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The MATLAB based SDR design in High Level System Architecturefor Noise Analysis.

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ABSTRACT

Wireless communication networks have become more popular in the past two decades since the advent of cellular communications. The rapid growth in cellular communications has proved that wireless communication is viable for voice and data services. Traditional wireless devices are designed to deliver a single communication service using a particular standard. Software defined radio is an emerging technology, for multi-service, multi-standard, multi-band, reconfigurable radio systems, which are reprogrammable by software. Software Defined Radio (SDR) is a flexible architecture which can be configured to adapt various wireless standards, waveforms, frequency bands, bandwidths, and modes of operations. A software defined radio is a transmitter and receiver system that uses digital signal processing (DSP) for coding, decoding, modulating, and demodulating data. In this Paper, we proposed the analysis of noise levels with respect to all type of parameters associated with SDR. For that we have to plot graph accordingly for sent and received signal.Also, we will produce the optimize model with minimum noise in transmission and the development of a framework for the design and implementation of software defined radio based wireless communication systems

Keywords

Additive White Gaussian Noise; System Error Rate; QAM encoder & decoder; Software Defined Radio.

I. INTRODUCTION

SDR is defined as “Radio in which some or the entire physical layer functions are software defined”. SDR is flexible; it provides low cost, increase in capacity, Intepolability and many benefits to the end user [1]. In this paper, software definable baseband section of the wireless communication system is designed, simulated and implemented. MATLAB SIMULINK is used as high level modeling tools in the design process. Simulation of the system with these MATLAB tools forms the first step of the design process for reconfigurable computing. The transmitter section of the baseband is implemented, which is used to analyze the system in real time [13].

In the baseband section of the communication system, the transmitter consisting of the QAM encoder, interpolation, OFDM modulation and spreading is simulated. The receiver side consists of spreading, OFDM demodulation, decimation and QAM decoder. Fig. 1 shows Software definable baseband section of the wireless communication system model implemented in this paper.

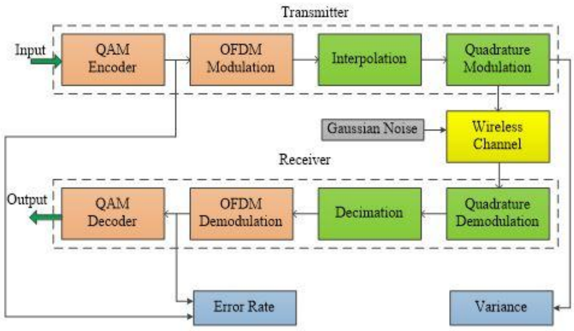

Fig. 1. Block diagram of Encrypted SDR

II. SDR Design

A. QAM Encoder

The QAM encoder are key elements within any quadrature amplitude modulation system. The encoder is used to encode the signal, often data, onto the radio frequency carrier that is to be transmitted. QAM is a bandwidth efficient signaling scheme [9].

The QAM encoder essentially follows the idea that can be seen from the basic QAM theory where there are two carrier signals with a phase shift of

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90° between them. These are then amplitude encoded with the two data streams known as the I or In-phase and the Q or quadrature data streams. These are generated in the baseband processing area.

The two resultant signals are summed and then processed as required in the RF signal chain, typically converting them in frequency to the required final frequency and amplifying them as required.

It is worth noting that as the amplitude of the signal varies any RF amplifiers must be linear to preserve the integrity of the signal. Any non-linearity will alter the relative levels of the signals and alter the phase difference, thereby distorting he signal and introducing the possibility of data errors.

The data is generated in the form of extract bits. The digital data is converted into four blocks each containing 2 bits. Four QAM encoders are used for encoding the data wherein the outputs are multiplexed and send for frame conversion. The data from frame conversion is sent to input of OFDM modulation after applying normalization to it.

B. OFDM Modulation

If IEEE 802.11 a is to be implemented into an SDR, it should be recognized that its modulation mode is OFDM [2]. Orthogonal frequency division multiplexing (OFDM) is used for transmitting a number of data messages simultaneously through a linear band-limited transmission medium at a maximum data rate without interchannel and intersymbol interferences [3].

At the receiver, after down- ®conversion, the m-subcarrier component corresponding to the received data is first coherently detected with FFT and then multiplied with gain to combine the energy of the received signal scattered in the frequency domain as shown in Fig. 2. Wireless Local Area Networks (WLAN) development is ongoing for wireless point-to-point and point-to-multipoint configurations using OFDM technology [8].

