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OPTIMIZATION OF RECEIVED SIGNAL USING SLOTTED WAVEGUIDE ANTENNA FROM LONG TERM EVOLUTION (LTE) DRIVE TEST DATA USING COMPUTATIONAL INTELLIGENCE

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Abstract- In LTE system Channel estimation is an important part of the system. Least Square (LS) & Minimum mean Square Error (MMSE) Algorithms are employed for LTE Downlink. The problems associated with LS is its High Mean Square error & Drawback of MMSE is its Complexity. Novel Technologies such as Orthogonal Frequency Division Multiplexing (OFDM), Multiple Input Multiple Output (MIMO) Antennas along with Nature Inspired Algorithm can enhance the performance of the current wireless communication system. The paper aims at optimization of LTE pilots assisted signal received in LTE Drive Test. Pilots are transmitted along with data to obtain channel knowledge, which help at the receiver for decoding of the received signal where a LS, MMSE Combined with Hybrid Taguchi Genetic algorithms are applied, Performance of this algorithms have been evaluated for different channel models and their performance has been measured in terms of Bit error rate (BER) & Symbol error rate (SER).

Keywords: Genetic Algorithm, Taguchi, BER, SER, SNR, Antenna, LTE.

1. INTRODUCTION

LTE techniques be a part of a range of arouse the curiosity in these days for remote communication. The enterprise of numerous radio wires leads in a noteworthy alternate in ability except any extra particular manipulate or transmission ability [1]. MIMO frameworks misuse the multipath structure of the engendering channel. Be that as it may, relationships amongst channel state information are affected by using the radio wire properties. As the receiving wires are placed side by side in a MIMO cluster, frequent coupling affects may also happen [2]. All these influences ought to be taken care when planning a receiving wire cluster for LTE systems. Many LTE radio wire graph optimization ponders have been special in writing.

Capacity equations are very important for shared coupling and spatial relationship influences with a Rayleigh blurring Channel being accepted [3, 4].

In expansion, the structure of geometry viewed represent specially uniform direct clusters with bifurcation between the elements being optimized. The difficulty of how originators can fittingly select the quantity of radio wires at the topsy-turvy base station and portable gadgets has been tended [5, 6]. Optimizing the MIMO framework capability with unequal costs of actualizing receiving wires at each channel closes has been managed. In any case; in this work, the fetched work is communicated using approximated asymptotic expression for the ergodic capability calculations. From geometry will power point of see, Uniform Direct Cluster (ULA) is the principal frequent geometry in modern times far off frameworks [7].

The Uniform Circular cluster (UCA) is as an optionally available geometry with a few upgraded properties. The comes about in [8-10] appear that the spatial relationship diminishes for UCA in contrast to ULA on regular for little and direct Precise Spread for comparable gap sizes. On the different hand, ULA has less spatial relationship than UCA for close broadside angle-of-arrivals with direct as in a later work, Recioui and Bentarzi [11] challenged ability maximization thru optimizing the spacing s between the elements of a direct cluster taking under consideration frequent coupling and spatial relationship at the identical time [12].

A channel display used to be proposed to account for both frequent coupling and spatial relationship and has been accredited with the aid of comparing it to its self sustaining partners. The comes about uncover an upgrade in system potential relative to the tactics exact in writing which can be beneficial in existing day remote verbal exchange frameworks [13]. The geometry considered in that work was once a straight cluster of halves of wave dipoles geared up in a side-by-side setup at both transmitter (Tx) and collector (Rx) [14].

So distant, strategies based totally on the hereditary calculation, subterranean insect colony optimization, molecule swarm optimization, Tabu look, bees' calculation, differential advancement, and Clonal willpower have ended up prevalent, and they have been utilized in fathoming radio wire cluster design amalgamation problems. The exhibitions of these strategies are found to be most desirable than these of the classical optimization instruments and the regular explanatory strategies [15]. Each of these strategies has its focal points and drawbacks. Developmental optimization strategies that are successful in tackling multi modal work optimization problems have moreover been related in radio wire plan.

Taguchi strategy has a place to the path of optimization strategies named global optimizers whereas the greater recognizable, traditional techniques such as slope and the quasi Newtonian strategies are labeled as neighborhood optimizers. The qualification between nearby and worldwide optimization strategies is that the regional strategies create comes about that are incredibly subordinate on the on the starting point or preliminary guess, while the global strategies are distinctly impartial of the initial conditions.

