Chapter 12
USRP-Based Secure Data Transmission

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ABSTRACT

With the advent increase in growth of wireless technology Orthogonal Frequency Division Multiplexing (OFDM) gains popularity in recent years. OFDM forms the fundamental backbone of many currently used wireless transmission standards. It is a multicarrier modulation scheme which overcomes the need for equalizer to mitigate ISI caused due to multipath propagation. In this work, an OFDM based transceiver has been developed utilizing various modules like Source Coding, Channel Coding, IFFT-FFT, scrambler, cyclic prefix, and signal mapper. To ensure secure data transmission, Hadamard matrix is XORed with the data. This provides a low level of protection to the image which is transmitted. LabVIEW has been used as the processing tool to develop the transceiver and the prototype developed has been tested using Universal Software Radio Peripheral (USRP).

INTRODUCTION

The development of wireless systems has opened the doors to connect globally because of its cheaper cost and ease of use. But, even with the presence of these perks, there is a need to combat a severe issue called multipath fading which leads to Inter Symbol Interference (ISI) or cross talk.

Orthogonal Frequency Division Multiplexing (OFDM) (Gouda, Hussien, Ragab, Anwar, & Gouda, 2017) solves the above said issue. It is a distinct type of FDM, where users are provided a set of subcarriers overlapping in frequency domain (Bartalwar & Deepa, 2017). However, these subcarriers are specially designed to be orthogonal to each other, which allow them to occupy the same bandwidth without any interference. This, in turn negates the use of guard bands. As a result, the subcarriers can be closely packed to increase the channel efficiency.

In OFDM, high speed data streams of large bandwidth are split into parallel, slower sub streams of lower bandwidth called subcarriers (Salwa & Eldin, 2017). These subcarriers are centred on carrier frequencies on both sides of Direct Current (D.C). As the bandwidth increases so does the number of

DOI: 10.4018/978-1-7998-2701-6.ch012

subcarriers in it. The subcarriers are placed in a manner that all the other sub carriers have zero components at the peak of one subcarrier. Such subcarriers are called orthogonal. Orthogonality is achieved by ensuring that all the subcarriers have same symbol duration Ts and the subcarrier is maintained at equal spacing of f=1/Ts.

In time domain these subcarriers will be represented as everlasting sinusoids at these carrier frequencies. However, in order to transmit data over these subcarriers they are loaded with modulation symbols that represent the constellation points of digital modulation schemes like Quadrature Phase Shift Keying (QPSK) and M-ary Quadrature Amplitude Modulation (QAM) (Sklar & Ray, 2001).

Image Acquisition

This work emphasises on transmitting only gray scale images (Saravanan,2010). Grayscale is one type of images where the value present in every pixel element represents only the amount of light present, i.e. the intensity. The levels of shades are given by 2^n, where n is the number of bits taken into account. Since the focus is on an 8 -bit gray scale image, there are 2^8 i.e. 256 levels ranging from 0 to 255.The input data considered is a 256*256 gray scale image.

Security

Encryption is the process of encoding the data such that only those with the encryption key can access the data (Balouch, Aslam, & Ahmed, 2017). At the transmitter end, the array elements are shuffled according to the encryption key while at the receiver end, the received data is reshuffled according to the same key thus restoring the originally transmitted data. To ensure a low-level security to the image which is transmitted through OFDM transceiver Hadamard sequences are XORed.

Hadamard matrix is a square matrix consisting of two values 1 and -1 having rows which are mutually orthogonal to each other. This can be explained in two basic terms. In geometric terms, each pair of rows is mutually perpendicular vectors whereas in combinatorial terms, it can be said that each pair of rows has exactly half matching elements. Certain Hadamard matrices are used as error correcting codes such as Hadamard codes. Hadamard matrices are also used for low scale encryption purposes as multiplication of an image with a similar size Hadamard matrix results in a scrambled image (Lee, Shahab, Kader & Shin, 2016).

USRP

The developed transceiver using LabVIEW tool is then implemented using USRP. The USRP Software Defined Radio Device is a tuneable transceiver (Nafkha, Naoues, Cichon, & Kliks, 2014). Any wireless system can be designed utilizing LabVIEW software tool and various parameters can be analysed by transmitting and receiving the signal using USRP.

This work aims at developing OFDM based transceiver which includes modules like source coding, channel coding, signal mapper, scrambler-descrambler, IFFT-FFT block with the aid of LabVIEW tool. The image is encrypted using Hadamard sequences and it is transmitted and received using USRP.