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ANALYSIS OF LINEAR ARRAY ANTENNA FOR SLL REDUCTION USING SMART ANTENNAS

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ABSTRACT

In this thesis proposed a very simple and powerful method for the synthesis of linear array antenna. This method reduced the desired level of side lobe level (SLL) as well as to steer the main beam at different-different angle. A new method for adaptive **beam** forming for a linear antenna arrays using genetic algorithm (GA) are also proposed. Genetic Algorithm is an iterative stochastic optimizer that works on the concept of survival of the population values based on the fitness value. An adaptive genetic algorithm has been used in linear array to optimize the excitation levels of the elements resulting in a radiation pattern with minimum side lobe level. These algorithm can determinate the various values of side lobe level and phase excitation for each antenna to steer the main beam in specific direction.

Keyword: Smart Antenna, Genetic Algorithm (GA), Side Lobe Level (SLL), Linear Array Antenna.

INTRODUCTION OF SMART ANTENNAS

Smart antennas have recently been proposed as a solution to enhance the capacity of wireless communication systems for 3G network [1]. They are also considerably important because of their potential for decreasing interference, improving quality of service [2], enhancing power control and extending battery life in portable units. In an adaptive antenna system, beam forming algorithms the weight of antenna arrays can be adjusted to form certain amount of adaptive beam to track corresponding users automatically and at the same time to minimize interference arising from other users by introducing nulls in their directions[3]. Antennas are a very important component of communication systems. By definition, it is a device that converts guided electromagnetic waves into unguided ones and vice versa. Antennas demonstrate a property known as reciprocity, which means that an antenna will maintain the same characteristics regardless if it is transmitting or receiving.

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SMART ANTENNA CONSTRUCTION

Omni-directional or sectored antennas used incurrent wireless communication systems, can beconsidered as an inefficient use of power as mostof it has been radiated in other directions thantoward the user. Signals that miss the intendeduser will cause interference to other users in thesame or adjoining cells [1].The concept of smart antennas is to employbase station antenna patterns that are not fixed inany direction but adapt to the current radioconditions. In other words, the antenna is todirect a single beam to each user. Smart antennasdirect their main lobe, with increased gain, in the direction of the user, and they direct nulls in directions away from the main lobe [2-3]. Shown in Figure 1, consist of an array of antenna elements and a smart processing of antenna signals. We will concentrate on the adaptive arrays that make use of the Direction of Arrival (DOA) information from the desired user to steer the main beam towards the desired user. The signals received by each antenna element are weighted and combined to create a beam in the direction of the mobile by utilizing signal processing signal processing algorithms [4]. These algorithms determine the uplink weight vectors for performing beam-forming on the received signals as well as the downlink weight vectors for performing beam forming on the transmittedsignals [3].

