RADIATION PATTERN AND POLARIZATION SHIFTING OF ANTENNA USING FPGA & CORDIC

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ABSTRACT

Today's world of wireless communication revolves around the way of transmitting the signal in the desired direction. Varied gain, varied phase, varied polarization and varied angle microstrip antennas are attractive for mobile communications, radar, electronic detection and covert applications, etc. to tackle various Inter-Symbol Interferences and Fading. These phase shifters are not easily programmable. In this paper we are representing a way of replacing phase shifter with FPGA and CORDIC.

Keywords: ***Radiation Pattern, Polarization, Phase Shifter, VHDL, CORDIC.***

I INTRODUCTION

In wireless communication the signal transmitted from an antenna can be shifted in a particular direction by using phase shifter [1]. Instead of using a phase shifter, the work of it can be done by using an algorithm CORDIC, an acronym for COrdinate Rotation Digital Computer. This algorithm can be implemented using FPGA. And then the output obtained in the form of current can be given to antenna or an array of antenna to obtain desired output. IE 3D-Electromagnetic Simulator and Optimization software can be used to simulate the antenna or array of antenna and then the polarization or radiation pattern can be changed as per our requirement. Hence the phase shifter can be replaced by CORDIC algorithm implemented on FPGA. This will save both money and time. As once a satellite is launched in the space then it is very much costly and time consuming to go in space and check the default in it and then do the right corrections. Hence the best way is to do all that from earth. If phase shifter is used in antenna and we want to change the phase or there is some default in it, then it will be very much difficult to remove that default, but using a program for all that work will save both time and money to change phase, also now there will be no worry for hardware damage (as no hardware so no hardware default).

FPGA'S are chosen because they are on – site programmable and highly suitable for hardware implementation. FPGA devices lead higher speed and capacity as well as low power consumption. A field-programmable gate array

(FPGA) is a large-scale integrated circuit that can be programmed after it is manufactured rather than being limited to a predetermined, unchangeable hardware function.

II METHODOLOGY

THE CORDIC ALGORITHM: CORDIC (digit-by-digit method, Volder's algorithm) (for COordinate Rotation DIgital Computer) is a simple and efficient algorithm to calculate hyperbolic and trigonometric functions. It is commonly used when no hardware multiplier is available (e.g., simple microcontrollers and FPGAs) as the only operations it requires are addition, subtraction, bitshift and table lookup.

THE SIMULATION LANGUAGE VHDL: VHDL is acronym for VHSIC hardware description language (VHSIC is an acronym for Very High Speed Integrated Circuits). It is a hardware description language that can be used to model a digital system at many levels of abstraction, ranging from the algorithmic level to gate level. It also allows you to model the system as an interconnection of components. Test waveforms can also be generated using the same constructs.

A general purpose electromagnetic simulation and optimization package IE3D-Electromagnetic Simulator and Optimization software is used for the analysis and design of planar and 3D structures for Microstrip antennas. An array of three planer antenna is designed and then the outputs that are phase obtained from CORDIC algorithm, in the form of current is given as input to these three antennas and corresponding radiation patterns are obtained. And the results of CORDIC algorithm and IE 3D -Electromagnetic Simulator and Optimization software are same. Now the output from the CORDIC algorithm can be used to shift the polarization of an array of antenna in experimental setup.

IV RESULTS & CONCLUSION

4.1 Results from CORDIC Algorithm

TABLE 1: Results Obtained From CORDIC

Phase shift(in degree)		I	II	III
0	Mag.	1	1	1
	Phase	0	0	0
30	Mag.	1	0.890625	0.46875
	Phase	0	30	60
40	Mag.	1	0.677875	0.03125
	Phase	0	45	90

Table 1 shows the results obtained from CORDIC algorithm. Zero degree phase shift means the phase difference between antenna 1 and antenna 2 is zero degree and phase difference between antenna 2 and antenna 3 is also zero degree.

4.2 THE RESULTS FROM IE 3D -Electromagnetic Simulator and Optimization Software

With the aim of shifting radiation pattern and polarization till now I have got the results from my CORDIC algorithm and these results that is the phase I have given to IE 3D -Electromagnetic Simulator and Optimization software and got the radiation patterns at different phases. The array of three rectangular Patch antennas is shown below and corresponding radiation patterns are also shown in figures on preceding pages.

