OFDM) system is a digital multi – carrier modulation technique intend offers high spectral efficiency. The main aim set is to arrive

as an efficient unified system for multipurpose wireless system that would cater to all existing standards. OFDM system is used in many applications as it offers high spectral efficiency, high robustness and combats multipath fading. Outcome of the proposed system will be confirmed by unified and extended simulation based experiments in OFDM. Unified approach produces the better BER performance as compared to specific design. Integrated antenna for DAB and DVB system produces the better gain as compared to DAB and DVB system. The proposed unified approach provides the high scalability, flexibility and cost effective as compared to individual design for different OFDM standards[1].

Loreta Andoni et. al. (2019) depicted that TV broadcasters are facing day by day with the challenge of providing new services such as 3D television, ultrahigh definition television (UHDTV) and DVB-T/H, which need higher capacity systems. Nowadays attention is focus on using multi-antenna systems in emission and reception, which is considered as a technique which increase data rate and improve the reception quality compared to traditional systems with single antennas in emission and reception SISO (Single Input Single Output). The Digital Video Broadcasting (DVB) project is studying the application of MIMO (Multi-input Multi-output) technique in television broadcasting systems. But adding antennas to reception side requires a significant investment in infrastructure. For this reason, studies are being carried out to assess whether the improvement in system performance justifies it. Actually, the second generation of digital video broadcasting (DVB-T2) is using MISO (Multi-input Single-output) mode based on the Alamouti code, which uses only one antenna on the reception side. MISO technique allows improvements in the received SNR and also ensures that the ripples and notches do not occur in a SFN network. This result from the fact that in MISO mode the transmitted signals are no identical as in SISO SFNs and the signals combination make it possible to avoid degradation. A DVB-T2 MISO SFN network should be considered as a specific form of an SFN, where the synchronization in term of time, frequency and content is an important aspect for correct operation of the system. A lot of searches has shown that the MISO gain is limited mainly in the region in between the two transmitters where their coverage overlaps. The MISO gain is significant provided when the power imbalance from different transmitters of the network is small. Finally, analyses in the influence of the pilot pattern and relative delay in both SISO and MISO have resulted that the performance in MISO can be reasonably kept for a wide range of delays over the guard interval[2].

Bundit Ruckveratham et. al. (2019) experimented the laboratory measurements were performed by modeling a synchronization test of DVB-T2 signals from two transmitters. The experiment was performed by changing the static delay of the transmitter for a performance test in the GI range to analyze the effect of the SFN. The experiment was recorded and the received signal was inspected by the DVB-T2 analyzer. This research uses DVB-T2 modulation parameters for broadcast digital terrestrial television in Thailand for the SFN mode. The minimum received signal threshold of the SFN was confirmed by the QEF criteria test. The experimental data are stored in large numbers to ensure reliability. Every 10 μs of delay time is repeatedly measured 20 times, dividing the delay time into 27 ranges from 0 μs to 270 μs. Measured both the normal reception and minimum receiving signal. The measurement data were the power, MER, spectrum variation, noise margin, and C/N . The total number of measurements was 5400 times. The received signal threshold at the QEF criteria throughout the delay time within the GI corresponded to the received signal power of 66.03 dB, MER of 7.93 dB, a noise margin of 3.02 dB, and C/N of 21.3 dB. Since the experiment was a closed system, no multipath and external noise existed; the measurement channel is equivalent to a Rician channel. The limitation of this experiment is that the modulation parameters are used for broadcasting in Thailand only. The evaluation of the SFN specifically analyzes the received signal power from two transmitters that broadcast to the receiver at equal signal strength levels. This scenario is the most likely to affect the received SFN signal. In reality, the signals from both transmitters may reach the receiver with different signal strengths. Even in a real propagation channel, the received signal will be affected by the environment and terrain, which may be different from these results. However, the experimental results can be used as a guide for network planning design and network efficiency improvement for SFN broadcasting, as well as for designing a gap filler system[3].

Sukamto et. al. (2018) analyzed that the performance comparison between 2K mode and 8K mode on DVB-T. The comparison is presented into account many different parameters such as number of carriers, number of used carriers, and duration. The transmission and reception have been simulated using Matlab. And observe that between 2K mode and 8K mode has similiar performance. With the delay taken care of so the differences is small, and the reception result is straightforward. The large value of PAR 8K mode is bigger than 2K mode. It shows that 2K mode is more stable than 8K mode, so 2K system is more appropriate for mobile transmission. But in Single Frequency Network (SFN) 8K mode system is better because have bigger space transmitter[4].

Anugrah Nair et. al. (2018) observed different multiple access techniques and their under lying principles. Without the use of multiple access techniques, it has been observed that different types of difficulties would rise. Thus, each technique has its own under lying principle eliminating different disadvantages building

up speed, accuracy, capacity and efficiency in different network communications. So improve a system different modulation, encoding and interleaving techniques has been used[5].

III. MODULATION IN DVB-C

DVB-C uses Quadrature Amplitude Modulation (QAM) for the modulation of the data on the carrier. Normally 32-QAM is used but lower level modulation schemes, such as 4-QAM and 8-QAM and 16-QAM modulation schemes can also be used. The data capacity increase with higher level modulation schemes. The data capacity increase with higher level modulation schemes, but the data will be less robust against noise and interference. To increase the payload capacity of the DVB-C system higher level of modulation is used.

Why use 64-QAM Modulation in DVB-C: DVB-C uses the same 8 MHz channels as used for the distribution of the old analogue TV. An 8 MHz channel can carry a payload capacity of 38.5 Mbps if 64-QAM is used. In this way, the distribution of digital television channels can be introduced without the need to cease the distribution of analogue television.