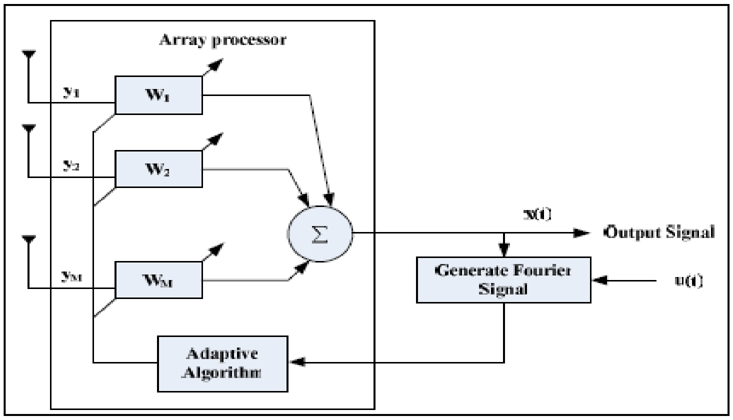

Fig. 1 Consist of an array of antenna elements Smart Antenna Systems

The basic idea of "smart" concept used for antenna systems, which are simple hardware elements, is the use of a digital signal-processing capability to transmit and receive in an adaptive, spatially sensitive manner. In other words, such a system can automatically change the directivity of its radiation patterns in response to its signal environment. In comparison with other antenna systems this technology can dramatically increase the performances (such as power consumption, capacity etc.) of a wireless system. The fundamental idea behind a smart antenna is not new but dates back to the early sixties when it was first proposed for electronic warfare as a counter measure to jamming [14]. Until recently, cost barriers have prevented the use of smart antennas in commercial systems. Thus in existing wireless communication systems, the base station antennas are either omni-directional which radiate and receive equally well in all azimuth directions, or sector antennas which cover slices of 60 or 90 or 120 degrees [15]. However, the advent of low cost Digital Signal Processors (DSPs), Application Specific Integrated Circuits (ASICs) and innovative signal processing algorithms have made smart antenna systems practical for commercial use. The smart antenna systems for cellular base stations can be divided into three main categories, which are illustrated in Figure 2.

- Switched Beam Systems.
- Phased Arrays and
- Adaptive Systems.

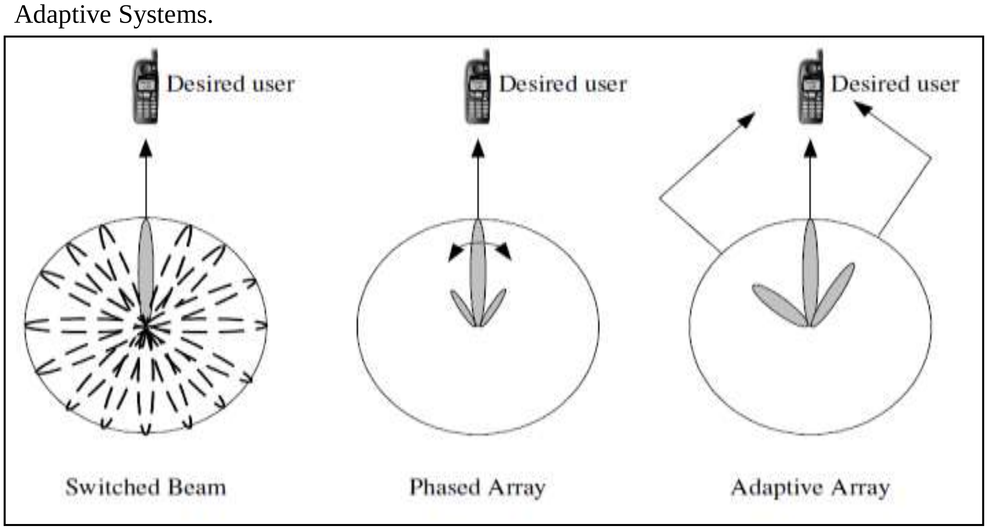

Fig. 2 illustrated in Figure (a) Switched Beam Systems, (b) Phased Arrays and (c) Adaptive Systems.

It has to be noted that this division is not rigid and switched beam and phased array systems are simpler physical approaches to realizing fully adaptive antennas. This step by step migration strategy has been used to lower the initial deployment costs to service providers.

PHYSICAL CONSTRUCTION OF ANTENNA

Antennas can be constructed in many different ways, ranging from simple wiresto parabolic dishes, up to coffee cans. When considering antennas suitable for 2.4 GHzWLAN use, another classification can be used. We identify two application categories which are Base Station and Point-to-Point. Each of these suggests different types of antennas for their purpose. Base Stations are used for multipoint access. Two choices are Omni antennas which radiate equally in all directions, or Sectorial antennas, The classification of antennas can be based on frequency/size and directivity.

FREQUENCY AND SIZE

Antennas used for HF are different from the ones used for VHF, which in turn are different from antennas for microwave. The wavelength is different at different frequencies, so the antennas must be different in size to radiate signals at the correct wavelength. We are particularly interested in antennas working in the microwave range, especially in the 2.4 GHz and 5 GHz frequencies. At 2.4 GHz the wavelength is 12.5 cm, while at 5 GHz it is 6 cm.

