Comparison between Yagi and Shaped lunar Patch Antennas at lower Microwave Frequencies for Wireless Communication Applications

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Abstract:

There are various patch antennas used for Wi-Fi and Wi-MAX applications once an enough gain and bandwidth are secured. Yagi antennas may be used if suitable design is used. Meantime Shaped Patch antennas are also useful provided careful design is considered. Modified designs of Yagi antennas, in which the gain and bandwidth can be enhanced. On the other hand Patch antenna become very adaptive if careful selection of geometrical shaping on the patch are selected. Beside the geometry type, careful consideration of lunar opening and ring thinks are important in enhancing bandwidth and gain. For the former, careful design procedure has been considered for elements spacing and other parameters to enhance the areal structure for better gain and bandwidth values. As for the latter "Lunar Patch", different circular patch shaping have been tried to select most optimum that gives suitable values for bandwidth and gain for this type of applications. Results encouraging in microwave frequency ranging from 2.5 GHz to 5 GHz using annular shaped patch, while better results are obtained solely at 2.45 GHz using Yagi antenna patch structure.

***Keywords*—lunar and Yagi- patches, Bandwidth, gain and microwave wireless applications**

1-Background:

Wireless communication becoming mostly independent on microstrip patch antennas in many aspects especially in bandwidth and gain due to advantages of these types of these antennae. Depending on the application requirements these patched may be structured in different ways and modes to suit the operational environment. Research work continues to investigate enhancement on the structures of this type of radiator on any of its main parts; namely the conductive strip, dielectric substrate and the conductive ground plane. Now to obtain enough bandwidth, less insertion loss with acceptable gain level. Any improvement of these parameters are obtained by well-planned intervention of the original dimensions and area of any of the three main parts of the patch mentioned above, [1-4].

Optimum synthesis of antenna arrays include the use of non-uniform spacing methods to account for mutual coupling, and the use of numerical empirical optimization techniques. Different techniques for spacing optimization between array elements are available and suitable ones are adopted in this work through the simulation work, [5-8].

2- Design and structures

2-1 Annular Structure Design: [9]

This topic of patch structure in general and the annular shape of intervention the conductive strip is supported by many well-known references as examples]. Operating wavelength and frequency are expressed by:

$$\lambda_{gs} = 2\pi R \quad (1)$$

***R* is the radius of the annular slot.**
λ_{gs} Is the guided wavelength.

$$\lambda_{gs} = \frac{\lambda_o}{\sqrt{\varepsilon_{reff}}} \quad (2)$$

Resonant frequency

$$f_n = \frac{ne_o}{l\sqrt{\varepsilon_{reff}}} \quad (3)$$

Where: n = 1, 2, 3 for mode number.
Geometry of proposed antenna is as shown in figure 1.

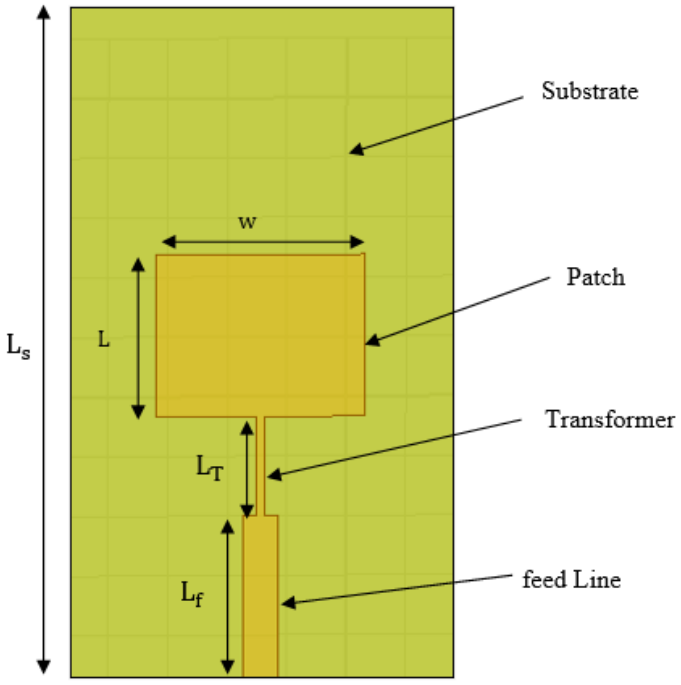

Figure 1: Shows the geometrical configuration of the proposed microstrip patch antenna.

Material used in the structure was FR4 epoxy with relative permittivity$\varepsilon_r = 4.4$, thickness = 1.6 mm. For the sake of investigations and obtaining results, the structure has been simulated using the HFSS software and different geometry and inclusions have been tried to arrive at suitable bandwidth range for the above-mentioned applications. Next section gives more details and investigations.

2-2 Yagi patch array:[10]

- **The parameters to be used of the Yagi antenna for the proposed design method are:** Wave length (λ), radius of each element (a), Length of each element (L)

Spacing between elements (S) and the number elements (N; as shown in figure-2 and values of elements as given below.

