Optimizing 5G Communication Through Hew Radix FFT-Powered P-OFDM for Reduced BER

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Abstract — Orthogonal Frequency Division Multiplexing (OFDM) is a hopeful technique for attaining high data rates in mobile environment because of its multicarrier modulation. As the sub carriers are orthogonal in OFDM, the spectrum of each carrier has a null at the center frequency of each of the other carriers in the system. But in time varying channel the orthogonally between subcarriers are distorted due to Doppler Spread (DS) which introduces the Inter Carrier Interference (ICI) that diminishes the system performance. To enhance the OFDM system performance over time varying channels, an ICI self-cancellation scheme with hew radix FFT at receiver is implemented. The OFDM pruning at the receiver side using hew FFT is suggest for ICI reduction techniques in the thesis work. The work is implemented using MATLAB. Simulation and the outcome is measure in terms of BER and Twiddle factor count.

Keywords: HRFFT: HEW RADIX Fast Fourier Transform, P-OFDM: Pruning Orthogonal Frequency Division Multiplexing, 5G: 5th Generation, BER- Bit Error Rate, PAPR- Peak Average to Power Ratio

I. INTRODUCTION

The ICI among sub-carriers is one of the major problems of the OFDMbased 5G communication. The main cause of ICI is the CFO, induced either due to Doppler shift arises by channel or due to the mismatching of transmitter and receiver oscillator. The ICI may also be caused by the phase noise and timing offset. However, the ICI induced by CFO, phase noise and due to timing offset can be compensated or corrected. Since the Doppler spread or shift is random, its impact can only be reduced or mitigate. Not only due to Doppler spread, the ICI induced due residual frequency offset, which is the result of estimation error, is also required to be mitigated separately. Therefore, a separate method besides of CFO estimation and correction at the receiver is required to reduce the ICI. Several techniques have been introduced in the past to reduce ICI. These include frequency domain equalization [3, 5], self-cancellation scheme [8 and 14], and hew FFT technique (pulse shaping at the transmitter and receiver windowing) [, 2, 5, 6, 8, 4, 9, 11, and 19]. The receiver hew FFT is one of the best ICI reduction techniques available in the literature [6]. This chapter deals with the study and analysis of receiver hew FFT techniques and proposed a new window for ICI reduction.

The real effect of a high ICI are-

1) Increased intricacy in ADC & DAC.
2) Reduced in productive working of RF intensifiers.
3) Information data lost or corrupted
4) Low quality audio and video communication.

Proposed Hew Radix Fast Fourier Transform: The power dissipation of FFT depends on the number of arithmetic computations. Hew Radix FFT (HRFFT) has the lowest number of arithmetic operations among all the FFT. SRFFT is an ideal solution for low power FFT design. In this work, we proposed the implementation of SRFFT for 4/8/16-point FFT on MATLAB. System generator tool is used for FFT design. HRFFT algorithm involves with least number of arithmetic computations among all the known FFT algorithms. HRFFT is a good candidate for the implementation of a low-power FFT processor.

The N-point discrete Fourier transform is defined by

$$X(k) = \sum_{n=0}^{N-1} x(n) W_N^{nk}$$

Where $W_N^{nk} = e^{-2\pi jnk/N}$ and k=0,1,2….N-1

$$X(2k) = \sum_{n=0}^{\frac{N}{2}-1} [x(n) + x(n + N/2)] W_{N/2}^{nk}$$

$$X(2k+1) = \sum_{n=0}^{\frac{N}{2}-1} [x(n) - x(n + N/2)] W_{N/2}^{nk} W_N^n$$

The basic idea behind the proposed HRFFT is the application of a radix-2 index map to the even-index terms and a radix-4 map to the Odd-index terms. For the even-index terms, it can be decomposed as

$$X(4k+3) = \sum_{n=0}^{\frac{N}{4}-1} [x(n) - x\left(n + \frac{N}{2}\right) + j\left(x\left(n + \frac{N}{4}\right) - x\left(n + \frac{3N}{4}\right)\right)] W_N^n W_{N/4}^{nk}$$

$$X(4k+3) = \sum_{n=0}^{\frac{N}{4}-1} [x(n) - x\left(n + \frac{N}{2}\right) + j\left(x\left(n + \frac{N}{4}\right) - x\left(n + \frac{3N}{4}\right)\right)] W_N^n W_{N/4}^{nk}$$

Where $k = 0, 1, \ldots, N/4$. The formulas above result in the L-shaped split-radix butterfly structure, which can be found in [2] and the scheduling of the L-shaped butterfly is irregular. Table 1 shows the comparison of arithmetic computations required in Radix-2 and Hew radix of 16-point FFT. Figs. 1and 2 show the signal flow graph of Radix-2 and Split Radix 16-point FFT.

