

# Improving OFDM Channel Estimation using Genetic Algorithm and Discrete Fourier Transformation

Tarun Kumar

Post Graduate Student,  
Department of Electronics & Communication Engineering  
I.K. Gujral Punjab Technical University  
Kapurthala, Punjab, India  
tarunk205@gmail.com

Dr. Dalveer Kaur

Assistant Professor,  
Department of Electronics & Communication Engineering  
I.K. Gujral Punjab Technical University  
Kapurthala, Punjab, India  
dn\_dogra@rediffmail.com

**Abstract**— Data transmission within Wireless sensor is a cause of concern due to low speed, high traffic and limited capabilities of sensors. To enhance the data transmission rates, OFDM (Orthogonal Frequency Division Multiplexing) is used. OFDM significantly enhances the rate with which data is transmitted from source to destination. As traffic over the channel within OFDM increases transfer rate again comes into stake. Bit error rate increases by the application of traffic. This literature purposes genetic algorithm with DFT (Discrete Fourier Transformation) to reduce Bit Error rate (BER) and Signal to noise ratio (SNR). The objective function is set up to take SNR below threshold value. The iteration producing least SNR is selected as optimal generation and correspondingly BER is retained. Result shows improvement from existing literature by 20%.

**Keywords**- OFDM, BER, SNR, LS, MMSE

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## I.INTRODUCTION

In mathematics, Discrete Fourier Transformation(DFT) is used in order to convert equally spaced signals to equal length signals [1]. In DFT, Inverse DFT is used along the sender end to convert transmitted signal into carrier format along sender end. DFT is placed at receiver end to decode the data received. The signal transmission in wireless sensor involves sensors. Detailed description of WSN is given in further discussion.

### A. WIRELESS SENSOR NETWORK(WSN)

Wireless sensor network consists of sensors placed at sufficient distance from each other so that they can establish communication. WSN are used in variety of fields like healthcare, military, biological, environmental, home and other commercial applications. WSN is capable of sensing, actuating and relaying thousands of sensor nodes and put remarkable impact everywhere [2].

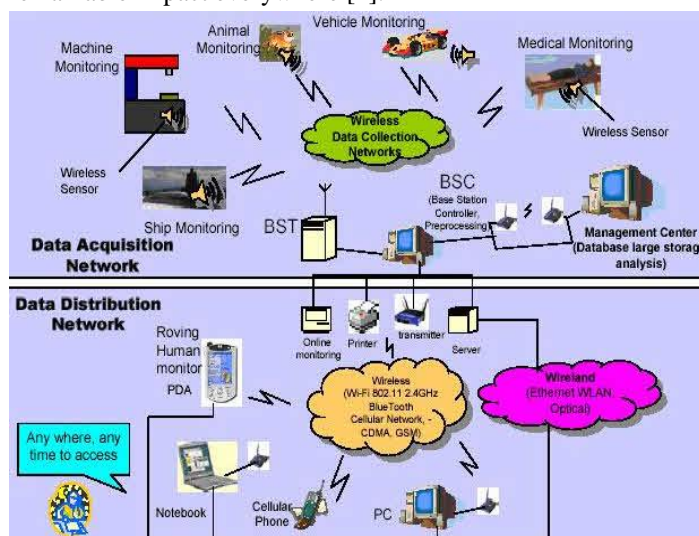


Figure 1: Wireless Sensor Network

WSN is a system which incorporates a gateway to provide wireless connectivity back to the wired world and distributed nodes. It is network consisting of spatially distributed autonomous devices using sensors to monitor physical as well as environmental conditions [3]. WSN is a wireless network that consists of base stations and numbers of nodes. These networks is used to monitor physical or environmental conditions like sound, pressure, temperature and co-operatively passes data using network to a main location.

### B. OFDM

OFDM is one of the best techniques to transfer data at high rate with high bandwidth efficiency [4, 5]. It is used in various fields like digital audio broadcasting systems, digital video broadcasting systems, digital subscriber line standards and wireless LAN standards such as the American IEEE standard. By using different phase shifting keys user can avoid the time varying channel [6]. OFDM receiver is a channel estimation block. Efficiency of channel estimation directly impacts bit error rate performance of the OFDM system. Channel estimation can be done using LS or MMSE for frequency domains.

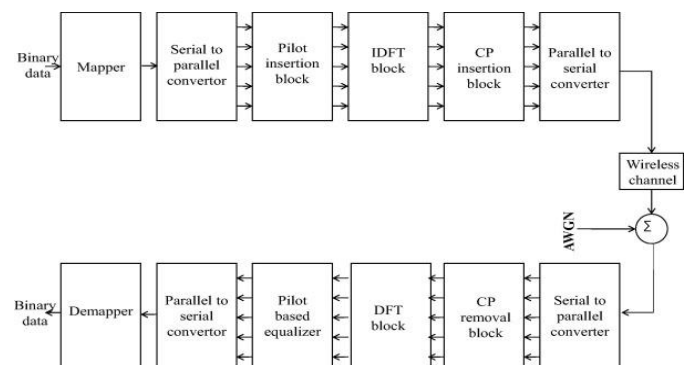


Figure 2: A typical baseband OFDM system block

## II.CHANNEL ESTIMATION TECHNIQUES

The channel for data transmission depends upon flat fading or selective fading type [7, 8]. The synchronization between transmitter and receiver is required for achieving better results. By using frequency synchronization BER performance of any given channel can be reduced. LS based and MMSE based are two techniques which are discussed below:

