Electronic Scanning in Space of the Planar Array of Four Patch Antennas

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Abstract:

The rectangular patch antenna is set to play a significant role in the development of the next-generation wireless communication systems. The purpose of this report is to provide the design of the rectangular patch antenna system by studying the performance of patch antenna array, and to achieve the electronic scanning in space of the radiation patterns by a four rectangular patch antennas plan array. The designed patch antenna square array will have an array of four elements and its performance will be evaluated in terms of radiation patterns.

Results given by the ***MATLAB*** *and* ***PCAAD (Personal Computer Aided Antenna Design)*** *software will be tabulated and antenna radiation patterns will be plotted for discussion before wrapping up with a conclusion and suggestion on future developments.*

Keys words: Electronic scanning; Design of the patch antenna; Square array patch antenna.

1- Introduction :

Practically, it is often necessary to design a microstrop patch antenna that is going to produce the features of radiation wanted. In general, there are more demands to design an antenna that has at faraway field a radiation model that is null in some directions or give a model with a very before definite distribution, low beam width , a minimum of side lobes with a low level [1].

The obligation to resort to a mechanical displacement of a array antennas to explore the space is an important constraint and can come to limit the performances of this array antennas [2], [3]. In his principle, the electronic scanning consists to control quickly the phase of the various elementary sources of a array, what can be made of several manners, following the processes used to feed the sources and to produce the phase shifting.

In addition, the electronic scanning [4], that permits to control the position of the beam of array antennas in short time, offer biggest interest, because it permits to free the array antennas of the constraint " space-time ". In this case, the phase shifting unit is introduced on the passage of the waves from the emitter to the beaming sources.

In this paper, we are going to assure an electronic scanning by an array of four patch antennas in the space, the results of simulation by PCAAD (Personal Computer Aided Antenna Design) and the programmes in MATLAB software will be given.

2 - Results of simulations:

The performances of an array of four microstrips patch antennas will be examined by the variation of the excitation phases in β_x and β_y between the elements (patches) of the array respectively in the x-axis and in the y-axis. The general radiation pattern that is formed by the combination of the radiation pattern of an isolated patch antenna and the array factor of a plane array of four beaming elements will be analyzed.

The simulation on the plane array will be executed, while using the software **MATLAB** and **PCAAD** with the parameters predetermined following:

The patch length, L = 4.04 cm
The patch width, W=5.94 cm,
The thickness of the dielectric, h = 0.127 cm
The dielectric constant, $\varepsilon_r = 2.42$
The resonance frequency of the antenna $f_r = 2.31$ GHz
The wave length $\lambda = 12.98$ cm

A linear polarization in the x-axis.

Patch Number = 2×2

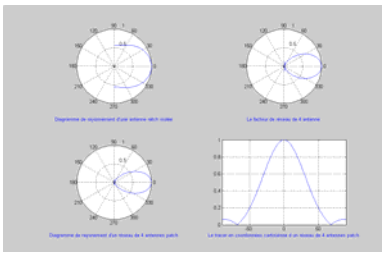
The space between the patches is 7 cm in the x-axis, 7.5 cm in the y-axis (this space between the patches has been found to produce the best radiation pattern after several tests)

The excitation amplitude of the patches is 1 (uniform)

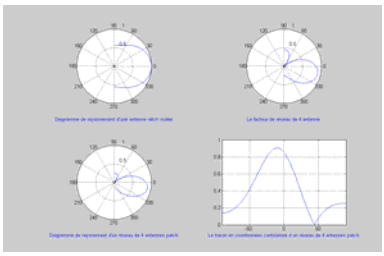
The electronic scanning in the space of a rectangular array of patch antennas is obtained by the in β_x and β_y variation in the two plans E and H. In this case, we can varying the in β_x and β_y at a time from 0° to 180° with a step of 45°, and we observes the effect of this double variation on the directivity, the amplitude and the rotation of the radiation pattern in the two plans E and H.

The results given by our program in the software MATLB, are illustrate in the figures (1) and (2). The same resulted are given by the software PCAAD in the tables (1) and (2) in the two planes E and H, in which we visualizes the radiation pattern of an isolated patch antenna, the array factor of four antennas, the radiation pattern of an array of four antennas patches in polar rectangular representation.

