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An extended channel estimation technique for cognitive radio

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ABSTRACT

Cognitive radio has lot a technical issues and channel estimation is one of them. The amount of data which could be transferred via channel in a provided time interval is referred as channel estimation. A lot of previous techniques like Least Square (LS), Discrete Fourier Transformation (DFT) has played vital roles in order to optimize the same. This paper introduces the usage of AI (Artificial Intelligence) in combination with Swam Intelligence to optimize the channel estimation. The evaluation is made on the base of Bit Error Rate (BER) and Mean square Error (MSE).

1. INTRODUCTION

Cognitive radio has two issues namely routing optimization for primary as well as secondary users and the channel estimation for a limited bandwidth. The bandwidth utilization is measured for orthogonal frequency division multiplexing (OFDM) in order to attain high-speed data transfer. OFDM gives a better way of communication by eliminating interference occurring in various fading channels. For fast-varying channels (viz. in mobile systems), no insignificant fluctuations of the channel achievement are expected among consecutive OFDM symbols (though, in every symbol) for ensuring sufficient tracking accuracy, so, it is suitable to place the subcarriers of pilot in every OFDM symbol.

OFDM is utilized for the fast data transfer as the data propagates orthogonally in the channel. The general diagram of OFDM structure is shown in Figure1.

Serial to Parallel converter (S/P): It will convert data from serial input data stream to the parallel data stream. Every symbol transmits 40 to 4k bits of data so there is need of conversion of serial to parallel at the transmitter side.

Modulation: Modulates the data according to channel.

Inverse Fast Fourier transform (IFFT): Utilized for domain transfer

Additive White Gaussian Noise (AWGN): Out of several Channels, it is one of the channels for the data transfer from source towards destination.

Fast Fourier Transform (FFT): Reverse zone transfer.

Demodulation: It is the process in which the received signal is obtained with original characteristics at the receiver side as was fed from the transmitter side.

Channel estimation is known as a significant area in wireless OFDM systems. While the signal transmission is taken then due to various factors like multipath fading, the presence of objects etc., the signal strength get reduced, this results in the distribution of signal into time and frequency domain which make channel transfer function look unequal. So, there is a need for channel estimation [6]. There are various methods of channel estimation but pilot based system is mainly used for estimating the channel properties or channel state information (which describes the propagation of the signal from transmitter and receiver and shows the integrated effect of scattering, fading and power decay) and correct the received signal.

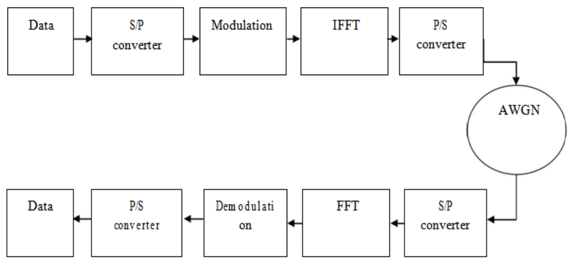

Figure 1. General architecture of OFDM

2. RELATED WORK

Bhasker et al. [13] described an OFDM having equalizer viz. Zero Forcing (ZF) with Minimum Mean Square Error (MMSE). Also, usage of modulation method is executed to provide good reliability, multipath fading, good inter symbol rate. Equalizers are used to work as the transmitter. The outcome depicts that, with MMSE and ZFE equalizers, the bit error rate (BER) performance is improved. Tian Ming et al. [17] proposed the analysis based on SNR and the data is propagated through various channel like Racian, AWGN etc. The work is continued in Mitalee Agrawal [10] who utilized optimization algorithm to enhance the performance of estimation. Allert et al. [18] demonstrated a comparison of modulation techniques.

3. PROPOSED WORK

The proposed architecture utilizes Cuckoo Search in combination with Neural Network to optimize the estimated channel. The work is divided in two stages namely optimization and validation. Algorithm 1 represents the working of the proposed algorithm.

Algorithm 1: OptimizeAndValidate()

```
AllData = Random(1,96) bits // Initializing 96 bit random data
foreachbitvalue in AllData // Foreach bit of data
Num_subchannels = 256 // Total number of subchannels
Num_pilots = Num_subchannels /8 // Total number of Pilot bits
//  Generate the guard interval
Guard_interval = Num_subchannels /4
Foreach bit in Alldata

FFT_Data = FFT(Num_subchannels_Data)// Performing Fast Fourier Transformation for each bit
Bit_transfer=ApplyModulation and set to transfer
    // in the dataset
End For
ForeachBitvalue in  Bit_transfer
Current_Egg=Bit_transfer(Bitvalue)// Initializing Cuckoo Search
EggThreshold=CuckooFit(); // Generating threshold for cuckoo search
if isfit(CurrentEgg)
        Accept();
else
        Drop Entire BitPattern;
End
// Performing validation step
TrainNeural(Fit_Cuckoo,Bit_transfer);
        Validate();
        If validation.error<.30
                Transfer();
        Else
                Reoptimize();
        End
End Algorithm
```

Algorithm 1 aims to optimize the pattern data that has to be transferred. A transfer environment is set which includes basis 96-bit data preparation, application of Fast Fourier Transformation (FFT), Modulation etc. When the data is ready to transfer Cuckoo Search is applied. Cuckoo search is a hard threshold based swarm intelligence algorithm. It does not allow even one bit to be corrupted. The cuckoo fitness checks every bit and even if a single bit of that stream does not gratify the fitness constraint then the entire stream is dropped. After the application of Cuckoo search, the optimized dataset goes for validation. Neural Network follows a training and classification mechanism. The training set contains the optimized values and unoptimized values. Post classification, if the simulation error is less than.30 i.e 30% then the data is validated else it is dropped. Figure 2demonstrate the training layer of Neural Network.

