ANALYSIS AND REDUCTION OF TIMING JITTER USING HYBRID OFDM - DFMA PONS

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Abstract -*The popular instrumentation technique known as ORTHOGONAL frequency-division multiplexing (OFDM) has been widely used in wireless broadband systems to prevent frequency-selective fading in wireless channels. Hybrid OFDM-DFMA PONs (orthogonal frequency division multiplexing—digital filter multiple access passive optical networks) hold out hope for seamless and low-cost optical and mobile network convergence in 5G and beyond. This PON has a higher signal transmission capacity and spectral efficiency than hybrid OFDM-DFMA PONs. This project presents using hybrid OFDM-DFMA PONS to analyse and reduce timing jitter. The vibration process employs a Quadrature Amplitude Modulation (QAM) modulator. The Inverse Fast Fourier Transform (IFFT) technique is used in this project. The Inverse Fast Fourier Transform is used to convert a signal from the spectral domain to the time domain (IFFT). To obtain the channel signal, identical code cyclic shifted prefix (ICCSP) signals are used in the parallel to serial conversion procedure. Since this project demonstrated its effectiveness and reduced noise errors, it is being used for further advancement. MATLAB software is used to carry out this project.*

Key Words**: IFFT-** ***Inverse Fast Fourier Transform, ICCSP- identical code cyclic shifted prefix.***

1. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is widely used in digital wireless telephone networks due to important characteristics like excellent data rate signal transmission with high bandwidth capability and its stability with respect to the multi path delay that occurs in digital networks. In both wired and wireless communication systems, an imaginative strategy is heavily used. The most difficult tasks in Wireless Communication Systems (WCS) are maintaining a larger number of Sub Carriers (SCs) and providing satisfied Quality of Service (QoS) requirements in relation to Bit Error Rate (BER) in frequency spectrum. By merging the antenna arrays at the receiver and transmitter in time variant along with frequency selective channels, an Orthogonal Frequency Multiplexing Division (OFDM) scheme maximizes system capacity as well as modulation scheme. The current research work focuses on reducing information loss, lowering the Peak to Average Power Ratio (PAPR) in both carriage and detailed reporting, keeping the Bit Error Rate (BER) within the threshold, and analysing the Signal to Noise Ratio (SNR) in Multiple Input Multiple Output OFDM signals [1].

The multi-carrier modulation (MCM) technique orthogonal frequency division multiplexing (OFDM) has been shown to be very effective for communication over channels with frequency selective fading. It is extremely difficult to handle frequency selective fading in conventional communication receivers because the receiver design becomes extremely complex. Precisely where you are now. Instead of addressing the issue of resonance stringent fading as a whole, OFDM addresses it by converting the entire frequency selective fading channel into a number of narrow spectral flat modulation scheme. By using simple equalisation schemes, flat fading makes it easier for the beneficiary to combat connection tracking and Inter Symbol Interference (ISI). The majority of proprietary communication and broadcasting technology, including IEEE 802.11 wireless local Area Networks (WLANs), Zig Bee, Ultra Wide Band (UWB), and others, is based on spread spectrum regulation. These WLANs offer data rates ranging from 1 to 11 Mbps via frequency hopping and direct sequence. Despite these relatively high data rates, there is an increasing demand for higher data rates for wireless broadband Local Area Networks (LANs) and Metropolitan Area Networks (MANs) (MANs) [2]. Spread spectrum systems were unable to meet the even higher data rates required by multimedia applications due to inefficient bandwidth utilization. Furthermore, multimedia applications that operate outdoors or in industrial environments necessitate a wireless network that can operate more effectively in "RF hostile" surroundings.

High spectral efficiency and a sizable increase in demand for high data rate multimedia based services are the two main prerequisites for the continued technological advancement in wireless communications in the future. For the improvement of the data rate and system performance, several advancements have recently been incorporated into 3G wireless communication systems (for example, high speed downlink packet access (HSDPA) in wideband code division multiple access (WCDMA) systems, and 1x evolution-data and voice (1xEV-DV) for cdma2000 systems) [3]. High data rates are necessary for the continuous proliferation of wireless multimedia applications and services, including video teleconferencing, network gaming, and high quality audio/video broadcasting. At this time, it is clear that the current 3G wireless systems, even when operating at their total potential, cannot keep up with the demand for broadband wireless services. The fourth generation (4G), beyond third generation (3G), LTE, and fifth generation (5G) wireless communication systems are anticipated to support much higher data rate services than the developing 3G systems (up to 100 Mbit/s in outdoor spaces and up to 1 Gbit/s in indoor spaces).