Type	Additions/Subtractions	Multiplications
Radix-2	64	24
Hew Radix	46	21

Table 1: Comparison of arithmetic computations between Radix-2 and Hew radix FFT of 16-point

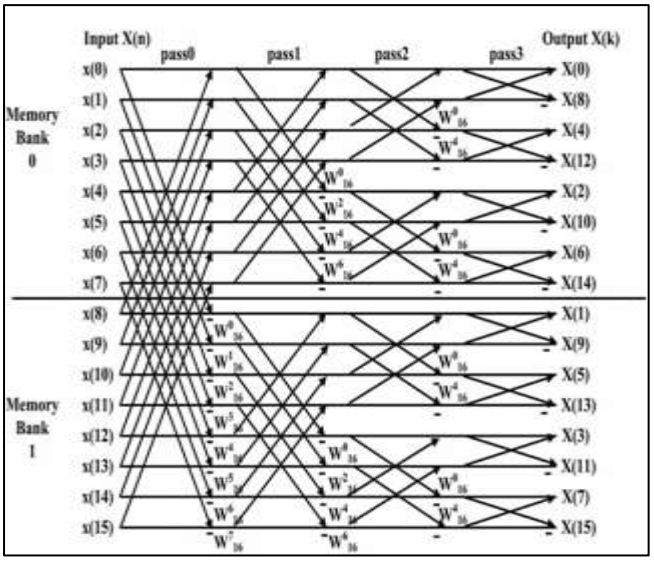

Fig. 2: Signal flow graph of radix-2 FFT

We present a Hew radix FFT algorithm consisting of radix-4 butterflies. The major advantages of the proposed algorithm include mixed radix butterflies, whose structure is more regular than the conventional Hew radix algorithm. The Hew radix FFT is obtained by dissolving the radix of 4 point into 2 and 4 divisional part subsequently so these divisions help in reducing the power and many other r elated computations.

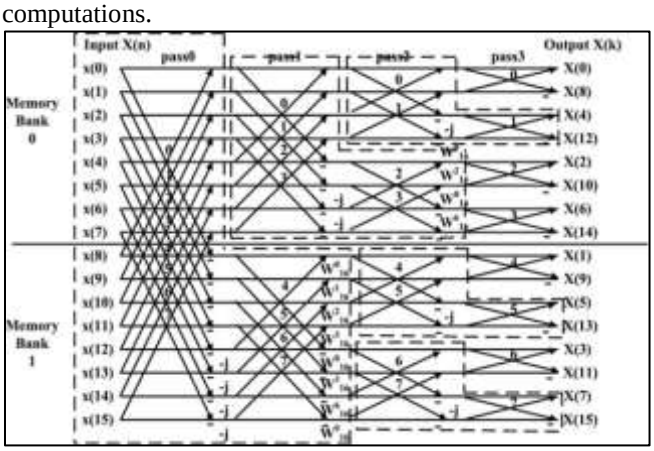

Fig. 3: Signal flow graph of HRFFT

The above diagrams represent the difference in the structural representation of the both FFT and Hew radix FFT.

II. LITERATURE SURVEY

Author	Work	Journal	Outcome
De-Zhuang Qin [1]	Advanced an innovative pruning algorithm based on Radix-2/4 and SRFFT, which can ignore random zero inputs/outputs with the help of pruning matrix intelligently.	IEEE 2018	They observe PSNR 70.625 and 9.2184e-06
Jinia Rahman et al [2]	Compatible Windowing andOverlapping Scheme Implemented on Hybrid Preceded mmWave Massive MIMO NC- OFDM System. Hybrid Precoded and 3D beamforming scheme implemented simulated system.	AJECE-2018	0.2524e-05 BER observed
G. Harish Kumar et al [3]	have implemented a novel and efficient input zero traced FFT pruning (IZTFFTP) algorithm based on DIF radix-2 technique.	IJSEAS-2015	BER observed is 0.8267e-05

