Design of Multi-Band Microstrip Ring Antenna for Wireless Sensor Network

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***Abstract*— A novel miniaturized Multi-Band antenna applicable for wireless sensor network discussed here. The proposed antenna is easy to design. The geometrical structure of the microstrip antenna is a simple square patch which is implemented on single layer. The antenna fed by probe feeding technique, which is present along with the antenna radiator at the same layer. And square ring structure is introduced for achieving multiband operation. The proposed antenna exhibits better impedance matching at each resonant frequency. The first resonating frequency of the designed antenna is 3.4 GHz and later it resonates at 4.5 GHz, 5.8GHz and 7.5 GHz. Very good gain is recorded at all of the resonances. The antenna was implemented on FR 4 substrate with dielectric constant of 4.4, thickness of 1.66mm and loss tangent of 0.02.**

Keywords*— *Microstrip antenna, Capacitive couple, Square ring model, Multi band, WSN, High gain.

I. INTRODUCTION

MICROSTRIP ring antennas are widely used because of their low cost design, low weight and compact size. In this century, microwave communication system having great demand due to its compact size, economic, easy of fabrication and integration into MMIC design [1- 4]. Due to small size, high efficiency and high accuracy microstrip patch antenna are demanded now a days. Microstrip patch antennas are widely used in RF microwave communication as well as in wireless mobile communication. For the above said reason the multiband microstrip patch antennas are studied seriously [5, 6]. The multiband behavior of the microstrip patch antenna has better advantages compare to single band antennas. Multi-band design approach will be helpful for propagating more than one band of frequency simultaneously, that is an advantage for RF Microwave communication and Wireless communications [7-11]. Such types of Microstrip antenna also useful for GPS, GSM, PCS, CDMA, DCS, RADAR, RFID, WSN and many more wireless communication system. This design technique is very much helpful for minimizing the complexity of the communication system.

Generally, the main radiator of the microstrip antenna is of different shapes and there is various types of feeding techniques are available. This proposed antenna is optimized with well designed structure and uses probe feeding techniques with capacitive coupling. The proposed antenna showing better impedance bandwidth at every resonant frequency. The proposed antenna is superior than other design existed because of its notable efficient operation and better gain response.

In this century, wireless sensor technology have deployed frequently. Also the communication between end devices is becoming wider in different region. The communications between different regions have to very easy, where the wireless sensor network and sensor node are an essential parameter to make it happen. The wireless sensor network is having number of sensor node (figure 1) and the sensor node builds a network topology as required for specifics communication service between the devices.

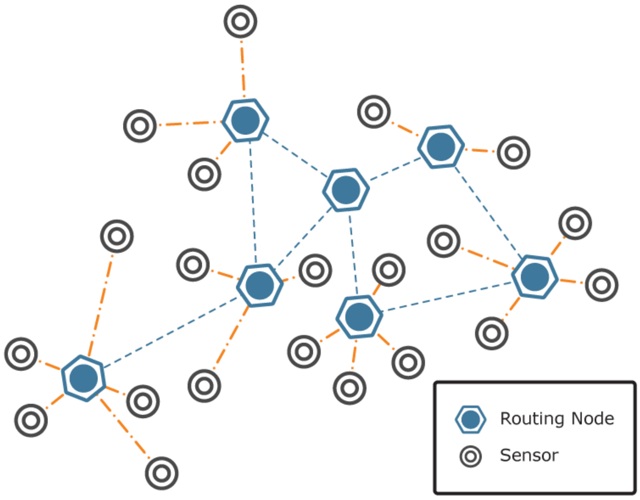

Fig. 1. Example of WSN cluster.

II. ANTENNA DESIGN AND DISCUSSION

For the designing of Microstrip antenna some basic parameters are required. These are the resonant frequency, dielectric constant of the material used. These parameters are helpful for calculating the dimension of the antenna patch, where it intends to resonate first. The Operational frequency band has been chosen based on different applications as the design frequency. The resonant frequencies obtained are used in WLAN, Bluetooth; RFID based wireless sensor nodes and other wireless applications.

The proposed microstrip antenna is design in a single layer. As mentioned earlier the feeding technique of the discussed antenna is a capacitive coupled probe feed, separate feed patch is used for this. Both antenna radiator and feed patch is placed in same layer with specific gap between them and the cross sectional view is shown in Figure 1. Main radiator of the discussed antenna is designed on FR4 substrate (ϵ_r=4.4), with 1.66 mm substrate thickness and loss tangent of 0.02. The actual dimension of the proposed microstrip patch is 15.5×16.4mm^2. The cross sectional view of the proposed antenna structure is shown in figure 2.