In OFDM the IFFT mapping is carried out. The data is sent to the intermediate buffer through additional GI window and afterwards delay is given before sending to switch. Parallelly DSP constant is applied in delayed window. The output data is given to the input of interpolation.

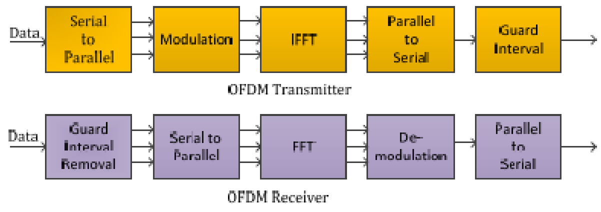

Fig. 2. IEEE 802.11 a Transmit and Receive OFDM

C. Interpolation

In Digital Signal Processing, one can manipulate signals after they have been converted from analog voltages and currents into digital form i.e., as sequence of numbers. Normal analog operations of filtering, mixing, and signal detection all have their parallels in the DSP world. Because the cost of complex digital processing is very low.

The primary reason to interpolate is simply to increase the sampling rate at the output of one system so that another system operating at a higher sampling rate can input the signal.

In interpolation block, the data is unsampled. In unsampling the data, amplitude of the signal is increased. The data is unsampled twice (2freq + 4 feq = 6 freq) and after amplitude correction, this data is given for quadrature Modulation.

D. Quadrature Modulation

Quadrature Amplitude Modulation is a form of modulation which is widely used for modulating data signals onto a carrier used for radio communications.

The amplitude corrected unsampled data is divided into real and imaginary parts. The real part is multiplied with DSP cosine wave and imaginary part is multiplied with DSP sine wave and further both the outputs of multiplied data are added and sent to the channel.

DSP sine and cosine waves are considered as data is in binary/digital form.

E. Channel

In the RF channel, gain is applied to the Quadrature Modulated output signal and corresponding delay is applied. Additionally, Gaussian noise is fed to check the effect of the noise data during transmission which will be captured through SDR at receiver. 96 sample frame rate is considered in the

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Gaussian noise generated which can be changed accordingly [10].

F. Qudrature demodulation

The data received at Quadrature demodulation block is the data with Gaussian noise. This block performs exactly reverse procedure of Quadrature Modulation i. e. data is split into real and imaginary parts. The real part is multiplied with DSP cosine wave and imaginary part is multiplied with DSP sine wave. The multiplied data of real part with DSP cosine wave is sent to in phase mixing gain and the multiplied data of imaginary part with DSP sine wave is sent to Quad mixing gain. These are combined to the real-imaginary complex.

G. Decimmation

Decimation is the process of reducing the samplingrate of a signal. The term downsampling usually refers to one step of the process, but sometimes the terms are used interchangeably Complementary to upsampling, which increases sampling rate, decimation is a specific case of sample rate conversion in a multi-rate digital signal processing system. A system component that performs decimation is called a decimator.

The data is first filtered out and send for downsampling. In downsampling the amplitude of the signal is reduced. This is done thrice as 2 freq per downsampling (Total 2 freq * 3= 6 freq). The data is then fed to frame sync. In frame sync, the frames are accumulated for being transported to OFDM demodulation.

H. OFDM Demodulation

The OFDM Demodulator object demodulates using the orthogonal frequency division demodulation method. The output is a baseband representation of the modulated signal, which was input into the OFDM Modulator companion object.

In OFDM demodulation, Fast Fourier Transform(FFT) is carried out. The data is sent to the spectrum scope wherein the frequency of the signal is plotted.

The output waveforms viz unsynchronized data output, spectrum scope and discrete-time scatter plot scope are derived from the OFDM demodulation block.

