International Journal of Electronics Communication and Computer Engineering
Volume 3, Issue 2, ISSN 2249 –071X

An Approach for increasing SNR with varying data rate in OFDM transmission system

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***Abstract*— OFDM is a multi carrier modulation technique in which the carriers are Orthogonal to each others as a result of which it provides high bandwidth efficiency and multiple carriers share the data among themselves. This paper describes an approach for reduction in BER with increment in SNR and varying the data rates of OFDM transmission system. We present a scheme of basic OFDM transceiver with 32-point QAM and 128 point FFT which reduce the BER when SNR increases in the system. The design unit consist of transmitter and receiver characteristics using 32 QAM and whole system is implemented over MATLAB 7.8.0.**

***Keywords*— 32-QAM, 128-IFFT/FFT, BER, Viterbi detector**

I. INTRODUCTION

Orthogonal frequency-division multiplexing (OFDM) is a method of encoding digital data on multiple carrier frequencies. High spectral efficiency (SE) [1] optical modulation formats are attracting active research in an effort to increase system capacity to meet the ever-increasing network traffic demand. High SE formats generally use multi-level modulation that is usually susceptible to inter-symbol interference (ISI). Coded orthogonal frequency-division multiplexing (COFDM) [2] is a promising technique to support high-level modulation formats as it is capable of minimizing the ISI through the reduction of subcarrier modulation speed and the insertion of guard interval between adjacent symbols. The primary advantage of OFDM over single-carrier schemes is its ability to cope with severe channel conditions (for example, attenuation of high frequencies in a long copper wire, narrowband interference and frequency-selective fading due to multipath) without complex equalization filters. Channel equalization is simplified because OFDM may be viewed as using many slowly modulated narrowband signals rather than one rapidly modulated wideband signal. The low symbol rate makes the use of a guard interval between symbols affordable, making it possible to eliminate Inter-symbol interference (ISI) and utilize echoes and time-spreading (that shows up as ghosting on analogue TV) to achieve a diversity gain, i.e. a signal-to-noise ratio improvement. This mechanism also facilitates the design of single frequency networks (SFNs), where several adjacent transmitters send the same signal simultaneously at the same frequency, as the signals from multiple distant transmitters may be combined.

In this paper our main attention is to reduce the BER while increasing the SNR for this work we increase the data rate to 32 point with 128- points IFFT and measured the BER. In section II processing blocks of OFDM transceiver are described with Trellis encoding, Viterbi decoder, QAM and FFT/IFFT. Implemented algorithm is designed in section III. Corresponding results of OFDM processing blocks and conclusion is presented in section IV and V.

II. PROCESSING BLOCK OF OFDM TRANSCEIVER

The OFDM transceiver includes the following block for the transmission of message signal:

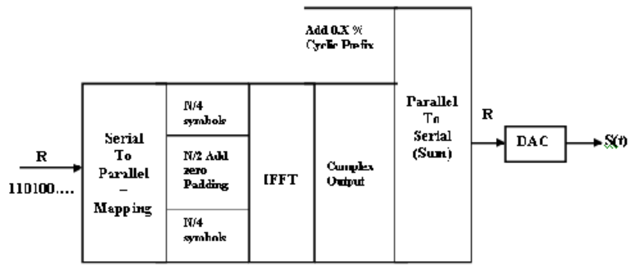

Fig.1 The OFDM transmitter system

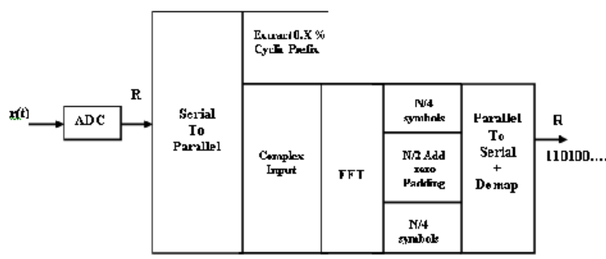

Fig.2 The OFDM receiver system

The main objective is to design an OFDM Transmitter and Receiver system with less BER. For this purpose the modulation technique and FFT/IFFT [3] are the main building blocks of OFDM. In our approach 32-QAM [4] and 128 point

IFFT/FFT are used. But before describing those we are explaining some basic blocks of OFDM.

A. Trellis Encoding

A convolutional encoder [6] is a finite state machine. An encoder with n binary cells will have 2n states. An actual encoded sequence can be represented as a path on this graph. One valid path is shown in red as an example. This diagram gives us an idea about decoding: if a received sequence doesn't fit this graph, then it was received with errors, and we must choose the nearest correct (fitting the graph) sequence.

