International Journal of Microwave Engineering and Technology
Vol. 1: Issue 1
www.journalspub.com

Application of Rectangular Patch Antenna for a Moisture Content Sensor

Nirbhay Agarwal*, P.K Singhal
Department of Electronics, Madhav Institute of Technology and Science, Gwalior (Madhya Pradesh), India

Abstract

Micro-strip patch antenna is a low cost, easy to fabricate, light weight which is used for transmit and receive electromagnetic wave. This paper tells about the micro-strip rectangular patch antenna moisture sensor for different types of rice which are basmati rice and ambemohar rice both are easily available in Indian market and it has been measured by using two different substrate RT-duroid 5880 and FR4 lossy. A relationship is to be developed between the return loss and frequency at different moisture percentage. On adding definite amount of water at fixed weight of rice a different relationship is formed between return loss and frequency, and to compare a graph between these two substrate.

Keywords: *Rectangular patch antenna, Computer simulation technology (CST), Printed circuitry board (PCB), Rice samples*

****Author for Correspondence:*** *Email ID: nirbhay.itm@gmail.com*

INTRODUCTION

Antenna is heart of Wireless Communication. Now a day's wireless communications have progressed very rapidly in recent years and mobile devices become smaller. As per condition of the mobile we should modify the dimension of the antenna accordingly. The narrow bandwidth of the antenna restricts its wide usage. Wireless sensor network concentrates about the development of low cost, light weight, small size [1]. The first commercial sensor was for fish meat processing[2], for ripeness for oil for palm fruits[3], in green tea leaf for moisture content[4], to find the moisture content in rice[5], and to find the broken rice percentage[6]. At present, more than half of the world population covers the rice food intake [6] but there is difficulty in milling process which leaves large amount of rice either fallow or as discarded. There is alternative vision about the rice characterization that is maximum number of the customer wants the optimum quality rice in the form of long grains discussed about the look quality of rice, which displays a major problem of rice production in numerous of rice producing areas of the world, and this particularly is a lot extra important in case of rice production. In recent times, there is a strong stress for intensification of the total world rice production by cultivating the quality of rice. The core difficulties lie in cooking value, eating quality and processing quality and to some extent in milling quality. The look of grain governs the quality of rice to large extent. Quality is a significant factor at the back and front end of rice manufacture. If quality milled rice is probable at the end insurance of quality paddy is requisite at beginning of the process. According to the International Rice Research Institute (IRRI), measurement of quality provides data that can be used for decision making, optimization and the development of processes and technologies as well as for evaluating the properties, function, quality

and reliability of the same. A rectangular patch antenna is designed on two different substrate such as FR4 lossy and RT Duroid 5880 and after that two types of rice sample has been taken in same amount and to add the water in the same ration then the variation in frequency as well as return loss has been drawn.

ANTENNA DESIGN AND PRINCIPLE OF OPERATION

Firstly, rectangular patch antenna is designed on Computer Simulation Technology (CST) at FR4 lossy substrate having 4.3 permittivity and RT Duroid 5880 lossy having permittivity 2.2 a simulation result has been obtained. After that a designed was sketched by Autocad software. The sketched antenna is printed on act paper and by using iron technique the antenna is superimposed on act paper. Finally the antenna was etched using ferric chloride solution and then it will measure on spectrum analyser.

(a). Width of Patch (W)

$$W = \frac{1}{2fr\sqrt{\mu o \varepsilon o}}\sqrt{\frac{2}{\varepsilon r + 1}}$$

Where f_r = resonant frequency

(b). Effective Dielectric Constant of the Substrate (ε_r)

$$\varepsilon_{reff} = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left[1 + 12\frac{h}{W}\right]^{\frac{1}{2}}$$

Where, h = height of substrate

εr = dielectric constant of substrate

(c). Extension in Length

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon reff + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon reff - 0.258)(\frac{W}{h} + 0.8)}$$

(d). Length of Patch (L)

$$L = \frac{1}{2fr\sqrt{\varepsilon reff}\sqrt{\mu o \varepsilon o}} - 2\Delta L$$