Least Square (LS) based frequency domain channel estimation methods are simple in implementation but didn't require KCS.KCS includes parameter like channel length, number of channel taps and AWGN noise power etc. LS estimates Channel Frequency Response (CFR) to obtain CFR at all positions [9]. The CFR after calculation converted into CIR using an IDFT block which is de-noised by performing truncation and thresholding operations.

$$X^r(n) = S^r(n) + W^r(n) \quad (1)$$

Where S is an arbitrary data vector, W is the noise factor added to it.

LS estimator calculates the values of channel bandwidth using the following equation

$$H_{LS}^{\wedge} = X^{-1}H \quad (2)$$

$$H_{LS}^{\wedge} = [(X_k/Y_k)]^T \quad (K=0, 1, \dots, N-1) \quad (3)$$

Minimum Mean Square Error (MMSE) estimation includes information for the parameter to be estimated to achieve improved estimation performance [10]. This channel estimation is given in the case of a non-invertible channel covariance matrix as a single input single output OFDM system.

$$H_{MMSE} = F g_{MMSE} = F[(F^H X^H)^{-1} R_{gg}^{-1} \sigma_n^2 + X F]^{-1} Y \quad (4)$$

## III.PARAMETER EVALUATION STRATEGIES

Bit Error Rate (BER) is the number of bits received during the transmission of data through channel and that can be altered due to noise, wireless multipath fading, interference, distortion, bit synchronization etc which causes error during transmission [11], [12]. The transmission BER is the number of bits that are in corrected before error correction, divided bit is the total number of error bits.

$$BER = \text{number of errors} / \text{total number of bits sent}$$

Signal to Noise Ratio (SNR) is a measure that how strong the signal is compared to the noise [13, 14]. If the noise is present in the signal then it will make the signal undetectable. SNR is the ratio between signal powers and the noise power and it can be calculated as:

$$SNR = \frac{P_{\text{signal}}}{P_{\text{noise}}} \quad (5)$$

## IV.PROPOSED SYSTEM

In the proposed system, DFT uses Genetic Algorithm(GA) to reduce BER and SNR [15, 16, 17]. GA is used to resolve both constrained and unconstrained optimization problems and these algorithms repeatedly modifies a population of individual solutions [18, 19, 20]. By using this algorithm we try to reduce the BER and SNR that comes during transformation of data through channels. The proposed algorithm as under:

### GAOFDM

- Input: Number of Symbols, Transmitter, Receivers, Multicarrier (MC)
- Output: SNR, MSE
- a. Initialize Generation(G) with random selection
- b. Calculate DFT Matrix  
 $F = \text{dftmtx}(nFFT)/\text{sqrt}(nFFT)$
- c. Calculate SNR by the use of Equation as  
 $\text{snr} = 10.^{(\text{EsNodB}/10)}$
- d. Perform Modulation using modem functions as  
 $\text{modObj} = \text{modem.qammod}(M)$
- e. Transmission of data towards receiver
- f. Perform demodulation  
 $\text{demodObj} = \text{modem.qamdemod}(M)$
- g. Generate Random Taps
- h. Perform normalization operation
- i. Perform Pilot bit insertion
- j. Perform Inverse Fourier transformation using IFFT
- k. Perform Channel Convolution and AWGM  
 $y = \text{conv}(xout, g);$
- l. Perform Channel Estimation in terms of GA\_DFT\_LS and GA\_DFT\_MMSE
- m. Records parameters for comparison in next generations.
- n. End of generation
- o. Calculate fitness by comparing parameters with Threshold value and perform uniform crossover and flip bit mutation.
- p. Repeat steps b to m until all the generations is complete.

## V.FLOWCHART

In our proposed system by using Genetic Algorithm objective function is used to reduce SNR value. This process of reducing the SNR value works till we receive better result.

