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Design and Implementation of SCF method for PAPR Reduction of OFDM Signals Using ANN

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***Abstract*— Clipping and filtering methods is considered one of the simplest ways to cut down high peak to average power ratio (PAPR) of orthogonal frequency division multiplexing (OFDM) signals. The existing simplified CF method clips the high PAPR in single iteration with reduced complexity. However, these low complexity methods depend upon large complicated fast Fourier transform procedures. In this paper we come up with an advanced method which adopts trained ANN to incorporate with the SCF algorithm. Compared to SCF method, the advanced proposal based on ANN and SCF method provides good performance with respect to bit error rate (BER) with incomparably shortened computing complications. In addition to this it also presents an attractive metric which is a more efficient predictor than peak to average power ratio.**

***Keywords*—Artificial neural networks, SCF, BER, OFDM**

I. INTRODUCTION

The main difficulty faced by orthogonal frequency division multiplexing (OFDM) systems is high peak-to-average power ratio (PAPR). Various approaches have been proposed including clipping and filtering method. CF technique is considered as uncomplicated and most extensively used methods for minimizing high PAPR of OFDM signals. Since CF technique results in regrowth of peak due to filtering method. therefore, one more method called iterative clipping and filtering method was proposed. This method requires a huge number of repeated clipping and filtering steps in order to diminish the peak regrowth. Hence, this method makes computation more complicated. Complications of the preceding method can be reduced using another method called simplified CF (SCF) method was proposed. In SCF technique, using just one clipping and filtering step, one can obtain the comparable minimization in PAPR as that of preceding method. However, this method needs large complicated fast Fourier transform (FFT) procedures and framework computations to obtain good results.

The present day applications of Artificial neural network (NN) technique now involves various communication and signal processing areas one such application is PAPR reduction of OFDM signals. Artificial neural network (ANN) has been one of the powerful techniques in cutting down high PAPR with flexible designing and learning capabilities. In this paper, we portray an unusual way for diminishing high PAPR of OFDM signals which uses SCF algorithm and neural network module. The cubic metric (CM) is utilised to demonstrate efficiency of a designed system in decreasing the high amplitude fluctuation in OFDM signals. The designed system attains comparative CM decrease as that of ICF and SCF methods with much diminished computing complications by using only one IFFT module. The below figure 1 shows the block diagram of existing SCF method.

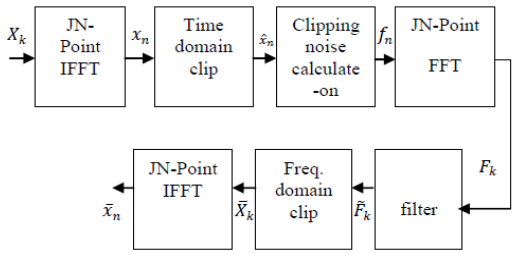

Fig. 1: Block diagram of existing SCF method

II. PAPER ORGANIZATION

The rest of the paper is organized as follows: In section II, we discuss about scope of the work. Section III gives the detailed information about the steps involved in methodology. Section IV describes the complexity testing. Section V gives the derived results and followed by conclusion and future works.

III. SCOPE OF THE WORK

a. Design and Implementation of new SCF method for diminishing high PAPR of OFDM signals using artificial neural networks.
b. Training and Testing of neural network module using MATLAB neural network toolbox.
c. Complexity testing of designed system with the existing methods.

IV. METHODOLOGY

SCF-NN Scheme

SCF method reduces PAPR with low complexity, but still it requires complex FFT/IFFT operations. Therefore, the main objective of the designed system is to diminish the complications while computing large complicated IFFT/FFT procedures in SCF method and also obtaining comparable CM performance

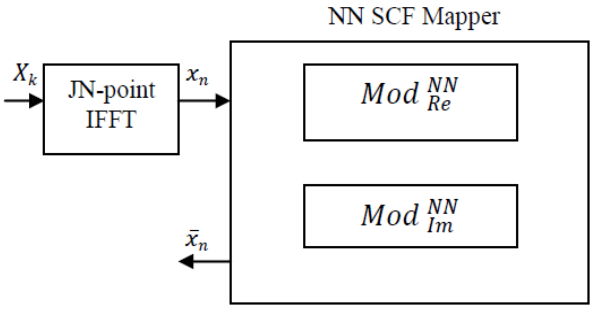

Fig. 2: Block diagram of the designed system

The above Figure 2 shows the block diagram of designed system. It contains of two NN modules. First, we divide the input signal into two parts: real part and imaginary part. In our work, we are testing Multilayer perceptron neural network (MLPNN) as NN module. The collection of input-output data set is used for training them. It has two hidden layers, the input data is handled by these layers with triangular activation function.

Steps required for training and testing of the designed system are as follows:

1) Initially, we need two things one is input signal for training the NN module and the other one is required output signal. The OFDM signal x_n is used as input signal and obtained SCF signal is used as the required output signal.