LTE-A is expected to support data rates of up to 1 Gbit/s, and 5G, a gigabit wireless standard for millimeter wave communication, is anticipated to support data rates greater than 1 Gbit/s. The primary technology obstacles to accomplishing this high data rate will be accomplishing high spectral efficiency, managing high frequency-selectivity due to the use of large bandwidth, managing high PAPR due to the introduction of more subcarriers, and selecting an effective signaling scheme for higher data rates. Therefore, it is essential that any future wireless systems integrate the most recent technical developments in the physical layer. Today's preferred data communication methods include WLAN and WiMAX (Worldwide Interoperability for Microwave Access) [4].

1.1 ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING (OFDM) COMMUNICATION SYSTEMS

Orthogonal Frequency Division Multiplexing (OFDM), one of the methods used to design a digital communication system, has been cited as one of the most advantageous methods. Widely accepted as a bandwidth-efficient transmission method for wireless communications, OFDM systems. The signal processing and communication systems communities are becoming increasingly interested in this subcarrier method. These systems' central idea is to use the Fast Fourier Transform (FFT) and its inverse to split the entire bandwidth into much smaller sub-bands while maintaining separability between the bands (IFFT). This band division's primary goal is to reduce Inter Symbol Interference (ISI) issues brought on by wide-band transmitters made possible by resonance channels. When dealing with the frequency-selective nature of high data rate communication channels, OFDM—sometimes referred to as a frequency-domain approach to communications—has significant advantages. Additionally, it has strong multipath tolerance, is robust against narrowband co-channel interference and channel fading, has a high spectral efficiency, is simple to implement, etc.

The addition of the cyclic prefix (CP) to the transmission signal, which helps it combat the effects of delay, is another key benefit of using the OFDM technique. Despite these significant benefits, OFDM also has a number of drawbacks, including a loss of bandwidth due to guard time, a high Peak to Average Power Ratio (PAPR), and a propensity for frequency and phase offset errors. Wideband digital communication systems like Wireless Local Area Network (WLAN), Asymmetric Digital Subscriber Line (ADSL), International Telecommunication Union (ITU-T), and Metropolitan Area Network have all greatly benefited from the above-mentioned advantages of OFDM (MAN) [5].

1.2 POWER LINE COMMUNICATION (PLC) SYSTEMS

PLC systems, which use the existing power cable infrastructure for interaction, are one of the key technologies that can contribute to the development of home networks and, more recently,energy resources in Smart Grid Technology (SGT). Even though there are still some regulatory and standardization issues with PLC systems, PLC is still regarded as one of the biggest competitors in the broadband communication market for in-building connectivity. If the power cables are already in place for energy distribution purposes, PLC systems are desired for their high availability, ease of use, ability to transmit data at a high rate with associated services (internet, high definition video (HDV), video on demand, etc.), and low infrastructure cost. It is now encouraging to see that researchers in this field are taking into account the deployment of PLC in SGT in terms of communication over the National Grid and its associated networks. PLC systems, like all other technologies, have their own set of limitations and technical glitches.

For signal strength with a high frequency and low power, the power line channel may occasionally seem harsh because the medium is frequently subjected to a variety of interfering noise sources, such as stationary, cyclostationarity, or impulsive noise generating devices. Bit errors in PLC systems originate from one of the main sources of interference, known as Impulsive Noise (IN) (IN). Impulsive noise mainly occurs for a fraction of time and may be mainly characterized by its period, inter-arrival time and magnitude. In order to overcome these obstacles and interferences, many efforts have been made in characterizing and simulation models the PLC channels [6].

1.3 MODULATION AND DEMODULATION OF OFDM

All SCs are successfully integrated with the OFDM systems, and the carriers' orthogonally is maintained through monitoring. Hence, OFDM generates an efficient spectrum depending on modulation, demodulation scheme and inputs. Each of the carrier is transferring the assigned data to the particular destination. After that, in consequence of modulation scheme the necessary amplitude as well as carrier phase is estimated. The common modulation methods used in OFDM systems include Quadrature Amplitude Modulation (QAM), which doubles bandwidth, Binary Phase Shift Keying (BPSK), which is used for a wide frequency range [7].

