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STUDY AND SIMULATION OF DAB ON MATLAB

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Abstract:

Digital audio broadcasting (DAB) is a promising technology that offers several advantages over traditional analog radio. In this paper, we present a study and simulation of the DAB system using MATLAB to evaluate its performance and potential for radio broadcasting. The simulations were conducted using the Simulink, a MATLAB-based tool that provides a comprehensive modeling and simulation environment for DAB signals. Our study shows that the DAB system offers superior sound quality, efficient use of bandwidth, and the ability to transmit additional information alongside the audio signal. However, the performance of the system can be affected by various factors such as signal interference and receiver design. Our simulations also show that the DAB system can be optimized for specific scenarios by adjusting the modulation and error correction schemes.

Keywords: DAB, Matlab, simulation, modulation

I. Introduction

The new digital radio system, Digital Audio Broadcasting (DAB) has the capability to replace the existing AM and FM audio broadcast services in many parts of the World in near future. This was developed in the 1990s by the Eureka 147 DAB project. DAB is very well suited for mobile receivers and provides very high tolerance against multipath reception and inter symbol interference (ISI). It allows use of single frequency networks (SFNs) for high frequency efficiency. In several countries in Europe and overseas, broadcasting organizations, network providers and receiver manufacturers are already implementing digital broadcasting services using the DAB system. Perceptual audio coding (MPEG-2), Coded Orthogonal Frequency Division Multiplexing (COFDM), provision for the multiplex of several programmes and data transmission protocols, are the new concepts of digital radio broadcasting.

Digital Audio Broadcasting (DAB) is a digital radio transmission system that uses a set of standards to deliver audio and data services to a wide range of devices, including smartphones, tablets, and traditional radio receivers. The main advantage of DAB over analog radio is its ability to deliver high-quality audio and additional data services in a more efficient and costeffective manner. DAB systems use various modulation schemes such as QPSK, 16-QAM, and 64-QAM to encode the digital data, which is then transmitted over the airwaves. DAB uses OFDM technology that makes it resistant to Multipath fading and inters symbol interference (ISI). FM reception can be badly affected by shadowing and by passive echoes (the arrival at the receiver of delayed “multipath” signals which have been reflected from tall buildings and hills).

II. System Model

Simulink model in MATLAB

The analog signal is concealed and correlated to channel coding like convolutional and turbo codes and then bit streams are 16-QAM mapped. The data can then be passed to the OFDM generator by making use of IFFT algorithm the high data rate, bit stream is break into ‘M’ parallel data streams of less data rate and separately modulated onto orthogonal sub carriers. Because of the property of orthogonality, the sub carriers are 90 degrees phase with each other so the Inter Symbol Interference is Zero. Theoretically and at last the symbol is provided with cyclic prefix and this frame structure is transmitted through AWGN Channel. The proposed blocks are:-

A.Information source

This is the first block in the transmitter section of the DAB system model for simulation. It generates random binary data bit sequence for FIC and MSC. Therefore the data for one transmission frame is given by: MSC is a time interleaved data channel divided into a number of sub channel which are individually convolutionally coded.FIC is used to signal the multiplex configuration of the DAB transmission and service Information.

B. Convolution Encoder

The Convolutional Encoder block encodes a sequence of binary input vectors to produce a sequence of binary output vectors. This block can process multiple symbols at a time. Here the output data stream Tx_bits from previous block is input to convolutional encoder. Channel coding is based on punctured convolutional forward- error-correction (FEC) which allows both Equal and Unequal Error Protection (UEP) described in section . DAB system has a convolutional encoder with constraint length 7 and octal forms of generator polynomials are 133,171, 145 and 133, respectively.

C.Interleaver

The General Block Interleaver block rearranges the elements of its input vector without repeating or omitting any elements. If the input contains N elements, then the Elements parameter is a column vector of length N.

D.Modulator

In mobile communications the multipath effect can degrade the phase of the carriers. The solution to this problem is to send the information as the difference between the phases of two symbols. This is accomplished by this block which performs π/4 shifted differential QPSK modulation. In this modulation scheme there is no absolute phase reference, each symbol is referenced only against the previous symbol. This greatly simplifies the decoder. QPSK mapping The QPSK digital symbol mapping block is responsible for mapping (in parallel) serial bit stream in each data block into a digital constellation according to QPSK modulation scheme given in DAB standard.

E.OFDM Transmitter

The OFDM modulator divides the frequency band into multiple subcarriers, each of which carries a modulated symbol. The subcarriers are orthogonal to each other, which means they do not interfere with each other. This makes OFDM well-suited for frequency-selective fading channels, which can be found in terrestrial broadcasting.After modulation, the signal is upconverted to the transmission frequency and amplified before being transmitted through the antenna.

