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Implementation with Adaptive Modulation Technique and OFDM Based Approach

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Abstract:

An Adaptive mododulation techniques is widely used in OFDM this technique cannot only improve the utilization efficiency of spectrum but also the bit error rate performance of system. Adaptive encoders and Adaptive decoder techniques are designed for OFDM system with the help of Convolutional Encoder/Adaptive Viterbi Decoder and Hamming Encoder/Hamming Decoder. Similarly, an adaptive modulation and demodulation techniques are designed for OFDM system with the help of QAM modulation and QPSK modulation. In this section, an adaptive OFDM has been designed by combining all adaptive techniques such as adaptive FFT, adaptive Encoders, adaptive Decoder, adaptive modulation and adaptive demodulation.

Keywords: **Adaptive modulation, Adaptive OFDM ,Adaptive encoder/decoder,Adaptive FFT and Hamming encoder/decoder.**

1.INTRODUCTION

Orthogonal Frequencis my Division Multiplexing (OFDM) based wireless data transmission system multi-carrier system in which single higher rate data stream can be divided into multiple lower rate data streams. Modulation and De-Modulation technique play an important role in OFDM based data transmission system. Based on Modulation technique only, the frequency transformation technique and encoding and decoding techniques are enabled. In previous chapters, adaptive frequency transformation techniques and adaptive encoder/adaptive decoder techniques are proposed for OFDM System. These both are executed based on SNR values generated from modulation techniques. But in the current research work, an adaptive modulation and adaptive demodulation technique also proposed by using two different types of effective modulation and demodulation techniques. OFDM technology has been tremendous and swift growth in the field of wireless communication field. For instance, 3G, 4G and LTE based System requires an effective adaptive OFDM system to establish data transmission. The structure of OFDM is shown in figure 1.1

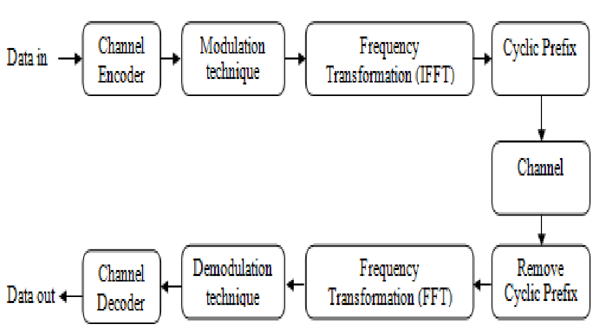


Figure 1.1. OFDM block diagram

The OFDMconsists of channel encoder,modulationtechnique,frequencytransformation,cyclic prefix and channel.InOFDM,modulation technique used is QAM ,which is widely used for modulating data signals onto a carrier used for radio communication.The cyclic prefix acts as a buffer region or guard interval to protect the OFDM signals from intersymbolinterference.Cyclic Prefix is used in OFDM to operate reliably.The channel is used in OFDM transmitter.It is a connection between transmitter and receiver is established through a communication channel.The cyclic prefix is removed in OFDM receiver.

The total count of binary input values are considered as the threshold value of adaptive modulation and adaptive demodulation techniques. Based on their results only, an adaptive frequency transformation and adaptive encoders and adaptive decoder techniques can be executed.

Two effective modulation techniques called as “Quadrature Amplitude Modulation (QAM)” and “Quadrature Phase Shift. Quadrature Amplitude Modulation or QAM is a form of modulation which is widely used for modulating data signals onto a carrier used for radio communications. It is widely used because it offers advantages over other forms of data modulation such as PSK, although many forms of data modulation operate alongside each other. In view of the fact that both amplitude and phase variations are present it may also be considered as a mixture of amplitude and phase modulation.QAM restores the balance by placing two independent double sideband suppressed carrier signals in the same spectrum as one ordinary double sideband suppressed carrier signal.

Quadrature Amplitude Modulation appears to increase the efficiency of transmission for radio communications systems by utilizing both amplitude and phase variations, 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. In view of the fact that both amplitude and phase variations arepresent it may also be considered as a mixture of amplitude phase modulation.

