Design of Microstrip Yagi Antenna at 5 GHz for Wi-Fi Application

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ABSTRACT: Microstrip Yagi antenna presented in this paper is suitable for Wi-Fi application at 5 GHz. The antenna has two elements which are parasitic and driven element that consists of directors and reflector. The analysis has been carried out to obtain the return loss, bandwidth and gain which is return loss, bandwidth, and gain. This designed antenna with array application consists of two branches of microstrip Yagi antenna that have been connected in a composite array format. The proposed Yagi antenna design has been analysed in terms of resonant frequency of 5 GHz, return loss -19.417dB, VSWR of 1.27, gain of 6.23 dBi and percentage bandwidth of 19%. The antenna using FR-4 substrate with thickness substrate of 1.6 mm.

Keywords: *5 GHz; Yagi Uda; Wi-fi*

1. INTRODUCTION

Over the last 15 years, the printed microstrip Yagi antenna has been proposed in various applications. Numerous research are being conducted for Yagi antenna suitable for wireless communications, which use the microwave or millimetre band. A Yagi antenna is a directional antenna that radiates signals in one main direction. It consists of a long transmission line with a single driven element consisting of two rods connected on either side of the transmission line [1]. Antenna arrays has advantage which are low profile, light weight, easy fabrication and so on. This microstrip antennas are widely used around the world [2].

The parasitic element shorter than the driven element by 5% is known as a director and it acts as a convex mirror as it beams up the incident energy from driven element. In the microstrip antenna, parasitic elements can be placed around a driven element to enhance the gain of the single driven element by several decibels. Yagi-Uda is chosen due to its high gain capability, low cost and easy to manufacture [3].

2. METHODOLOGY

The geometry of the Yagi antenna design is shown in Figure 1. It consists of a driven patch element, coupled director and reflector patch elements. The reflector elements, R will be treated as one element with a gap through the middle of feeding element. The driven element, D is excited by a simple feeding structure through a small gap of the reflector elements. A 50 Ω microstrip feedline is fed to the center of the driven element as a feeding structure. To establish the directionality of the beam as well as to increase the antenna gain, directors D1 and D2 are used.

The first step in designing the antenna is by designing a single element which is substrate. The substrate is design using FR-4 lossy material with thickness of the substrate h = 1.6 mm. The substrate dimension is 80mm x 65mm as in Figure 1.

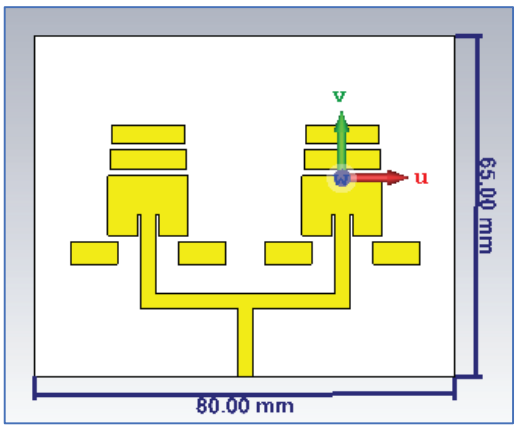

Figure 1: Dimension of substrate.

Firstly, the antenna started with driven patch element (D) followed by parasitic elements in the forward beam act as directors (D1) while the patch in the rear act as reflectors (R). Microstrip line is used to feed the microstrip Yagi as a feeding method. In this design, two microstrip Yagi antenna of one branch have been connected in a composite array format using corporate-feed network.

The director width are slightly shorter than driven element width while the reflector width is longer than the driven element width. The parameters and dimension of the antenna are shown in Figure 2. Figure 1 shows the front view of the antenna. The width of the feedline and spacing is adjusted to make sure that the impedance of the antenna is 50Ω.

3. RESULTS AND DISCUSSION

The proposed microstrip Yagi antenna has been simulated using CST microwave studio. This antenna aiming for WLAN application that have 5GHz band for frequency and return loss bigger than 10dB. The antenna was designed step by step and was simulated. The results obtained shown in figure 3 to figure 5.