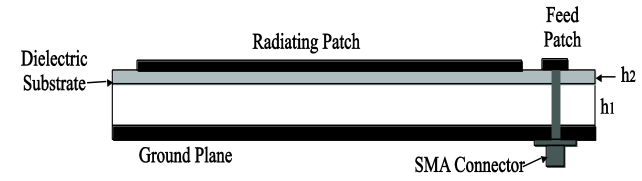

Fig. 2. Cross section view of the designed antenna.

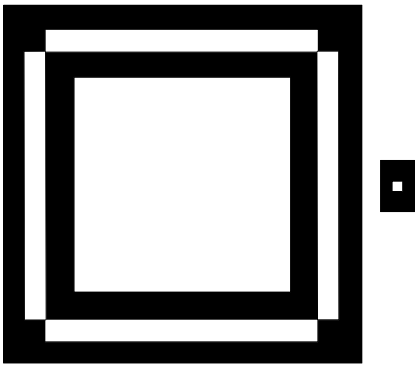

Fig. 3. Geometrical structure of the discussed antenna.

In figure 3 architecture of the discussed antenna is shown. Here the nearly square patch antenna is miniaturized to square ring structure. This square ring structure is make realization of multi-band operation. The square ring again optimized with rectangular slots for achieve more band of operation. With the final structure as shown in figure 3 the proposed microstrip antenna is having five operating bands. The air gap provided in between the ground plane ante the FR$ makes the operating band wider than usual. The proposed antenna is good impedance band with at each resonance.

The proposed microstrip antenna is fed by probe feeding technique. For this a separate feed patch is used. The feed patch is present in the same layer alongside with main radiator of the antenna.

The behavior of the antenna is periodically analyzed with IE3D software. The geometrical structure of the proposed antenna is a square patch. The square patch is introduced with rectangular slots and step by step observation is carried out for optimizing the performance of the antenna, keeping the other parameter fixed. The simulation of the antenna is done by Method of Moment (MoM) based IE3D software, which is the Integrated Electromagnetic simulation package for arbitrary 3D volumetric passive devices, having Microsoft windows graphical user interface.

III. RESULTS AND DISCUSION

Simulation for the purposed antenna is performed and the results are shown below:

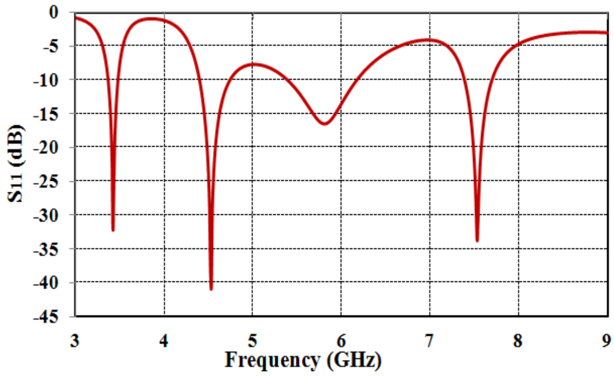

Fig. 4 Return loss characteristic.

The simulated S11 parameter is shown in figure 4. The figure 4 demonstrates that the proposed antenna is having very good impedance matching at each resonant and here the return loss characteristics at each resonant frequency is very deep. The band of operation at each resonant is wider and the average operational range is 500MHz.

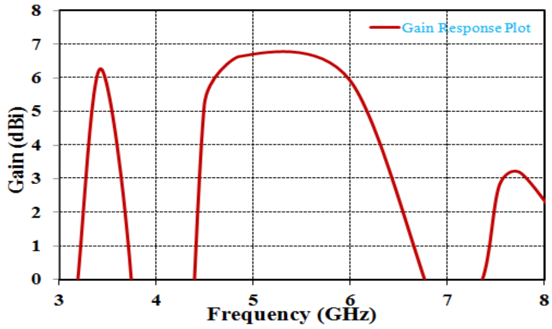

Fig.5 Gain Response plot at respective resonances.

Gain of discussed antenna is better than previous work. The gain of the proposed antenna is around 7dBi max. The gain response plot of the microstrip patch is shown in figure 5.

IV. CONCLUSION

A novel single-Probe-fed multi-band ring type microstrip antenna has been designed and the behavior of this antenna is verified using IE3D simulator. The Simple square ring antenna geometry leads to multiband operation with better impedance bandwidth has been discussed. The efficiency of the antenna is very good. The gain response of the proposed antenna is very good, which is 7dBi of max gain response. Such type of antenna is very much helpful of sensor node application. As the gain is very high, the antenna is having tremendous application in wireless sensor network.

V. ACKNOWLEDGMENT

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