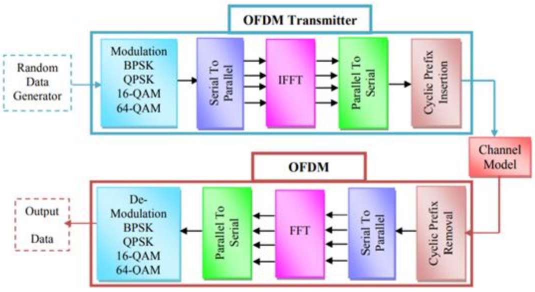

Figure 1.1 General Structure of Modulation and Demodulation components of OFDM System.

Inverse Fast Fourier Transform is used to transform the selected amplitude signal into a time domain signal (IFFT). The IFFT scheme effectively handles time domain signal transformations and keeps carriers orthogonal 3. In order to convert time domain signals to frequency domain signals, the FFT method is helpful. This transformation yields the mean orthogonal sinusoidal components and aids in determining the equivalent waveform. In a time domain signal, the amplitudes and phases of the data symbol's sinusoidal components represent the frequency spectra. The FFT is reversed in the IFFT transformation method. Figure 1.1 shows the general layout of the OFDM demodulation and modulation process. Figure 1.1 depicts modulation, which is the variation of signal waves that are transmitted over a communication medium or channel to lessen the impact of noise. After receiving the primary data, this process entails determining the received data that has been demodulated. Data modulation and a suitable modulation strategy enable the OFDM transceiver. In order to prevent inter-symbol interference (ISI) and to deliver a cyclic prefix (CP) to groupings or signals [8].

2. PROPOSED SYSTEM

Current steering (CS) digital-to-analog converters (DACs) are widely used in many rapid communication applications due to their quick current steering capabilities. The CS-DAC has two output types: return-to-zero output and non-return-to-zero output (NRZ) (RZ). The RZ DAC lowers the temporarily generated nonlinearity of the NRZ DAC. Therefore, it is believed that RZ DAC is more prone to timing mistakes. In order to meet the demanding conditions placed by future 5G networks, such as ultra-reliable low latency links, massive device connectivity, and ever-increasing demands for higher capacity, it is essential to provide elastic, flexible, dynamic, and high-performance optical networks that seamlessly converge the traditional mobile and fixed networks into cloud access networks (CANs). These converged networks can thus offer improved network bandwidth utilization effectiveness and versatility through features like shared, on-demand bandwidth provision. Additionally, in order to support the current rigid vendor-locked-in network topology, a software-defined networking (SDN) platform must be used to support the central abstraction and virtualization of the network infrastructure. The two main types of timing errors are timing skew and timing jitter. Dynamic element matching (DEM) attempts to reduce the noise level caused by code-dependent chromatic disruptions caused by timing skew brought on by timing irregularities across data lines. Timing jitter affects all unit current cells simultaneously, in comparison to timing skew, and the error stochastically shifts with each sampling instant.

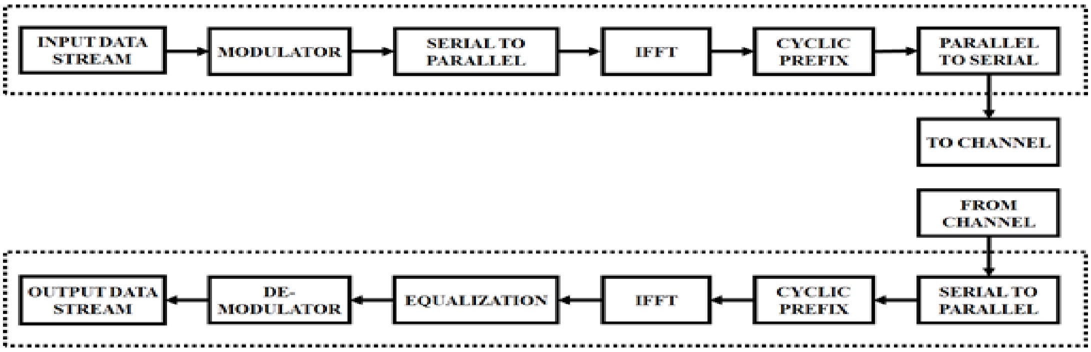

Figure 2.1 Block Diagram for Proposed System

The modulation process was applied to the input signal. An electronic current known as a transceiver applies low-frequency modulation to high-frequency signals. The transmitter then used IFFT to convert each user's modulated signal into time domain. An IFFT signal is employed for the identical code cyclic shifted prefix (ICCSP) process that follows. The parallel to serial conversion process is used to obtain the channel signal using the ICCSP signals. The ICCSP and IFFT processes receive the channel signal after that. For the current signal, equalisation and demultiplexing are permitted. Finally, the output signal is attained.

