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Implementation of linear Antenna Array for Digital Beam Former

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Abstract*— *This paper presents generation of digital beam in signal of interest direction and null beam in signal of not interest direction. For proposed linear array, synthesis is performed using auxiliary phase algorithm with 10 array element. All array elements are spaced half wavelength apart and lying positive Y-axis. All array elements are considered to be isotropic radiators.

Index Terms— **Beam forming, Radiation Pattern, Signal of Interest, Signal of Not Interest.**

I. INTRODUCTION

Beam forming is a signal processing technique used with arrays of transmitting or receiving transducers that control the direction of, or sensitivity to a radiation pattern. When receiving a signal, beam forming can increase the receiver sensitivity in the direction of wanted signals and decrease the sensitivity in the direction of interference and noise. When transmitting a signal, beam forming can increase the power in the direction the signal is to be sent. The main objective of this spatial signal pattern shaping is to simultaneously place a beam maximum toward the signal of interest (SOI) and nulls toward directions of interfering signals or signals not of interest (SNOI).

II. AUXILLIARY PHASE ALGORITHM

The proposed Auxiliary Phase Algorithm is an iterative method of power synthesis for antenna array of arbitrary geometry. The method, here called auxiliary phase algorithm (APA) [1], enables to generate patterns with single or multiple main lobes and low pattern amplitude in large angular regions. A considerable advantage of the presented approach is the low CPU time necessary to perform the synthesis, which is due to the simple closed form expressions employed to perform each iteration step to the use of a proper weight function.

With reference to Cartesian coordinate system, the far field pattern of an antenna array of N elements, in the generic direction of the X-Y plane, can be written as:

$$F(\mathbf{a};\varphi) = \sum_{n=0}^{N-1} a_n p_n(\varphi) e^{j\frac{2\pi}{\lambda} r_n \cos(\varphi-\varphi_n)} = \sum_{n=0}^{N-1} a_n f_n(\varphi) \tag{1}$$

Where φ is the azimuth angle, **a**= $[a_1, a_2, \dots, a_N$ is the column vector of the complex excitation voltages, p_n (φ) is the radiation pattern of the nth array element, r_n and φ_n are the polar coordinates of the position of the nth array element, and λ is the wavelength.

Consider now a real positive function F_0 (φ), representing the desired radiation pattern amplitude. This function is assumed to be normalized with respect to unity. We want to generate an array pattern whose modulus approximates F_0 (φ). To this purpose, we search for an array pattern F(a;φ) whose amplitude minimizes the function

$$\mathcal{F}[|F(\mathbf{a};\varphi)|, F_0(\varphi)] = \int_{-\varphi_L}^{\varphi_L} \left| |F(\mathbf{a};\varphi)| - \frac{F_0(\varphi)}{w(\varphi)} \right|^2 w(\varphi)d\varphi \tag{2}$$

Where w(φ) is a real positive weight function and φ_L is a constant depending on the array geometry ($\varphi_L=\pi/2$ for a linear array, $\varphi_L=\pi$ for a circular array). The weight function is chosen to have high values in the angular regions where low amplitudes are required for the pattern, therefore in these regions the pattern requirements are satisfied with more precision.

Note that, with the above formulation, the synthesis is performed in the directions of the plane $\theta = \frac{\pi}{2}$. Thus, the array pattern behavior is not controlled in the directions characterized by $\theta \neq \frac{\pi}{2}$. By consequence, even if for $\theta = \frac{\pi}{2}$ low side lobes are obtained with the synthesis algorithm, for $\theta \neq \frac{\pi}{2}$ higher side lobes might arise. In spite of this, a prescribed behavior of the radiation pattern is often required only in the plane of the array, rather than in all the space directions [2]. In such cases, performing a synthesis in all the space directions is not necessary, and would require a much greater number of degrees of freedom of the structure, hence a much greater number of array elements. For this reason, and for the sake of simplicity, in this paper we limit ourselves to consider the synthesis in the $\theta = \frac{\pi}{2}$ plane, even if the array elements are arbitrarily arranged in the plane.

In linear array synthesis, synthesis is performed with auxiliary phase algorithm with 10 array elements. All array elements are spaced half wavelength apart and lying along positive y-axis. All array elements are considered to be isotropic radiators. Fig.1 shows array geometry for linear array.