Besides, neighborhood techniques put imperatives on the arrangement space such as differentiability and coherence which are difficult or indeed outlandish to fulfill in hone. The worldwide strategies, on the different hand, are normally self reliant of the commencing point and put a number of constraints on the association space [16]. This is regularly frequently the case in troubles which are defined discretely or might also incorporate non differentiable capacities. Another fascination emerges inside the straightforwardness of the calculations and the ease at which they may be modified [17].

The Taguchi strategy, which ought to be a energetic format approach, employments numerous ideas from measurable exploratory plan for assessing and enforcing upgrades in items, forms, and gear. The basic tenet is to make strides the quality of a object with the aid of minimizing the have an effect on of the version motives without meting out with the causes [18-19]. The two primary instruments utilized within the Taguchi method are the 1st signal-to-noise proportion (SNR) which measures fine tuning of channel 2. Orthogonal clusters which are utilized to think about several format parameters at the equal time [20, 21]. On the different hand, amongst the existing optimization calculations, hereditary calculations (GAs) have gotten magnificent consideration with admire to their viable as proven optimization methods for complicated issues and have been correctly related in distinct zones [22, 23]. The most precise highlight of the GA as an optimization method is its verifiable parallelism, which may additionally be an end result of the development and the hereditary-like handle [24].

2. MATERIALS AND METHOD

2.1. Channel Estimation in LTE

In an LTE framework, numerous pilot photos are embedded with a few records photographs and balanced with a acquire of OFDM modulators [1]. Numerous receiving wires are utilized to transmit the OFDM modulators yield at the transmitter side. Within the recipient side, the distinctive alerts from the transmitter are come to with a bunch of OFDM demodulators and the CSI can be assessed through any preparing primarily based calculations. A basic variations technique used to be conveyed with two radio wires at the transmitter and one receiving wire at the collector and more than a few issues such as manage necessities, extend impact, channel estimation mistakes and bit mistake price execution have been talked about.

Numerous channel estimation strategies are depicted by way of distinct analysts in LTE framework. These techniques are training based, daze and semi-blind channel estimation techniques [6]. The LS and MMSE are the most important well acknowledged estimation strategies [2, 3, 4]. The LS estimation has less complexity but at the same time, it has tall MSE. The MMSE estimation has much less MSE than LS estimation at moo values of SNR with greater complexity. A Developmental Programming-based channel estimation is related to optimize LS and MMSE estimation. This strategy minimizes the MSE more than the LS and MMSE estimation. far-off better; A an awful lot better; A higher; A stronger; An improved & GT; An improved pilot based totally estimation is created for rapid time altering framework to gauge Rayleigh channel complex adequacy (CA) and the provider recurrence counterbalanced (CFO) [12]. The execution of LS calculation is multiplied by way of the optimization of pilot tones making use of differential development calculation in an unused approach. Moreover sparsity-aware method of NBI estimation is displayed to pass ahead the execution of LTE framework [23].

2.2. GA-Taguchi Based Optimized Channel Estimation

The most goal of the proposed GA-based optimized channel estimation is to distinguish the most gorgeous channel with much less MSE than the present LS & MMSE channel estimations. The piece design of the proposed GA-optimized channel estimation is regarded in Figures 1 and 2 [9].

Application of Genetic Algorithm in Estimated Channel Selection using Least Square technique is explained in Figure 1, where particles after decided iterations will find out best fittest solution, similarly Application of Genetic Algorithm in Estimated Channel Selection using Minimum Means Square Error is explained in Figure 2, where particles after decided iterations will find out best fittest solution [18].

Optimization techniques are evolved by the inspiration of biological methods like mutation, crossover, inheritance and selection. Optimization is a process that attempts to optimize i.e., to maximize or minimize the objective function by using mathematical steps. It is also called as mathematical programming [19]. An optimization algorithm is a method in which the optimum or satisfactory solution is found by iteratively comparing various solutions. Therefore, the purpose of optimization is to find the "best" solution and design the system relative to the given constraints [20].

