NULL STEERING PATTERN USING GENETIC ALGORITHM

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Abstract

In this paper, the technique for antenna array pattern synthesis with null steering using the Genetic Algorithms (GA) is presented. This technique is capable of synthesizing the array pattern with nulls imposed at the directions of undesired interferences while simultaneously maintaining the main beam directed towards the desired signal. The validity of the proposed technique is demonstrated via the simulation results.

Keywords: Null steering, genetic algorithm

Introduction

Null steering antennas are very important in wireless communication as it improves the signal to interference ratio by placing the null in the interference direction while pointing main lope to the desired direction [1]. Generally, the null positions in antenna pattern are the function of the complex weights. Their values are obtained by solving the linear equation. Nevertheless, the direction of interferences signals must be known exactly. This causes the problem in practice as the directions of interferences are varied with time in the real time situation. To solve the problem, the adaptive null steering is adopted, as it has the ability to track the interference direction.

Many an algorithms are used for the adaptive null steering problem. K. Güney and A. Akdagli [2] proposed *Tabu Algorithm* to search the complex weight to gain the desired null position. K. Güney and M. Onay [3] show an efficient method based on *Bees Algorithm* for the pattern synthesis of linear antenna arrays with the prescribed nulls. D. Karaboga, K. Gune y, and A. Akdagli proposed *Touring Ant Colony* optimization algorithm [4] presented for null steering of linear antenna arrays by controlling both the amplitude and the phase of array elements.

One of the major challenge's algorithms for adaptive null steering is *Genetic Algorithm* (GA) [5-8]. It is the powerful searching method. The GA that proposed in the previous works was based on minimized the array output power. The direction of main lobe must be kept to point in the desired direction during the process. Thus, it might be unsuitable in case of the desired signal arrives off the broadside direction. To solve the problem, the minimize error signal using GA is adopted. It is demonstrated in this paper.

Methodology

Figure.1 shows the operation of adaptive null steering antenna using GA to minimize array output power. The desired signal and interference signal are arrived in the direction of 0 degree (broadside direction) and 40 degree, respectively. The Dotted line is the initial pattern and the Solid line is the adapted pattern. It is seen that, the adaptive null steering antenna can place null in the interference signal. Thus, the signal to interference signal is improved. Nevertheless, in case of the designed signal arrives off the broadside direction the antenna is pointed main lobe incorrectly. This is shown in Figure 2, which the desired signal and interference signal are arrived in the direction of 20 degree and 40 degree, respectively

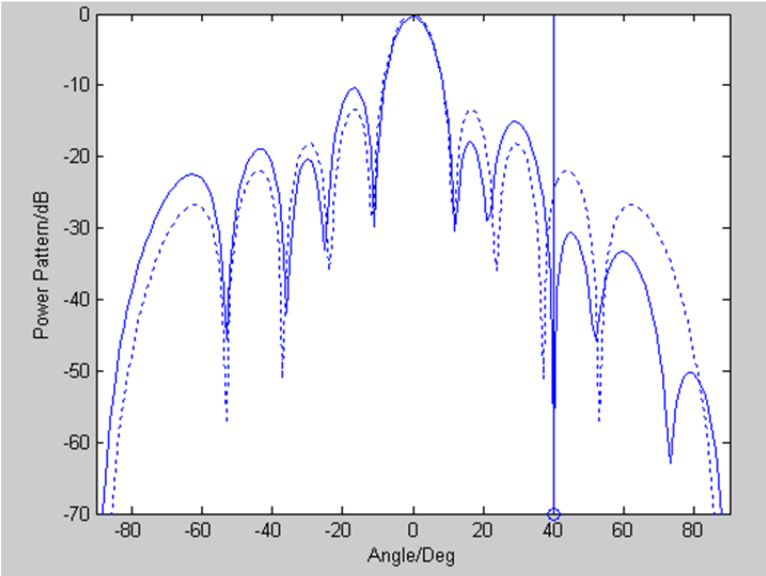

Figure1 Antenna Pattern of adaptive antenna using GA
Desired signal direction = 0 degree
Interference signal direction = 40 degree

