DESIGN OF EFFICIENT IMPLEMENTATION OF Π/4 DQPSK MODULATION FOR MULTIPATH FADING CHANNELS

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ABSTRACT

This project will be base on the wireless communication using π/4 Differential Quadrature Phase Keying (π/4 DQPSK) modulation technique in the transceiver system. This modulation technique will be evaluated using the channel with the present of Additive White Gaussian Noise (AWGN) and multipath Rayleigh fading. The design of the system will be totally base on simulation. In this case the simulation tool MATLAB will be used. In this project, normal receiver structure for π/4 DQPSK was redesign by using multiplier-less method. The new receiver was designed to obtain simpler structure in term of hardware implementation where it able to reduce number of Integrated Circuit (IC) used in the design. Performance of the new receiver structure then will be evaluate base on the error performance of the system. In this case, relation of Bit-Error-Rate (BER) and Signal to Noise Ration (SNR) will be used to produce the result of error performance. Normal and new receiver structures which were design in π/4 DQPSK system will be study base on error performance and hardware complexity to obtain the most efficient result for the communication system.

ABSTRAK

Projek ini melibatkan kajian mengenai transmisi tanpa wayar yang menggunakan teknik modulasi π/4 Differential Quadrature Phase Keying (π/4 DQPSK). Teknik modulasi ini akan dikaji menggunakan laluan yang mempunyai Pertambahan Bunyi Hingar Putih Gaussian (AWGN) dan kelenturan pelbagai laluan Rayleigh (multipath Rayleigh fading). Sistem ini akan dikaji dengan menggunakan simulasi computer MATLAB. Didalam projek ini, penerima biasa akan diubah suai dan dicipta menggunakan cara tanpa pendaraban. Penerima jenis ini dicipta untuk mendapatkan struktur yang lebih mudah terutama apabila melibatkan penggunaan alatan dimana ia akan menggurangkan penggunaan penyatuan rekabentuk (IC) didalam struktur. Penerima baru ini akan dinilai melalui kadar kesilapan bit didalam sistem. Kaitan antara kadar kesilapan bit dan kadar Signal dan hangar akan digunakan di dalam penilaian ini untuk mendapatkan keputusan kadar kesilapan sistem. Penerima biasa dan penerima yang baru yang dicipta dengan menggunakan modulasi π/4 DQPSK akan dikaji berdasarkan kadar kesilapan dan kesenaggan hardware untuk mendapatkan keputusan yang terbaik bagi digunakan didalam sistem komunikasi.

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π/4 DQPSK	π/4 Differential Quadrature Phase Shift Keying
AWGN	Additive White Gaussian Noise
IC	Integrated Circuit
BER	Bit Error Rate
SNR	Signal to Noise Ration
MTSO	Mobile Telephone Switching Office
PSTN	Public Switched Telephone Network
DSP	Digital Signal Processing
N-LOS	Non-Line of Sight
CPFSK	Continuous Phase Frequency Shift Keying
BPSK	Binary Phase Shift Keying
QPSK	Quadrature Phase Shift Keying
OKQPSK	Offset Keyed Quadrature Phase Shift Keying
RF	Radio Frequency

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CHAPTER 1

INTRODUCTION

1.1 Background.

Historically all telephone communications were accomplished by a wired line network. All telephones were connected to the network with a pair of wires. Recently, a wireless network has emerged where the link between the network and telephone is wireless. This wireless technology has been employed and recognized as a step forward.

Figure 1.1 shows an overall wireless communications systems. Communications today is on the move. In cars, office buildings, manufacturing plants, shopping malls and wherever people go, wireless telephones and other communications systems go with them. Base stations are at the heart of wireless communications systems. All base station cell sites connect to the Mobile Telephone Switching Office (MTSO). The MTSO in turn interfaces to the Public Switched Telephone Network (PSTN) by connecting to a Central Office. Control of all cell sites, all subscriber records, statistics, and billing is maintained at the MTSO. In the future, smaller "Microstations" will bring wireless services into offices, factories, schools, shopping malls and wherever there is a need for mobile communications.