So, the QAM modulation is preferred. The main purpose of this paper is to achieve lower area, power and delay consumption by an adaptive modulation techniques.OFDM is selected as one of the most promising techniques that can achieve the required performances by its spectral efficiency and also the bit error rate system. The remaining parts of this paper are as follows:section 2,describes the proposed Adaptive modulation and demodulation network architecture and adaptive OFDM and about architecture of SDF and MDF;Section,QAM modulation and QPSK modulation 3,details a performance evalution study of the proposed scheme;Finally section 4,concludes the paper by summarizing the main results and some additional research directions

2. ADAPTIVE MODULATION AND ADAPTIVE OFDM MODEL.

In this section ,we describe the proposed method by an OFDM based approach and achieving the efficiency performance.we begin by presenting the structure of this architecture,then we detail the different processing methods in OFDM approach.

2.1 Proposed Adaptive Modulation Techniques

The above described two modulation techniques are used here to make an adaptive system. The width of input data is considered as the threshold value. For instance, the width of input data is 2 means, an adaptive system selects QPSK modulation and demodulation technique to reduce the hardware utilization and power consumption. In other hand, if the width of input data is 4 means, an adaptive system selects QAM modulation and demodulation technique to improve the speed of the modulation operation. Based on dividing more sampling the speed of the processors have been improved significantly.

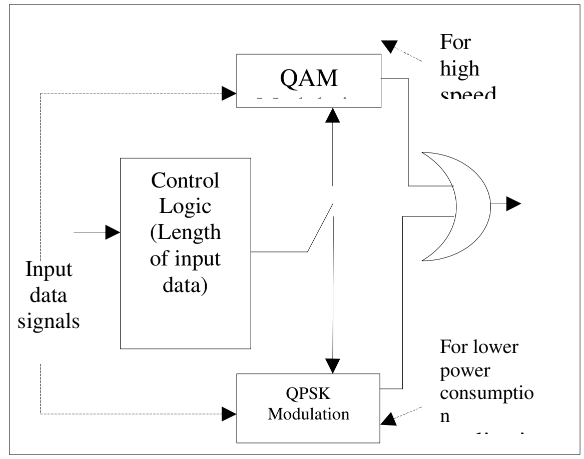


Fig. (a) Adaptive Modulator

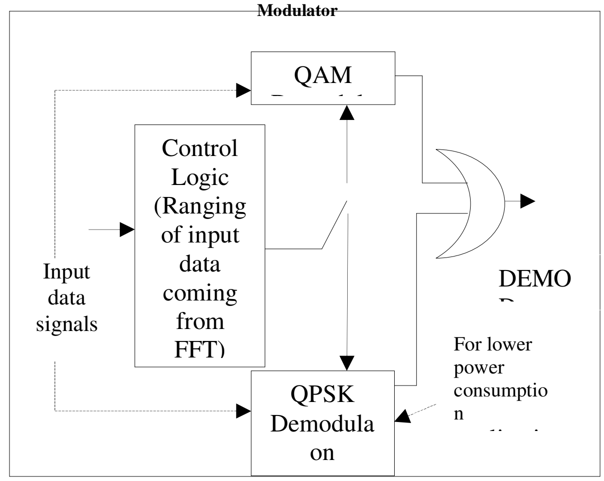


Fig. (b) Adaptive Demodulator

Figure 2.1 Architecture of Adaptive Modulation and Adaptive Demodulation technique

For instance, QAM have 2^4=16 samples hence, more sampling signals gives more parallelism. But QPSK modulation has only 2^2=4 samples hence, less number of parallelisms which reduces the hardware consumption but not speed. The architecture of proposed adaptive modulation and demodulation technique is shown in Figure 21. Figure 2.1 (a) indicates adaptive modulation techniques using QAM modulation and QPSK modulation. Figure 2.1 (b) indicates adaptive modulation techniques using QAM demodulation and QPSK demodulation.