Table 1: Literature summary

De-Zhuang Qinet al [1] has more ICI will prompt non-linearity segment in Encoder and SRFFT, which may corrupt execution & brings Inter Symbol Interference (lSI) in OFDM frameworks. Jinia Rahman et al [2] they attempted to consolidate few basic & fundamental plans such as Compatible Windowing and Overlapping Scheme, In this procedure parts of unique OFDM flag are cut (i.e after IFFT) which are few degree bits at larger amount than a limit level. Be that as it may, at section time flags in band bending problem & out band development problem particularly known as neighboring divert impedance get represented in an arrangement of correspondence bringing about corruption of BER execution. Thusly it is fitting for few degrees to reduce problem of ICI before shaping few OFDM images & furthermore earlier transmission of P-OFDM images into nonlinear HPA & D/A converters. G. Harish Kumar [3] A novel input zero traced FFT pruning (IZTFFTP) plan in view of subcarrier gathering approach is proposed for ICI reducing in OFDM frameworks. Be that as it may, IZTFFTP is a mind boggling calculation & its equipment will devour lot power & general framework throughput will lessens.

III. METHODOLOGY

From literature review, it was reviewed that scheme for reducing ICI belonging to frequency domain achieves good results than domain of time parameters because of its ability to achieve less ICI with minimized distorted values in I/P signals & thereby not producing any distortion. By dealing techniques infreq. Domain FFT was choose to be best frequency domain methods just by reducingICI when done comparison with other techniques .Hybrid technique uses interleave at input end &also using de-interleave at receiver.

A. Proposed Hew RADIX FFT (HRFFT) For Pruning OFDM:

The information in space of recurrence succession image (X) is parceled into few disjoint sub-blocks (V) which needs increase by arrangement of groupings of stage (WV) correspondingly taking HRIFFT of partitioned pieces (changing over in area of time incomplete transmit arrangement). sub - pieces are ideally consolidated by autonomously duplicating with stage calculates just to get OFDM images in area of time with least ICI. Figure given demonstrates HRFFT graph showing each square. Here, information which is inputted as images square gets isolated

into various non-joint sub-pieces which are spoken to by vectors. Mathematically information which is input X has been given as XV as takes after-

$$x = \sum_{v=0}^{V-1} X_v$$

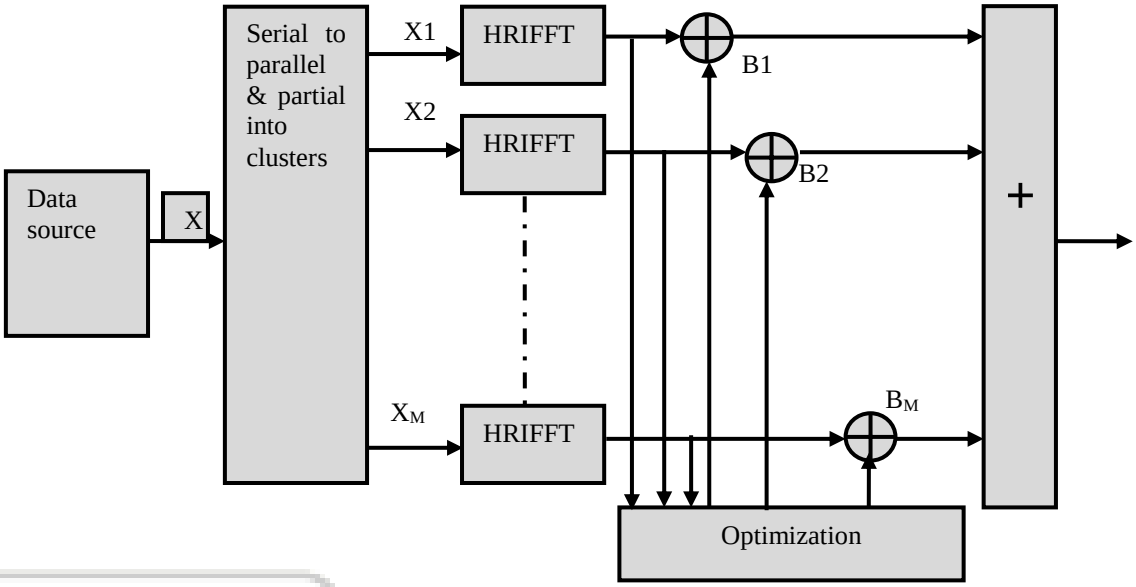

Fig. 4: Block diagram of Partial transmit Sequence and HRFFT

The HRIFFT operations are performed for each piece of information in HRFFT technique. The ICI run in fractional transmit is high when sub squares nos. are expanded & it likewise got expanded by stage variables nos. & furthermore by expansion no. of sub pieces segment significant intricacy which is included is to discover for upgraded medium of all stage vectors when sub squares number got expanded FFT Technique.

