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FULL-LENGTH ARTICLE

Design of a hybrid reconfigurable Software Defined Radio transceiver based on frequency shift keying using multiple encoding schemes

Nikhil Marriwala [a,*], O.P. Sahu [b], Anil Vohra [c]

[a] Electronics and Communication Engg. Dept., University Institute of Engineering and Technology, Kurukshetra University, Kurukshetra, India
[b] Electronics and Communication Engineering Department, NIT, Kurukshetra, India
[c] Department of Electronic Science, Kurukshetra University, Kurukshetra, India

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Abstract Software Defined Radio (SDR) is the technology which has given researchers the opportunity and flexibility of integration and intercommunication of existing and future networks together. The radio spectrum is the most vital resource for a mobile operator in today's world of modern wireless communications. After analyzing the spectrum allocation map one can conclude that the most of the prime spectrums falling under the licensed bands have already been allocated for licensed users for exclusive use. There are very few unlicensed bands for the unlicensed users. SDR offers a perfect solution to this problem of spectrum scarcity being experienced in wireless communication systems. The demand for reliable, high data rate transmission has increased significantly these days, which leads the way to adoption, of different digital modulation techniques.

The aim of this paper was to analyze Frequency Shift Keying (FSK) Transceiver built using Laboratory Virtual Instrumentation Engineering Workbench (LabVIEW) and to measure the reduction in data errors in the presence of Forward Error Correction (FEC) channel coding algorithms namely the Convolution and the Turbo Codes. Through this design a graphical representation of Bit Error Rate (BER) vs E_b/N_0 where (E_b) is Energy per bit and (N_0) is Spectral noise density has been given in the presence of Additive White Gaussian Noise (AWGN) introduced in the channel. FSK is widely used for data transmission over band pass channels; hence, we have chosen FSK for the implementation of SDR. The SDR transceiver module designed has been fully implemented and has the ability to navigate over a wide range of frequencies with programmable channel bandwidth and modulation characteristics. We are able to build an interactive FSK based SDR

* Corresponding author.
E-mail address: nikhilmarriwala@gmail.com (N. Marriwala).
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transceiver in a shorter time with the use of LabVIEW. The outputs achieved show a low BER for very high data rates in the presence of AWGN noise.

1. Introduction

SDR systems are the ones which can adapt to the future-proof solution and it covers both existing and emerging standards. An SDR has to possess elements of reconfigurability, intelligence and software programmable hardware. As the functionality is defined in software, a new technology can be easily implemented in a software radio by means of a software upgrade. Channel equalization is an important subsystem in the Software Defined Radio (SDR) receiver [15]. For many years modulation techniques have been extensively used for various wireless applications, but the modern communication system requires data transmitted at a higher rate, larger bandwidth [16].

This paper discusses an SDR system built using LabVIEW for FSK Transceiver. SDR provides an alternative to systems such as the third generation (3G) and the fourth generation (4G) systems. There are two frequency bands where the Software Defined Radio might operate in the near future, i.e. 54–862 MHz Very High Frequency (VHF) and Ultra High Frequency (UHF) TV bands and 3–10 GHz Ultra-wideband (UWB) radios [19,6]. A Software Defined Radio comprises of a programmable communication system where functional changes can be made by merely updating the software. SDR can be reconfigured and can talk and listen to multiple channels at the same time. The transmitter of an SDR system converts digital signals to analog waveforms. The analog waveforms generated are then transmitted to the receiver. The received analog waveforms are then down converted, sampled, and demodulated using software on a reconfigurable baseband processor. Normally, high performance digital signal processors are used to serve as the baseband processor. SDR systems can be used in ubiquitous network environments because of its flexibility and programmability. The use of digital signals reduces hardware, noise and interference problems as compared to the analog signal in transmission, which is one of the main advantages of digital transmission.

In this paper, the software simulator of the FSK Transceiver has been designed using LabVIEW [7,14,13]. FSK is chosen to be the modulation scheme of the designed Software Defined Radio system due to its easy implementation and widespread usage of legacy communications equipment, and FSK modulation techniques are considered to be very common technology for transmission and reception in current and future wireless communication, especially in the VHF and UHF frequency bands giving excellent BER vs SNR ratio with high data rates. A fully implemented SDR has the ability to navigate over a wide range of frequencies with programmable channel bandwidth and modulation characteristics [5,20,9]. The role of modulation techniques in an SDR is very crucial since modulation techniques define the core part of any wireless technology. They can be reconfigured and can talk and listen to multiple channels at the same. The role of modulation techniques in an SDR is very crucial since modulation techniques define the core part of any wireless technology. SDR's inherent flexibility must, however, be planned for in advance via hardware and software considerations, ultimately resulting in increased code portability, improved communications system life cycles, and reduced costs [1,18,10]. The elementary concept of the SDR is that the radio can be totally configured or defined by the software so that a common platform can be used across a number of areas and the software used to change the configuration of the radio for the function required at a given time. There is also the beingness that it can be re-configured as upgrades to standards arrive, or if it is required to manage other role, or if the ambit of its process is denatured. SDR can be reconfigured and can peach and hear to duplex channels at the identical time. The personation of modulation techniques in an SDR is very important since modulation techniques define the core for any wireless systems [11,8,3].

The main interest in any communication group is the sure sending of signals of information from a transmitter to a receiver. The signals are transmitted via a guide who corrupts the signal. It is needful that the distorting effects of the channel and noise are minimized and that the information transmitted through the channel at any given time is maximized. The channel is subject to various types of dissonance, twisting, and interference [2]. Also, some communication systems have limitations on Transmitter power. All of this may lead to various types of errors. Consequently, we may need some form of error control encoding in order to recover the information reliably [22].

2. Related work

To ensure reliable communication forward error-correcting (FEC) codes are the main part of a communication system. FEC is a technique in which we add redundant bits to the transmitted data to help the receiver correct errors. There are two types of FEC codes: the convolutional codes and block codes. When we use Block codes they are defined by n and k, where n describes the total number of coded bits and k gives the number of input bits. In convolutional codes the coding is applied to the entire data stream as one code word [4]. In the year 1948, Shannon showed that arbitrarily reliable communication is only possible till the signal transmission rate does not exceed a certain limit which was termed as channel capacity. After this different algebraic codes such as Golay codes, Bose–Chaud huri–Hocquenghem (BCH) codes [1], and Reed–Solomon (RS) codes were created and used for error correction. The next series of codes originally referred as recurrent codes or Convolutional codes were given which helped further to improve the error control coding. The convolutional codes have efficient encoding and decoding algorithms and high performance over AWGN channels. Later on concatenated coding schemes were also given. Also some weak points were there of convolutional codes during bursty transmissions which were later on reduced using Reed–Solomon codes (RS codes) [17] by serially concatenating a convolutional code with an RS code. Development of