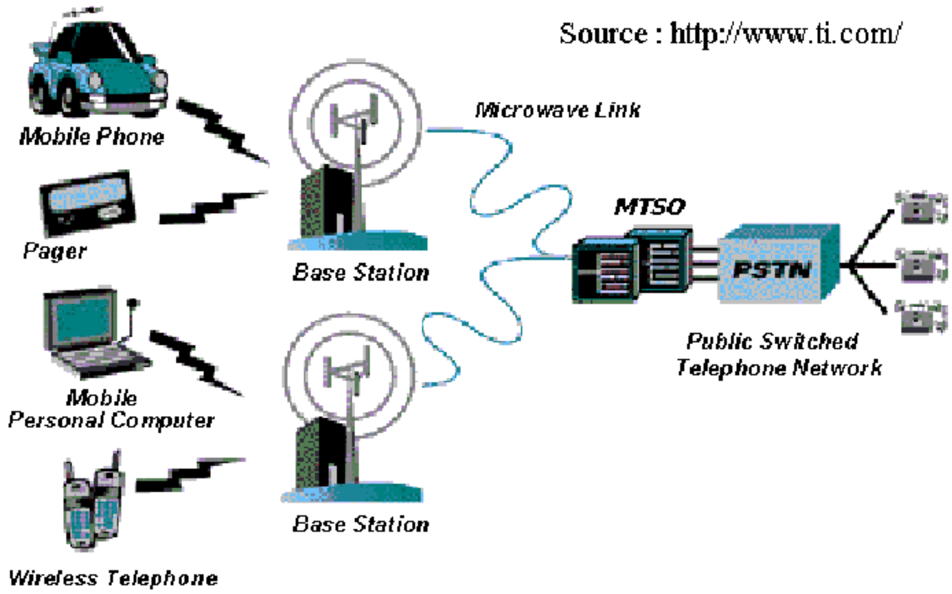

Figure 1.1: The overall system of wireless communications.

Driving this new mobility in communications is high-speed digital technology, and in the forefront of this technology is Digital Signal Processing (DSP). DSP is a prime enabler for digital communications and is confronting the specific needs of wireless systems for higher levels of integration and greater performance with low power consumption. DSP technology will also continue to be the key baseband technology on which digital wireless systems are built. DSP solutions will grow in importance as the partition between the radio and the baseband subsystem gradually moves to drive more and more functionality into the signal processor.

1.1.1 Modulation.

Modulation plays a key role in any communication system. The type of modulation used depends on the type of the communication channel. The choice for modulation technique has a direct impact on the capacity of a digital communication system. It determines the bandwidth efficiency of a single physical channel is terms of the number of bits per second per hertz (bit/s/Hz) and it is therefore important that this choice is discussed in detail.

In selection a suitable modulation scheme for a digital communication system, consideration must be given to achieving the following:

1. High bandwidth efficiency
2. High power efficiency.
3. Low carrier-to-co channel interference power ration (CCI)
4. Low out-of-band radiation
5. Low sensitivity to multipath fading
6. Constant or near constant envelope
7. Low cost and ease of implementation

To optimize all these features at the same time is not possible as each has its practical limitation and also is related to the others. For example, to achieve high bandwidth efficiency one may choose to use high-level modulation. However, if this is done two consequent disadvantages are introduced. Hence, a trade-off among all the above features must be adopted.

1.2 Problem Statements

Nowadays wireless has been very important and choice of communication for world wide user. However, there are two important criteria need to be consider in every type of communication which are efficiency in term of error performance and hardware design.

The implementation of modulation technique in communication that has efficient error performance and hardware design is very difficult to achieve in practical environment. With the additional circuitries, good error performance for communication system is very easy to achieve but not for hardware design.

Basically most of modulation techniques used a lot of multiplier in its design. The multiplier is difficult to design in term of hardware especially if the multiplication operation involves floating point. Base on the difficulties involve, the communication system will be expensive especially for the application required simpler and cheaper system.

1.3 Project Objective

The objectives and aims of this project are to investigate and evaluate the error performance of π/4 Differential Quadrature Phase Keying (π/4 DQPSK) modulation technique with the new implementation of hardware design subject to the channel with Additive White Gaussian Noise (AWGN) and Rayleigh fading. The performance study will be carried out base on the relationship of Bit Error rate (BER) and Signal to Noise Ratio (SNR). The relationship will be compare for the variable of receiver structures. The receiver structures will be design to have batter implementation in term of hardware design.

There will be three different type of π/4 DQPSK system models will be use d in this project. Those models are:

1. π/4 DQPSK modulation system using baseband differential detector as a receiver structure.
2. π/4 DQPSK modulation system using multiplier-less (1^{st} sector) receiver structure.
3. π/4 DQPSK modulation system using multiplier-less (1^{st} and 2^{nd} sector) receiver structure.

1.4 Scope of Work

This project is an entirely simulation project using scientific computer simulation software, MATLAB 7.0. All models which been explained in previous sub chapter will be design by using m files in MATLAB 7.0. There will be no hardware design and application field test involve in this project.

As describe in sub chapter 1.3, there will be only three receivers structure will be investigate and evaluate which are baseband differential detector, multiplier-less (1^{st} sector) and multiplier-less (1^{st} and 2^{nd} sector). All of those receiver will be evaluate using the same transmitter.

There are two extreme cases of channel noise and fading that will be subjected to the π/4 DQPSK system models. The model will be simulated with different receiver structure under thermal noise, represented by Additive White Noise Gaussian (AWGN). Then, the channel is simulated with various different parameters using Non-Line of Sight (N-LOS) multiple reflected rays represented as multipath Rayleigh fading. In other word, the channel simulation will be focus on AWGN and Rayleigh fading only.

Since there are involvement of noise and fading in the channel, error will produce during data transmission across the channel. In this case additional circuitries (error correction) can be used to reduce the error. But for this project, the evaluation and investigation will be base on transmitter and receiver without error correction scheme.

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