2.2 Adaptive OFDM techniques

When data input is 2-bit, QPSK modulation will be selected hence signal strength should lies between 0.5 to 1, thus adaptive system automatically selects Convolutional Encoder, R2MDC FFT and Adaptive Viterbi decider techniques for exhibiting data communication. Similarly when data input is 4-biot, QAM modulation will be selected hence signal strength should lies between 0 to 0.1, thus adaptive system

automatically selects Hamming encoder, R2SDF FFT and Hamming Decoder for exhibiting data communication.
For High Speed Requirement the following techniques are selected in OFDM:

- ➢ Quadrature Amplitude Modulation
- ➢ Radix-2 Single path Delay Feedback FFT
- ➢ Hamming Encoder

For Less Area Utilization and Lower Power Consumption Requirement the following techniques are selected in OFDM:

- ➢ Quadrature Phase Shift Keying Modulation
- ➢ Radix-2 Multipath Delay Commutator FFT
- ➢ Hamming Decoder

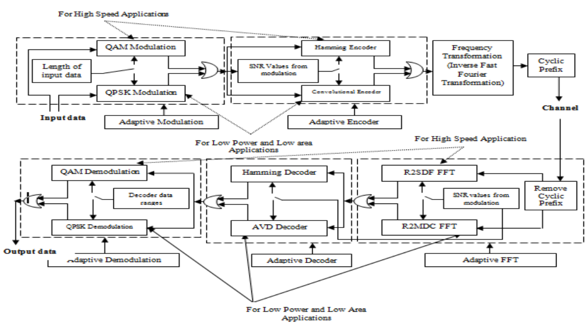


Figure 2.2 Architecture of Adaptive OFDM System

2.3 QAM MODULATION

Digital amplitude modulation is an alternative principle to digital phase modulation. In digital phase modulation, amplitude of signals kept no changes and varies the phase of the signals in every step. But, in case of Quadrature Amplitude Modulation (QAM), both amplitude and phase of the signals varies based on input bits. In QPSK modulation, two bits (debits) are to be considered to perform modulation. But, in case of QAM modulation four bits are to be considered to perform modulation. Like QPSK modulation, QAM modulation also has in phase and Quadrature channel. The advantage of using QAM is that able to carry more bits of information per symbol.

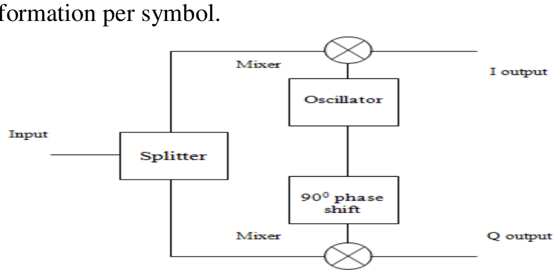


Fig 2.3(a) Block diagram of QAM

The block diagram of QAM is the input bits are four in case of QAM modulation whereas input bits of QPSK is two. Hence, QAM modulation is bandwidth efficient than QPSK modulation. The constellation diagram of QAM modulation is illustrated in Figure.