SIMULATION RESULTS ANALYSIS OF LINEAR ARRAY FOR SLL REDUCTION

This section gives the simulation result for various linear antenna array design obtained by GA technique. five linear array structures are assumed, each maintaining a fixed spacing between the elements. The antenna model consists of N elements equally spaced with distance of separation $d = 0.5\lambda$ along the y-axis. In our investigation, there is an array of 5, 10, 15, 20, elements. Small number of elements is preferred in this work. The selection of number of elements depends on the designer's choice based on the cost, size, aperture of the antenna, and speed of convergence. As the number of elements increases, the cost increases. Aperture increases and the performance gets improved. Various results for pattern generation for side lobe level is given in following table.

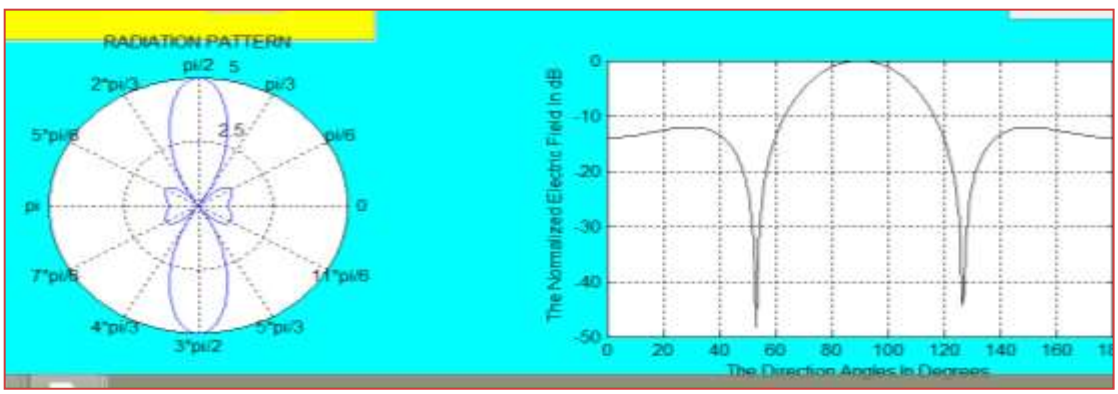

Figure 3: Radiation pattern with side lobe level of -12.04dB for N = 5 elements.

