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Novel BPSK-OFDM-SSB Modulation System using DCT and DHT

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***Abstract*—In this paper, we propose and evaluate OFDM(Orthogonal Frequency Division Multiplexing)-SSB(Singe Side Band) for improving spectral efficiency. The proposed system is based on OFDM system using DCT(Discrete Cosine Transform) and DHT(Discrete Hilbert Transform). This proposed system transmits a BPSK (binary phase shit keying) modulation signal through a single sideband. Therefore, spectrum efficiency can be improved into 2 times than the conventional DSB(double sided band) communication system. Conclusively, the proposed system can transmits two different BPSK signal with each different single sideband in DSB band.**

***Keywords*—SSB; OFDM; DHT; DCT;**

I. INTRODUCTION

In these days, the usage of mobile devices such as smart phones and tablet PCs has rapidly been increasing. The recent mobile devices are mostly based on wireless OFDM communication system, and resources of radio communication system are becoming closely limited. because of this limited frequency band, very efficient communication system is crucially necessary for the transmitting the huge data amount. So, there are so many researches for improving spectral efficiency. Especially, next 5G mobile communication system needs very spectrum efficient modulation system and multiple access system. Also, the frequency resource is strictly limited in every country. Therefore the new waveform design and radio access technology are really important all over the world. One of the possible ways to improve the spectrum efficiency is to use the SSB (single side band) modulation method. In this paper, we propose and evaluate the OFDM-SSB scheme using BPSK, DCT and DHT for improving spectral efficiency. DCT and DHT are the first time to be applied into OFDM-SSB communication system, so that this can be very good contribution of this paper.

II. PROPOSED SYSTEM MODEL

A. DCT(Discrete Cosine Transform)

Discrete cosine transform is one of discrete Fourier transforms used in OFDM system. The formula of DCT is eq.(1).

$$A_k = \sum_{n=0}^{N-1} a_n \cos[\frac{\pi k}{N}(n+\frac{1}{2})] \quad (1)$$

Also the formula of IDCT is.

$$A_n = \sum_{k=0}^{K-1} \sqrt{\frac{1}{N}} \cos[\frac{\pi}{2N}(k-1)(2n-1)] \quad (2)$$

B. Proposed System model

In this paper, the proposed system model is the same as Fig.1 and Fig.2. The transmitter uses the IDCT instead of the IDFT which used in OFDM system .Also similar with conventional SSB scheme, the proposed system modulates signal by using DHT and uses IDCT, and then multiply complex number for making 90 degree phase difference[2]. Then that signal subtract from modulated signal by IDCT. And then transmit the signal after adding CP. In the receiver after removing CP, for demodulating each signal using DCT, DHT and complex number[3][4].DCT and DHT are the first time to be applied into OFDM-SSB communication system, so that this can be very good contribution of this paper.

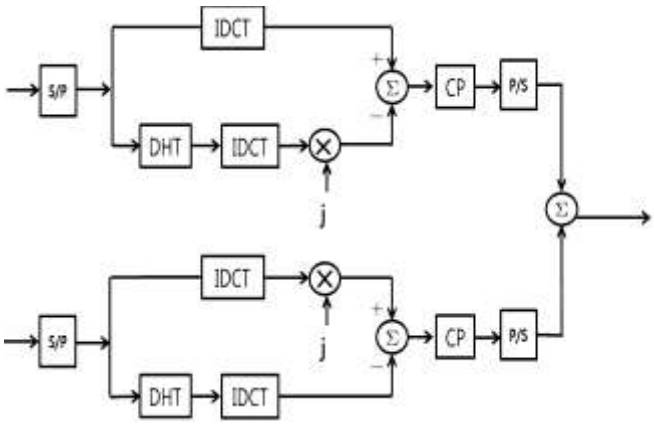

Fig.1. Transmitter of proposed OFDM-SSB system.

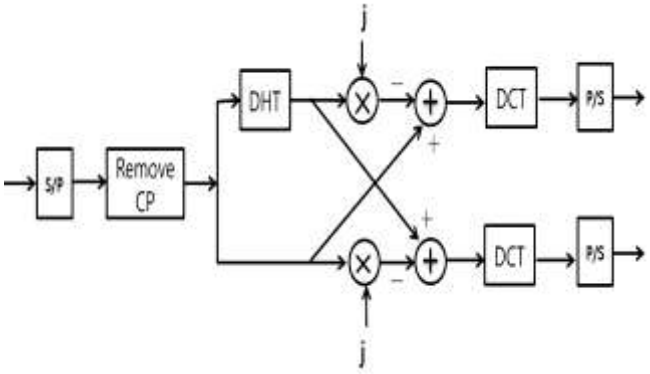

Fig.2. Receiver of proposed OFDM-SSB system.