B. Viterbi Detector

A Viterbi decoder uses the Viterbi algorithm for decoding a bitstream that has been encoded using forward error correction based on a convolutional code.There are other algorithms for decoding a convolutionally encoded stream (for example, the Fano algorithm). The Viterbi algorithm [5] is the most resource-consuming, but it does the maximum likelihood decoding. It is most often used for decoding convolutional codes with constraint lengths k<=10, but values up to k=15 are used in practice.

C. Quadrature Amplitude Modulation

QAM is a signal in which two carriers shifted in phase by 90 degrees are modulated and the resultant output consists of both amplitude and phase variations. The number of points on the constellation is indicated in the modulation format description, e.g. 32QAM uses a 32 point constellation.

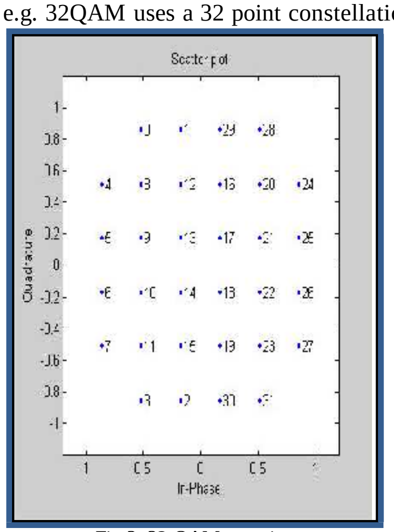

Fig 3. 32-QAM mapping

More points on the constellation, it is possible to transmit more bits per symbol. However the points are closer together and they are therefore more susceptible to noise and data errors.

In this case there are six *I* values and six *Q* values resulting in a total of 36 possible states (6x6=36). This is too many states for a power of two (the closest power of two is 32).

So the four corner symbol states, which take the most power to transmit, are omitted. This reduces the amount of peak power, the transmitter has to generate. Since $2^5 = 32$, there are five bits per symbol and the symbol rate is one fifth of the bit rate.

D. FFT/IFFT Blocks

The OFDM signal is generated by implementing the Inverse Fast Fourier Transform (IFFT) at the transmitter and Fast Fourier Transform (FFT) at the receiver side. Waveforms which are analog in nature must be sampled at discrete points before the FFT/IFFT algorithm can be applied.

The DFT operates on sample time domain signal which is periodic. The equation for DFT is —

$$X(k) = \sum_{n=0}^{N-1} x(n)\, W_N^{nk} \quad \text{for } K=0,1,\ldots\ldots N-1 \qquad (1)$$

On the other hand, the inverse DFT for data sequence {X(k)} with k = 0,1,2…..N-1 defined in equation (2).

$$x(n) = 1/N \sum_{k=0}^{N-1} X(k)\, W_N^{-nk} \quad \text{for } n=0,1,\ldots\ldots N-1 \qquad (2)$$

The computation of each point of DFT requires the (N-1) complex multiplication, (N-1) complex addition. Thus to compute N points in DFT require N(N-1) complex multiplication and N(N-1) complex addition.

E. 128-Points Butterfly Diagram

Higher radix FFT algorithm has less number of the nontrivial complex multiplications, compared with the radix-2 FFT algorithm which is the simplest form in all FFT algorithms [3]. In an example for 128-point FFT and 64-point FFT, the number of nontrivial complex multiplications of radix-8 FFT algorithm is 152 and 48, which is only 58.9%and 48.9% of that of radix-2 FFT algorithm.

Thus, in order to save power dissipation of the complex multiplier operation we use 128 IFFT/FFT point.

III. Implemented Algorithm

A. At Transmitter end

- Generate the Data "D".
- While D!=Null

{

- Encode the generated data.
- Insert the interleaving Bits into Data.
- 32- QAM Mapping of data.

International Journal of Electronics Communication and Computer Engineering
Volume 3, Issue 2, ISSN 2249 –071X

- Insert the Pilot Carrier
- Conversion into 128 IFFT Domain
- Append Cyclic Prefix.

}

Transmit the generated data through AWGN channel

B. At Receiver end

- Receive the Data Bits “T”.
- While T!=Null

{

- Remove Cyclic Prefix
- Conversion into 128 FFT Domain
- Synchronize the Pilot Carrier.
- 32 QAM De-Modulation of received data.
- De-interleaving Bits from Data.
- Decode the generated data.

}

Calculate the Bit Error Rate for the received Data.