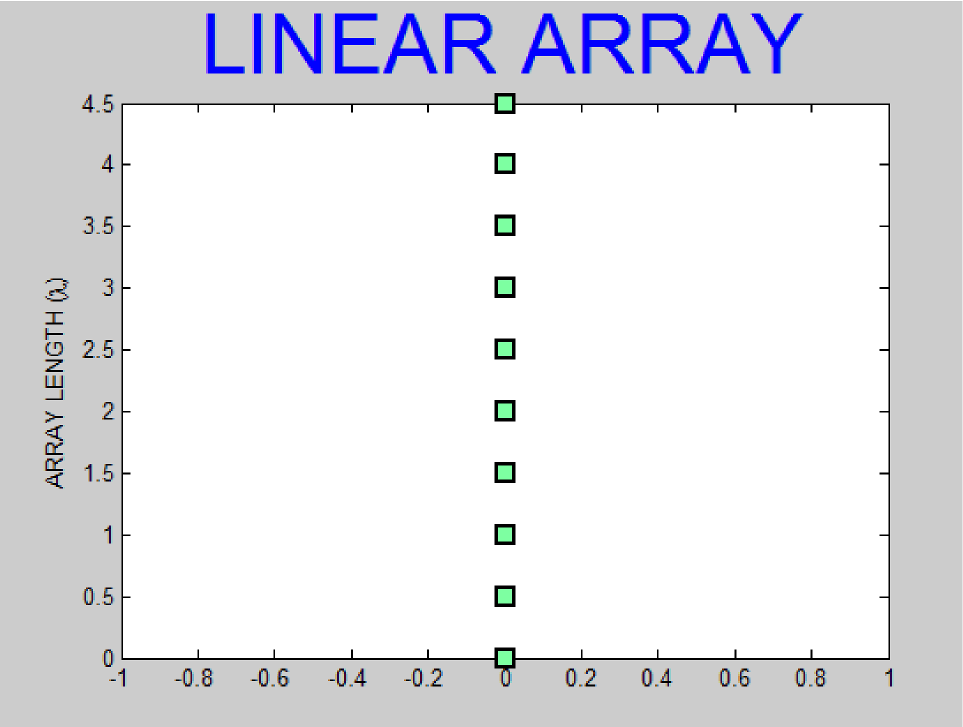

Fig.1 Uniform linear array with n=10 lying along positive y-axis

III. SIMULATION RESULTS

The auxiliary phase algorithm synthesis method adopts an auxiliary function having the desired amplitude pattern and a generic phase pattern, and determines in closed form the array pattern approximating the auxiliary function in amplitude and phase. So the first objective is to generate a desired amplitude pattern. The desired amplitude pattern contains location of signal of interest, signal not of interest and side lobes. The signal of interest and interferers can be mostly shown by any of the following shapes:

- Gaussian shape
- Laplacian shape
- Flat-top shape

Because of the smoothness of the Gaussian function, it helps in accurately approximating the approximation pattern to desired pattern.

Fig.2 and Fig.3 shows the synthesized pattern and excitation values for signal of interest (SOI) direction is 0^0 and

Signal of not interest directions are 100^0, 50^0, and -100^0.

