A Beam Forming Algorithm for Better and Enhanced 5G Interference-Coexistence Communication

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***Abstract*- When Multiple wireless systems are connected to a particular network in the same frequency band, the chances of interference are high. In this paper a new method is put forward. Through antenna array processing, the interference is taken care of. This technique provides less Mean Square Error (MSE) than Linearly Constrained - Least Mean Square (LC-LMS). Golay beamforming is suggested for handling interference and coexistence. For Arbitrary Sized Arrays, Power efficient broad beams is considered. The above mentioned Arbitrary Sized Arrays (ASI) relies on doubling of the ULA, which provide ways to construct Uniform Linear Arrays (ULA). The Convergence rate seems to be faster than the classical methods.**

***Keywords*- Mean-Square-Error, wireless systems, 5G network, beamforming, Uniform Linear Array.**

1. INTRODUCTION:

A far-flung implementation of 5G technologies have begun to arise in many countries all over the globe [1]. As we step foot into this advancing world of technologies, working with higher data rates and amplifying performance of the network have inspired us to use these technologies. Due to this vast growth of 5G system, the researchers have been looking at the restrictions of the fourth generation (4G) communication systems. Now that we live in our fifth generation of technology, the amount of data or information that has to be transmitted and received require much more higher technologies.

New wireless network systems which satisfy several different traffic requirements simultaneously for the evolution of 5G technology must also be kept in mind [17]. 5G communication system will change the view of wireless communication. It has numerous and magnificent applications along with super-fast data rates supported with good performance. This makes it necessary to make essential changes to the communication infrastructure and inventive apprehension of the anticipated performance. In wider ranges, high frequencies are always to a fault brittle. Hence high frequencies are well suited for any indoor communications [5,6]. This has motivated researchers to scrutinize the probability of constructing transmitters that produce strong signals by not amplifying the power. Beamforming and Multiple Input Multiple-Output (MIMO) are examples. The process of transmitting signals to a specific device or direction rather than spreading it in all the directions is called as Beamforming. In wireless communication, the most disastrous element is interference. There are researchers who have proposed beamforming methods to reduce the radiations in all the directions and improve the performance of the network. The user apparatus is expected to receive signal power. Due to the inadequate distance where the users are, this cannot be achieved. In addition to this, the user apparatus receives a better and enhanced signal power when the beams are not equally radiated equally in all the directions. This is usually done with the use of various antennas. This beamforming technique decides the figure and the direction at which the beam is aimed, how antenna elements must be used, the structure, the detachment of these elements along with the phase at which the signals are transmitted into the antennas. Through adaptive beamforming techniques, we can either get rid of interference or enhance the Signal to Interference Noise Ratio (SINR) [20]. A plan that depends on finding the exact locations of the users by obtaining the user's angles with the help of femtocells is proposed. Eventually, the users are affiliated again which provides the highest interference plus noise ratio (SINR) with the help of femtocells. High speed in convergence and in steady state SINR (signal to interference plus noise ratio) can be obtained successfully which is slightly sensitized to the step size of the final output SINR [18]. A dense deployed environment may be affected by the interference occurrence probability, whereas the spectral efficiency and throughput are substantial improved.

2. RELATED WORKS:

Antenna arrays is one of the widely investigated topics due to its numerous applications, extending from immense MultipleInput-MultipleOutput (MIMO) to cell organizing in cellular networks [16]. Indicated by the Direction of Arrival the adaptive antennas make use of different antennas for forming an array. To form a beam the Digital Signal Processor (DSP) is used [19]. Here an intrinsic less-dimensional positioning for an ideal multicast beamform will result in a greater number of transmit antennas. Which in turn leads to an effective algebraic algorithm and more specifically to the system which has big antenna array [6]. A Modified Great Deluge Algorithm (MGDA) requires complementary sequence and with the help of stochastic optimization it provides power efficient broad beamforming [7]. The open loop forced norm algorithm is used for norm control in LMS adapting method, it also performs Generalized Sidelobe Canceller (GSC) when more interreference impacts the Beam [10]. The weakness of Least Mean Square Algorithm is delayed convergence [21]. The proposed beamformer efficiently analyses the vector weights by attaining interference subspace for the existence of many interferences by using Duvall arrangement to clear the signal element from the data vector [12]. Instead of the old LCMV (Linear Constrained Minimum Variance) filter, a method is proposed. There is a log-sum done on the coefficients which is named as LC-LMS (Linearly Constrained Least Mean Square) [5].

In this research study, the second section discusses about the pre-existing methodology and techniques. While in the third section a novel algorithm and implementation of a beamforming algorithm is discussed. Finally in the fourth and fifth section, results obtained while implementation of the proposed algorithm is explained along with the final conclusion of the results.

