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DESIGN AND ANALYSIS OF COMB SHAPE MICROSTRIP PATCH ARRAY ANTENNA FOR WLAN APPLICATIONS

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Abstract

A comb shape rectangular slotted 1 × 4 microstrip patch array antenna is proposed and designed for wireless local area network applications. The functional parameters of the antenna namely, return loss, VSWR, radiation pattern are analyzed. The FR4 substrate is used to the proposed antenna. The dimension of proposed antenna is 143mm of width and 71mm of length and the patch dimension is 29.6mm of width and 38mm of length. The return loss and VSWR of 1 × 4 array antenna is -34.8815dB and 1.012, respectively. The rectangular slots are taken in equal length and width in order to enhance the performance.

Keywords:

Microstrip Patch Array, WLAN, Rectangular Slot, FR4, 1 × 4 Array, Return Loss

1. INTRODUCTION

In recent years, the development of telecommunication system has given to a variety of services including wireless local area network (WLAN) [1], long term evolution (LTE) [2] and laptops or cell phones. Antennas are mostly used for wireless communication. The most available antennas like microstrip patch antenna [3], monopole antenna [4], dipole antenna [5], array antenna [6], loop antenna [7] and aperture antenna [8]. Even then microstrip patch antenna guarantees low profile, compact and affordable manufacturing for real time applications. An antenna is an electrical conductor. It can be used for both transmission and reception and also a transducer. An antenna array is a set of individual antennas used for transmitting or receiving radio waves. Array antenna is mainly used for improving performance of communication systems and used to reduce the interference that are coming from different directions [9]. It provide higher gain and directivity.

WLAN is a wireless computer network that connects two or more users through wireless method within a limited area such as a home, school, computer laboratory, or office building. Most modern WLANs are based on IEEE 802.11 standards and are marketed under the Wi-Fi brand name [10]. The IEEE 802.11 has two basic modes of operation: infrastructure and ad hoc mode. In adhoc mode, mobile units transmit directly peer-to-peer. In infrastructure mode, mobile units communicate through an access point that serves as a bridge to other networks

In the literature, there are multitudinous techniques is employed to design the microstrip patch array antenna for WLAN applications, such as, Yagi array antenna [12], log-periodic array antenna [13], dipole array antenna [14], high gain double-sided array antenna [15] and multiband array antenna for WLAN/WiMAX [16]. From this reported work, it is scrutinized that the performance of the antennas is poor. To overcome these alleviate aforesaid issues, in this endeavor a rectangular slot is taken in these proposed microstrip patch array antenna [17]. Recently dual band multiport MIMO slot antenna [18], four-element MIMO antenna [19], square ground plane with circularly etching and two arc-shape slotted stubs base antenna [20], wideband Fabry–Pérot resonator antenna [21], a bowtie-shaped MIMO dielectric resonator antenna [22] and hexagonal slot dual band frequency reconfigurable antenna [23] are reported for WLAN applications.

In this paper, a comb shape rectangular slotted microstrip patch 1×4 array antenna is proposed and designed for WLAN application. The resonant frequency of proposed antenna is 2.4GHz. This antenna is designed in FR4 substrate with 0.8mm thickness, 1mm feed width and substrate dimension of proposed antenna is 143mm width and 71mm length and patch dimension is 29.6mm width and 38mm length.

This paper is organized as follows. Section 2 describes the proposed antenna design. Section 3 presents results and discussion of proposed array antenna. The impact of return loss with respect to the frequency for substrate thickness and number of array elements are reported in section 4. Finally, section 5 presented the conclusions.

2. ANTENNA DESIGN

The proposed comb shape rectangular slotted 1×4 microstrip patch array antenna is shown in Fig.1. The formation of proposed patch antenna is design is depicted in Fig.2. The FR4 substrate is used with the dimension of 143mm width and 71mm length. The width and length of the patch are 29.6mm and 38mm, respectively. The thickness of the substrate is 0.8mm and a dielectric loss tangent is considered as 0.02.

