Development of Lesser Complexity Transmitter and Receiver for Generalized Frequency Division Multiplexing Systems

M. Venkata Sudhakar, U. Sirisha, K. Sudheer Kumar, K. Ramya

Abstract: The modulation scheme with Orthogonal frequency division multiplexing (OFDM) employs single cyclic prefix (CP) for each symbols whereas Generalized frequency division multiplexing (GFDM) utilizes single CP per symbol group; due to this reason OFDM is not bandwidth efficient. In this paper, the implementation of transmitter and receiver with minimum complexity for GFDM application is proposed. By incorporating Fourier transformation and inverse transformation techniques along with circular convolution in transceiver, the computation complexity is minimized. The effective band width of GFDM is improved by using cyclic prefix (CP) for each symbol. The simple receiver with matched filtration (MF), zero-force (ZF), and minimal mean-square-error (MMSE) scheme is proposed for demodulation. The results of the adopted scheme are compared with OFDM scheme.

Index Terms: GFDM, transmitter and receiver

I. INTRODUCTION

OFDM is one of the latest and mostly adopted schemes in wireless based systems [1-3]. With the advent of the 5G wireless systems, this was invented for the wide range of high bandwidth applications; which lead to the new signaling techniques in the present days. The drawback of OFDM is emission of signal in out of band regions. GFDM has a lot of special properties than OFDM; this leads to the implementation of high computational capacity GFDM for real time applications. The bandwidth of GFDM scheme is more efficient compare to that of OFDM scheme.

II. METHODOLOGY

The proposed system consists of GFDM Transmitter and, GFDM Receiver. Proposed low complexity GFDM transmitter and its implementation details is presented in Fig.1. The multiplication of vector 'd' and matrix 'B' leads to the complicated computations $(MN)^2$. Hence, complexity becomes an issue for real-time system design either by increase of number of subcarriers or increases by parameters 'M'.

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Therefore, alternative scheme are required to enhance the performance of the system; this enable us to introduce the new method of Multiplexing (GFDM) [4,5].

Where y is the output of the transmitter, B is the modulation matrix, d is the data vector, F_b is the $MN \times MN$ normalized block DFT matrix.

Proposed GFDM receiver and its implementation details is presented in Fig.2. The MF receiver direct development [6] entails a multiplication of vector and matrix; that has the calculation cost of $(MN)^2$ complicated multiplications. Therefore, the equation of d_{MF} is given as [4]

(2)

Where Γ is a sparse matrix , and d_{MF} is output of the matched filter.

(3)

Hence MF estimates of d is obtained as [4]

(4)

The multiplication of matrix A^H to the vector y is the principal calculation load in ZF reception [6] which has computational cost of $(MN)^2$. The Zero Forcing (ZF) approximation of the received symbols from transmitter is generated by [4]

The equation of d_{MMSE} receiver [6] is given as [4] (5)

(6)

In this the circular convolution needs to be calculated in the frequency domain, known as fast convolution, in order to have the lowest complexity. MMSE estimates of the transmitted symbols is obtained as [4]

(7)

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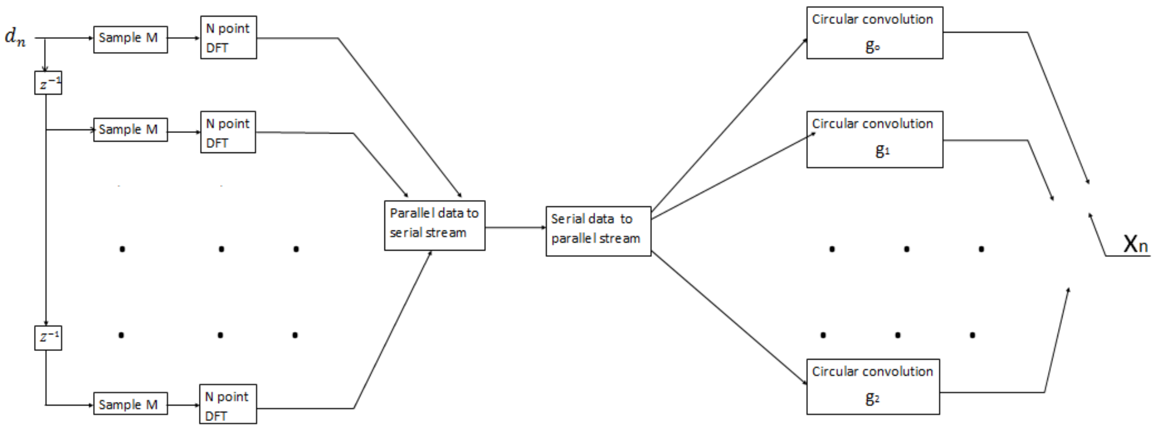

