Performance comparison Analysis between Multi-FFT OFDM for Power Line Carrier Communication

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ABSTRACT:- With the development of the smart grid, power line communications (PLC) is becoming more and more important. Compared with traditional modulation, Orthogonal Frequency Division Multiplexing (OFDM) has the advantages of the full use of spectrum, inherent robustness against narrowband interference, and excellent robustness in multi-path environments. This paper is devoted to compare FFT-based OFDM in Broadband-,PLC. (BB-PLC)

Therefore OFDM (16 QAM) has been utilized for the purpose of analysis of the channel performance while ensuring the speed and robustness of the channel to be the main criteria for any kind of services or applications .Moreover there usually arises a problem of power failure and reliable communication over remote locations and therefore the solution for it is an interfacing between wired and wireless communication technologies and hence in the thesis work, a comparison of the bit error probability had been shown between the performance of the channel while using multi FFT OFDM this comparison provides an solution to choose the technology according to the requirement of application.

Keywords-FFT; OFDM; smart grid; BB- PLC; NPLC; PLC standand.

INTRODUCTION:

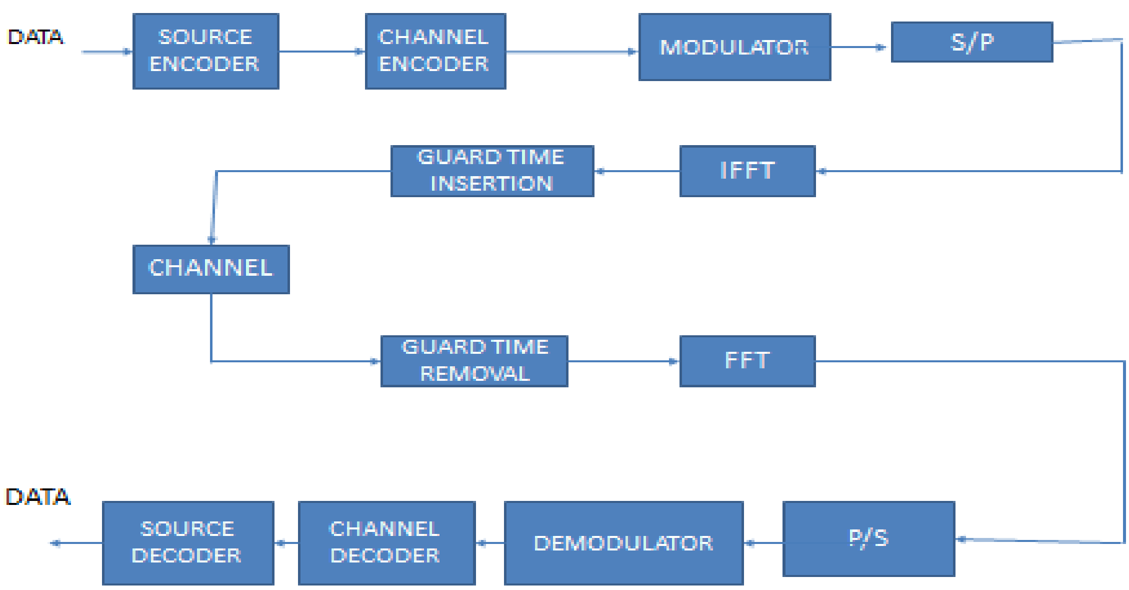
Traditional power line communications use single-carrier modulation such as Frequency Shift Keying (FSK), Spread Frequency Shift Keying (SFSK) and Binary Phase ShiftKeying (BPSK), which only reach low data rate. New transducers such as the synchrophasors or Phasor Measurement Units (PMUs) are being today deployed in the transmission side of the grid. The immediate consequence of PMU deployment is that a large amount of data is being generated and the networking provisions for delivering this amount of data at the required QoS are not in place yet [1]. New generation of PLC prefers multi-carrier modulations for its advantages. IEEE1901.1 standardize the broadband PLC for in-home PLC-based local area networks and internet access, while standardization of narrow band PLC for smart grid applications is in progress. There are two main kinds of multi-carrier modulation, namely FFT-based OFDM and wavelet-based OFDM. In this paper we focus on the FFT-based OFDM accounting for the general applications. Currently, there is no universal standard for NB-PLC, but two standards are widely used and can be the reference of the new NB-PLC standards: PLC G3[3], which has been launched by ERDF and Maxim, and PRIME[4], initialized by the PRIME Alliance (Iberdrola, Texas Instruments et. al.). Since IEEE1901.1 is mature enough, we take it as the deputy of BB-PLC. PLC G3 is frequency-band compliant with CENELEC, FCC, and ARIB while PRIME is only compliant with CENELEC.