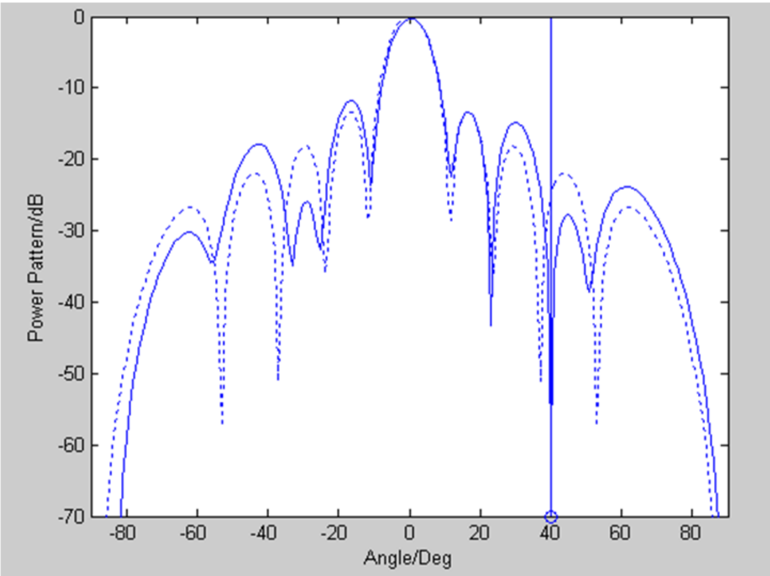

Figure2 Antenna Pattern of adaptive antenna using GA
Desired signal direction = 20 degree
Interference signal direction =40 degree

To solve the problem, we propose adaptive null steering based on minimizing error signal array output. Figure 3 shows block diagram of proposed adaptive null steering antenna.

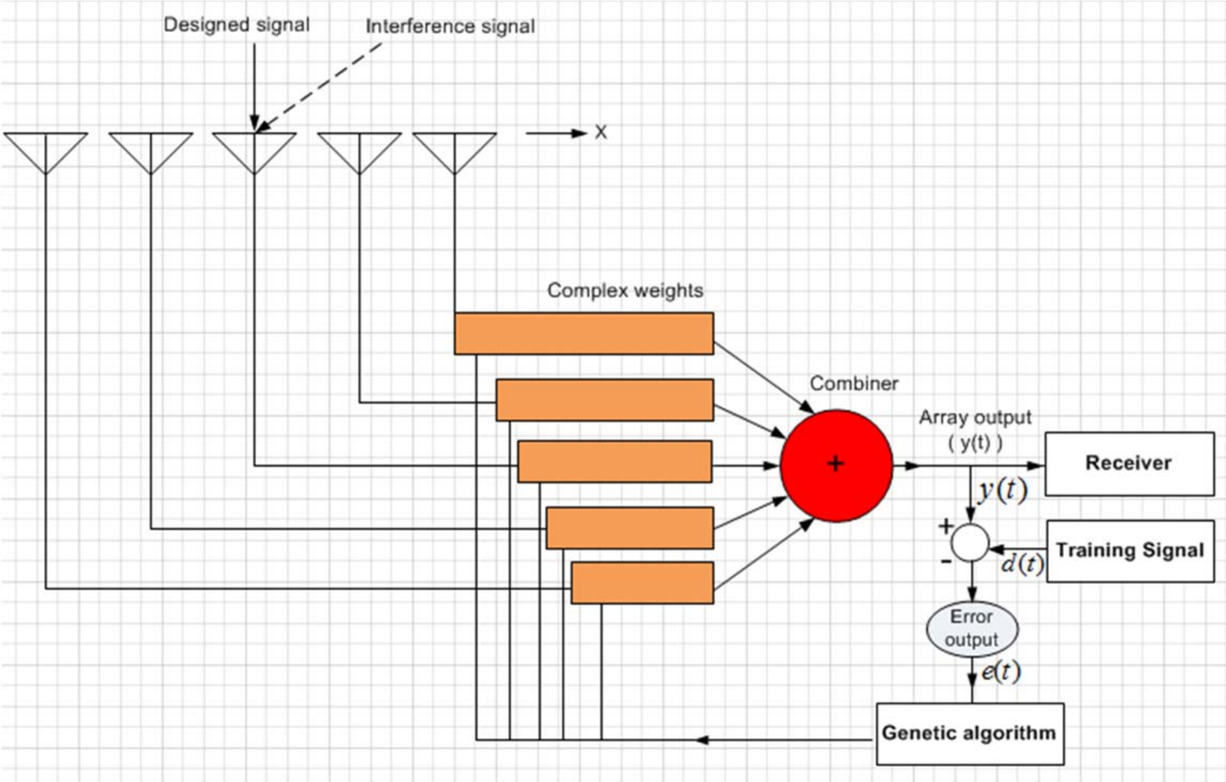

Figure3 Proposed adaptive null steering system

The block diagram of the proposed adaptive null steering system is shown in Figure 3. The system consists of the linear antenna array, complex weights, combiner and processor. The received signals of each antenna element are passed to the complex weights for adjusting the magnitude and phase and are fed to the combiner to combine them as the array output signal. The error signal is considered to use as the cost function for the GA process, it can be generated by comparing the array output signal to the training signal. The error signal is passed into the processor that contained the GA algorithm to process the minimize error signal.