The Neural Network is supplied with 50 Neurons to transfer the data from Input Layer to the hidden layer. The mark 4 in the input layer denotes that the data is divided into 4 segments as the output of Cuckoo Search. On the basis of training mechanism, the Neural Network performs a regression analysis and utilizes it to generate the validation error.

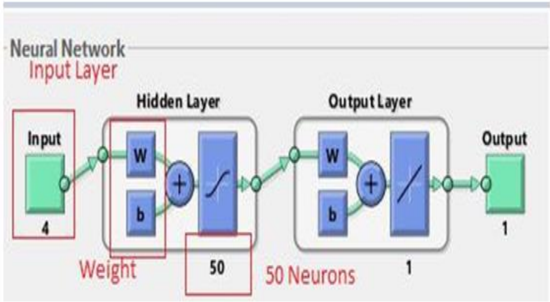

Figure 2. Training Layer of Neural Network

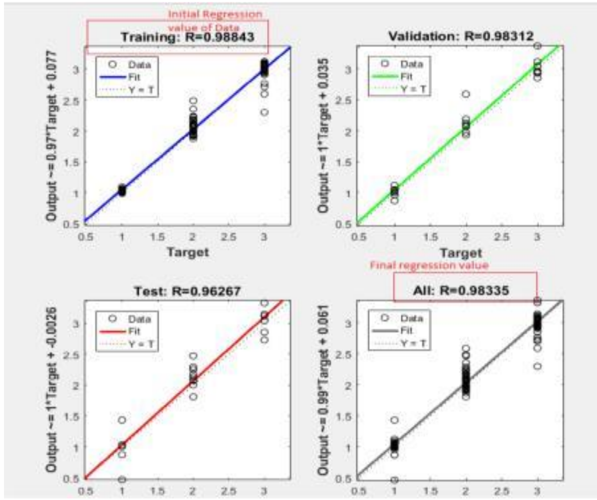

Figure 3. Regression Analysis of Data

Figure 3 shows that the R (R->Regression) at initial training stage stands a value of .988 and after the cross-validation is stood 0.983 which is a very minor difference. This produces an error below 10 percent and data is validated.

4. RESULTS

The following parameters are calculated after the validation of Neural Network.

Table 1. BER Comparison

Iteration Count	BER Cuckoo Neural	BER-LS
10	0.036	0.078
100	0.039	0.086
500	0.042	0.096

The optimized architecture results in less BER as compared to LS. The simulation is made for 10,100 and 500 iterations in which the proposed Cuckoo-Neural demonstrates a consistency in reduced BER.

Table 2. MSE Comparison

Iteration Count	MSE Cuckoo Neural	BER-LS
10	0.0023	0.4955
100	0.0027	0.6500
500	0.0063	0.6763

The story is no different for MSE. The proposed solution results in a maximum MSE of .0063 which is quite less in comparison to LS which is .6763.

Figure 4(a) and (b) represents the graphical interpretation of Table 1 and Table 2.

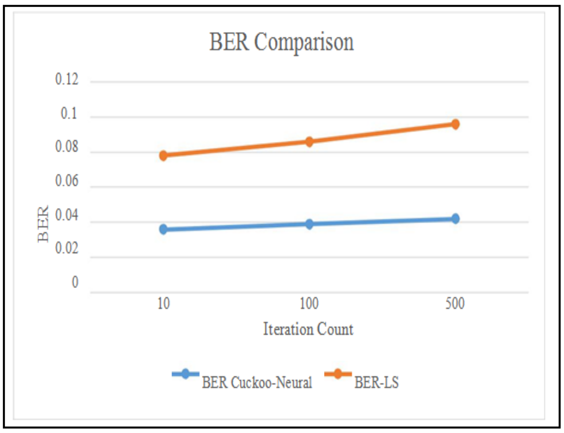

Figure 4(a). BER

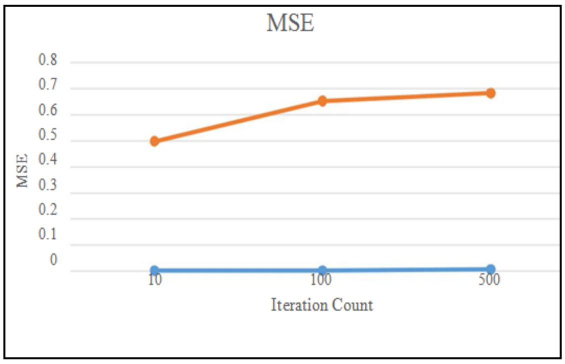

Figure 4(b). MSE

5. CONCLUSION

Channel estimation is identified as one of the key issues in cognitive radio. This paper utilized Cuckoo search and Neural Network to optimize the performance of Channel Estimation. The evaluation is made on the base of BER and MSE. The proposed algorithm ended up with an optimal value of MSE and BER. The simulation is done for 500 iterations and every time the proposed solution showed significant improvement as compared to LS.

The proposed work leaves a lot of futuristic opportunities. Other swarm intelligence techniques can also be tried with the proposed algorithm.

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