Fig. 1. Implementation of GFDM transmitter

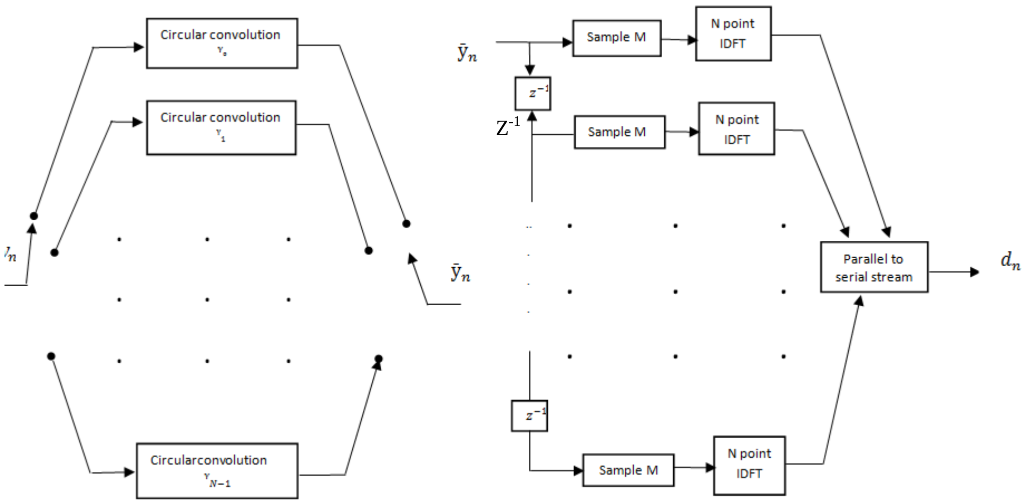

Fig. 2. Implementation of GFDM Receiver

III. RESULTS

MATLAB software is a higher-performance language for computations of complex models. Computations are carried out by using the MATLAB for GFDM modeling. The relation between block length and number of complex multiplications is shown in fig.3 for OFDM and GFDM. Complexity comparison of various GFDM transmitter schemes and the OFDM transmitter scheme for N = 2048 with for various values of overlapping factor M of 5 are plotted.