As we uses the 64-QAM modulation to increase the payload of the DVB-C system, the data become less robust against noise and interference. So, the efficiency of the DVB-C system decreases and that effects the clarity of different channels of DVB-C system.

By using Interleavers, the problem of robustness of data against noise and interference decreases. Interleavers are devices that permute sequences of symbols: they are widely used for improving error correction capabilities of coding schemes over bursty channels

IV. INTERLEAVING IN DVB-C

Interleaving is used to convert convolutional codes from random error correctors to burst error correctors. The basic idea behind the use of interleaved codes is to jumble symbols at the receiver. This leads to randomization of bursts of received errors which are closely located and we can then apply the analysis for random channel. Thus, the main function performed by the interleaver at transmitter is to alter the input symbol sequence. At the receiver, the deinterleaver will alter the received sequence to get back the original unaltered sequence at the transmitter.

Original message:

ARE YOU SURE THAT THEY ARE COMING TO LUNCH WITH US

Interleave matrix:

A	R	E	Y	O	U	S	U	R	E
T	H	A	T	T	H	E	Y	A	R
E	C	O	M	I	N	G	T	O	L
U	N	C	H	W	I	T	H	U	S

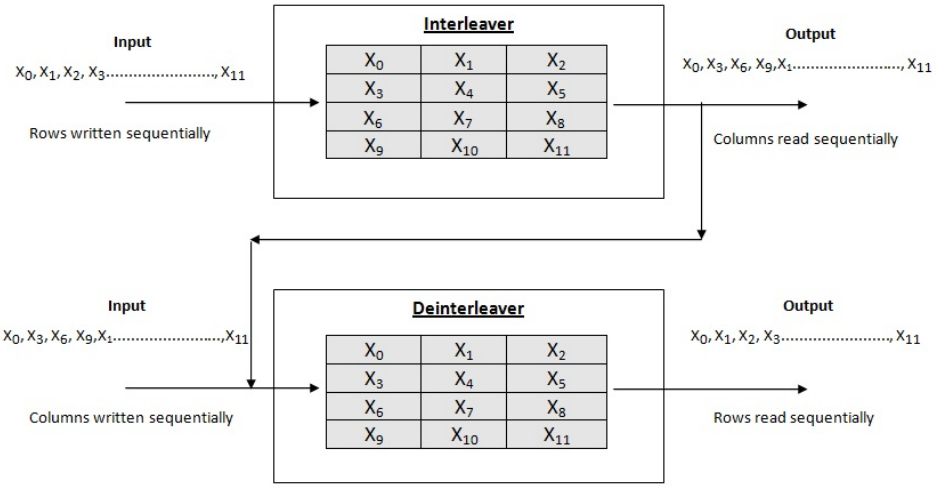
Interleaved message:

ATEU RHCN EAOC YTMH OTIW UHNI SEGT UYTH RAOU ERLS

Then interleaving techniques are used for randomizing the bits in a message stream so that burst errors introduced by the channel can be converted into random errors. Different types of interleavers are used in DVB-C namely Convolutional, Matrix, Helical, Random etc.

Block Interleaver

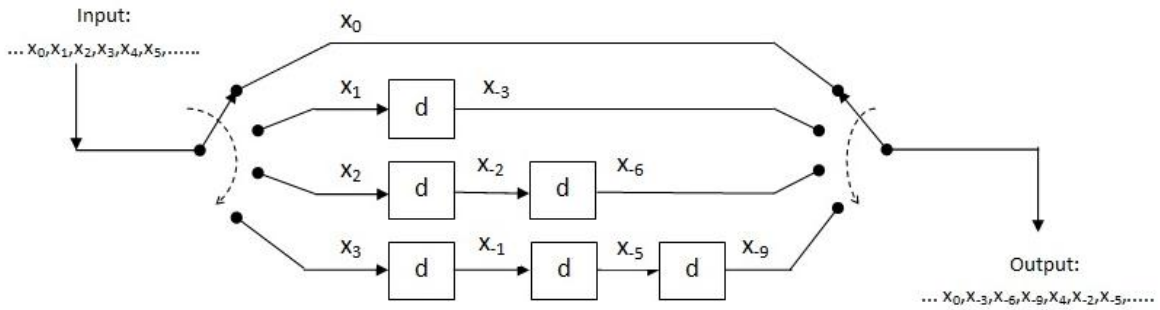
The Figure below shows a 4 x 3 block interleaver



The above interleaver is called as a block interleaver. Here, the input symbols are written sequentially in the rows and the output Symbols are obtained by reading the columns sequentially. Thus, this is in the form of M x N array. Generally, is length of the N codeword.

Convolutional Interleaver

Cross interleaver is a kind of multiplexer-demultiplexer system. In this system, delay lines are used to progressively increase length. Delay line is basically an electronic circuit used to delay the signal by certain time duration.



V. CONCLUSION

The digitalisation of television signals today is a well-known and widely implemented process. It consists basically of the representation of a picture - and the accompanying sound - by a binary bit-stream, a series of '0's and 'l's. However, compression and transmission of these signals through a communications channel- satellite, terrestrial or cable- becomes practical only after the raw digital data has been subject to a series of processes. And therefore, if it is wished to be able to interconnect digital TV equipment from different suppliers, or to receive such transmissions satisfactorily, different modulation and error detection schemes are used. So DVB-C system is designed to withstand with interference and fading in communication channel. Channel coding and modulation is needed for a system in order to sustain in any type of environment especially in multipath fading channel.

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