III. Related work

During its development DAB system has been publicly demonstrated many times. It has been subject to extensive computer simulations and field tests in Europe and elsewhere. It is now in regular service in many European countries and throughout the world. In 1995, the European DAB Forum (Euro Dab) was established to pursue the introduction of DAB services in a concerted manner world-wide and it became the World DAB Forum in 1997 . As a result of developments within the Eureka 147 project, the DAB Standard or DAB Specification in the form of EN 300401 was approved by the European Telecommunications Standards Institute (ETSI), which defines the characteristics of the DAB transmission signal, including audio coding, data services, signal and service multiplexing, channel coding and modulation. The first digital sound broadcasting systems providing CD-like audio quality was developed in early 1980s using Satellite technology. The system employed very low data compression and was not suitable for mobile reception. It used frequency in the range 10-12 GHz. Therefore it was not possible to provide service to large number of listeners. It was realized terrestrial digital sound broadcasting would do the job and to develop this new digital solution an international research project was necessary. So, in 1986 few organizations from France, Germany, United Kingdom and The Netherlands signed an agreement to cooperate in the development of a new standard and with this Eureka-147 project was born. Members of European Broadcasting Union (EBU), who were the part of work on the satellite delivery of digital sound broadcasting to mobiles in the frequency range between 1 and 3 GHz, also joined the Eureka- 147 project. Later International Telecommunications Union (ITU-R) and the European Telecommunications Standards Institute (ETSI) started the standardization process. Following goals were set up for DAB from the beginning with the sole aim of quality audio for mobile reception:

- Well suited for mobile reception in vehicles, even at higher speeds
- Efficient frequency spectrum usage
- Transmission capacity for ancillary data
- Low transmitting power.
- Terrestrial, cable and satellite delivery options
- Easy tuning of receivers
- Large coverage area than current AM and FM systems.

Eureka 147 consortium alone started choosing the most appropriate transmission method based on thorough simulation and field test. Results showed that broadband solutions performed better than the narrow-band proposal, while the frequency-hopping solution was considered too demanding with respect to network organization. Since the spread-spectrum