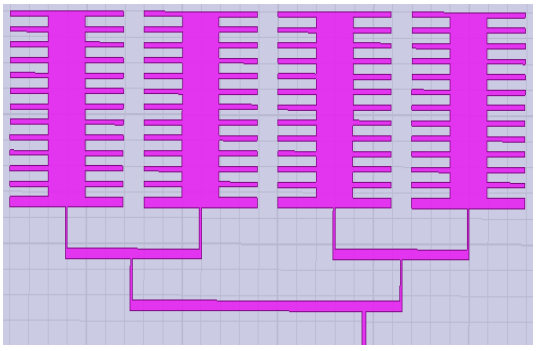

Fig.1. Schematic represenation of proposed 1×4 comb shape rectangular slotted microstrip patch array antenna

The microstrip feed with 1mm feed width is employed. The proposed antenna structure is designed like a comb; all the rectangles are similar in dimensions except the last rectangle. There are 13 slots positioned in each dimension. The structural

parameters of comb Shape rectangular slotted 1×4 microstrip patch array antenna are listed in Table.1. The proposed antenna is designed using High Frequency Structural Simulator (HFSS) software. In microstrip patch antenna, the width and length are most vital parameters which are ascertained using [24].

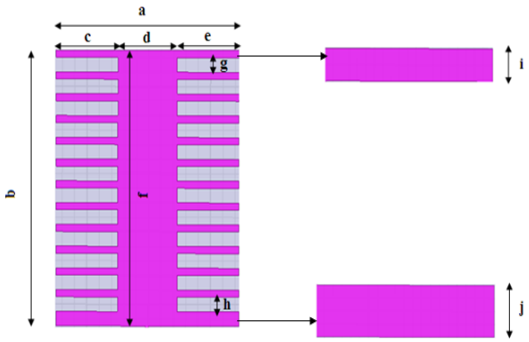

Fig.2. Sectional view of patch formation of the proposed antenna

Table.1. Structural details of comb shape rectangular slotted 1×4 microstrip patch array antenna

Parameter	Values (mm)
a	29.6
b	38
c	10
d	9.6
e	10
f	38
g	2
h	2
i	1
j	2

3. SIMULATION RESULTS AND DISCUSSION

The Fig.3 shows that the return loss of comb shape rectangular slotted 1×4 Microstrip patch array antenna. The return loss of proposed antenna is -34.8815dB at resonant frequency of 2.4GHz.

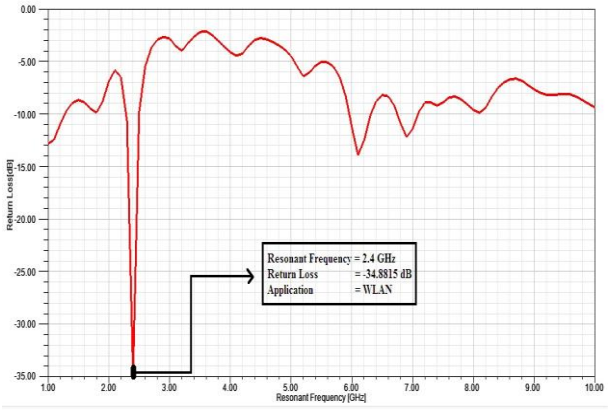

Fig.3. Return loss of the proposed proposed 1×4 comb shape rectangular slotted microstrip patch array antenna

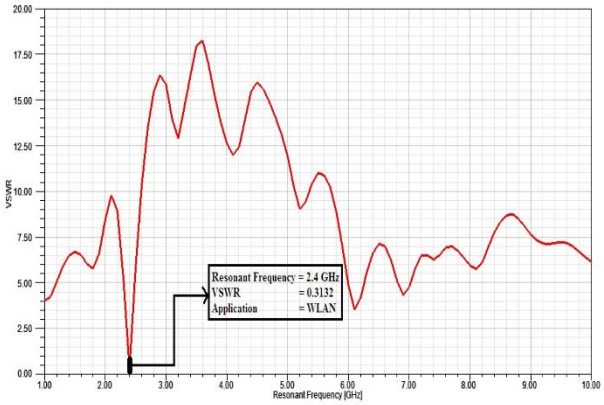

Fig.4. VSWR of the proposed antenna

The Fig.4 depicts the response of the VSWR for proposed comb shape rectangular slotted 1×4 microstrip patch array antenna. The VSWR of proposed antenna is 1.012 at 2.4GHz. The value of the return loss and VSWR is altered or controlled by increasing the number of slots in the comb drive. The simulated radiation pattern of proposed antenna is shown in Fig.5. The representation of the 2D radiation pattern of simulated result is isotropic radiation pattern. The proposed antenna meets the requirements of WLAN application.