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III. EVALUATION OF SIMULATION

TABLE Ⅰ. SIMULATIONPARAMETERS

Modulation	OFDM-BPSK
DCT size	64
Subcarriers	52
CP length	16
Channel	AWGN
Number of symbols	10^4

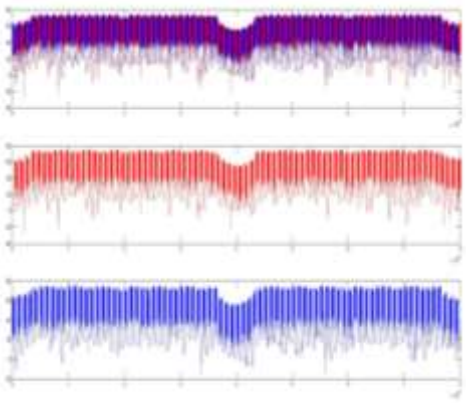
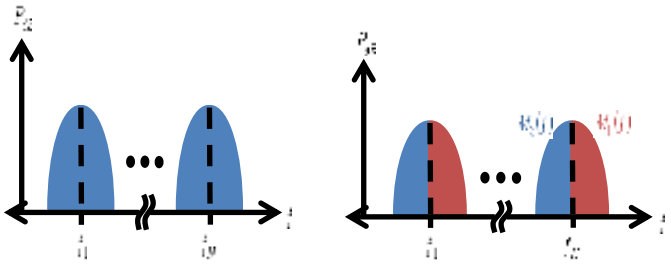


Fig.3. Spectrum of proposed OFDM-SSB system.



(a) Conventional DSB spectrum (b) SSB spectrum

Fig. 4. Conventional DSB spectrum and SSB Spectrum of proposed system.

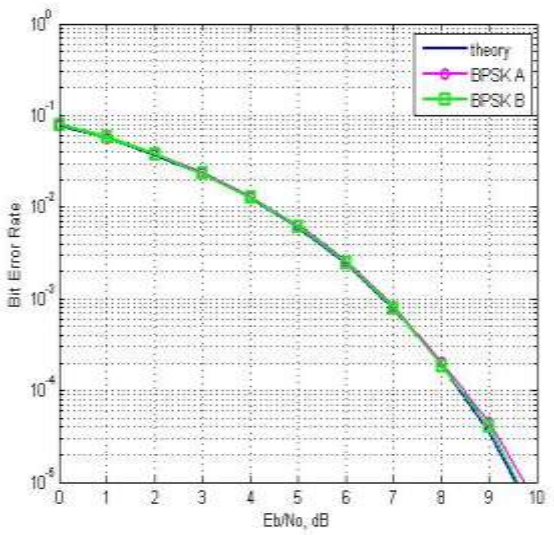


Fig. 5. BER performance of BPSK OFDM-SSB in AWGN.

In this paper, we used MATLAB program and simulate for evaluating performance of the proposed OFDM-SSB system with the system parameters table.1. We have done simulation of the proposed system using BPSK modulation. Fig. 3 shows two signal doesn't affect each other signal when two signal become one signal. Fig. 4 shows two signal spectra : DSB spectrum and SSB Spectrum of proposed system..

As a result we simulate for evaluating BER performance in AWGN Channel. Fig. 5 shows two BPSK signal performance are similar with theoretical BPSK performance. So we could know the proposed system works very well.

IV. CONCLUSIONS

In this paper, we have proposed and evaluated OFDM (Orthogonal Frequency Division Multiplexing)-SSB(Singe Side Band) for improving spectral efficiency. Basically, the modulation type was BPSK. The proposed system is based on OFDM system using DCT(Discrete Cosine Transform) and DHT(Discrete Hilbert Transform). This proposed system transmits a BPSK (binary phase shit keying) modulation signal through a single sideband. Therefore, spectrum efficiency can be improved into 2 times than the conventional DSB(double sided band) communication system. Conclusively, the proposed system can transmits two different BPSK signal with each different single sideband in DSB band.

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