A HRFFT is proposed first time for ICI reduction using receiver windowing. The proposed window is a modified version of the MBH window family. It is used in a P-OFDM system to reduce the effect of frequency offset on both the parameters i.e., the ICI and BER. Proposed procedure is a HRFFT base pruning OFDM, point behind plan containing a blending of two proper strategies. It consolidates hew radix & further more pruning system. Essential square is demonstrated as follows (Figure 3.3). At transmitting end, initially flood of information will get changed by lattice of HRFFT & later on this information which has undergone change will prepared by SLM square. Inevent that its goes through IFFT hinder, information square goes by dealing with HRFFT framework then everyone of coefficients autocorrelation of IFFT input got diminished, & consequently ICI may be reduced. Here information goes through SLM unit & afterward will work with HRFFT unit. Here considering case if HRFFT network is utilized after SLM then it additionally do diminishing of ICI of flag. O/P flag of ICI will be lessened. piece of transmitters appeared beneath.

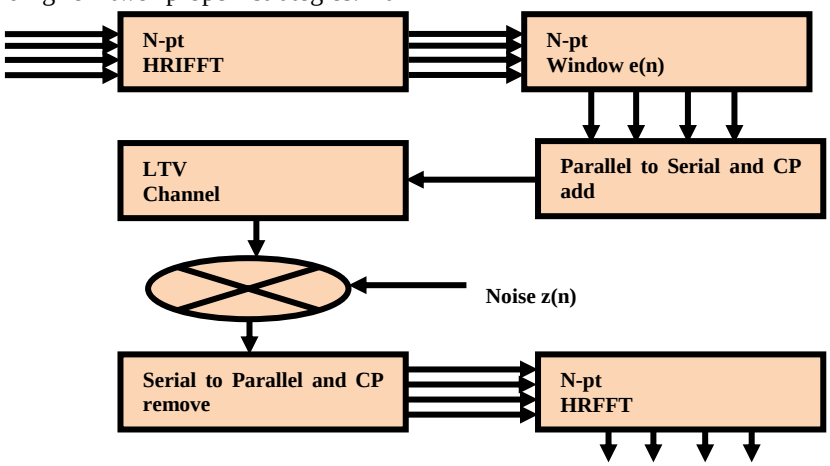

Fig. 5: block diagram of proposed P-OFDM diagram

P-OFDM bearer flag (burst sort) is whole of at least one OFDM images each contained 52 orthogonal subcarriers, with baseband information on each subcarrier being freely regulated utilizing quadrature sufficiency adjustment (accessible configurations: BPSK, QPSK, 16-QAM, or 64-

QAM). This composite baseband flag is utilized to regulate a primary RF transporter.

