Performance Analysis of Multiple FEC Channel Coding Algorithms for Software Defined Radio Using Quadrature Amplitude Modulation

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ABSTRACT

This paper describes the development of a Software Defined Radio (SDR)-based Transceiver simulation model using Quadrature Amplitude Modulation (QAM) Scheme and analyze its performance using Forward Error Correction (FEC) channel coding algorithms namely the Convolution and the Turbo Codes. This model efficiently evaluates the performance of high data rate multi array M-QAM, schemes. The performance of these FEC codes is evaluated when the system is subjected to noise and interference in the channel. In this design Additive White Gaussian Noise (AWGN) channel has been considered. The design is analyzed using Bit Error Rate (BER) and Signal to Noise Ratio (SNR) for different M-QAM techniques. The simulation results give a possible solution for future SDR systems which may be used in various wireless communication systems. An experimental result shows that the QAM transceiver achieves the transmission of data at high level accurately. FEC Channel coding scheme is used wherever the re-transmission of the data is not feasible. On the receiver side, this channel coded signal is decoded in order to get back the original data even if the channel coded signal undergoes some interference from the noise in the transmission medium. The Performance is then analyzed in terms of BER for Convolution Coding and Turbo Coding algorithm at a particular value of SNR in LabVIEW graphical programming. Finally, comparison has been drawn based on different parameters between the existing SDR system and the proposed design in this paper to analyze and highlight the effectiveness of the proposed SDR design.

KEYWORDS

AWGN, Bit-Error-Rate, LabVIEW, M-QAM, Signal to Noise-Ratio, Software Defined Radio

1. INTRODUCTION

The fast progress in Radio Frequency Identification (RFID) communications has proved that wireless communication can be effectively used for data service for high data rates (Han, Lim, & Lee, 2007) (Björkqvist & Virtanen, 2006). Conventional wireless devices have been intended to convey a single communication service using a definite standard. It hence becomes costly to improve and maintain the wireless system each time a novel standard is launched in the market (Journal & Automotive, 2015). Hence SDR comes as a possible solution to make wireless communication systems more supple and consumer friendly. SDR refers to those reprogrammable or reconfigurable radios in
which the corresponding hardware can perform various functions by the updating of the software. SDR has generated tremendous curiosity in the wireless communication business because of the wide-ranging system and deployment benefits it offers (Weis, Sarma, & Rivest, 2004)(Hannan, Islam, Samad, & Hussain, 2010). SDR increases the flexibility and extends hardware life time (Haghhighat, 2002)(Marriwala, Sahu, Khullar, & Vohra, 2011). The construction of the SDR in our design primarily consists of three components i.e. a transmitter, a channel and a receiver. In this paper we have implemented and designed a Software Defined Radio (SDR) M-ary QAM Modem for Gaussian Channel using LabVIEW. SDR’s can be reconfigured and can talk and listen to multiple channels at the same time. The use of Modulation techniques in an SDR is quiet crucial since these techniques delimit the core line of all the wireless applications (Marriwala & Sahu, 2013) (States, Force, Fourier, Fourier, & Fft, 2004) (Noseworthy, n.d.) (Mitola, 1995). SDR’s flexibility must be planned well in advance by the use of software and hardware considerations, which shall result in improved code portability, superior communication life cycles, and abridged costs (Johnson, 2013). The transmitter of an SDR system converts digital signals to analog waveforms. In this paper, QAM has been chosen as the modulation scheme to be used in the SDR design as it is extensively used for different applications where transmission of data at high rate is done over band pass channels such as high speed cable, FAX modem, multi-tone wireless, and satellite channels (Bryan, 1995)(Kim, Kehtarnavaz, & Torlak, n.d.). In QAM it is possible to send two different signals simultaneously on the same carrier frequency. Digital cable television and cable modem utilize 64-QAM and 256-QAM. In this paper Gaussian noise is introduced in the channel i.e. AWGN channel is used instead of idle channel and is removed using adaptive filtering. LabVIEW is a Graphical User Interface also referred as “G” language. The main advantage of using LabVIEW in our design is that it uses data-flow-controlled execution, rather than using chronological execution of text-line based languages (Samad & Hussain, n.d.) (Vasudevan, 2010). LabVIEW has many built in function libraries for the serial, parallel and network computer ports as well as simple file operation for input-output (Cummings & Haruyama, 1999)(Hatai & Chakrabarti, 2009).

The organization of this paper is as follows: In Section 1 Introduction has been given, Implementation of M–QAM Modem in LabVIEW is described in Section 2, Section 3 presents the results after Simulation and finally section 4 explains the drawn Conclusions.

2. SOFTWARE DEFINED RADIO M-ARY QAM MODEM FOR GAUSSIAN CHANNEL

In this section the building blocks of the M-ary QAM transceiver designed in LabVIEW are explained. The designed system consists of two parts: the Transmitter section and the Receiver section. The Transmitter section consists of four modules which are a message source module, Pulse Shaped Filter module, QAM Modulator module and Gaussian Noise module. The Receiver has been designed using an Adaptive Filter module, Hilbert Transform module, QAM Demodulator module, Sync & Tracking module. A brief description of each block follows. The Front panel of M-ary QAM Modem system is shown in Figure 1.

2.1. Message Source

The initial module of QAM modem consists of a message source VI. Here Pseudo-random Noise (PN) sequences are used to spread the transmitting data in message source. PN Sequence is a definite sequence of pulses that keep on repeating itself after its period. A PN sequence is a sequence of binary numbers e.g. 0 & 1. The PN Sequence used in this design is generated by using a 5-stage Linear Feedback Shift register (LFSR) structure. LFSR is a linear function of its previous state. In a feedback shift register of linear type, feedback function is obtained using modulo-2 addition of the output of various flip flops. In the Message source VI for achieving frame synchronization Frame Marker bits are inserted in front of PN sequences generated(Baines & Pulley, 2003)(Oza et al., 2010). The frame marker bits are a distinct pattern of bits that never occurs in the stream for message data. A known
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