IV. Result

The complete model for this OFDM transceiver with 32-QAM and 128 IFFT/FFT point is designed in the communication tool box in MATLAB 7.8.0

- We randomly generate the data using “randint” function provided in MATLAB for the random generation of data.
- Encoding of data is carried out by “Trellis Encoding”.
- Insert the Interleaving Bits by using “matintrlv” function.
- QAM modulation is done of 32 QAM.
- After the cyclic prefix inserted data, we designed a channel for transmission, channel is prepared using “awgn” function.
- At the receiver side for the decoding purpose “Viterbi Detector “ is used.
- Bit Error Rate is calculated using the formula:
- BER = Error Bits / Length of Data

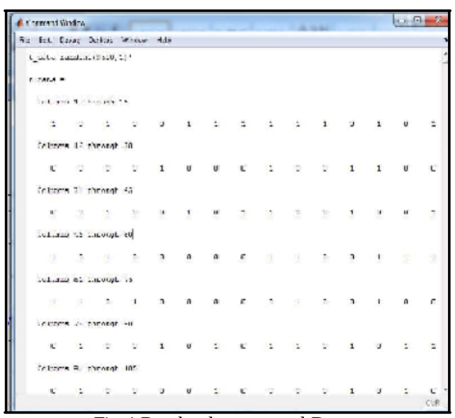

Fig 4 Randomly generated Data

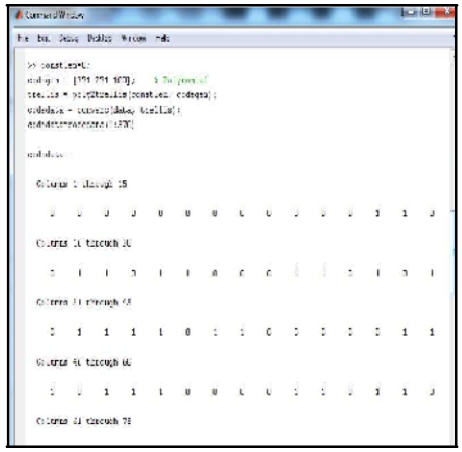

Fig 5 Encoding using Trellis Structure

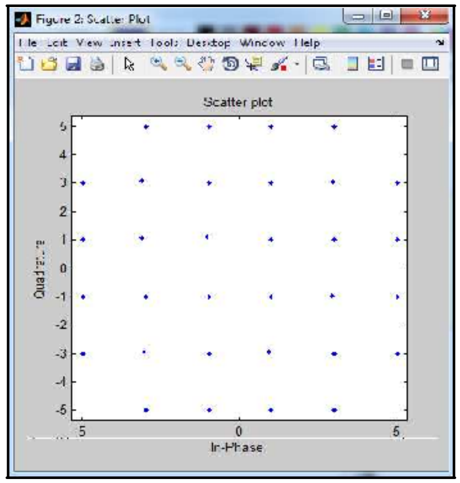

Fig 6 32-QAM mapping

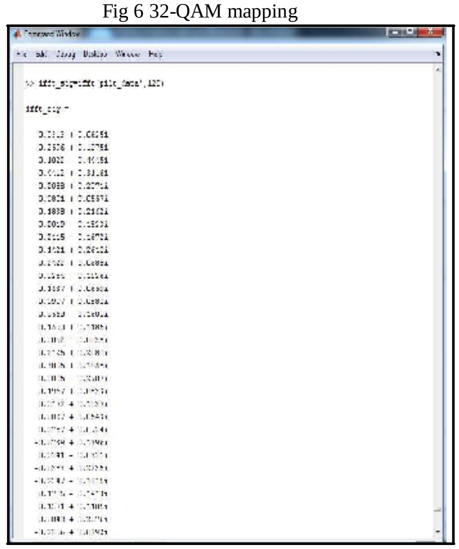

Fig 7 IFFT block Output

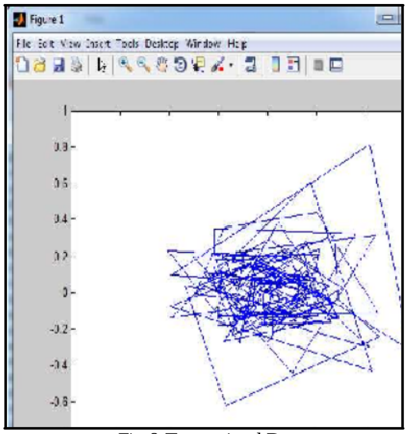

Fig 8 Transmitted Data

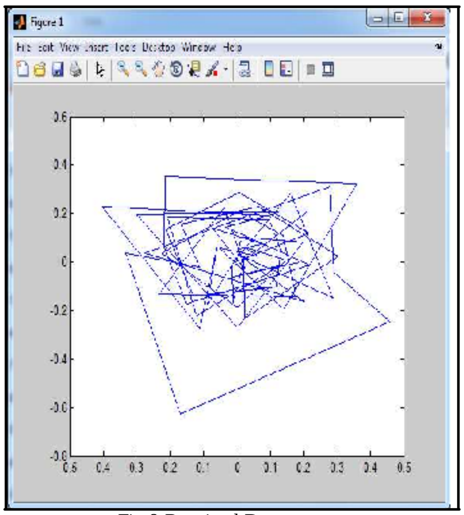

Fig 9 Received Data

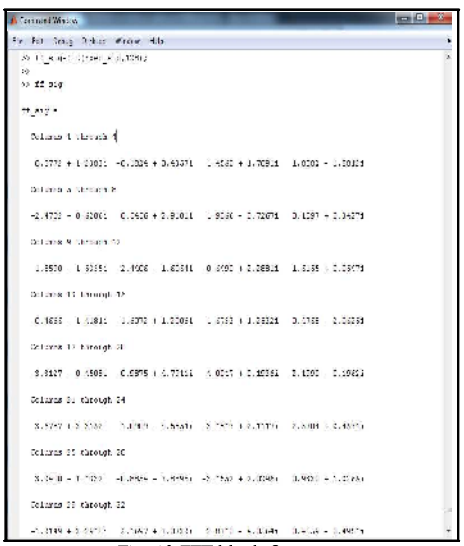

Fig. 10 FFT block Output

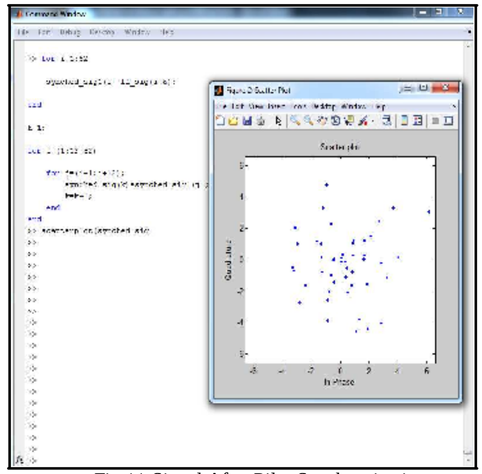

Fig 11 Signal After Pilot Synchronization

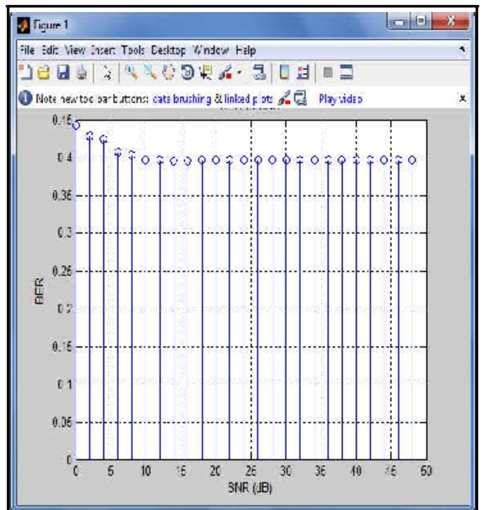

Fig 12 Stem Plot between BER and SNR

CONCLUSION

This paper has proposed a scheme for BER reduction and improvement in SNR using 32 QAM and 128 point IFFT/FFT. The result founded were better when compared with the previous scheme available.