(e). Length of Patch

$L_e = L+2\Delta L$

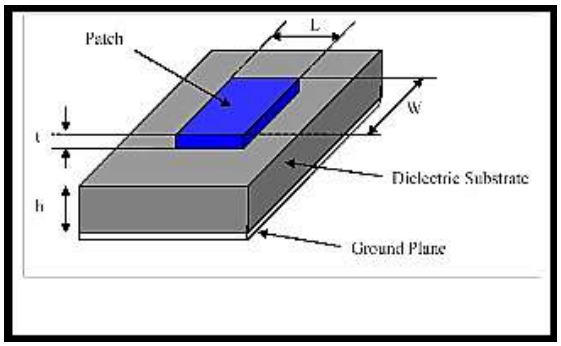

Fig. 1: *Geometrical View of Patch Antenna.*

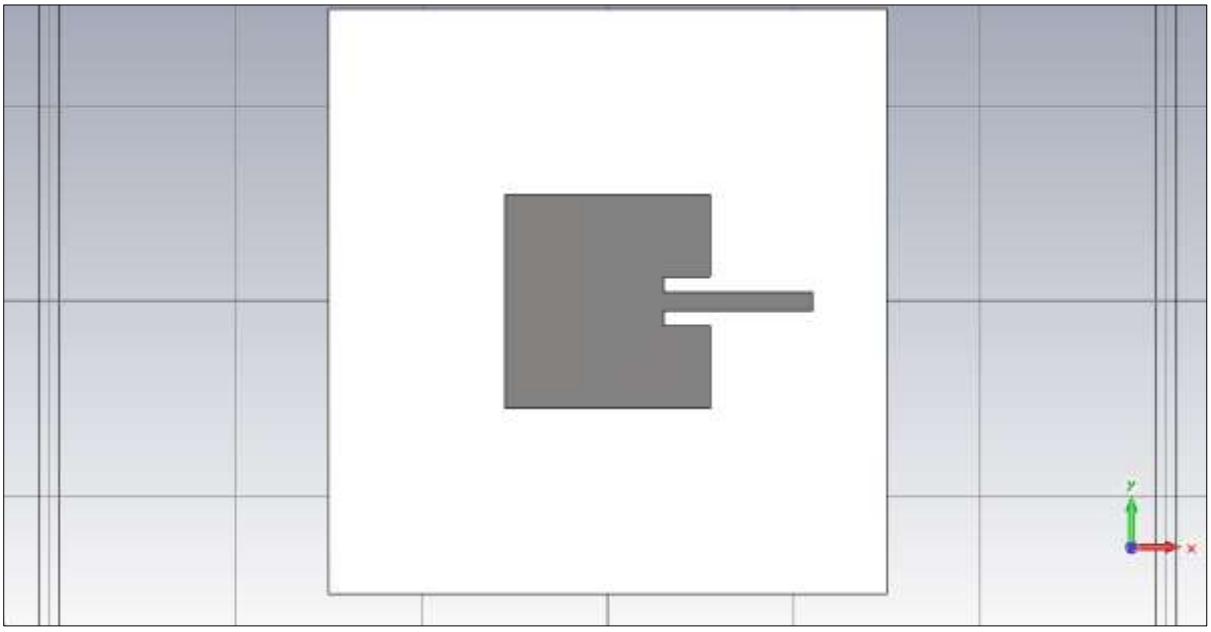

Fig. 2: *Front View of Rectangular Patch Antenna.*

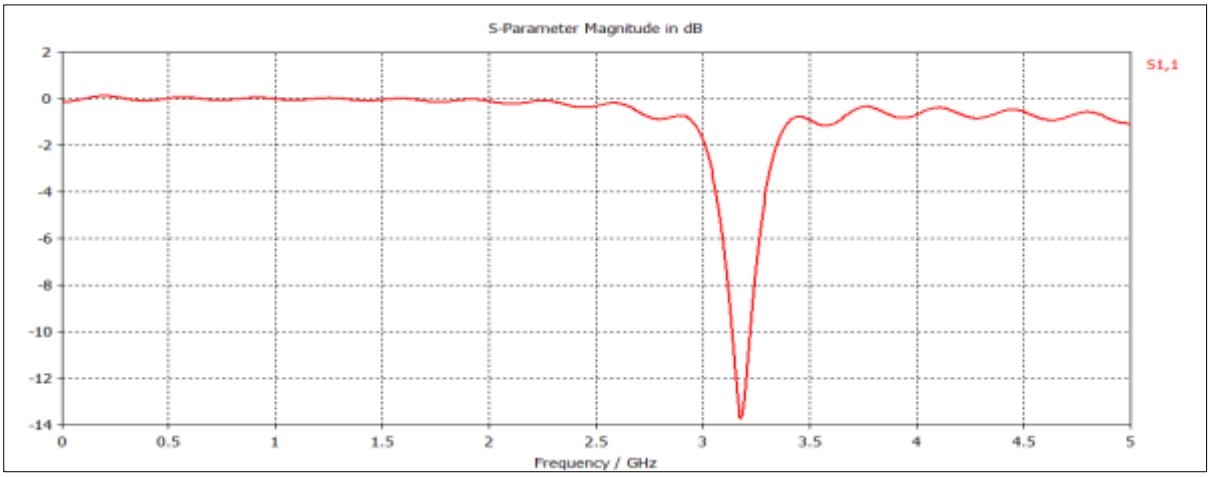

