Fractal Multi Input Multi Output Antenna for WLAN Applications

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Abstract

A novel scheme of microstrip-fed fractal Multi Input Multi Output (MIMO) antenna with fractal patches for WLAN, systems is studied and presented. The operating frequency of the presented MIMO is from 4.1 GHz to 6 GHz, which covers 5.5 GHz band. The simulated and measured results of the proposed MIMO illustrate that the frequency range is set to 4.1GHz up to 6 GHz for impedance bandwidths. The presented MIMO has size of 15×30mm^2. Different geometry and configurations of proposed MIMO array for multiple applications are studied. It illustrates that the attributes of small size, efficient radiation characteristic and less mutual coupling for MIMO application are promising.

Keywords: Index Terms— Antenna, Fractal, Microstrip, Multi-input multi-output system. MIMO

1. Introduction

Nowadays, telecommunication subsystems demand the elements for different subsystems and standards with specifications like wide-band operation, small-size, good peak gain [1-4]. For wireless communication, the WLAN is one of the important frequency bands. The WLAN is a long-distance communications standard that utilizes 5.5 GHz frequency of industrial band. The frequency range is 5.15–5.35GHz for practical WLAN application. Recently, there are different designs, with compact structure [2-7]. Efficient performance operations are significant requirement of this kind telecommunication. A single element is wanted if it can operate at desired bands. To decrease radiation losses and transmission line, a new kind of feeding circuit is used in traditional antennas [8-10]. Mainly, the distance among the elements of an array relates to the mutual coupling [7-12]. The distance between the antennas cannot be maintained too large. In recently researches, for reduction of the mutual coupling, the distance between the elements of the antennas is increased. But by utilizing the isolator between the elements the mutual effect is reduced. The basic MIMO antenna design geometry minimizes the correlation among the signals. In this study, we propose fractal geometry for mutual coupling reduction and novel design of MIMO antennas. Different isolation reduction techniques are used such as, multi-layer structure, EBG structure which all of the have complexity for reducing of mutual coupling effects [4-5]. A novel scheme of a WLAN band MIMO fractal array antenna best for different wireless communication applications is presented which have lots of advantages for instance, omnidirectional patterns easy integration with other microwave devices, and simple structure of a broad bandwidth. Arrays configurations of Antenna for MIMO applications are studied and provide the lowest mutual coupling because of fractal T-shaped isolator, beside that good omni direction radiation pattern are achieved. The proposed prototype has presented an outstanding structure for the efficient fractal MIMO antennas with fractal form isolator and the WLAN band antenna applicability to the MIMO array antenna subsystem. Efficient radiation performance and return loss are achieved at full band of the frequency range.

2. Antenna Design

Figure 1 depicts the presented fractal MIMO Antenna. The fractal MIMO antenna was fabricated on FR4 epoxy substrate with εr = 4.4 and loss tangent 0.028 and thickness 1mm. Initial element structure made of a T-shaped unitcell in order to create fractal radiating patch. Figure 1 shows Geometry of proposed Element. In addition, two elements of final designed is set vertically beside each other to form final design of MIMO array antenna. Figure 2 illustrates geometry of proposed fractal MIMO antenna. For signal transmission, the proposed scheme is connected to SMA connector. **2.1 state space model**

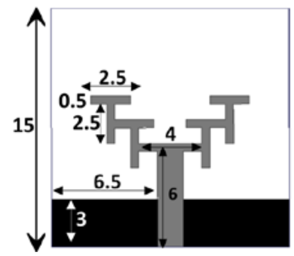
State space model nonlinear model based on the equations of state 9 modes:

m_{o2} m_{h2} m_{n2} m_{sm} $m_{w,an}$

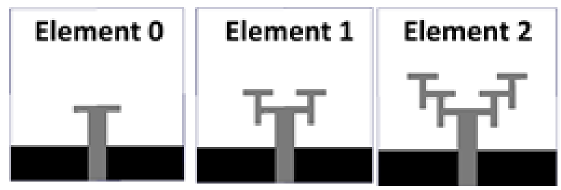
Wcp $m_{w,ca}$ p_{sm} p_{rm}

LTI system analysis in the subject line of the model used for the linear model

U voltage the compressor Vcm is.