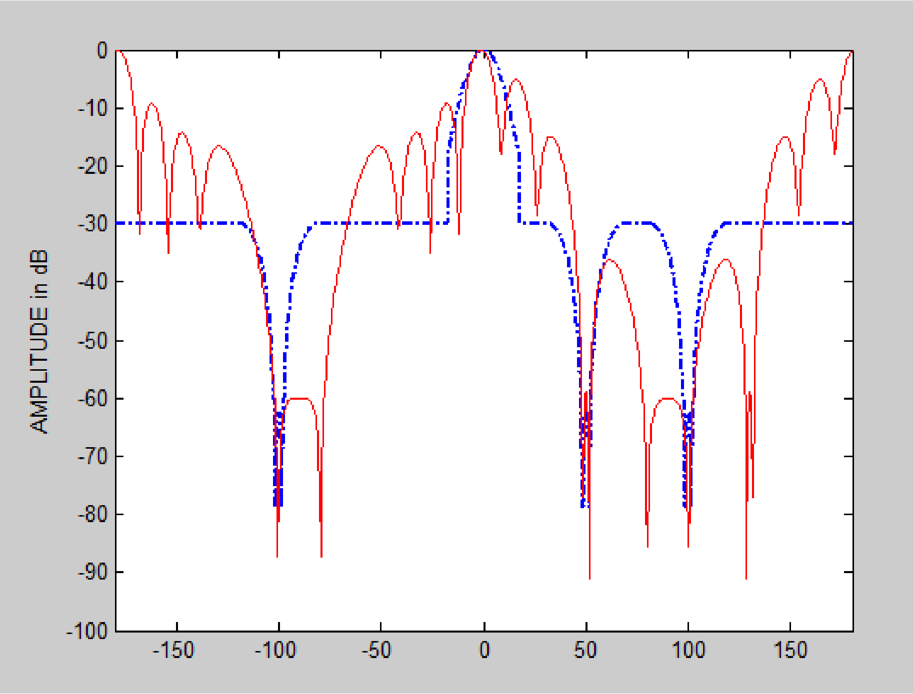

Fig.2 pattern synthesized for SOI=0^0 and SNOI=100^0, 50^0, and -100^0

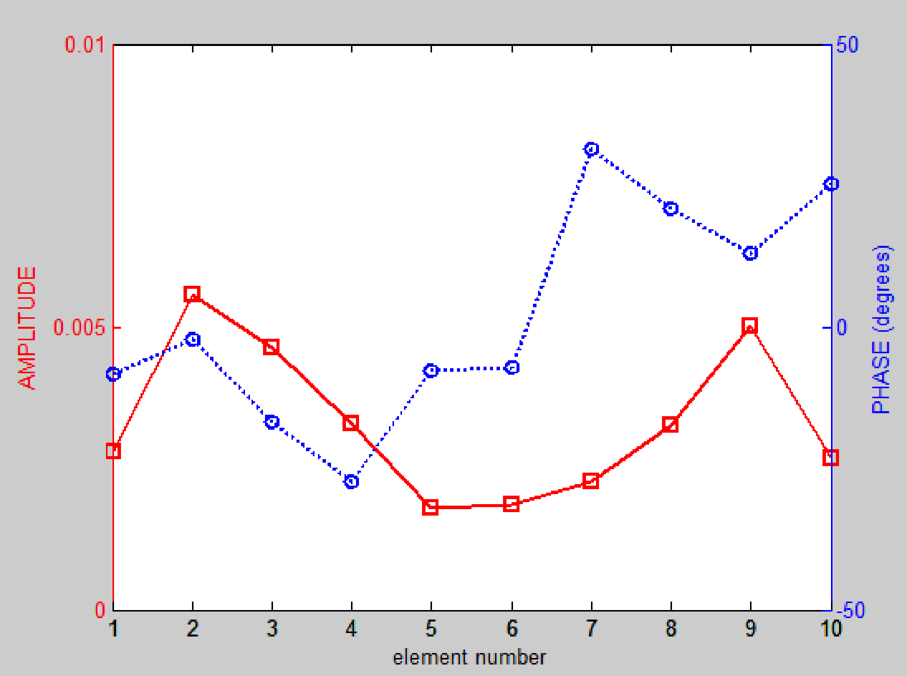

Fig.3 corresponding excitation to each antenna element

Fig.4 and Fig.5 shows the synthesized pattern and excitation values for signal of interest (SOI) direction is 100^0 and Signal of not interest directions are 50^0, and 150^0.

