ABSTRACT

Orthogonal Frequency Division Multiplexing (OFDM) systems are widely used in the standards for digital audio/video broadcasting, WiFi and WiMax. Being a frequency-domain approach to communications, OFDM has important advantages in dealing with the frequency-selective nature of high data rate wireless communication channels. As the needs for operating with higher data rates become more pressing, OFDM systems have emerged as an effective physical-layer solution.

This short monograph is intended as a tutorial which highlights the deleterious aspects of the wireless channel and presents why OFDM is a good choice as a modulation that can transmit at high data rates. The system-level approach we shall pursue will also point out the disadvantages of OFDM systems especially in the context of peak to average ratio, and carrier frequency synchronization. Finally, simulation of OFDM systems will be given due prominence. Simple MATLAB programs are provided for bit error rate simulation using a discrete-time OFDM representation. Software is also provided to simulate the effects of inter-block-interference, inter-carrier-interference and signal clipping on the error rate performance. Different components of the OFDM system are described, and detailed implementation notes are provided for the programs. The program can be downloaded from http://www.morganclaypool.com/page/ofdm

KEYWORDS

multi-carrier, orthogonal frequency division multiplexing (OFDM), frequency domain, carrier frequency offset, peak-to-average power ratio, simulations

Contents

Preface

Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier communication scheme widely adopted in the wireless communications industry. In this book, we provide a brief and comprehensive coverage of the OFDM system model, an overview of its advantages and disadvantages, along with MATLAB codes for simulation. This book is intended for practitioners or students with some elementary knowledge of digital communications. The main focus of this book is to aid readers in understanding the workings of a point to point baseband OFDM system and understanding how to simulate performance under certain impairments. A unique feature of the book is its emphasis on discrete-time representations which are used to simulate OFDM systems. In order to make the book accessible to a wider audience, we present several simulations, which provide a deeper insight into the subject. An extensive list of references is also included to support further reading.

We begin by highlighting the benefits that OFDM offers over the conventional frequency division multiplexing scheme in terms of bandwidth efficiency and implementation complexity. Following this, we motivate the need for OFDM systems by providing a brief introduction to wireless fading channels, with special emphasis on the time varying and frequency selective nature of such channels. We demonstrate that complex equalization at the receiver, which would be required for communication over frequency selective channels, are not needed in the case of OFDM systems, further motivating its use. Different variations on the basic OFDM system are also presented to illustrate its versatility. Drawbacks of OFDM such as high peak-to-average power ratio (PAPR) at the transmitter, and carrier frequency offset (CFO) at the receiver are described, along with their adverse effects on system performance. Techniques to mitigate their effects are also presented. All these concepts are supported with simulations. The programs used for these simulations, with detailed comments, are also provided.

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