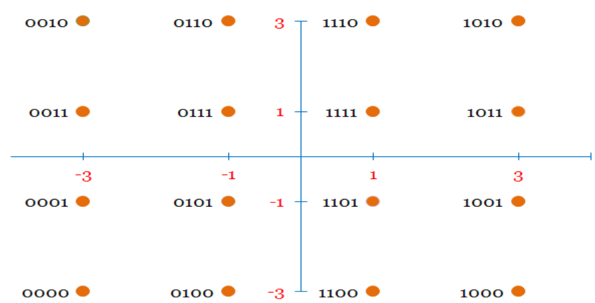


Fig 2.3(b) constellation diagram of QAM modulation

2.4 QPSK MODULATION

Quadrature Phase Shift Keying (QPSK) modulation is a type of digital modulation coming under Phase Shift Keying (PSK) modulation. In Binary Phase Shift Keying (BPSK) modulation, phase of information signal can be changes every steps based on a single bit digital signal.
QPSK modulation is bandwidth efficient, because each signal point represented as two bits. Hence, reconstruction of original signal using QPSK demodulation is also provides more accuracy than BPSK modulation. The block diagram of QPSK modulation is illustrated in Figure. 2.4(a). Based on debits, the frequency of inputs can be divided into two parts known as in phase and Quadrature phase represented in fig. 2 as I Channel and Q Channel respectively. The constellation diagram for QPSK modulation is illustrated in Figure.2.4(b)

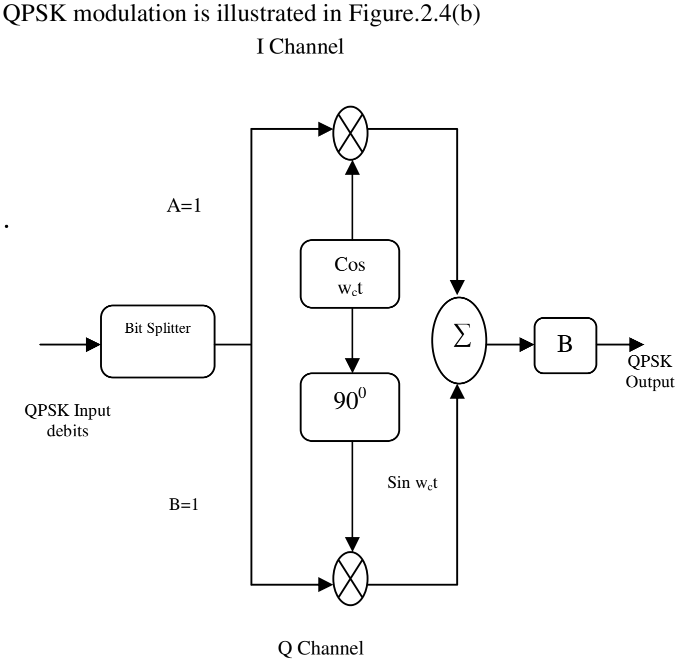


Figure 2.4(a) Block diagram of QPSK modulation

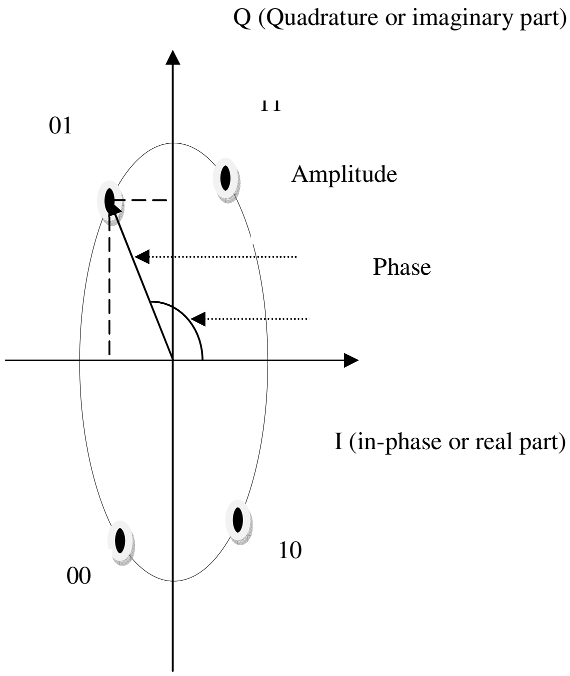
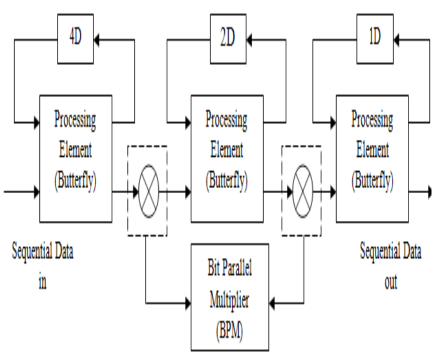


