SIMULATION OF OFDM OVER FIBER FOR WIRELESS COMMUNICATION SYSTEM

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To

My beloved parents and brothers for their unwavering

love, sacrifice and inspiration.

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ABSTRACT

Radio-over-fiber (RoF) technology has several benefits such as larger bandwidth, reduced power consumption etc. that has made it an attractive implementation option for various communication systems. Orthogonal Frequency Division Multiplexing (OFDM) is seen as the modulation technique for future broadband wireless communications because it provides increased robustness against frequency selective fading and narrowband interference, and is efficient in dealing with multi-path delay spread. This project investigates the feasibility of Orthogonal OFDM as a modulation technique to transmit the basebans signal over fiber. Laser diode and photodiode have been modeled and used as optical modulator and optical demodulator respectively. Results from a MATLAB/SIMULINK system model, which show the QPSK-OFDM transmitted and received signal before and after the transmission over fiber, power spectrum before and after the transmission over fiber, constellation before and after channel estimation. The model of this project can be used with different wireless communication systems such as Wireless LANs and Digital Video Broadcasting (DVB) and it is supporting to the 4th generation cellular systems.

ABSTRAK

Teknologi radio atas gentian (ROF) mempunyai beberapa kelebihan seperti jalurlebar besar, kurang pengunaan kuasa dll. Yang menyebabkan ia menjadi satu pilihan inplimentasi yang menarik untuk pelbagei sistem komunikasi. Pembahagian Frekuensi Multipleks Ortogon (OFDM) di lihat sebagei teknik modulasi untuk komunikasi jalur lebar tanpa wayar pada masa hadopan kerana ia memberi ketahanan terhadap pudaran frekuensi pilihan dan gangguan jalur nipis, dan ia cekop dalam menagani perebakan kelewatan pelbagai hala. Projek ini menyiasat sama ada OFDM boleh diguna sebagai teknik modulasi untuk menghantar isyarat jalurasas melalui gentian. Diod laser dan diod foto telah dimodel dan digunokan sebagai pemodulat optik dan demodulator optik. Keputusan daripada model system MATLAB/SimuLINK, menunjukkan QPSK – OFDM yang dihantar dan diterima sebelum dan selepas transmisi atas gentian, constellation sebelum dan selepas pengiraan saluran. Model untuk project ini boleh diguna dengan sistem komunikasi tanpa wayar yang berbeza seperti LAN tanpa wayar dan penyiaran video digital dan ia menyokong generasi ke 4 sistem selular.

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LIST OF SYMBOLS

ROF	-	Radio-over-Fiber
OFDM	-	Orthogonal Frequency Division Multiplexing
QPSK	-	Quadrature Phase Shift Keying
WLAN	-	Wireless Local Area Network
DVB	-	Digital Video Broadcasting
CS	-	Central Site
RS	-	Remote Site
IF	-	Intermediate Frequency
RF	-	Radio Frequency
ITS	-	Intelligent Transport Systems
BS	-	Base Station
APs	-	Access Points
QAM	-	Quadrature Amplitude Modulation
DAB	-	Digital Audio Broadcasting
BER	-	Bit Error Rate
Fi-Wi	-	Fiber-Wireless
ADROIT	-	Advanced Radio-Optics Integrated Technology
MSC	-	Mobile Switching Centre
RAP	-	Radio Access Point
CDMA	-	Code Division Multiple Access
WDM	-	Wavelength Division Multiplexing
SMF	-	Single Mode Fibre
POF	-	Polymer Optical Fibre
EDFA	-	Erbium Doped Fibre Amplifier
OTDM	-	Optical Time Division Multiplexing
DWDM	-	Dense Wavelength Division Multiplex

MZI	-	Mach Zehnder Interferometer
SCM	-	Sub-Carrier Multiplexing
IM-DD	-	Intensity Modulation and Direct Detection
ISI	-	Inter Symbol Interference
PN	-	Pseudo-Noise
DEF	-	Decision Feedback Equalizer
RIN	-	Relative Intensity Noise
FFT	-	Fast Fourier Transform
ICI	-	Inter-Carrier Interference
ADSL	-	Asymmetric Digital Subscriber Lines
VDSL	-	Very high-speed Digital Subscriber Lines
HDTV	-	High Definition Television
BER	-	Bit Error Rate
SER	-	Symbol Error Rate
FFT	-	Fast Fourier Transform
IFFT	-	Inverse Fast Fourier Transform