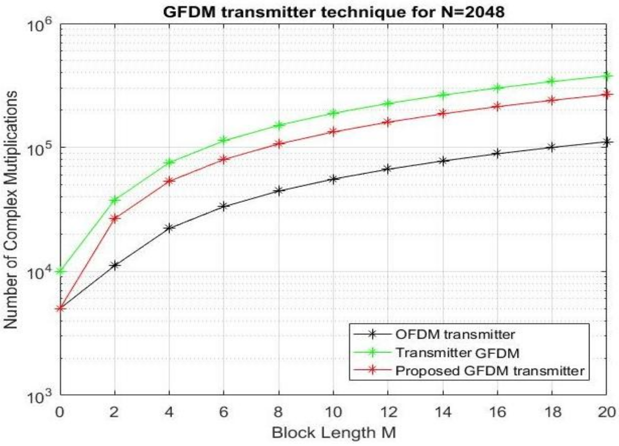

Fig. 3. GFDM transmission characteristics

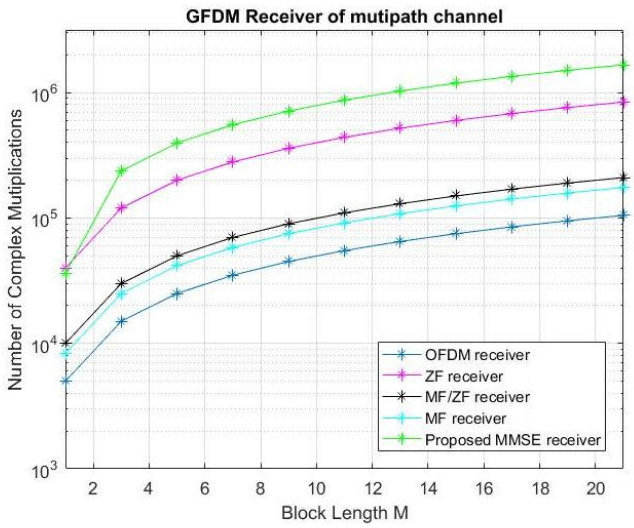

Fig. 4. GFDM reception characteristics

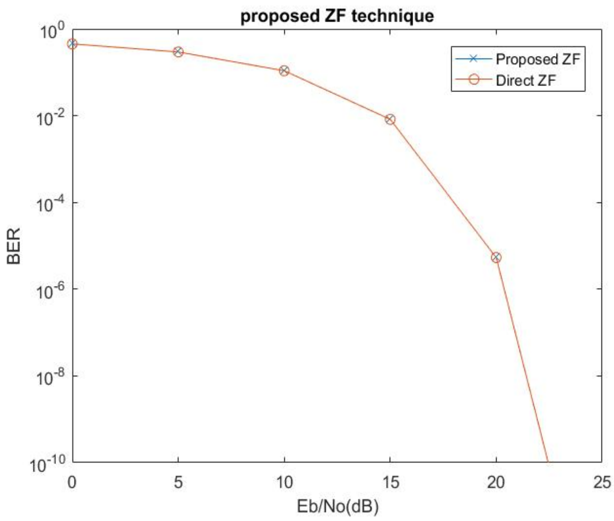

Fig. 5. ZF receiver characteristics

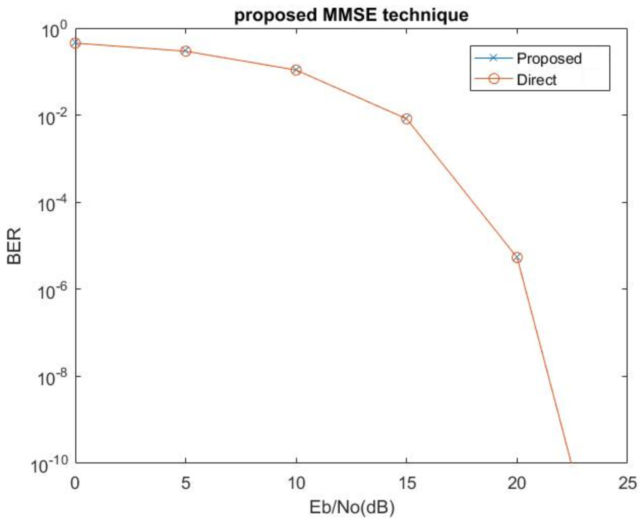

Fig. 6. MMSE receiver characteristics

In Fig.4, the comparison of various GFDM reception schemes with respect to OFDM reception when N = 2048 and I = 8 are plotted. In Fig.5, we can observe the graph between the BER to energy noise ratio in ZF.. In our proposed ZF receiver bit error rate is same as earlier scheme with minimum computational complexity. In Fig.6, we can observe the graph between the BER to energy noise ratio in MMSE. In our proposed MMSE technique this ratio is very less same as the ZF.

IV. CONCLUSION

The proposed GFDM offers less complexity with minimum computational complexity in comparison with OFDM scheme. The matrices of DFT as well as IDFT are used in transmitter and receiver to lower the system complexness. We have also proposed less complexity receivers with MF, ZF and MMSE schemes. The proposed systems are compared OFDM scheme in terms of computational complexity. It is observed that the scheme adopted gives minimum BER along with least computations. The special future of this method is less computational complexity for next generation wireless communication systems.

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