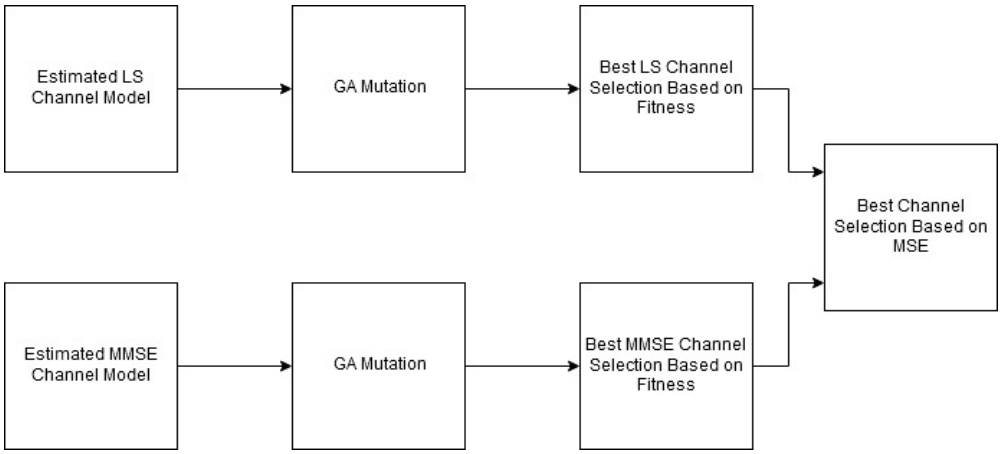

Figure 1. Block diagram of the Genetic Algorithm Based Least Square and Minimum Mean Square estimation model [8]

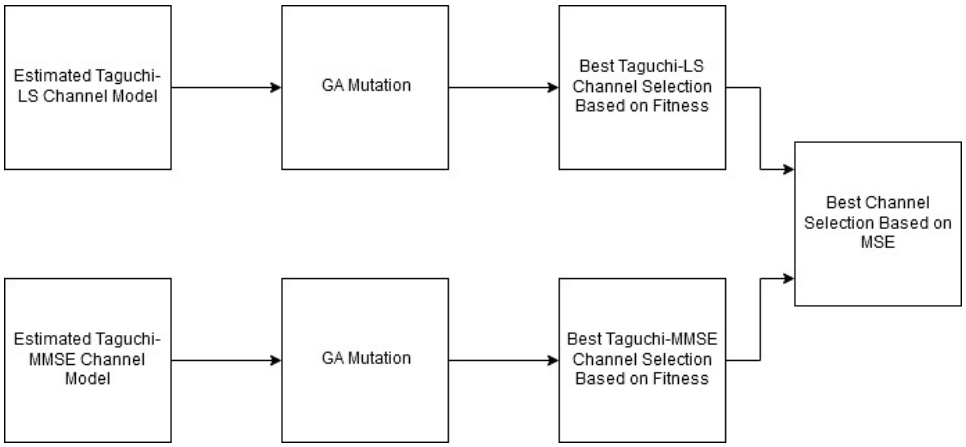

Figure 2. Block diagram of Genetic Algorithm Based Taguchi-Least Square and Taguchi-MMSE estimation model [12]

The genetic algorithm (GA) seem is the best solution because of its multi-objective optimization capability [23]. It can be implemented to solve the problems of channel estimation which have large search space and contradictory objectives. In the research models [24], the authors describe the cognitive decision making process using the GA to solve the multi-objective optimization problem in the Channel State Information Problem. However, this technique only considers the channel condition as the prime factor and lacks in terms of Signal to Noise Ration (SNR) & Bit Error Rate (BER) requirements [17].

In LTE communications the channel estimation is a very important from receiver user point of view. The different algorithms for channel estimation are to be defined and implemented in such a way that they must satisfy both the time domain parameters and frequency domain parameters. Therefore, Channel estimation and Optimization techniques are most essential works in LTE System Algorithms like LSE, MMSE are used to decrease error rate in the LTE system [16]. Also, Evolutionary Algorithm algorithms like "Genetic Algorithm" (GA), "Evolutionary Programming" (EP), "Particle Swarm Optimization" (PSO), "Artificial Bee Colony" (ABC) and "Cuckoo Search" (CS) algorithms are used with the defined objective to minimize errors, reduce complexity and thereby also improving performance of system [18].

In this proposed strategy, the present LS and MMSE channels are arbitrarily changed by GA, and the main channel is diagnosed based totally on the well-being work which is given inside the condition (1) and (2). So also, Taguchi-LS and Taguchi-MMSE evaluated channels are too arbitrarily changed through GA, and the most wonderful channel is diagnosed primarily based on the health work [9].

$$Fitness = [(H - LS)/H]^2 \quad (1)$$

$$Fitness = [(H - MMSE)/H]^2 \quad (2)$$

where, H is the reference channel.

Equations (1) and (2) defines the Fitness function for Least Square & Minimum Mean Square Function which is depend on H Matrix of Antenna. At that point, MSE is calculated for the GA converted LS, MMSE, Taguchi-LS and Taguchi-MMSE channels. At last, the finest channel with MSE is chosen from the bunch of GA-based LS, MMSE, Taguchi-LS and Taguchi-MMSE channels. The LTE system is represented as by equation (3).

$$Y = HX + N \quad (3)$$

where,
Y = Output Matrix,
X = Input Matrix,
H = Channel Matrix,
N = AWGN Noise Matrix.