(a)



(b)

Fig.1. (a) Geometry of proposed fractal Element (b) fractal design steps

Network input oxygen mass, the mass of hydrogen, nitrogen mass, cell output current and output voltage of the fuel cell is a neural network. This here with minimizing a quadratic loss function of the output error is made the error of comparing the output value with the desired output is achieved. Many optimization techniques are able to do so.

Block diagram of the control system by using a combination of equations of state-space model with the fuel cell process neural network shown.

3. Results and Discussion

The proposed fractal MIMO array antenna with fractal design techniques was fabricated, and the simulated and experimental results of the radiation characteristics and input impedance is studied over the paper. The scheme of the presented fractal MIMO antenna is depicted in Figure2. HFSS simulator is used to optimize the design.

Figure 3 shows The structure of the element design for MIMO antenna return loss performance. It is deduced by increasing the number of fractal levels the impedance matching of element is enhanced. In addition for generating the MIMO structure two arrays of elements are set vertically regarded to each other in order to form final design. By setting fractal unit cell in the top layer of substrate, the isolation is improved based on Figure 4 studies. It is obvious from Figure 4 scattering parameters that the isolator can efficiently reduce the coupling effect. More over WLAN band property which covers 5.5GHz frequency can be achieved. The fractal MIMO prototype with ultimate design was fabricated and tested. The fabricated antenna has frequency bands of 4.1-6GHz. Figure 5 illustrates the simulated smith chart for fractal MIMO antenna. The peak gain of fractal prototype MIMO is studied in Figure 6, it is clear that by increasing the frequency the gain is enhanced. Figure 7 shows the measured H-plane and E-plane radiation patterns, including the co polarization and cross-polarization. It is understood that the radiation patterns in x-z plane are omni directional. Figure 8 illustrates the scattering parameter study of fractal MIMO antenna. The characteristics of a fractal antenna array are suitable for MIMO applications because of different parameters for instance, radiation pattern and mutual coupling. Based on the proposed fractal geometry that any two fractal element can be arranged vertically each other. In this case, the spacing among the fractal array elements is set at less than half wavelength that proposed space because of isolator. It can be seen that the fractal array structure in which the antenna elements are vertical beside each other, has lower mutual coupling effects. Figure 9 shows return loss study of fractal MIMO antenna for port 2. Fig.10. shows the measurent parameter of fractal MIMO antenna. The fabricated fractal MIMO antenna on FR4 substrate is shown in Figure 11. Table 1 illustrates te Performance Comparison of The Proposed MIMO with Other Refrences. It is obvious that the prposed antenna has beeter performance than other refrences.