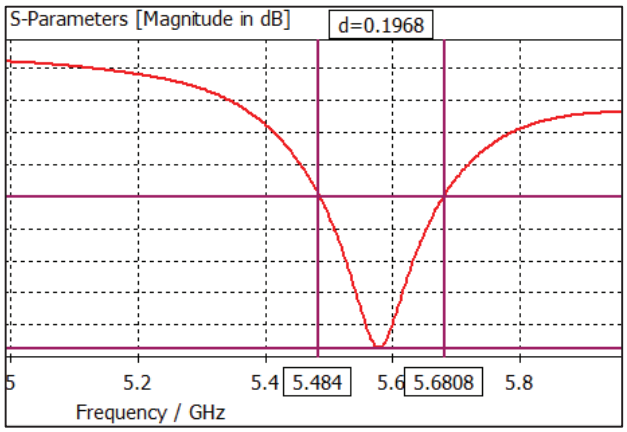

Figure 3: Simulated antenna Bandwidth

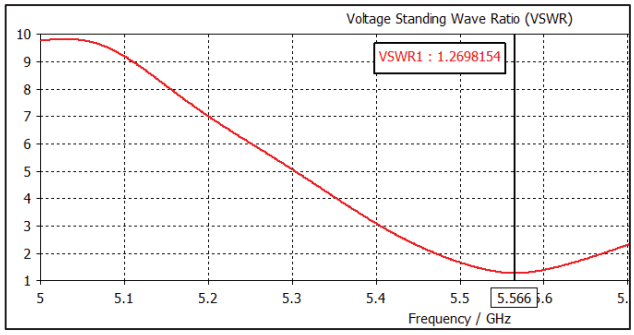

Figure 4: VSWR of the antenna

Results in Figure 3 shows that the return loss of this antenna achieved desired value which is less than -10dB. The S11 of this antenna fall at -19.417dB at 5.578GHz. The bandwidth percentage was at 19%, VSWR is 1.27 and the gain is 6.23 dBi. As mentioned above, the width of the feedline and spacing is adjusted to make sure that the impedance of the antenna is 50Ω to perfectly match with connector impedance for maximum power transfer to antenna with minimal back reflections.

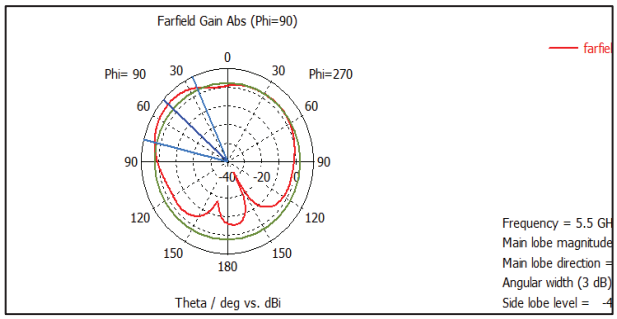

Figure 5: Simulated 2-D plot of radiation pattern

The simulated far field radiation pattern in Figure 5 indicates the gain of proposed microstrip Yagi antenna in 2-D space. The half power beamwidth is 35.2 degrees. Even though the bandwidth does not achieve the desired value, this antenna still suitable for WLAN application.

1. CONCLUSION

A microstrip Yagi antenna with array design has been presented suitable for Wi-Fi application. This work is designed using CST simulation tool. The designed antenna performance has been analysed in terms of return loss, resonant frequency ,bandwidth, gain as well as VSWR.

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REFERENCES

[1] Bevek Subba, Tashi Tenzin, Sangay Norbu, Thinley Tobgay, Tandin Zangmo, “Tuning of Yagi Uda Antenna with Gain Enhancement at 300 Mhz and 2.4 Ghz Bands For Wi-Fi Application”, *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, Vol. 8, no. 9, pp. 2355- 2361, 2019.

[2] R. E. Musril, H. A. Rahim, M. Abdulmalek, M. Jusoh and M. E. M. Salleh, "An Enhanced Gain of Yagi-Uda Antenna with Folded Dipole for Amateur Radio VHF Band Application", *Journal of Physics*, pp. 1-8, 2019.

[3] Zulfajri Basri Hasanuddin, Wardi, Gunawan Tari, "Low Cost Antenna Design for the Application of Over the Horizon Surface Wave Radar", *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, vol. 9, no. 2, pp. 2215-2218, 2019.