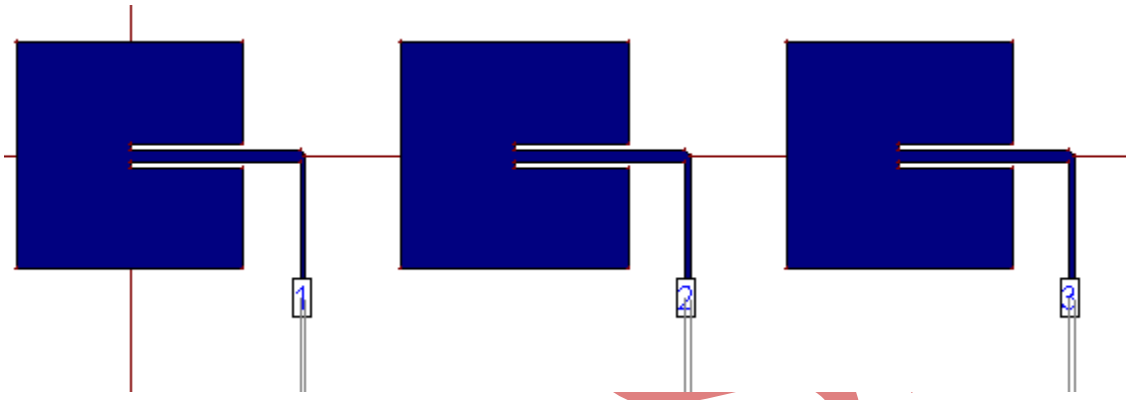


Figure 1 : Array Of Rectangular Patch Antenna

Figure 1 shows an array of rectangular Patch antenna, which is designed in IE 3D Electromagnetic Simulator and Optimization software. Here the array size taken is 17.6 cm. The spacing between the antennas taken is 2.6 cm. The feeding technique used is inset feeding. For this particular arrangement the dielectric constant taken is 2.2. Phase output obtained from CORDIC algorithm is given to this array of rectangular Patch antenna and then the radiation pattern is obtained at different phase shift. Radiation patterns at zero degree, 30 degree and 45 degree are shown in the figures shown below.

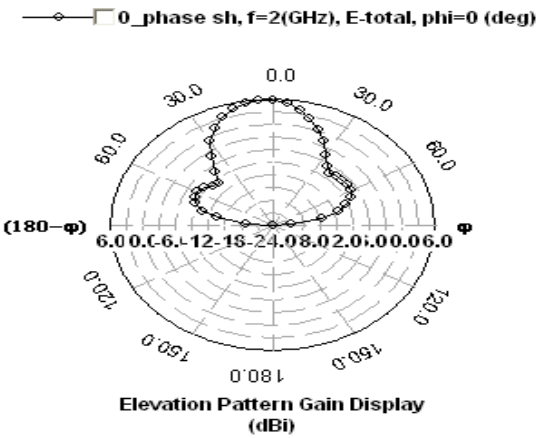
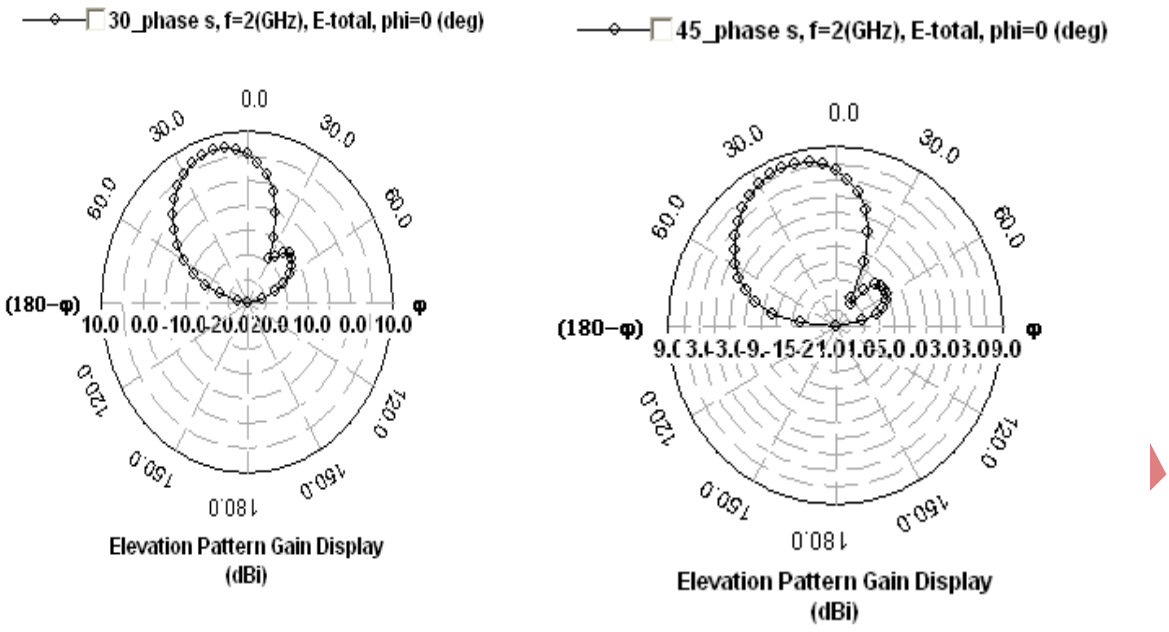


Figure 2: Radiation Pattern at Zero Degree Phase Shift



(a) (b)

Figure 3: Radiation Pattern at (a) 30 Degree Phase Shift, (b) 45 Degree Phase Shift

At zero degree phase shift the Elevation pattern gain display is shown in fig 2. This shows that when the phase shift between antennas is zero degree then the radiation pattern is also shifted in direction of zero degree. At 30 degree phase shift the Elevation pattern gain display is shown in fig 3(a), here also when phase shift between antennas is 30 degree then the radiation pattern is also shifted in direction of 30 degree. Similarly at 45 degree phase shift the radiation pattern is shifted in the direction of 45 degree as shown in figure 3(b). Hence we can say that radiation patterns are shifted as phase shifted, without using a phase shifter.

V CONCLUSIONS AND DISCUSSIONS

Radiation pattern for different phase angles obtained from both IE 3D- Electromagnetic Simulator and Optimization software and from CORDIC Algorithm implemented on FPGA are same. Main program is implemented on a FPGA using VHDL programming, on ModelSim Simulator. If the polarization shifting can be done by using CORDIC and FPGA without using a phase shifter then it will be a great revolution in the field of wireless communication. This will allow us to direct the signal in a direction in which we want. As all that will be done by using CORDIC algorithm then it will be easy to control the operation and time taken will be less. Signal loss will be reduced. This will bring a revolution in satellite communication also. As it is very costly and time consuming to remove any default in satellite after it is launched in space, but by software means it can be controlled from earth.

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