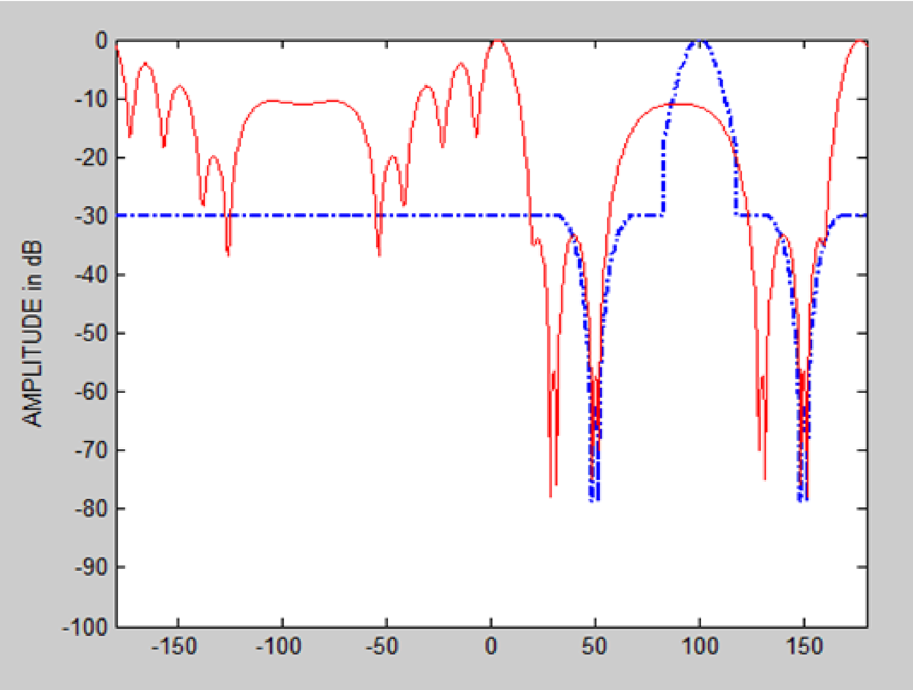

Fig.4 pattern synthesized for SOI=100^0 and SNOI=50^0, and 150^0

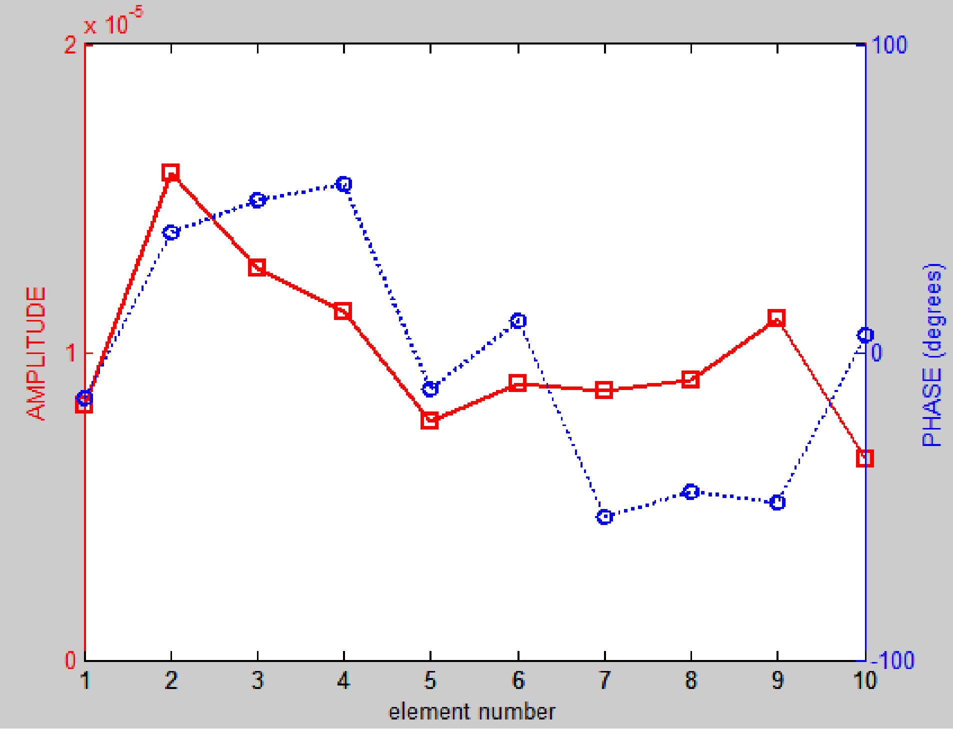

Fig.5 corresponding excitation to each antenna element

IV. CONCLUSION

From this research work we can conclude that radiation pattern of an antenna can be changed by changing the array geometry. Another topic of interest would be to optimize the weights and geometries of antennas consisting of non-identical elements. Antenna array analysis is almost exclusively performed with identical elements, and it would be interesting to observe if gains could be made by exploiting elements with different radiation patterns. The same concept can be extended to electromagnetic source and acoustic source localization also.

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REFERENCES

[1] M. Comisso and R. Vescovo, “fast iterative method of power synthesis for antenna array” Trans. Antennas Propag., vol. 57, pp. 1952–1962, july. 2009.

[2] S. Bellofiore, J.Foutz, R. Govindarajula, I. Bahceci, C.A. Balanis, A.S. Spanias, J.M. Capone, and T.M. Duman, “Smart antenna system analysis, integration and performance for mobile ad-hoc networks (MANETs),” IEEE Trans. Antennas Propag., vol. 50, pp. 571-581, May 2002.