2.1 CHANNEL

An important role for channel estimation in an OFDM system. By enhancing the system's bit error rate performance, it is used to increase the capacity of orthogonal frequency division multiple access (OFDMA) systems. A subset of frequency division multiplexing called OFDM makes use of multiple sub-carriers on nearby frequencies in a single network. An OFDM system also uses sub-carrier overlapping to increase spectral efficiency. Normally, adjacent channels that overlap can cause interference.

The steps are as follows.

I. Create a mathematical model using the channel matrix to correspond the signals that are sent and received.
II. Send a recognizable signal (typically referred to as a "reference voltage" or "pilot signal") and then listen for the receiver end.

Traditional Least Square (LS) and Minimum Mean Square (MMSE) estimation algorithms are used to perform the channel estimation. Bit Error Rate (BER) and Mean Square Error (MSE) levels are used to assess the MIMO-OFDM system's performance. Equalization in telecommunications is the reversal of distortion that a signal experiences while being transmitted through a channel. The frequency domain characteristics of the signal at the input are accurately replicated at the output when a channel has been equalized.

2.1.1 ADDITIVE WHITE GAUSSIAN NOISE

The AWGN channel model is frequently used in situations where the only obstruction to communication is the addition of wideband or white noise with a constant spectral density (measured in watts per hertz of bandwidth) and a Gaussian amplitude allocation. It is possible to determine the functions of the important resources of power and bandwidth using the AWGN capacity formula 5.8. The maximum achievable spectral efficiency through the AWGN channel is calculated using this equation as a function of SNR. Signals and the reliability of electrical systems can be distorted by noise because of its randomness. In order to measure a system's response to noise, noise power stations introduce an average amount of errors through the system using an AWGN channel.

2.2 MODULATOR

For contemporary applications like wireless backhaul, high-definition video, and 5G communications, high-speed data transmission is crucial. The spectrum windows surrounding the millimeter-wave (mm-wave) band can be used for the transceiver to achieve a data rate of up to 10 Gbps. Orthogonal frequency division multiplexing (OFDM), 16 quadrature amplitude modulation (QAM), 64-QAM, and other complex modulation schemes are frequently used to increase spectral efficiency with high data rates and good signal-to-noise ratio (SNR). The requirement for high linearity and low phase noise for the local oscillator (LO) and mm-wave transceiver, respectively, raises the design challenge significantly. To meet the SNR, the complex digital modulation requires an ultra-linear in-phase quadrature (IQ) modulator. A doubly balanced diode mixer or a resistive ring mixer can be used in general, but they typically use more LO power. To reduce the LO power, a reflective-type IQ modulator of the traditional or modified variety can be used. While some 90° and 180° hybrids are needed to generate the quadrature signals and the amplitude and phase errors of the hybrids degrade the modulation quality, some sub-harmonic pumping IQ modulators have been suggested to further lower the LO frequency. Furthermore, since it controls the SNR of the signal transmission, a low-phase-noise, low-jitter quadrature LO is essential for the high-speed digital transceiver, especially for the high-level modifications.

2.3 SERIAL TO PARALLEL

A serial-to-parallel device accepts a series of timed pulses and latches them onto a parallel array of output pins. It includes a serial data input interface that receives the serially received data and provides a received data word.

2.4 INVERSE FAST FOURIER TRANSFORM

The IFFT works by converting complex numbers that represent modulated subcarriers in the frequency domain into time-domain output data (analog OFDM symbol waveform). As a result, the IFFT block offers a quick method for modulating data onto N orthogonal subcarriers. The sum of all N sinusoids is what the IFFT output represents. One OFDM symbol is composed of the block of N output samples from the IFFT.

2.5 CYCLIC PREFIX

To prevent inter-symbol interference, Cyclic Prefix serves as a buffer region or guard interval between each OFDM symbol. The cyclic prefix isolates different OFDM blocks from one another when the wireless channel has numerous pathways or is frequency-selective. The linear convolution of the channel is changed into a circular convolution by the cyclic prefix. It can only use a circular convolution and the single-tap equalisation for which OFDM is renowned.

2.6 RECEIVER

This useful book serves as an obtainable emergence to the orthogonal frequency-division multiplexing (OFDM) receiver design, a system that enables the transmission of digital data over a network of carriers.