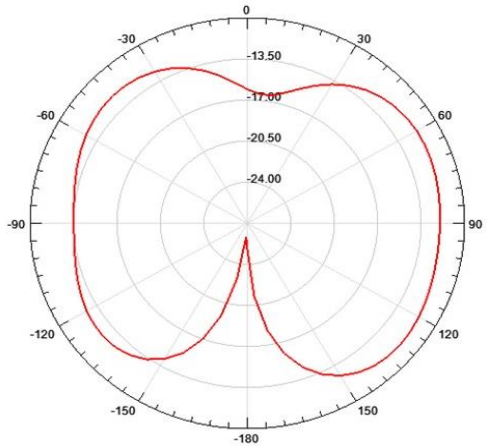

Fig.5. Radiation pattern of proposed antenna

Antenna gain is measured by antenna's ability to direct or concentrate radio frequency energy in a required direction or pattern. The gain of the antenna is 12.85dB. Directivity is a measure of performance of an antenna. Directivity is defined as the relation of the maximum radiation intensity to the average radiation intensity. The directivity of the proposed antenna is 13.18dB.

4. PARAMETRIC ANALYSIS

Here, initially the effect on return loss while increasing the substrate thickness is analyzed. Then the return loss of the antenna is investigated by varying the antenna elements from 1 to 8 in the design. The Fig.6 shows the impact of return loss while varying the substrate thickness. It is observed that the return loss is about -35dB at 0.8mm of substrate thickness. However, the performance is diminished for the substrate thickness of 1.6mm and 3.2mm.

Here substrate thickness of 0.8mm is used as it produced the better return loss when compared with the substrate thickness of 1.6mm and 3.2mm.

The Fig.7 shows the comparison analysis of comb shape rectangular slotted microstrip patch array antenna. From the simulated results, it is clearly investigated that there is resonant frequency shift while varying the number of array elements in an antenna. Further, there is significant improvement of return loss is observed at 1×4 array antenna.

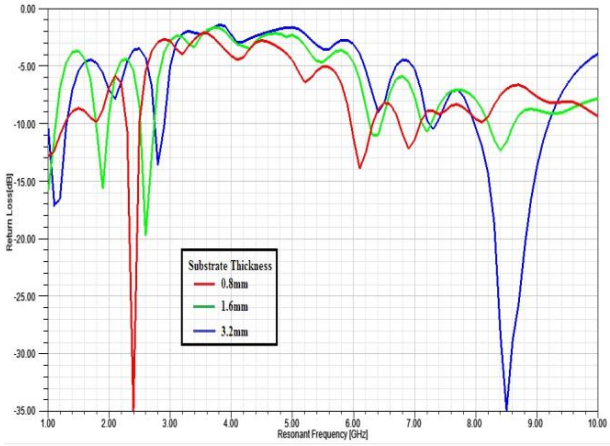

Fig.6. Impact of return loss with respect to substrate thickness

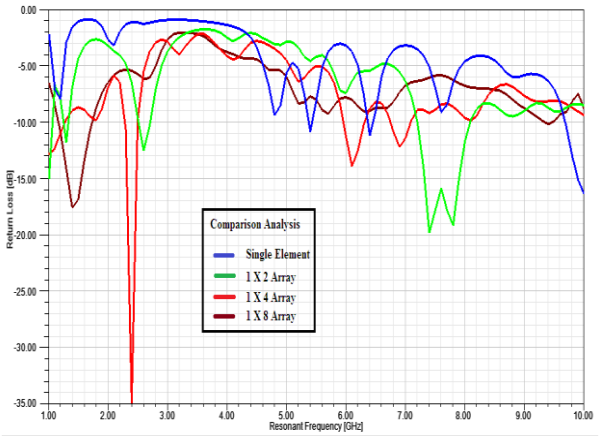

Fig.7. Comparison analysis of return loss vs. frequency of a single element patch, array of 1×2, 1×4 and 1×8 comb shape rectangular slotted microstrip patch array antenna

5. CONCLUSION

In this attempt, a comb shape rectangular slotted 1×4 microstrip patch array antenna is proposed and designed for WLAN application. The functional characteristics of the proposed array antenna investigated namely return loss, VSWR, gain and directivity. The proposed 1×4 array antenna is resonating at 2.4GHz, and the return loss and VSWR is about, -34.8815dB and 1.012, respectively. The overall size of the proposed array antenna is 143mm × 71mm and the patch dimension is 29.6mm width and 38mm length. Hence it could be amalgamated for WLAN applications.

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