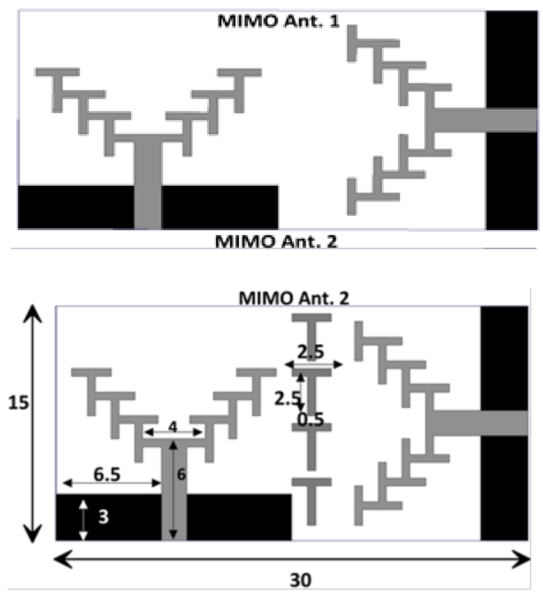


Fig.2 System Control output power

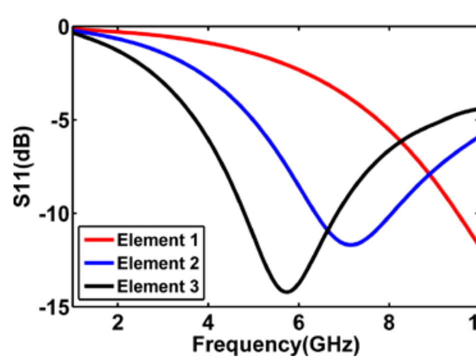


Fig.3. Return loss simulation for different designed fractal element 1, 2 &3

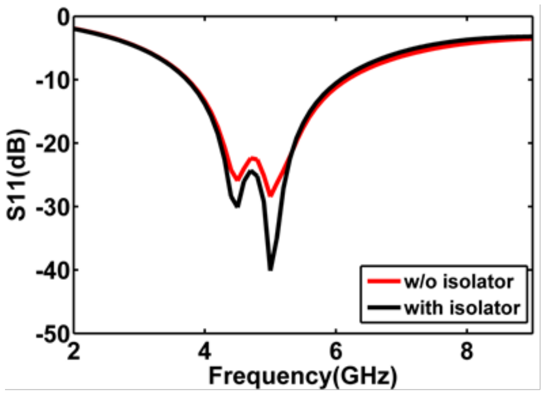
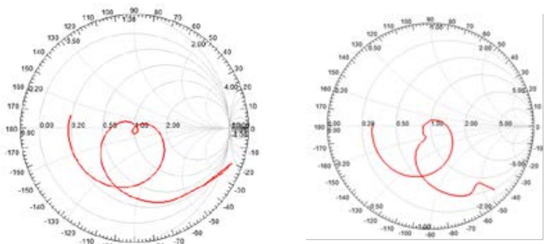


Fig.4. isolator effects on fractal MIMO antenna for port1



(a) (b)

fig.5. simulated smith chart for fractal MIMO antenna (a) S_{11}(b) S_{22}

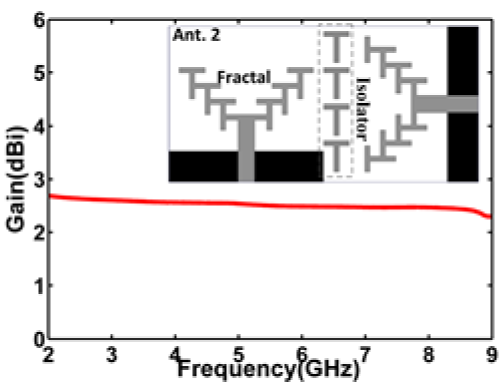


Fig.6. The peak gain of fractal MIMO antenna with fractal isolator (measured).