2.7 ML- MMSE EQUALIZERS

Due to the characteristics of MIMO systems, significant increases in data throughput and link range can be achieved without the need for additional bandwidth or transmit power. Multipath fading is the main cause of communication problems in wireless channels. The space-time pre-coding block again maps the overlapping code words to data symbols, which are then applied as input to the symbol mapper, space-time encoder, and antenna array, where they are detected by passing through the channel. The de-correlation between the channel components will increase with transmitter spacing when all antenna elements at the transmitter as well as the receiver are collocated, which is an extreme case. The MIMO channel can be modelled as the result of the addition of a fixed component and a fading component when there is a LOS component present between the transmitter and the receiver.

The MMSE detector is the best identification because it aims to strike a balance between reducing noise enhancement and cancelling out interference. Maximum likelihood detection determines which transferred signal vector with the given channel H has the smallest Euclidean distance between its received signal vector and the product of all possible transmitted signal vectors. The ML- MMSE equalisation is used to alter the sound of an instrument or to emphasize certain equipment and sounds. An equaliser can be used by a recording engineer to increase some high-pitches in a vocal part while decreasing low-pitches in a drum part.

2.8 DE-MODULATOR

By using an FFT operation to create N parallel data streams, the Orthogonal Frequency Division Modulation (OFDM) Demodulator System object demodulates an OFDM input signal. A parallel-to-serial conversion comes after a bank of N correlates, one of which is assigned to each OFDM subcarrier. A system that separates the modulating signal from the carrier and recovers the modulation (data, speech, video, etc.) (or carriers). It is the component in modems that accepts analogue signals as input and outputs digital data. See also modem and modulation. To extract the in formativeness from the modulated carrier wave, a demodulator is an electronic circuit (or computer programme in a software-defined radio).

3. RESULT AND DISCUSSION

The simulation results are examined using a software MATLAB/SIMULINK. The MATLAB is a high performance language for technical computing integrates computation, visualization and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. The simulation analysis was completed by using the same scenarios of the experimental set-up just to improve the concept verification.

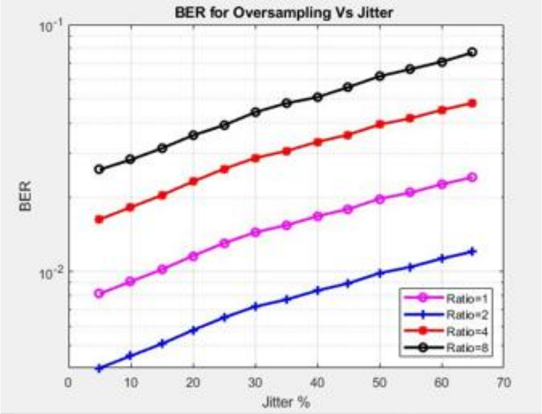

FIGURE 3.1 BER for Oversampling Vs Jitter

Figure 3.1 displays the result of the bit error rate compared for oversampling and jitter.

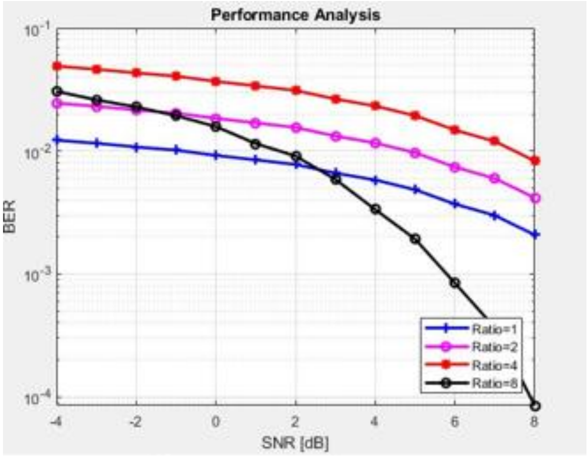

FIGURE 3.2 Performance Analysis

Figure 3.2 shows the performance analysis for the bit error rate (BER) and signal-to-noise ratio (SNR). The BER data demonstrate that, for each SNR level, BER performs better than the cutting-edge solutions illustrated by Figure 3.2.

4. CONCLUSION

The input signal was subjected to two mediating. High-frequency signals are modulated at low frequencies using an electrical circuit called a modulator. The modulated signals from each user were then transformed into time domain by the transmitter using IFFT. The identical code cyclic shifted prefix (ICCSP) process that follows uses an IFFT signal. The channel signal is obtained using the ICCSP signals through the parallel to serial conversion process. After that, the channel signal is received by the ICCSP and IFFT processes. Demultiplexing and equalisation are permitted for the current signal. The output signal is attained in the end.

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