Taking the different values of SNR in db we get variable values of bit error rate as in o db SNR the BER is 0.4473 and as we move towards 10, 20, 30 db of SNR BER decreases up to 0.4018. This shows that when we increase Signal to Noise Ratio, the Bit Error Rate decreases.

REFERENCES

1) Xiang Liu, S. Chandrasekhar, X. Chen, P. J. Winzer, Y. Pan, B. Zhu, T. F. Taunay, M. Fishteyn, M. F. Yan, J. M. Fini, E.M. Monberg, and F.V.Dimarcello, "1.12-Tb/s 32-QAM-OFDM Superchannel with 8.6-b/s/Hz Intrachannel Spectral Efficiency and Space-Division Multiplexing with 60-b/s/Hz Aggregate Spectral Efficiency" in ECOC Postdeadline Papers © 2011 OSA.

2) Xiang Liu, Qi Yang, S. Chandrasekhar, and William Shieh, "Transmission of 44-Gb/s Coherent Optical OFDM Signal with Trellis-Coded 32 QAM Subcarrier Modulation" in OSA / OFC/NFOEC 2010.

3) Yu-Wei Lin and Chen-Yi Lee, "Design of an FFT/IFFT Processor for MIMO OFDM Systems" in IEEE transaction on circuits and systems – I: regular papers, vol. 54, no. 4, april 2007.

4) Runfeng Yang and R. Simon Sherratt, "Enhancing MB-OFDM Throughput with Dual Circular 32-QAM" in IEEE Transactions on Consumer Electronics, Vol. 54, No. 4, November 2008.

5) Andrei Vityaev and Paul H. Siegel, Fellow," On Viterbi Detector Path Metric Differences" in IEEE Transactions on Communication , Vol. 46, No. 12, December 2002.

6) Yi Hong and Zhao Yang Dong, "Performance Analysis of Space-Time Trellis Coded OFDM System" in World Academy of Science, Engineering and Technology 13 2006.