3. RESULTS AND DISCUSSION

The execution of the proposed GA-optimized channel estimation for 4G-based 2×2 MIMO LTE framework with LTE Drive Test Data of 1709 rows on Anaconda platform by using spider application on python language is examined with the framework parameters appeared in Table 1.

Table 1. Simulation parameters

Parameters	Value
FFT Size	512
No. of Symbols	100
Modulation	QAM
No. of Pilots	4
Channel	AWGN

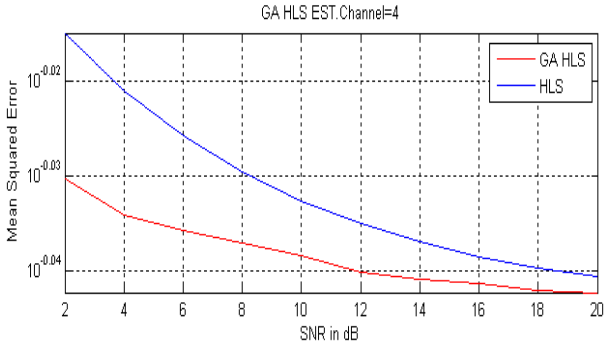

Figure 3. MSE versus SNR of LS and GA-based LS channel estimation

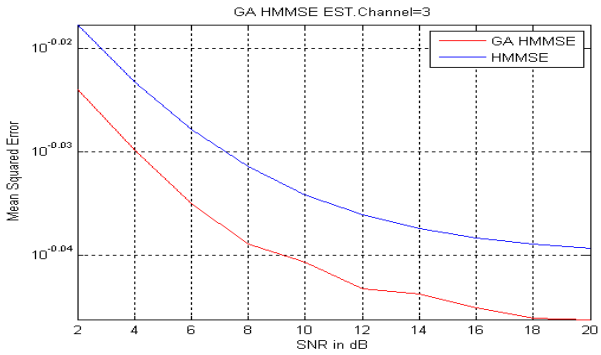

Figure 4. MSE versus SNR of MMSE and GA based MMSE channel estimation

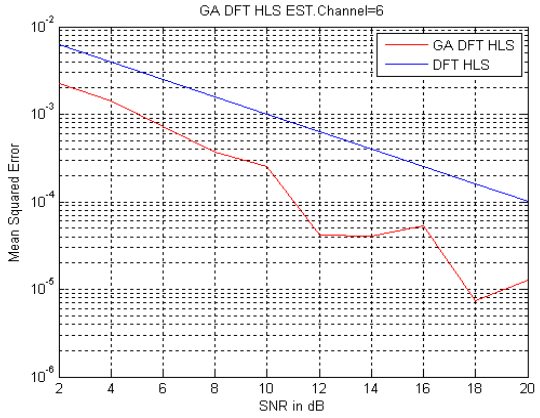

Figure 5. MSE versus SNR of Taguchi-LS and GA-based Taguchi-LS channel estimation

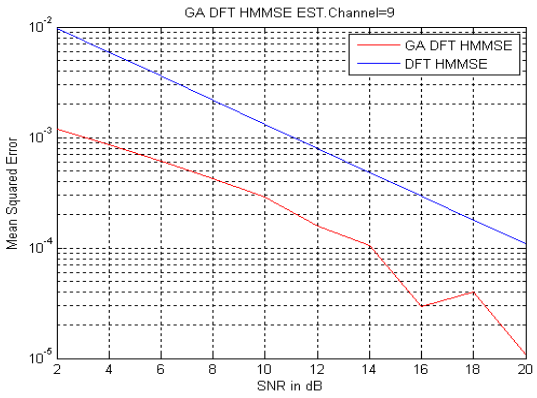

Figure 6. MSE versus SNR of Taguchi-MMSE and GA based Taguchi-MMSE channel estimation

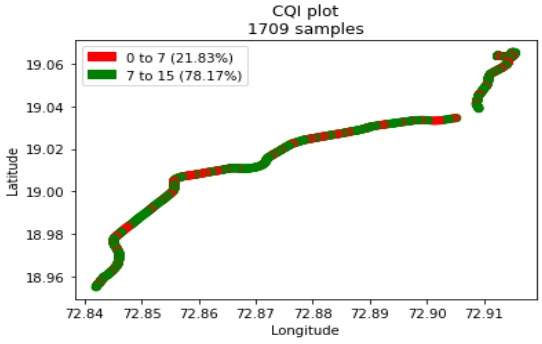

Figure 7. Latitude vs Longitude analysis of Drive Test Data

Drive Test Data received from Slotted waveguide Antenna is analysed with the help of evolutionary optimization Technique using Python Language. It can be analysed with the help of Matlab, Anaconda Platform & Google Colab. All Traditional Techniques LS, MMSE are Compared with Proposed GA-LS & GA-MMSE Technique.