Fig 2.4(b) constellation diagram for QPSK Modulation



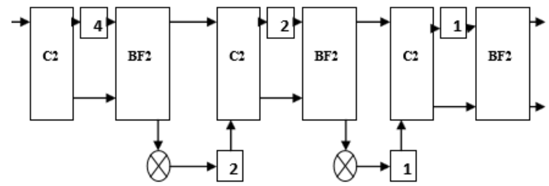
2.5 Data Flow structure of eight point R2SDF FFT structures have been illustrated in below Figure:

Architecture of SDF FFT

In eight point data inputs are sequentially given to the R2SDF FFT processor. Sequence of inputs is getting feedback through delay elements for performing the butterfly operation. In the place of twiddle factor multiplier, Bit Parallel Multiplier (BPM) has been implemented. Speed of the FFT processor can be improved due to pipelining process. However, it utilizes more hardware in terms of Slices and LUTs.

Structure of MDC

In R2MDC FFT structure, input sequence is broken into two parallel data streams flowing forward with correct "distance" between data elements entering the butterfly scheduled by proper delays. Both multipliers and butterflies are less utilization in R2MDC FFT structures. In abovefig, C2 represents the commutator structure and BF2 represents the butterfly structure



One of the straightforward approaches for pipeline implementation of R2MDC FFT algorithm is as follows:
1. The input data sequence is broken into two parallel data streams.
2. At each stage of this architecture half of the dataflow is delayed via the memory (Reg) and processed with the second half data stream.
3. The delay for each stage is 4, 2, and 1 respectively. The total number of delay elements is 4 + 2 + 2 +1 +1 = 10. 4. In this R2MDC architecture, both Butterflies (BF) and multipliers are idle half the time waiting for the new inputs. The 16-point R2MDC FFT/IFFT processor requires one multiplier, three radix- 2 butterflies and 3 commutators.

3.PERFORMANCE EVALUATION

This section is devoted for the evaluation of the performance of our proposed method. To evaluate the proposed adaptive modulation and demodulation model, ModelSim 6.3C is used in the current research work. The simulation result of proposed adaptive modulation (QAM) technique for establishing high speed operation is shown in Figure 3.1 . In this simulation result, input data has 4-bits hence, it is possible to divide 16 sub-carrier signal from higher rate 4-bit original signal. Similarly the simulation result of proposed adaptive modulation (QPSK) technique for establishing less area utilization and lower power consumption is shown in Figure 3.1

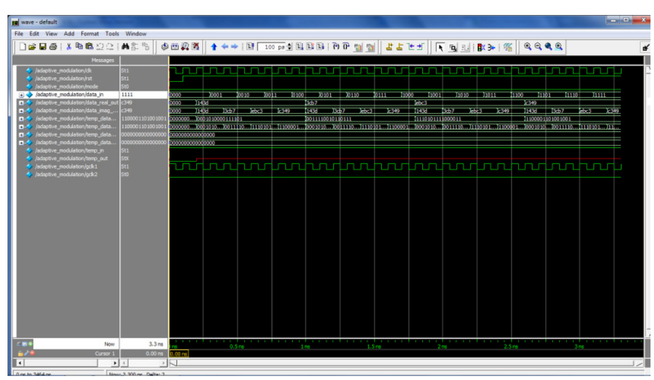


Figure.3.1 Simulation result of adaptive modulation (QAM) technique for establishing high speed operation