Power line communication has been emanated as one of the most enduring means of communication for smart grid applications especially while considering the biggest advantage i.e. an already established infrastructure, therefore sending out the control information over the same network will add only a little cost and hence opens the door for a plethora of applications.

The communication over Power Line is not so new when we are concerned about generation, transmission or deliverance of power but here our main concern is control and management of power rather than transmission or deliverance of power and this purpose can only be accomplished if we are utilizing the available resources in an efficient manner which in turn is dependent on the fast and effective transmission of data or control information over these channels. To ensure the fulfilment of these requisites there is a requirement to analyse the basic topological connections and the circuit modelling and thus determined the various control and traffic problems associated with the transmission of this information which usually varies according to applications.

Orthogonal frequency Division Multiplexing(OFDM):

OFDM is the key wireless technology for high data rate transmission in which the available spectrum is divided into several sub-channel and each sub-channel is modulated by a low data rate. It operates large bandwidth up to 20 MHz and high data rate up to 100 Mbps. If the subcarrier signals accomplish the orthogonality condition then this result in overlapping of spectrum and hence spectral efficiency is improved. This technique is known as Orthogonal Frequency Division Multiplexing (OFDM). Data with bit rate R is transmitted into N parallel channels, each one of them with separate frequencies. Over each channel, the total bit rate is spread in equal parts at rate R/N. In each channel the data will be mapped to represent an information symbol and then multiplied by its corresponding frequency. These parallel information symbols are summed to form one OFDM symbol. Thus the duration of each OFDM symbol is Ts=N/R. Orthogonality provides the carriers a suitable cause to be narrowly spaced with overlapping without inter carrier interference.



OFDM block diagram

MULTI-FFT DEMODULATION AND COMBINER:

The goal of multiple-FFT demodulation and combining is to reduce the ICI in the outputs.

- Pre-processing based on optimal, multiple re sampling of the received signal.
- Multiple FFT demodulators are used to approximate the optimal receiver front-end for arbitrarily time-varying channels.

Multiple FFT demodulators includes a technique for predicting the Doppler shift from the combiner weights.

- The proposed receiver replaces the conventional, single FFT demodulator with a few (e.g. two) FFTs and combiner whose outputs are combined in a manner that minimizes post detection error.
- The receiver also incorporates spatial diversity combining, an adaptive channel estimator and a phase prediction method to track the channel response across OFDM blocks.

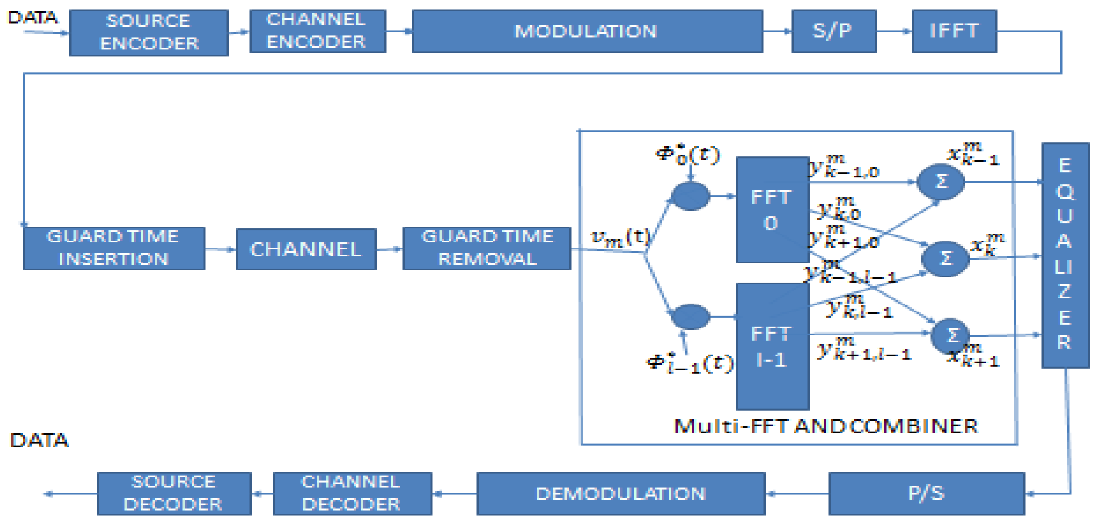


FIG.2.1 PROPOSED OFDM SYSTEM DESIGN

Power Line Communication:

Power Line Communication is defined as a technology that utilizes high, medium and low voltage electrical networks to provide various services like voice and data transmission in addition to providing the power to the electrical utilities required for their operation.