3. ALGORITHM DISCRIPTION:

i. Uniform Linear Array (ULA):

ULA (Uniform linear array) is applied to optimize problems and study the algorithm behaviour. The signals taken are of narrow band which are observed like plane wave at receiving destination. The Fig (1) shows that the arrays are organized in a line with equal gaps. The incidence angle θ is the angle between DOA and y axis. The ULA model is shown in the Fig (1).
In an ULA, the space between two neighbouring antennas d is λ/2 (λ is the signal wavelength) is presumed. Which results in the phase difference between the two neighbouring antennas as πsinθ. The leading antenna is used as a reference. When the incident angle is θ_t (t=0, s), the equivalent steer vector can be transcribed as

$$x(\theta_t) = [1, e^{j\pi \sin\theta t}, \ldots, e^{j\pi(S-1)\sin\theta t}]^T$$

Then the complete steer vector is

$$x = [x(\theta_0), x(\theta_1), \ldots, x(\theta_s)].$$

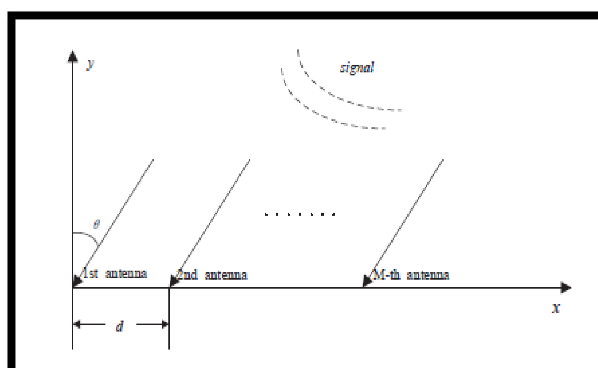

Fig (1): Uniform Linear Array of Antenna Model.

ii. Golay sequence:

The Array Size Invariant (ASI) beamforming depends on sequential doubling of the ULA, which provides something to do with the design of pattern-preserving weights for the ULA with sizes S = 2qR, where q ∈ N0 and R is the size of the proto array. First, we will find the similarity between our desired excitation weight vector and the golay complementary sequence.

Before we proceed, we need to know about Golay Sequences. First, we must define a function and let that be x, [x1, x2, xS] T∈ CS. This sequence or vector consists of unit norm complex values. Now we need to perform the Auto-Correlation Function for the two Aperiodic sequences we have. This is defined as:

$$R_x(\tau) = \begin{cases} \sum_{s=1}^{S-\tau} u_s u_{s+\tau}^*, & 0 \le \tau \le S-1, \\ \sum_{s=1}^{S+\tau} u_{s-\tau} u_s^*, & -S+1 \le \tau < 0, \\ 0, & \tau \in (-S, S). \end{cases}$$

This function can also be defined as Aperiodic Auto-Correlation Function (AACF).

Now a pair of unimodular sequence (x,y) will form the Golay complementary sequence. The final golay complementary sequence with complex values will be as follows:

$$R_x(\tau) + R_y(\tau) = 2S\delta(\tau)$$

The first sequence x will form it's Golay pair with the second sequence y to give Golay Complementary Sequence.

iii. *Modified Great Deluge Algorithm (MGDA):*

We have proposed a MGDA algorithm, in this we will have two phase sequence. Our algorithm will optimize our phases. The sequences are taken as follows: ϕx, [ϕx,1, . . ., ϕx,S] T and ϕy , [ϕy,1, . . . , ϕy,S] T. The sequence and the phases are related to each other by xs = ejϕx, s, ys = ejϕy, s, ∀s ∈ {1. . . S}.

The MGDA will maximize the utility function which is associated with the phase vector and will be calculated by maximizing ϕ X (ϕ) subject to ϕ ∈ [0, 2π) 2S,

In this equation, X(ϕ) is our utility function. To equalize we take:

X(ϕ) = − max τ∈ {−S+1..., S−1}, τ6=0 {| $R_x(\tau) + R_y(\tau)$|}.

Here the side lobes of the sum AACF must disappear altogether (i.e., X (ϕ) = 0), resulting to optimization. We will keep the side lobe level in a specific interval of tolerance nearing zero which might be adequate for real beam forming purposes.

Our principle will be implemented by increasing each phase ϕi by a corresponding increment value Δϕi. Then we will examine the resulting value of the utility function. When the utility value is above water level, our new state will be accepted and next phase will be altered, else the phase step must take an opposite side while the equivalent utility value will be compared with water level.

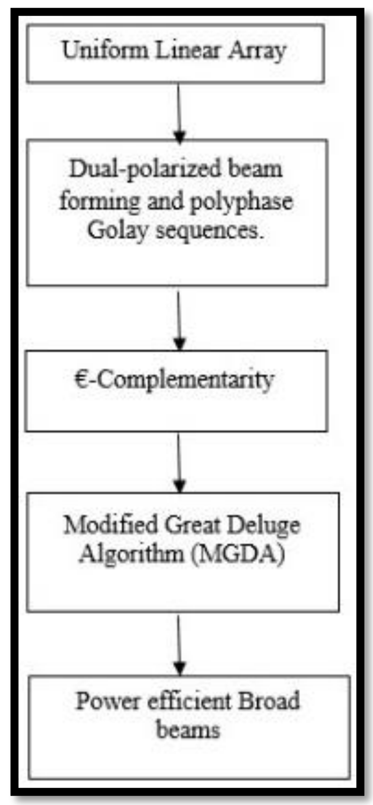

Fig (2): Block Diagram

ULA will simplify the optimization problem and analyse algorithm performance. As we know beams are more efficient and has got maximum throughput, hence golay sequence helps us to form the beams. The complementary is obtained from Golay with complementary angles between them. MGDA will optimize the phases of two-phase sequences.