2) Since both input signal and required output signal have independent real and imaginary parts. In order to train the real and imaginary parts, we develop real and imaginary NN modules using Mod_{Re}^{NN} and Mod_{Im}^{NN}.
3) Now, we need to achieve input signal x_n. Apply IFFT operation to the frequency domain OFDM signal X_k to get x_n.The obtained x_n is then used for testing method.
4) Finally, we get the desired output of NN based SCF signal $\bar{x}_n$ which is obtained as shown in following equation:

$$\bar{x}_n = Mod_{Re}^{NN}\{x_{RE}\} + j\, Mod_{Im}^{NN}\{x_{Im}\} \quad \ldots (1)$$

V. COMPLEXITY TESTING

In this section, we examine the computing complications of SCF method and NN based SCF method which is the designed system. Furthermore, we also include SLM technique as an additional method for analyzing computing complications. In case of SCF method, we noticed that even though it requires only single clipping and filtering step to diminish the high PAPR, it still requires three large complicated IFFT/FFT operations. This leads to increased computing complications. In SLM method, large number of IFFT/FFT operations is required to diminish the high PAPR of OFDM signals. Hence, SLM technique has highest computing complications compared to SCF method. Finally, in our designed system, we build up a trained ANN which is incorporated with SCF algorithm to get good performance with incomparably reduced computing complications. Hence, the designed system clips high PAPR without demanding complicated clipping operations. Therefore, we conclude that the designed system presents largely reduced computing complications compared to other techniques.

VI. SIMULATION RESULTS

The practical results show the simulation plots for signal to noise ratio versus bit error rate and also for tail distribution of cubic metric. From these resultant plots, we compare system performance of designed system with existing techniques. Figure 3 shows a resultant plot of tail distribution of CM. From this plot, one can figure out that the designed system provide comparable decrease in CM as that of SCF method with very small amount of performance loss. In Figure 4 & 5 we observe that the designed system provide equivalent bit error rate performance as that of the SCF method when the simulation is carried out using QPSK and 16-QAM modulations respectively.

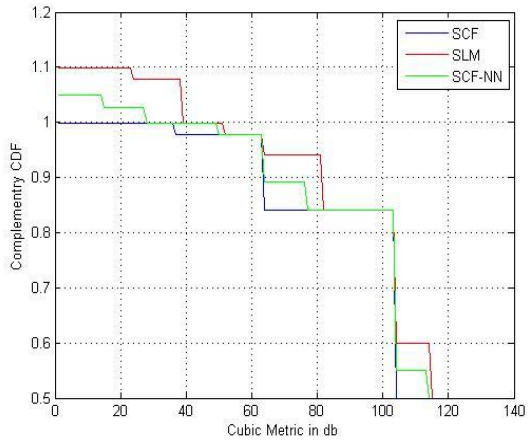

Fig. 3: Comparison of CM CCDF of designed system with SCF and SLM techniques using QPSK mdulation.

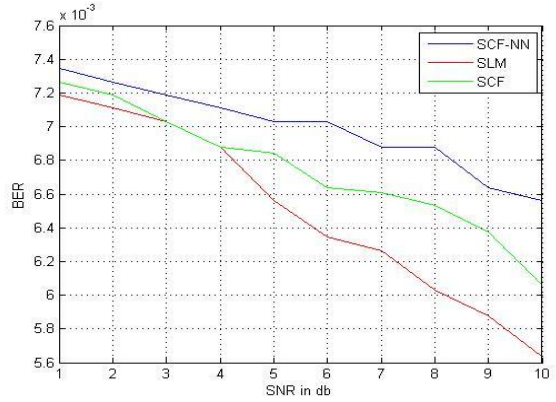

Fig. 4: A plot of SNR versus bit error rate comparison of designed system with existing techniques for QPSK modulation.

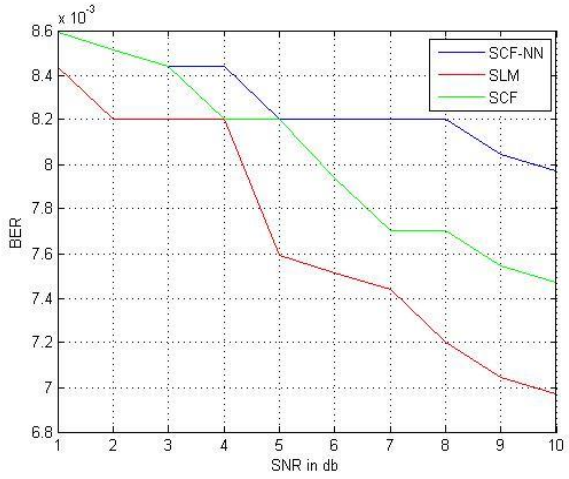

Fig. 5: A plot of SNR versus bit error rate comparison of designed system with existing techniques for 16-QAM modulation.

VII. CONCLUSION AND FUTURE SCOPE

In this paper, a new CF method is designed that adopts a trained ANN and SCF algorithm. The designed system uses only single IFFT module to diminish high PAPR of OFDM signal. Therefore, it results in incomparably reduced computing complications as that of the existing methods. In case of bit error rate performance it is examined from obtained results that the designed system provides equivalent bit error rate (BER) as that of existing SCF method with very small performance loss. It is possible to avoid small performance loss in future by using additional NN modules in order to get much improved results.

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