CHAPTER 1

INTRODUCTION

1.1 Introduction

Radio-over-Fiber (ROF) is a technology by which microwave (electrical) signals are distributed by means of optical components and techniques. A ROF system consists of a Central Site (CS) and a Remote Site (RS) connected by an optical fiber link or network. One of the major motivation and system requirement for ROF technology is the use simple and costeffective RS [5]. The electrical signal distributed may be baseband data, modulated IF, or the actual modulated RF signal. The electrical signal is used to modulate the optical source. The resulting optical signal is then carried over the optical fiber link to the remote station. By delivering the radio signals directly, the optical fiber link avoids the necessity to generate high frequency radio carriers at the antenna site. Since antenna sites are usually remote from easy access, there is a lot to gain from such an arrangement. However, the main advantage of ROF systems is the ability to concentrate most of the expensive, high frequency equipment at a centralized location, thereby making it possible to use simpler remote sites [5].

ROF is very attractive technique for wireless access network infrastructure, because it can transmit microwaves and millimeter-waves through optical fibers for a long distance.

Moreover, 5 GHz ROF link using a direct modulation scheme has been developed to support some important future wireless systems such as wireless local area networks (WLAN) intelligent transport systems (ITS), and the 4th generation cellular systems.

In particular, ROF is promising technique for WLAN infrastructures because ROF technique can manage WLAN modems at a base station (BS) and can solve serious interference problem between wireless signals caused by proliferated WLAN access points (APs).

Orthogonal Frequency Division Multiplexing (OFDM) is seen as the modulation technique for future broadband wireless communications because it provides increased robustness against frequency selective fading and narrowband interference, and is efficient in dealing with multi-path delay spread.

As stated above, OFDM uses multiple sub-carriers to transmit low rate data streams in parallel. The sub-carriers are modulated by using Phase shift Keying (PSK) or Quadrature Amplitude Modulation (QAM) and are then carried on a high frequency microwave carrier (e.g. 5 GHz). This is similar to conventional Frequency Division Multiplexing (FDM) or Sub-carrier Multiplexing, except for the stringent requirement of orthogonality between the sub-carriers.

Coded OFDM offers very robust communications with the frequency diversity that results from channel coding and interleaving.

Each of OFDM has been developed to support wireless communication systems such as WLAN, DAB, and DVB and future wireless systems such as the 4th generation cellular systems.

In this project QPSK-OFDM is used as a modulation technique to transmit baseband signal over single mode optical fiber link. Laser diode and photodiode have been modeled and used as optical modulator and optical demodulator respectively. The project model has simulated using MATLAB/SIMULINK software.

1.2 Problem Statement:

The demand for broadband services has driven research on millimeter-wave frequency band communications for wireless access network due its spectrum availability, and compact size of radio frequency devices

The mm-wave signals suffer from severe loss along the transmission as well as atmospheric attenuation.

One of the solution to overcome these problems is by using low-attenuation, electromagnetic interference-free optical fiber. ROF is considered to be cost-effective, practical and relatively flexible system configuration for long-haul transport of millimetric frequency band wireless signals using multicarrier modulation OFDM

1.3 The objective of this study

The aim of this project is to investigates the feasibility of OFDM as a modulation technique to transmit the baseband signal over fiber for wireless communication systems

1.4 Scope of this work

This project will cover the simulation of the OFDM over Fiber for wireless communication systems using MATLAB/SIMULINK software. A QPSK-OFDM signal will be simulated. Bit error rate (BER) performance of the OFDM will be evaluated.

1.5 Thesis outline

Chapter 1 consists of introduction of the project. The objectives of the project are clearly phased with detailed. The research scope and methodology background are also presented.

Chapter 2 included introduction about Radio-over-Fiber Technology, also introduce the benefits of ROF Technology and discussion Issues with the Fi-Wi System and the solutions for those issues and also mentions the application of ROF Technology where WLAN is one of them.

Chapter 3 presents the Orthogonal Frequency Division Multiplexing (OFDM). Consist of introduction, basic concept and the orthogonality of OFDM and also discusses the advantages and disadvantages of OFDM.

Chapter 4 is the methodology of project which starts with the flow chart of the project. Then, will followed by viewing the simulation model and the blocks used in MATLAB/SIMULINK

Chapter 5 contains results from a MATLAB/SIMULINK system model, which show the QPSK-OFDM transmitted and received signal before and after the transmission over fiber, power spectrum before and after the transmission over fiber, constellation before and after channel estimation

Chapter 6 concludes the thesis. The conclusion is given based on the analysis of results from the previous chapter. Recommendations for future works are also presented.

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