In the initial stages, the power line communication was meant for deliverance of power only but as the time had ripen up it had started gaining more importance in high frequency applications , also known as Broad-Band Power Line. Since then these electrical networks had been used by the electricity producers and distributors for the purpose of remote controlling and network monitoring as well.

It operate with electric power distribution system and provides a highly reliable means of communication among PLC devices which are electrically coupled to each other or located in proximity to the premises of power distribution system . A system for PLC comprises repeaters, bypass devices, backhaul devices, wireless backhaul devices, communication interfacing units etc.

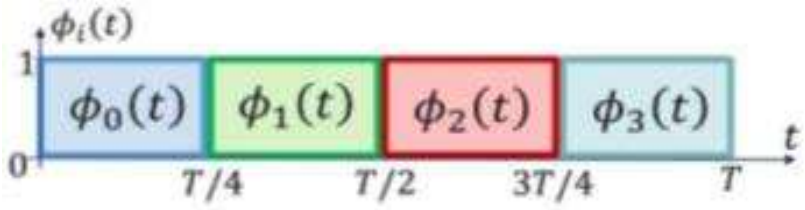
PROPOSED METHODOLOGY:

The multiple-FFT demodulation techniques draw on the notion that the channel variations may be decomposed based on a set of predefined functions. Given such a decomposition, the received signal is projected onto these functions, and the projections are passed on to FFT demodulation and subsequent combining.

The four ICI mitigation methods : Partial FFT demodulation (P-FFT) Shaped FFT demodulation (S- FFT) Fractional FFT demodulation (F-FFT) Taylor FFT demodulation (T-FFT

PARTIAL FAST FOURIER TRANSFORM (P-FFT):

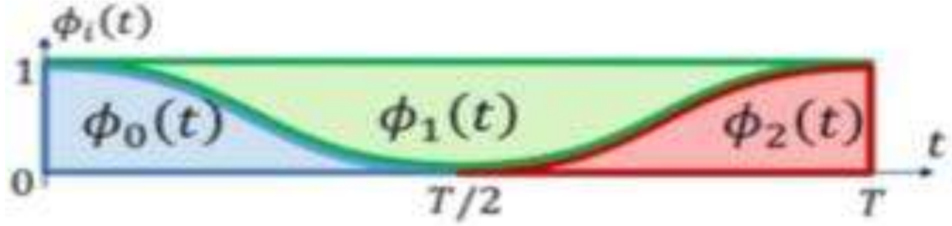
P-FFT divides the received OFDM block into I sections which are I times shorter than the original OFDM block. If the sections are sufficiently short, the channel variations are expected to be negligible during each section. The combiner reassembles the sections after giving each section a different weight. P-FFT thus resembles channel- matched filtering where the function is approximated as piecewise constant. P-FFT uses decomposition onto a set of non-overlapping flat windows in time.



Non overlapping rectangular wave- forms, eachcovering an interval of length (P-FFT)

SHAPED FAST FOURIER TRANSFORM (S-FFT) :

The precision of the approximation can be improved by smoothing the transitions between the sections. To this end, we introduce S-FFT which provides a smooth decomposition of the channel, preserving the continuity of the approximations to S-FFT uses smooth windowing.



Raised-cosine waveforms (S-FFT)

FRACTIONAL FFT DEMODULATION (F-FFT):

The FFFT is a generalization of the ordinary Fourier transform with an order parameter α and is identical to the ordinary Fourier transform when this order α is equal to /2. The FFFT belongs to the class of time–frequency representations that have been extensively used by the signal processing community. In all the time–frequency representations, one normally uses a plane with two orthogonal axes corresponding to time and frequency.