I. QAM Decoder

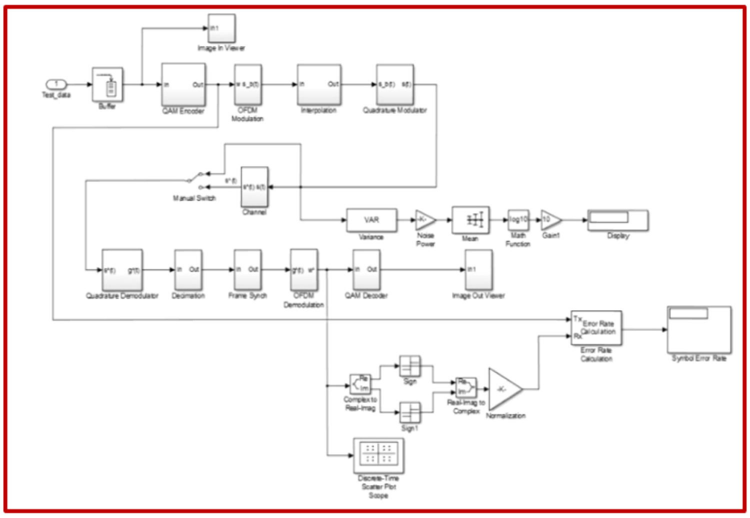
The Quadrature Amplitude Decoder is used for decoding the data from OFDM demodulation. Initially data is stored in buffer and given for frame separation. Four QAM decoders are used for decoding the data and further added and given delay before sending to image output viewer.

J. Image out viewer

The final image after encryption and decryption is given here for displaying in matrix viewer.

Simulated block diagram of the "Design of Encrypted SDR and Analysis of Noise in High Level System Architecture using MATLAB" is shown in figure 4.

Fig. 3: Simulated block diagram of SDR



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III. Results and Analysis

An image is being transmitted at the input of the SDR for the analyzing the effect of noise data during its transmission. The same image is then received at the receiving end image out matrix. The data output at the system error rate is found to be very minimal indicating the minimal effect of noise on the channel in the simulated results. Further the encryption and decryption of the corresponding binary data of the image is also carried out for securing the data. The implementation is done using Simulink library symbols and the MATLAB coding. The various output graphs are also plotted viz unsynchronized output, spectrum scope are shown below.

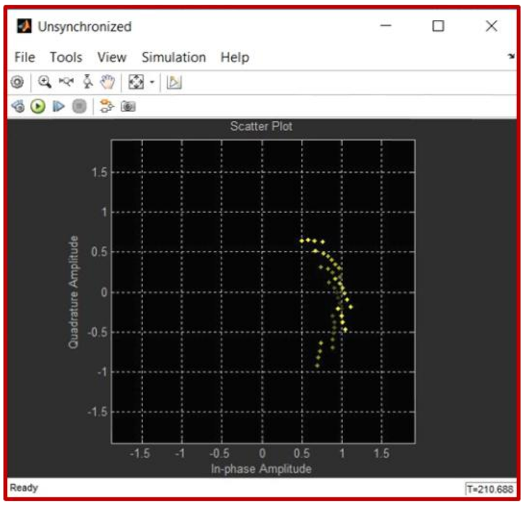

Fig. 4: Unsynchronized output waveform

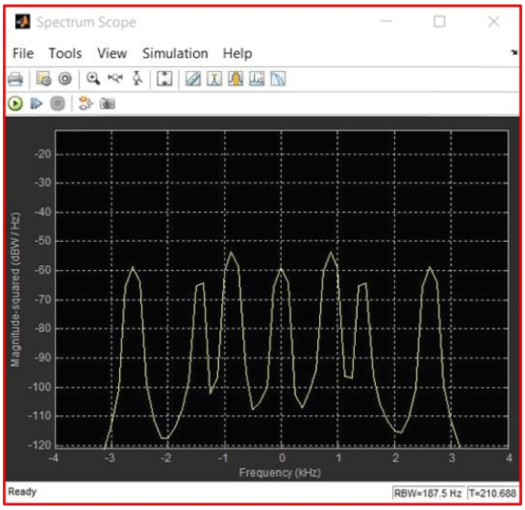

Fig. 5 Spectrum Scope

Variance and Symbol Error Rate:

Error Rate = BER(1-SyncER) + ½ SyncER ≈ BER [4].

IV Conclusion

The MATLAB based SDR design in High Level System Architecture is implemented. The application of the SDR is clearly indicative in this project. Emphasis is given on the minimizing the effect of noise in the channel during transmission of the data from transmitter to receiver. The encryption of the image data is also carried out by converting it to the binary data during transmission. It has been seen that the symbol error rate is very minimum making clear way out of transmission of secure and encrypted data using Software Defined Radio.

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