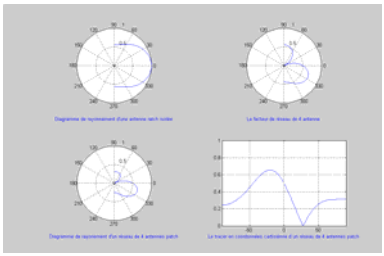
In E plan (φ = 0°) :



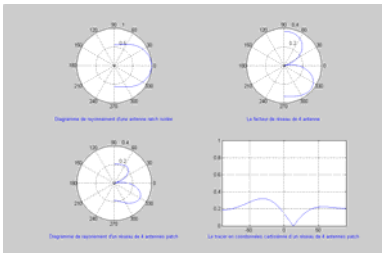
(i) β_x=0°, β_y= 0°



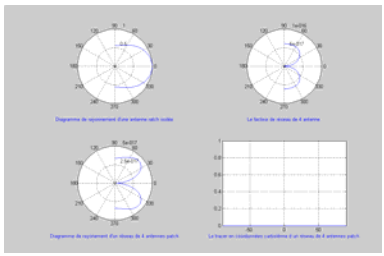
(ii) β_x= 45°, β_y= 45°



(iii) β_x = 90°, β_y = 90°



(iv) β_x = 135°, β_y = 135°



(v) β_x = 180°, β_y = 180°

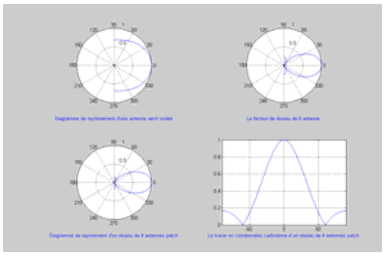
Figure 1: Radiation pattern of an array of four patches antennas in E plan, with β_x and β_y between 0° and 180°.

The simulations results by PCAAD software for a squared array of four patches antennas in the E plane, that is compatible with the radiation pattern by MATLAB software in E plane, as shown in the following table:

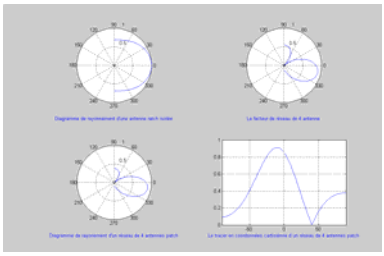
β_x (degree)	β_y (degree)	Directivity (dB)	beam width at 3dB (degree)	angle of the main lobe (degree)
0	0	12.62	24	0
45	45	14.08	23	-10
90	90	14.11	22	-20
135	135	9.47	23	-31
180	180	7.65	-	-42

Table 1: The characteristic parameters of the radiation pattern of a square array of four patches antennas in the E plane, given by the PCAAD software,

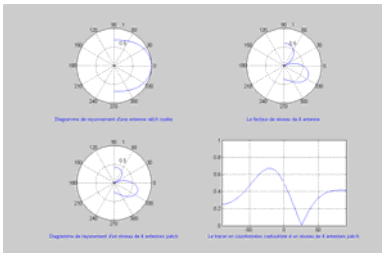
In H plan (φ = 90°) :



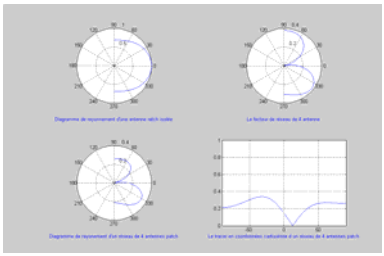
(i) β_x= 0°, β_y= 0°



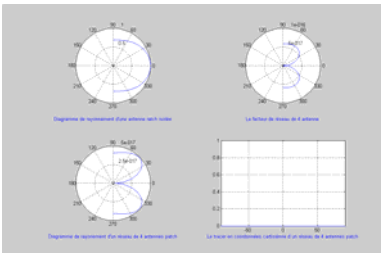
(ii) β_x = 45°, β_y = 45°



(iii) β_x= 90°, β_y= 90°



(iv) β_x= 135°, β_y= 135°



(v) β_x= 180°, β_y= 180°

Figure 2: Radiation pattern of an array of four patches antennas in H plan, with β_x and β_y between 0° and 180°.

The simulations results by PCAAD software for a squared array of four patches antennas in the E plane, that is compatible with the radiation pattern by MATLAB software in H plane, as shown in the following table:

β_x (degree)	β_y (degree)	Directivity (dB)	Beam width at 3dB (degree)	angle of the main lobe (degree)
0	0	12.62	21	0
45	45	14.08	20	-8
90	90	14.11	19	-16
135	135	9.47	19	-25
180	180	7.65	-	-38

Table 1: The characteristic parameters of the radiation pattern of a square array of four patches antennas in the H plane, given by the PCAAD software,

3 conclusion:

According to the radiation pattern by our program in MATLAB software and the same results given by simulation in the PCAAD software, we conclude that we can achieved an electronic scanning in the whole space (in E and H plans at the same time), by the variation of the excitations phases β_x and β_y at a time from 0° to 180°, in the two E and H plans.

The two plans (E and H) nearly have the same radiation pattern (directivity, amplitude, deviation angle of the main lobe), the good directivity is when β_x and β_y to 90°, and a major inconvenience presents itself, it is that the amplitude decreases quickly, and becomes nearly hopeless to 180°.

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