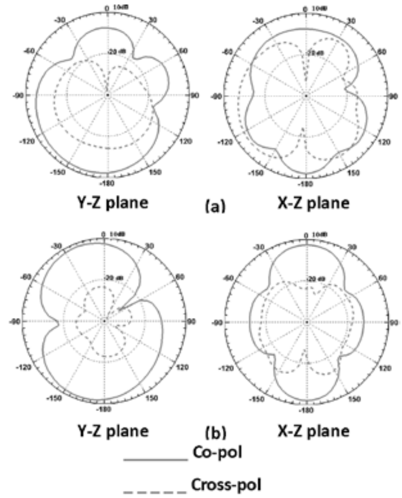


Fig.7. Radiation patterns of fractal MIMO antenna a) 4GHz b) 5GHz

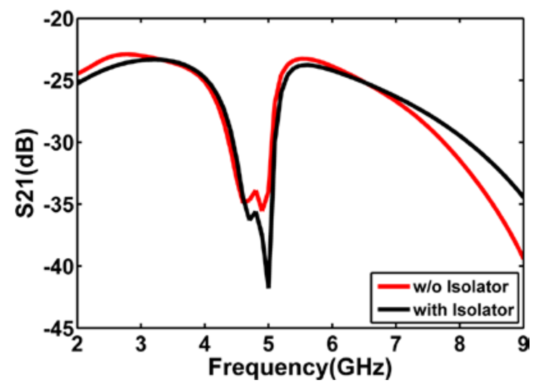


Fig.8. the scattering parameter study of fractal MIMO antenna (simulation)

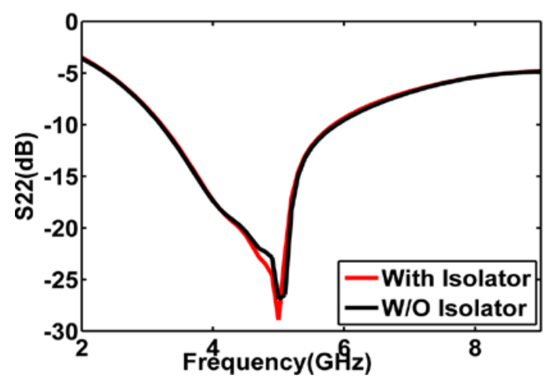


Fig.9. the scattering parameter study of fractal MIMO antenna for port 2(simulation)

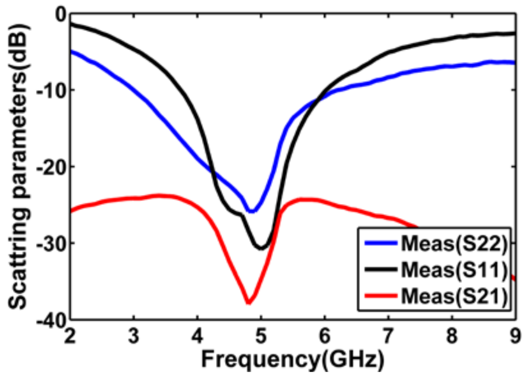


Fig.10. the scattering parameter study of fractal MIMO antenna (measurent)

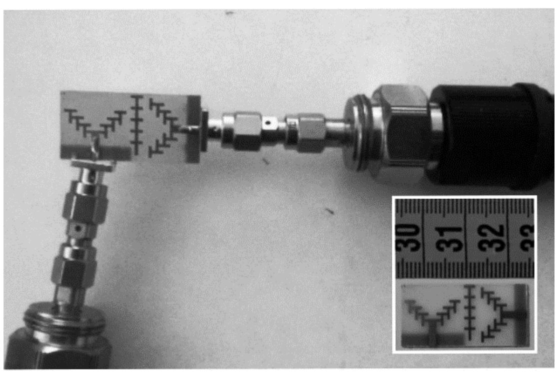


Fig.11. fabricated fractal MIMO antenna

Table 1 Performance Comparison of The Proposed Antenna with Other Refrences

	Peak Gain [dBi]	WLAN	MAX Isolation[dB]	Impedance BW [GHz]	Area [mm^2]
Ref. [1]	1	×	20	3-4.5	40×40
Ref. [6]	2	×	25	6-7.5	35×35
Proposed Antenna	2.8	✓	43	4.1-6	15×30

Conclusion

A unique microstrip-fed fractal Multi Input Multi Output with outstanding chractersic for WLAN application is presented. The operating frequency of the proposed fractal MIMO array antenna covers 4.1 GHz to 6 GHz subsystems (5.5 GHz). To achieve band performance fractal geometry T-shaped strip in the radiating patch are used. Two elements of arrays of element in vertical mode geometry is introduced for reduction of mutual coupling. Experimental and measured results illustrate that the proposed MINO could be an efficient choice for WLAN application.

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