IV.Result

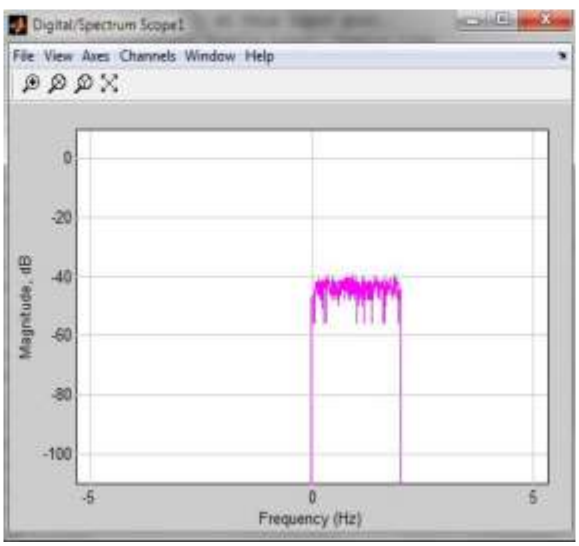

Fig 1. Output of OFDM Transmitter

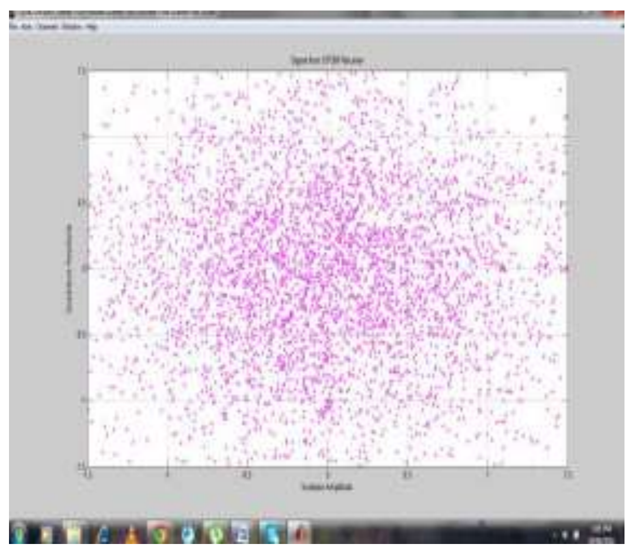

Fig 2. Constellation when SNR is 1db

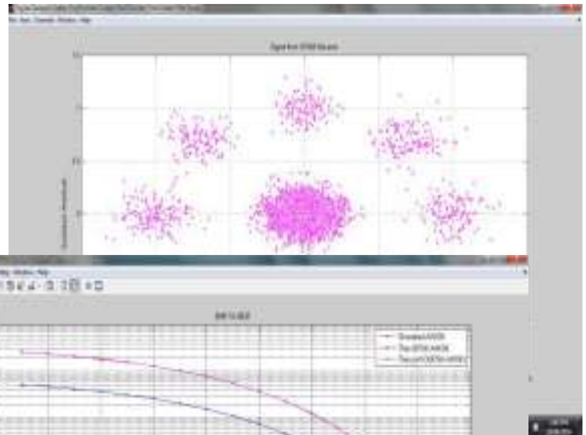

Fig 3. Constellation when SNR is 16 db

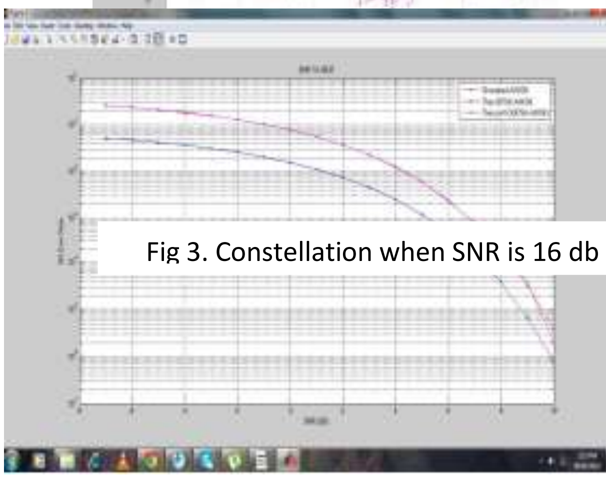

Fig 7. BER VS SNR

Figure 1 illustrates the frequency domain output of an OFDM (Orthogonal Frequency Division Multiplexing) transmitter, which carries a DQPSK (Differential Quadrature Phase Shift Keying) signal. The depicted signal represents the frequency components of the transmitted signal.

To summarize, the figures demonstrate that at lower SNR levels, the BER is higher, as evidenced by the random and dispersed nature of the constellation points in Figure 2. Conversely, at higher SNR levels, such as in Figure 3 with an SNR of 16 dB, the constellation points align in a more circular pattern. This observation reinforces the notion that a low SNR results in a higher BER, indicating a less reliable channel for communication.

In summary, the graph in Figure 4 demonstrates that as the SNR increases, the BER decreases. This relationship signifies an efficient system with improved performance and reduced probability of errors.

V.Conclusion

A software simulation model was developed which covers the major aspects of a real DAB transmission system. The performance of DAB modulation schemes can be predicted under specific artificial test conditions in Matlab/Simulink. The graphical user interface enables the user to adjust parameters rapidly and to obtain a quantitative feel as to how transmission quality is affected if these parameters are adjusted. Finding the relation between bit error ratio and subjective audio quality at an early stage leads to efficient performance estimation since extensive listening tests are avoided. This holds under a variety of impairments due to the fact that time and frequency interleavers spread errors out in frequency and time. Simulation in the complex baseband domain is well suited to predict the performance of modulation schemes including different kinds of channels. Frame-based processing should be used to model multi-rate systems such as DAB.The use of Matlab/Simulink allows for the prediction of DAB modulation scheme performance under specific test conditions. The graphical user interface (GUI) provides a way for the user to adjust parameters easily and quickly obtain a quantitative understanding of how transmission quality is impacted by these parameters.

VI.REFERENCES

[1] A. J. Bower, April 1998, “DIGITAL RADIO--The Eureka 147 DAB System,” Electronic Engineering BBC.

[2] Brian Chen and Carl-Erik W. Sundberg, March 2000 “An Integrated Error Correction and Detection System for Digital Audio Broadcasting", in IEEE Transactions on Broadcasting, vol. 46, pp. 68-78

[3] C.C. Lu and C. C. Huang Y.L. Huang, June 1997 "Synchronization system of digital audio broadcasting (DAB) receiver", in Proceedings of IEEE International Conference on Consumer Electronics, p. 370–371.

[4] ETSI., April 2001 "Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers" EN 300 401, V1.3.3, (2001-05).

[5] ETSI TR 101 496-3, 2001 "Digital Audio Broadcasting (DAB); Guidelines and rules for implementation and operation; Part 3: Broadcast network", V1.1.2 (2001-05).

[6] F. Kozamernik, 1995 "Digital Audio Broadcasting – radio now and for the future” EBU Technical Review, no. 265 autumn 1995.

[7] HamedHolisaz, and S. Mehdi FakhraieNarimanMoezzi- Madani, 1814-1817.

[8] "Digital Audio Broadcasting System Modeling and Hardware Implementation", August 2004 in IEEE Asia- Pacific Conference on Circuits and Systems, Proceedings, APCCAS, 2006, pp. Hector Uhalte Bilbao, “Dab Transmission System Simulation” Linkoping Institute of Technology, Master’s thesis.

[9] H. Harada &Ramjee Prasad, 2003 Simulation and Software Radio for mobile communications, Artech House. [10] Jeong-Ki Min and Hyoung-KyuSong, May 2003 "Frequency Synchronization for Digital Audio Broadcasting", in IEEE Transactions on Consumer Electronics, vol. 49, no.2, pp. 290-295.