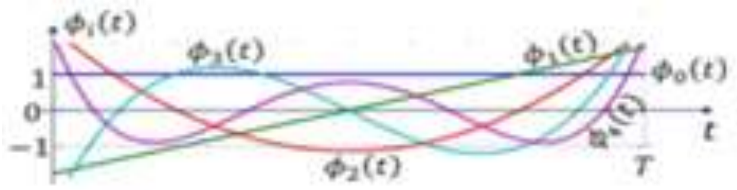
F-FFT is based on a decomposition onto complex exponentials.

complex exponentials at multiples of a fraction of the carrier spacing (F-FFT)

TAYLOR FFT DEMODULATION (T-FFT):

T-FFT is based on polynomial expansion of the time- varying channel coefficients. The idea of estimating the channel coefficients in time and/or frequency domain by polynomials and used for equalization where a 2-D polynomial expansion (in time and frequency) is employed to increase the accuracy of channel estimation and ICI equalization.

T-FFT uses Taylor series polynomials

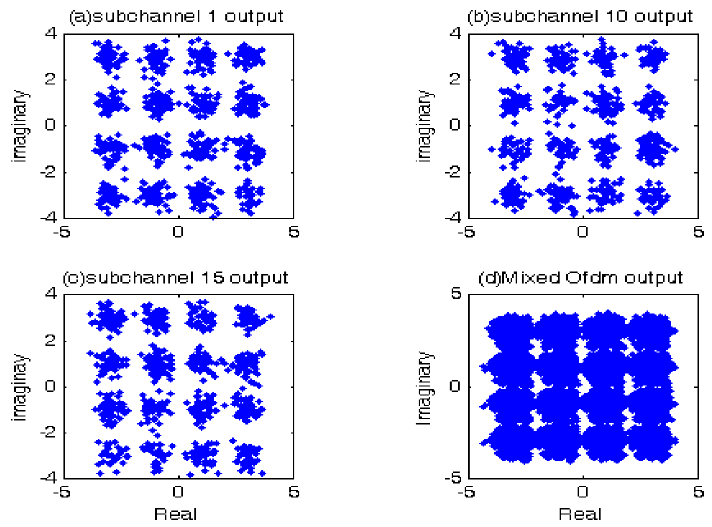


Orthogonal polynomials of degrees 0 to (T-FFT).

Evolution of combiner weights corresponding to one receiving element as detection proceeds over carriers and OFDM blocks during one frame with carriers for the first receiver element by using 16 QAM modulation techniques.

RESULT AND SIMULATIONS:

The Performance Evaluation of Power Line Channel has been accomplished using OFDM (16-QAM) and the OFDM is being used considering the requirement of higher data rate and robustness.



Sub-channel constellation scattering and the mixed OFDM-QAM output

COMPARATIVE ANALYSIS:

The MSE is improved by using 16 QAM modulation techniques as compared to QPSK.

Multi-FFT Techniques	MSE (16 QAM) (Proposed Work)	MSE(QPSK) (Base Paper Work)
P-FFT	-18.18	-9.8
S-FFT	-17.90	-10
F-FFT	-17.67	-10.5
T-FFT	-16.12	-9
Conventional detector with 3 equalizer taps	-17.95	-4.57
Conventional detector with 5 equalizer taps	-17.93	-7.18

The BER (Probability of error) is reduced by using 16 QAM modulation techniques as compared to QPSK.

Multi-FFT Techniques	BER (16 QAM) (Proposed Work)	BER(QPSK) (Base Paper Work)
P-FFT	0.0015	0.0045
S-FFT	0.0015	0.0022
F-FFT	0.0015	0.0035
T-FFT	0.0015	0.0042
Conventional detector with 3 equalizer taps	0.0015	0.0516
Conventional detector with 5 equalizer taps	0.0015	0.0143

CONCLUSION:

The Performance Evaluation of Power Line Channel has been accomplished using OFDM (16-QAM) and the OFDM is being used considering the requirement of higher data rate and robustness. The obtained results had been shown and the results indicate that there is a trade-off between the probability of error and the complexity and the major advantage of using OFDM is the requirement of a simple equalization technique which is an inverse model of the channel model .It is concluded that the multi-fft detection techniques has been applied to find out the MSE and BER performance of system using 16 QAM modulation scheme. The MSE and BER value has significantly improved by multi-FFT detection using 16 QAM as compared to QPSK. iterative ICI cancellation and equalization for OFDM.

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