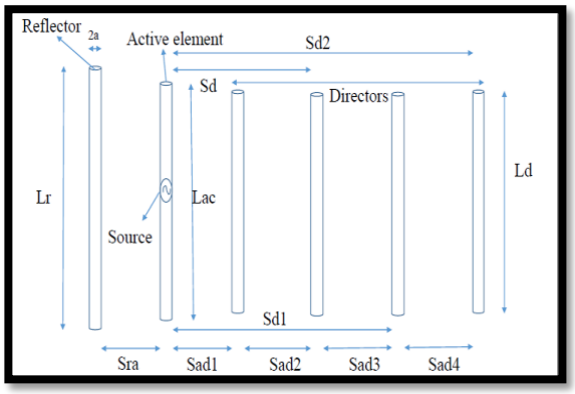

Figure-2 Yagi antennas with parameters.[10]

λ = c / f = (3x10^8) / (2.45*10^9) = 122.448 mm, (a) = 5.204 mm, (Lac) = 0.45λ = 55.1016 mm, (Lr) = 0.5λ = 61.227 mm.

(Lac) = 0.45λ = 55.1016 mm,(Lr) = 0.5λ = 61.227 mm, (Sra) of 0.25λ = 30.61 mm, (Sad1) = (Sad2) = (Sad3) = (Sad4) = 0.35 λ = 42.85 mm (Ld1) = (Ld2) = (Ld3) = (Ld4) = 0.4 λ = 48.97 mm .

3- Simulations and Results:

Simulation of both patch antennas structures has been full filled using suitable packages, FHSS and MatLab. Inputs and related primary parameters have been imitated from previous references. For the sake of conciseness, it has been considered best to present main achievements and recommendable results.

3-1 Results of Annular Shaped Patch:

Figure 3 shows the gain of proposal antenna, the total gain plot gives = 4.81 dB. The gain of antenna result is more as compared to isotropic antenna which means that more the gain more directional antenna.

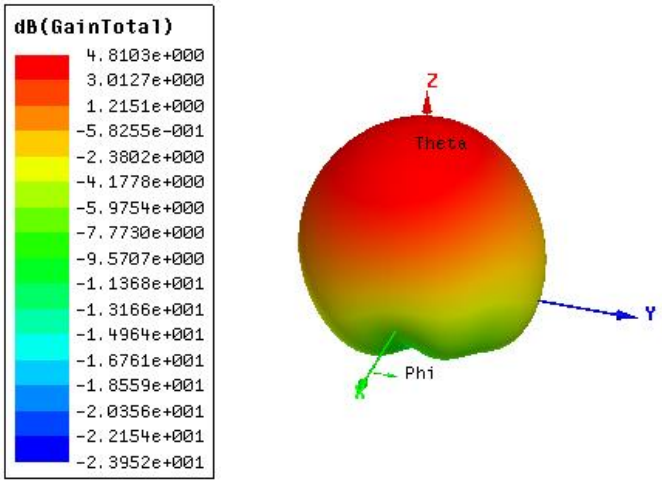

Figure 3: Radiation pattern Gain of the designed antenna measured at 5.15 GHz.

Results for microstrip antenna with open ring slot with double resonance frequencies; 2.64 GHz and 4.8 GHz gives bandwidth 35MHz and 117MHz respectively. Maximum gain for these different band is about 4.7 dB, which quiet reasonable.

3.2- Results of Yagi patch array:

At a chosen frequency of 2.45 GHz, Yagi patch antenna array has been optimized for a 10 element array and results are summarized in table-1 and figure-4.

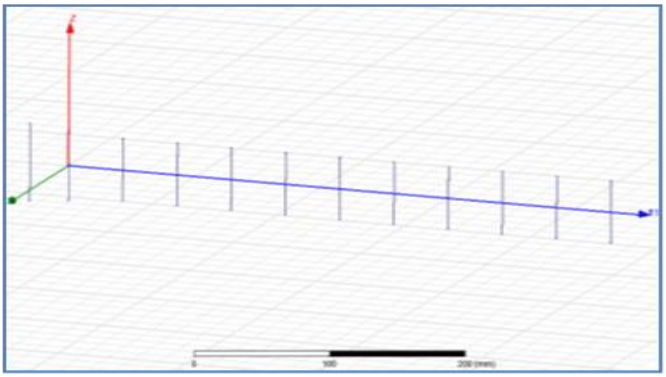

Figure-4 Yagi antenna with 10 directors.

Table-1 Relationship between number of directors and the gain.

Number of directors	Gain dB
4	11.26
7	12.544
10	14.77
13	15.543
15	15.836

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4-CONCLUSIONS:

Annular structured patch antenna with different annular ring dimensions have been investigated and tested. Sufficient bandwidth values are obtained for frequencies ranging from 2.5GHz to 5GHz, with return loss of practical acceptable level. As for the Yagi antenna structure one can say that high gain values with moderate bandwidth value can be obtained at only designated and chosen operating frequency.

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