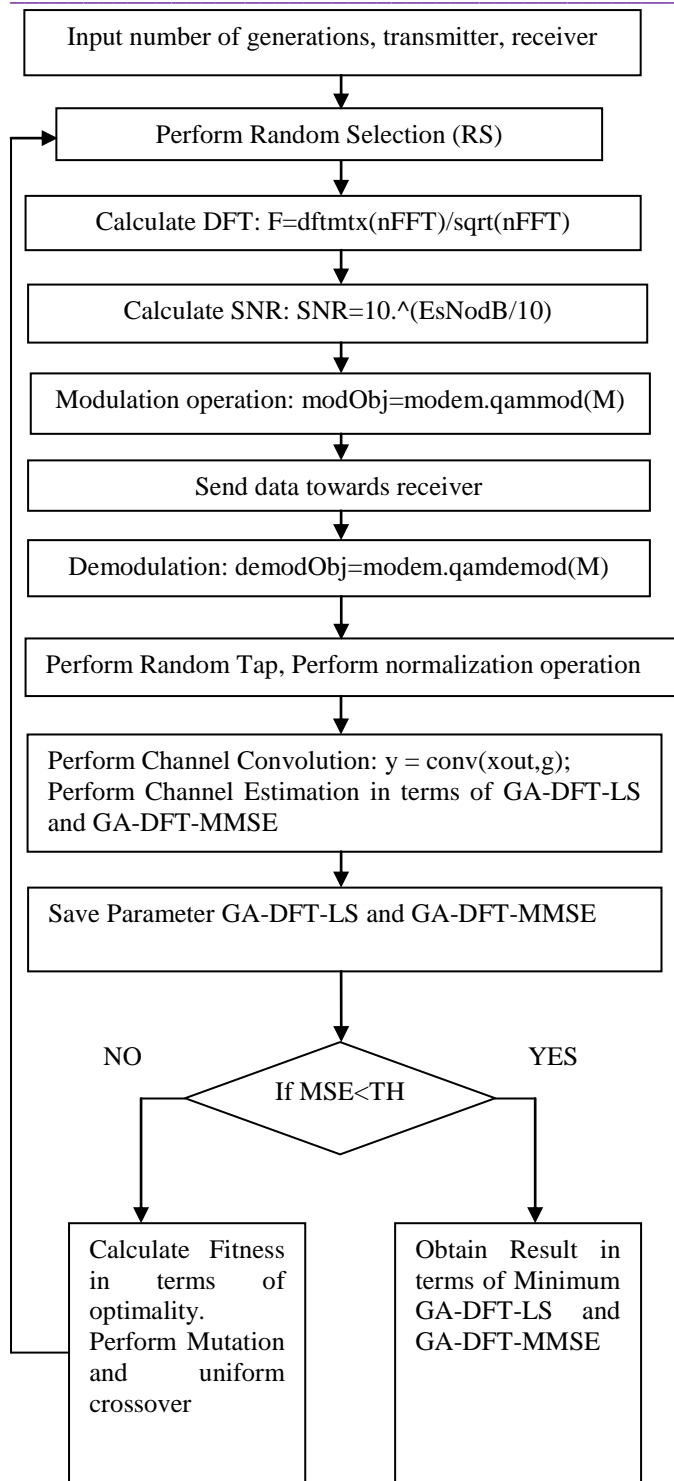


Figure 3: Flowchart of the Proposed Algorithm

## VI. PERFORMANCE ANALYSIS

The following graph shows the comparison between DFT-LS and GA-DFT-LS and displays the performance of both of them.

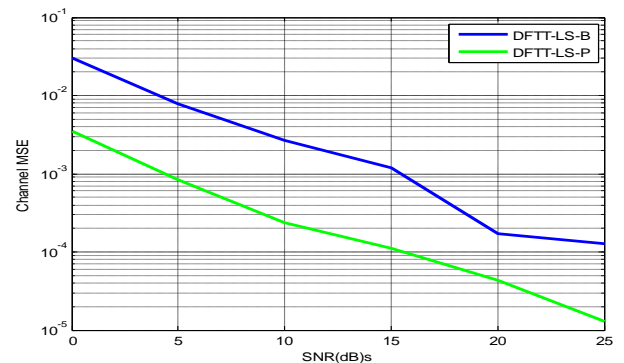


Figure 4: Comparison between DFT-LS and GA-DFT-LS

The following graph shows the comparison between DFT-MMSE and GA-DFT-MMSE and shows the performance of these channel estimation techniques.

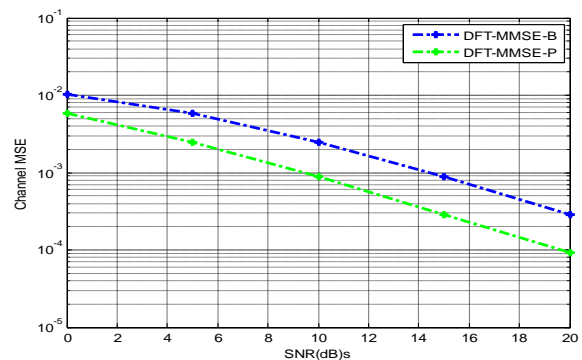


Figure 5: Comparison between DFT-MMSE and GA-DFT-MMSE

After applying genetic algorithm BER is considerably reduced along with SNR. Channel estimation is also improved by using genetic algorithm in OFDM.

## VII. CONCLUSION AND FUTURE SCOPE

MMSE is an efficient mechanism for channel estimation. As the traffic in wireless networking increases, the bit error rate is also increased. With signal to noise ratio, this figure keeps on increasing by leaps and bounds. To resolve the problem, DFT MMSE is used. DFT MMSE levels out the equally spaced signals and allows the symmetry to be established among the OFDM transmission process. The result is improved by the application of genetic algorithm. The generations will be evaluated and the generation giving the best possible result is retained. The objective of the entire operation is to reduce SNR and obtain optimal BER in case of DFT MMSE by the application of GA.

DFT MMSE that we did in our paper with genetic algorithm in the future can be implemented using PSO to further reduce BER.

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