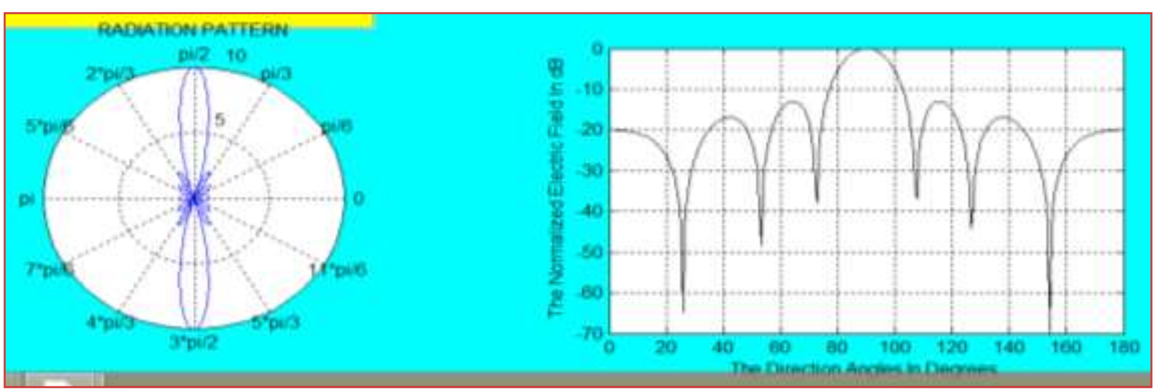

Figure 4: Radiation pattern with side lobe level of -13.00dB for N = 10 elements

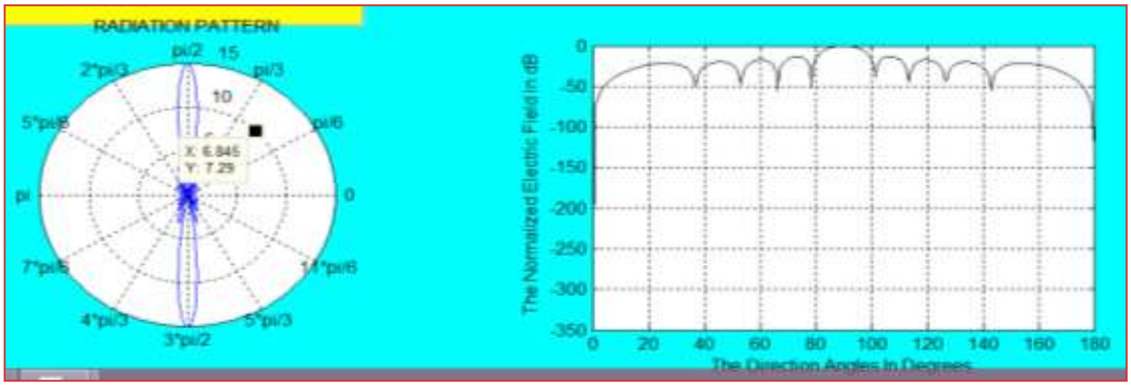

Figure 5: Radiation pattern with side lobe level of -13.14dB for N = 15 elements

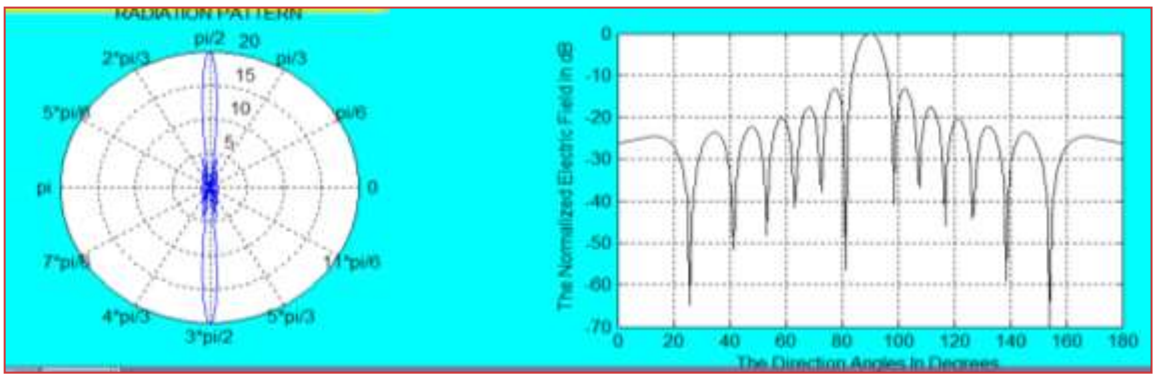

Figure 6:Radiation pattern with SLL of -13.22 dB for N = 20 elements

Table 1: Results for Radiation Pattern with SLL

Figure Number	Number of Element	SLL (dB)
3	5	-12.04
4	10	-13.00
5	15	-13.14
6	20	-13.22

CONCLUSION

From the above simulation results, it can be clearly seen that for frequency f = 2GHz, spacing between the antenna element is $\lambda/2$, side lobe level is reduced from -13.2233 to -12.0417. In case of N=5, spacing between two element is $\lambda/2$, directivity 10.3645, the SLL is -12.0417, for N = 10 spacing between two element is $\lambda/2$, directivity 14.19 the SLL is -12.9732. In case of N = 15 spacing between two element is $\lambda/2$, directivity 16.1573 , SLL is -13.1308. In case of N = 20 spacing between two element is $\lambda/2$, SLL is -13.2222.In case of N = 25 spacing between two element is $\lambda/2$, directivity 18.5064,SLL is -13.2.233.

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