This Figure 3 explains the Mean Square Error versus Signal to Noise Ratio of Least Square channel estimation technique and Genetic Algorithm based Least Square estimation Technique. It in reality demonstrates that the everyday MSE of GA-optimized LS channel estimation is 1.5% ($10^{-0.01}$) lesser than the MSE of LS channel estimation. It shows that When GA Combined with LS. It gives improved results when we compare it with LS only, definitely in GA complexity reduce & best solution received.

Figure 4 explains the Mean Square Error versus Signal to Noise Ratio of Minimum Mean Square Error channel estimation and GA combined MMSE channel estimation. By the inclusion of GA based totally optimized channel, the ordinary MSE is lowered 0.45% ($10^{-0.002}$) than the MSE of MMSE channel estimation. Definitely this improves the overall performance of LTE System & it helps to reduce complexity, increase efficiency.

Figure-5 and Figure-6 gives a complete analysis of Taguchi Based GA-LS & Taguchi Based GA-MMSE, from the results it appears that. Figure-5 demonstrate that how GA Taguchi-LS is truly better than Taguchi LS &

there is a difference of (10^{-1}) in Means Square Error similarly Figure-6 explains GA Taguchi MMSE & Taguchi MMSE this results gives complete explanation of How GA change & improve all traditional Channel Estimation Technique.

Figure-6 seems the way better execution of GA-optimized blended Taguchi-MMSE channel estimation than the Taguchi-MMSE channel estimation and LS channel. estimation in terms of MSE. By the presentation of GA, the best channel is recognized with the 0.21% lessening of MSE than the existing Taguchi-MMSE estimation.

Figure-7 explain channel quality Index for 1709 Samples of Drive Test results for LTE. These results are taken for Longitude of Different Location of Drive Test and this results than compared with latitude it is analyse separately for different samples like for 0-7 & 7-15 and as sample increases its ratio for different channel quality index also change.

Results Clearly Defines that LTE Drive test data when received using slotted wave guide Antenna & than by applying Genetic Algorithm Signal to Noise Ratio Improves as well as Complexity Reduces, Least Square method gives high losses as compared to Other Techniques & Minimum Mean Square Error gives better Results but its complexity is high. By this Novel Approach both Signal to Noise ratio Improves & Complexity Reduces.

Channel Quality Indication gives an exact Location estimation by considering Latitude & Longitude, for less samples results are congested but when we consider more samples it improves, Channel quality Indication improves for High Latitude & Longitude.

Traditional technique Least Square & Minimum Mean Square when merged & compared with Proposed Algorithm, it gives good results for new proposed technique.

4. CONCLUSION

An Effective Genetic Algorithm based optimized channel estimation for LTE framework is proposed in this research paper. In this proposed plot, execution of Least Square, Minimum Mean Square Error, Taguchi channel estimations and their optimization utilizing Genetic Algorithm has been carried out with the assistance of Google Colab and MATLAB. Using python language, the code has been designed and written where Genetic algorithm has been applied on LTE drive Test data of around 1709 samples of different Latitude & Longitude. Signal to Noise Ratio is Compared with Mean Square Error and Minimum Mean Square Error and Channel Quality Indicator is Calculated for different range of samples.

The results come about show up that Mean Square Error of Genetic Algorithm optimized Taguchi-Least Square channel estimation is 1.0% lesser than Taguchi-LS estimation and the GA-optimized Taguchi-MMSE estimation has much less 0.21% MSE than Taguchi-MMSE estimation. It clearly demonstrates that the proposed Genetic Algorithm based totally optimized Taguchi-MMSE channel estimation. Optimal Signal Detection in LTE system using Computational Intelligence is new direction of Research in wireless network because of Internet of Things large number of devices is continuously sharing large amount data therefore Channel Estimation is very important and our designed model solve the initial challenges in this direction. Inclusion of Particle Swarm Optimization (PSO) is future scope for new study on Channel Estimation using Evolutionary Algorithm.

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