The error signal is used as the cost function in the GA process is given by

$$e(t) = y(t) - d(t) \qquad (1)$$

where

$e(t)$ is error signal, $y(t)$ is array output and $d(t)$ is training signal.

Results

Figure 4 show the simulation antenna pattern of the proposed adaptive null steering antenna system. In the calculation, the number of antenna element is fixed to be 10 the spacing between the antennas is 0.5 lambdas. The desired signal and interference signal are arrived in the direction of 0 degree (broadside direction) and 40 degree, respectively. The Dotted line is the initial pattern and the Solid line is the adapted pattern. It is seen that, the adaptive null steering antenna can place null in the interference signal.

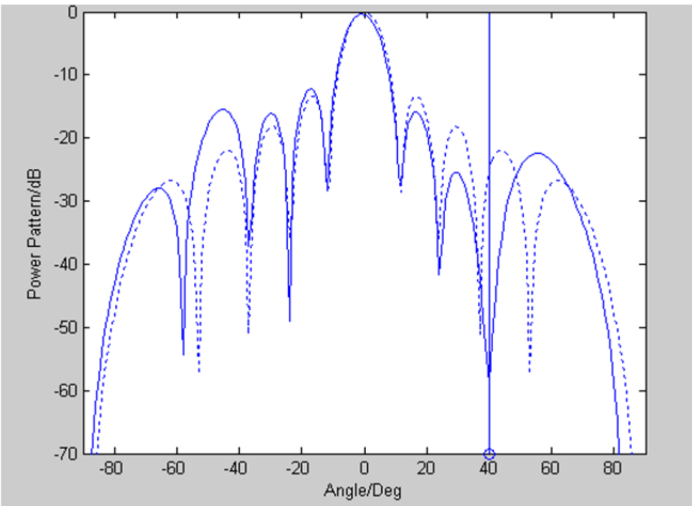

Figure4 Antenna Pattern of proposed adaptive antenna using GA
Desired signal direction = 0 degree
Interference signal direction = 40 degree

To demonstrate the advantage of the proposed antenna to solve the problem when the desired signal arrive in the off broadside direction, the desired signal and interference signal are assumed to arrive the antenna in the direction of 20 degree and 40 degree, respectively. The result is shown in Figure 5. It is seen that, the proposed adaptive null steering antenna can place null in the interference signal direction while point main lobe to the desired direction correctly.

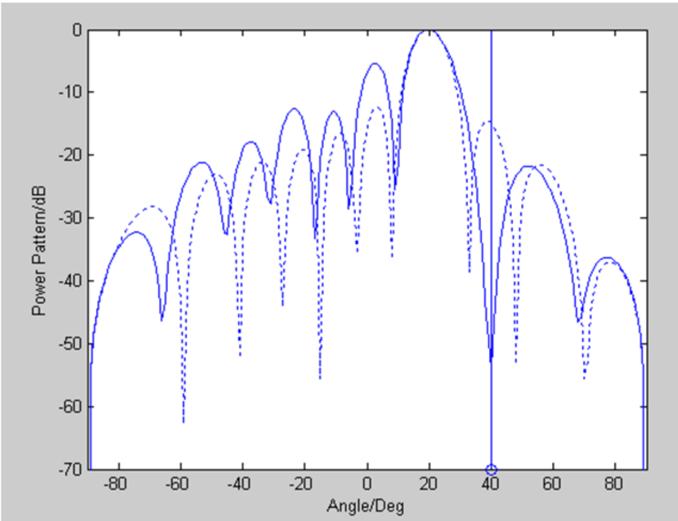

Figure 5 Antenna Pattern of proposed adaptive antenna using GA
Desired signal direction = 20 degree
Interference signal direction 40 degree

Discussion and Conclusion

This paper proposed the adaptive null steering antenna, based on applying the genetic algorithm to minimize the error signal. The validity of the proposed antenna system was demonstrated via the simulation results. It was shown that, the antenna can point main lobe to the desired direction while place null in the interference direction. Therefore, the signal to interference signal is improved.

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