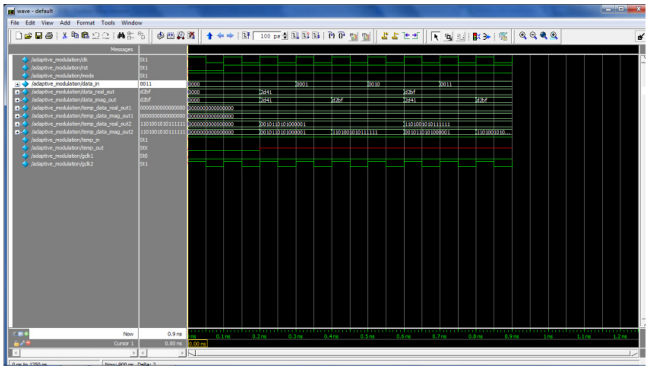


Figure 3.2 Simulation result of adaptive modulation (QPSK) technique for establishing less area and lower power consumption operation

Similarly, the simulation result of adaptive demodulation (QAM) for establishing high speed operation and simulation result of adaptive demodulation (QPSK) for establishing less area utilization and lower power consumption operation respectively. The inputs of demodulation is given into hexadecimal values, these values are generated from frequency transformation technique of receiver side. According to modulation principle, 16 combined modulated output gives 4-bit original input data and 4 combined modulated output gives 2-bit original input data.

SYNTHESIS RESULTS

The proposed adaptive modulation and demodulation techniques can be synthesized successfully by using Xilinx 12.1 (Family: Spartan 3, Devices: Xc3s200, Package: PQ208, Speed: -12) design tool. The synthesis result of QAM demodulation technique and QPSK demodulation technique to determine the area consumption is shown respectively. As shown in Figure , hardware slices required to implement QAM demodulation operation is 19 which is reduced to 12 in case of QPSK modulation. Similarly LUT consumption of QAM demodulation is 35 which are reduced to 22 in case of QPSK demodulation technique. The synthesis result of QAM demodulation technique and QPSK demodulation technique to determine the delay consumption respectively.

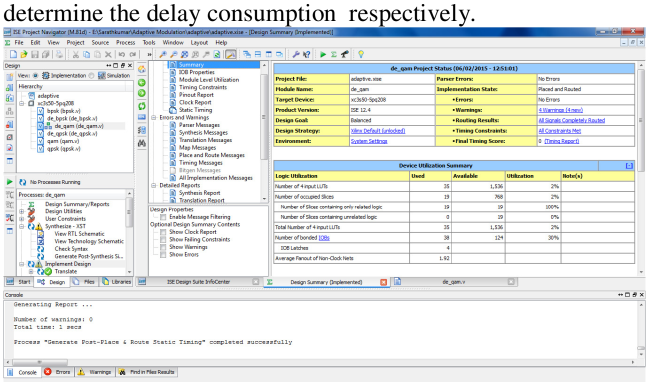


Figure 3.3 Synthesis result of QAM demodulation technique to determine area consumption

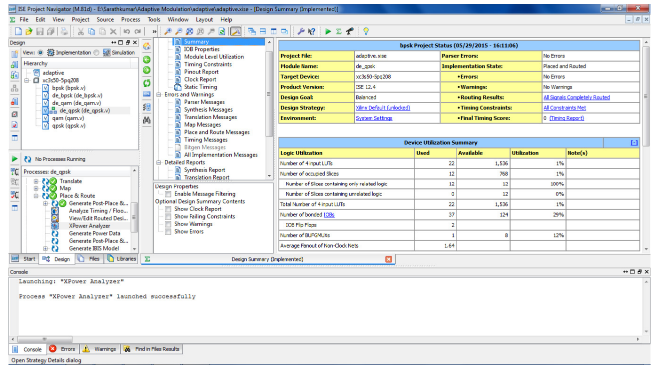
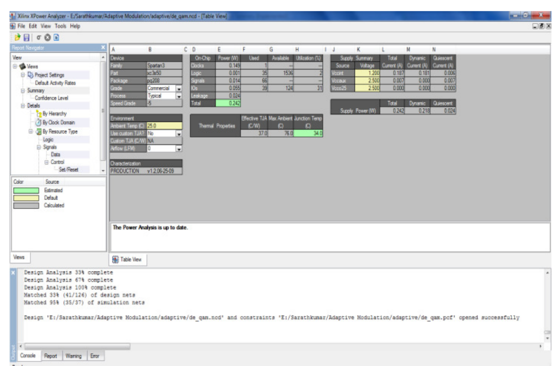