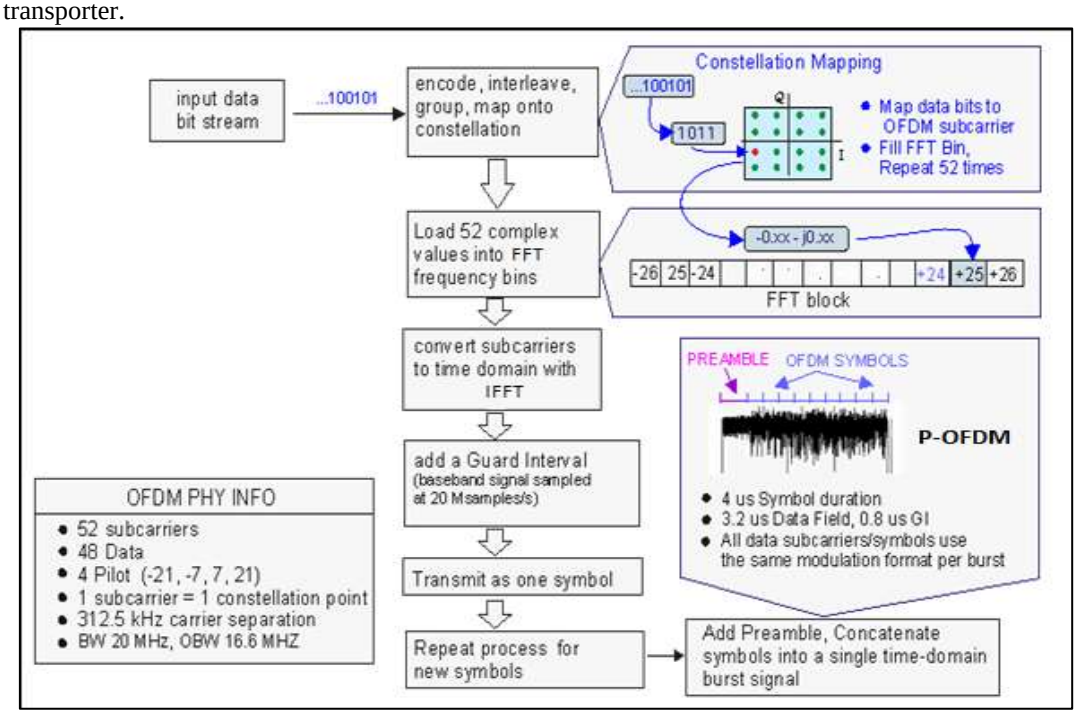

Fig. 6: OFDM signal generation process

To start P-OFDM flag creation handle, info information bit stream is encoded with convolutional coding & Interleaving. Every information stream is isolated into gatherings of "n" bits (1 bit - BPSK, 2 bits - QPSK, 4 bits - 16QAM, or 6 bits - 64QAM) & changed over into complex numbers (I+jQ) speaking to mapped heavenly body point. Note that bit-rate will be distinctive relying upon adjustment design, a 64-QAM star grouping (6 bits at once) may have a bit rate of 54 Mbps while a QPSK heavenly body (2 bits at time) may just be 12 Mbps. At that point 52 receptacles of HRIFFT square are stacked. 48 receptacles contain group of stars focuses which are mapped into recurrence balance files running from - 26 to +26, avoiding 4 Pilot & zero canisters. There are 4 Pilot subcarriers embedded into recurrence balance record areas - 21, - 7, +7, & +21. zero canister is Null or DC subcarrier & is not utilized; it contains a 0 esteem (0+j0).