4. *RESULT AND DISCUSSION:*

On Matlab our results are been compared with existing method. To test the proposed method's results in convergence rate, mean square and power efficiency we do simulations.

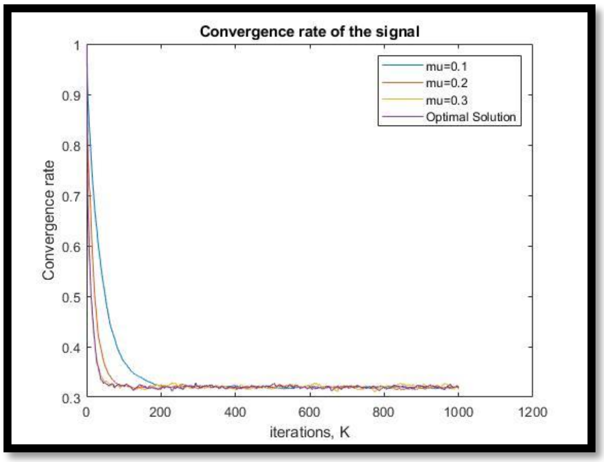

Figure (3): Convergence rate of the signal.

The Fig (3) shows the convergence rate of the signal, Mu is the convergence factor, in x axis number of iterations and in y axis the convergence rate for that iteration is plotted. Larger the value of mu faster the algorithm converges.

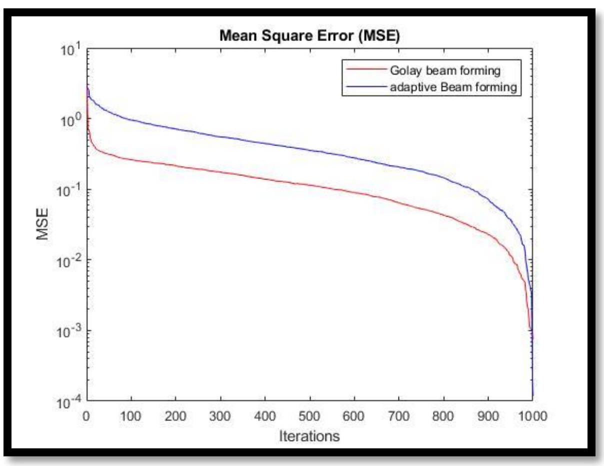

Fig (4): Mean square error Comparison.

The Fig (4) shows the comparison of the mean square error value of the proposed golay method and existing Adaptive Beamforming method. We plot number of iterations in x axis and mean square error in y axis. It can be seen that the mean square error for proposed method is less when compared with the existing method.

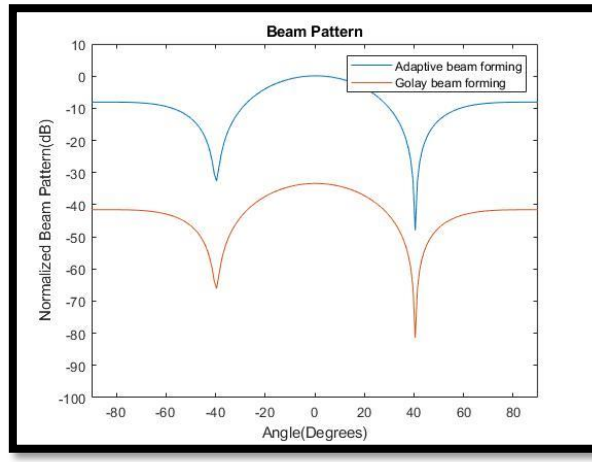

Fig (5): Comparison of beam pattern.

The Fig (5) shows the Beam pattern comparison, in x axis the angle in y axis the Normalized Beam Pattern power in dB is plotted. It can be seen that the power of the proposed beam pattern is less in comparison with the existing method.

5. *CONCLUSION:*

We proposed a new algorithm called golay sequence algorithm and adding the MGDA algorithm with it. Two aperiodic sequences are taken and auto correlation is provided resulting in a null value. These complementary sequences are golay sequences. For the antenna to generate sequence and to form beam we use golay algorithm. Our experiment will be performed on matlab platform. Firstly, we create input signal and get the desired signal. Then we take the signals which is polarized, after which we optimize the values. The optimization technique consists of the golay sequences and the MGDA algorithm. We calculate the beam according to the input generated. Our results will prove the efficacy of our method. A comparison of the beam pattern. Finally, we prove that our golay beamforming method is better than the adaptive beamforming method.

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