Figure 3.4 Synthesis result of QPSK demodulation technique to determine area consumption

As shown in Figure 3.4 , delay consumption for QAM demodulation technique is 6.141ns which is increased to 6.216ns in case of QPSK demodulation technique. Hence, QAM modulation technique gives best performance to improve the speed of modulation operation. Similarly the power consumptions are measured by using Virtual Circuit Dump (VCD) files. The power consumption of both QAM and QPSK modulation techniques respectively.The power consumption for QAM modulation operation is 242mW which is reduced to 197mW in case of QPSK modulation operation.
The comparison results of both QAM and QPSK demodulation techniques are shown in Table 3.5.

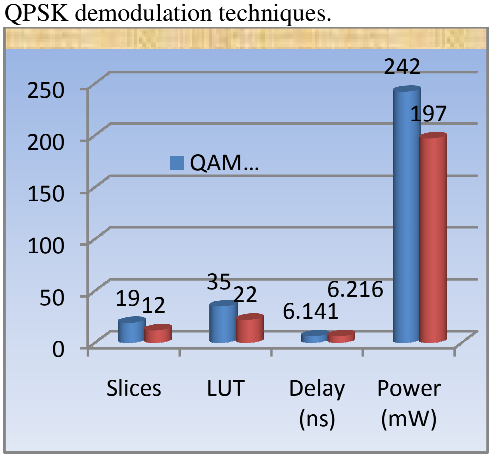


The performances of both QAM and QPSK demodulation techniques are graphically illustrated in Figure 3.6.

Table 3.5 for comparison result of QAM and QPSK demodulation technique

Type	Slices	LUT	Delay(ns)	Power(mW)	Application
QAM Demodulation	19	35	6.141	242	High Speed Application
QPSK Demodulation	12	22	6.216	197	Low Power and Low area Application

From table, it is clear that QPSK demodulation technique offers ***36.84% reduction in hardware slices, 37.14% reduction in LUTs and 18.59% reduction in power consumption*** than QAM demodulation technique. Similarly, QAM demodulation technique offers ***1.20% reduction in delay consumption*** than QPSK demodulation techniques.



X axis – Slices, LUT, Delay and Power in unit values (1 unit = 50mW for power, 1 unit = 50ns for delay and 1 unit = 50MHz for frequency)

Y axis – Methods (QAM Demodulation and QPSK

Figure 3.6 Performances of both QAM demodulation and QPSK demodulation in graphical view

From above analyzed results, it is clear that QAM modulation is better for high speed applications and QPSK modulation technique is better for less area utilization and lower power consumption applications

CONCLUSION

In OFDM, the design of efficient FFT structure with less number of component and high processing speed is very essential. In this project, the design of QAM Modulation With OFDM are proposed for smaller chip size and higher processing speed. The Verilog HDL code for the OFDM is synthesized and the simulation results are verified using Xilinx ISE 10.2i.The performance parameter include delay, area, power is analyzed. The Proposed QAM offers high speed than the QPSK. In future, the proposed R2SDF FFT is incorporated into OFDM transceiver for improving the spectral efficiency, bandwidth and high speed data transmission. Also efficient EDC (Error Detection and Correction) code will be designed to find the fault in data packet during data transmission. This OFDM can be used for Mobile Ad hoc Network (MANET) applications.

The proposed OFDM is absolutely contributed to the Wireless communication standards to improve the speed further. In addition to OFDM, convolutional encoding and decoding techniques are also plays a vital role in wireless standards. To implement OFDM in wireless standards, efficient FFT architectures and decoding techniques are essential. Therefore in future, the proposed OFDM using $R2^2$MDC FFT with WPT and Adaptive Viterbi decoder technique will be helpful to design and implement the wireless communication standards with improving efficiency in various aspects.

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