IV. RESULTS

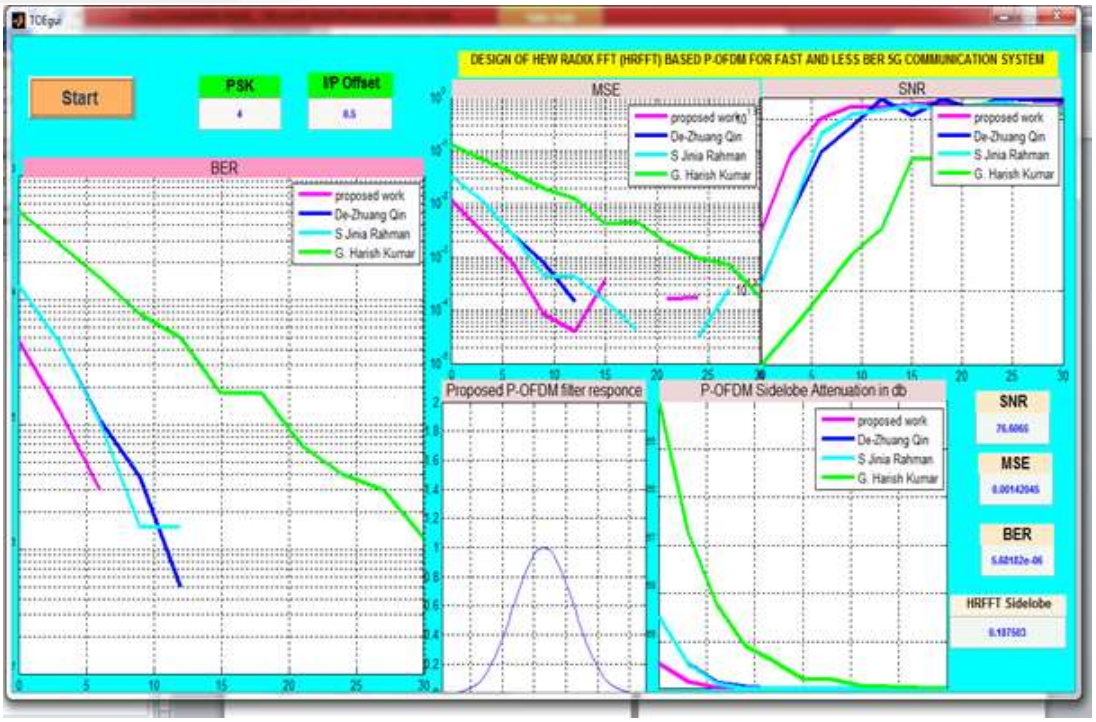

Fig. 7: MSE, BER, PSNR and Side-lobe attenuation obtain when 4PSK modulation

PSK	SNR Db	MSE Db	BER Db	Side lobe attenuation db
4	76.3046	0.00139	5.59091e-06	0.187503
16	60.3616	0.0598295	0.000239318	0.18762
64	53.2147	0.310176	0.00124889	0.188124

Table 2: Observe results

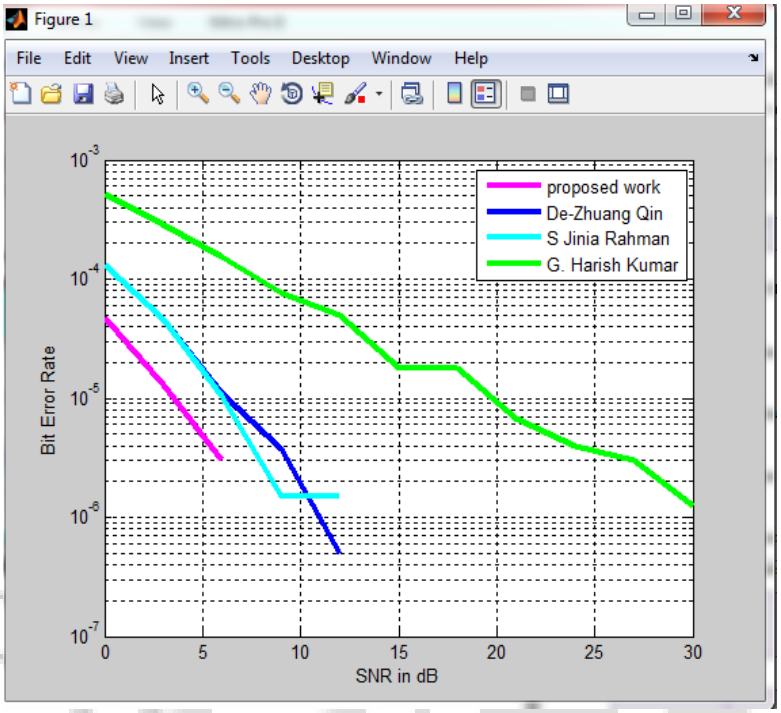

Fig. 8: BER obtain when 4PSK modulation comparative observation

Observe results at Input noise 15 db and 4PSK modulation				
Work by	SNR	MSE	BER	Side lobe Attenuation
De-Zhuang Qin [1]	70.625		9.2184e-06	
Jinia Rahman et al [2]	-		0.2524e-05	
G. Harish Kumar et al [3]	-		0.8267e-05	
Proposed	76.3046	0.00139	5.59091e-06	0.187503

Table 3: Comparative results

From the table 3 it can be observe that proposed work BER is least as compare with avaible other literature works.

V. Conclusion

In this work, we applied the HEW Radix FFT (HWFFT) in the P-OFDM transmitters to remove the ICI power in the fast time varying channels prior to receptions. As the results of the ICI self-cancellation, the system renders a strictly banded channel matrix with negligible banded approximation errors. Under the P-OFDM channel estimation, simulation result shows that the proposed ICI self-cancellation scheme outperform significantly with lower BER floors under time varying channel .It is concluded that HRFFT detection techniques has been applied to find out MSE&BER performance of system using 16 QAM modulation scheme .MSE&BER value has significantly improved by multi-FFT detection using 16 QAM as compared to QPSK.

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