Fig. 3: *Simulation Result of Rectangular Patch Antenna on Fr4 Lossy Substrate.*

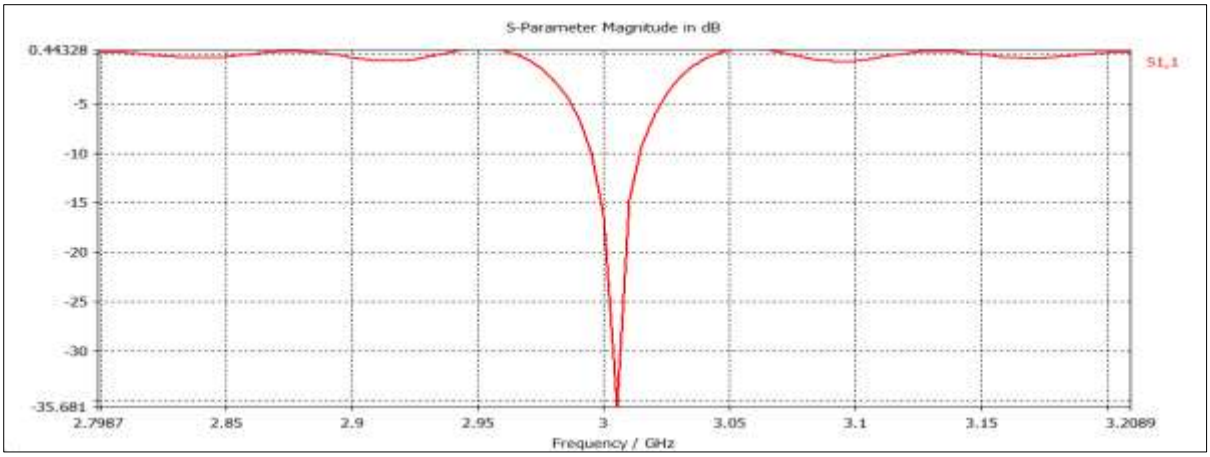

Fig. 4: *Simulation Result of Rectangular Patch Antenna on RT Duroid 5880 Lossy Substrate.*

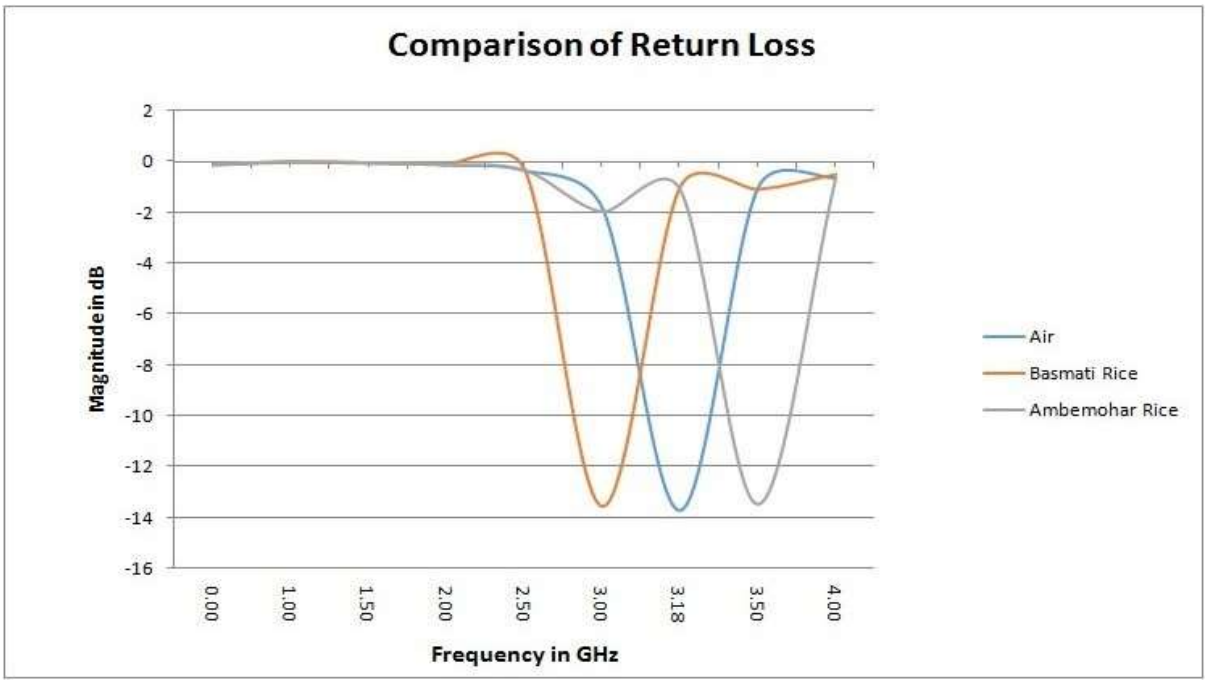

Fig. 5: *Comparison of Different Types of Rice in FR4 Substrate.*

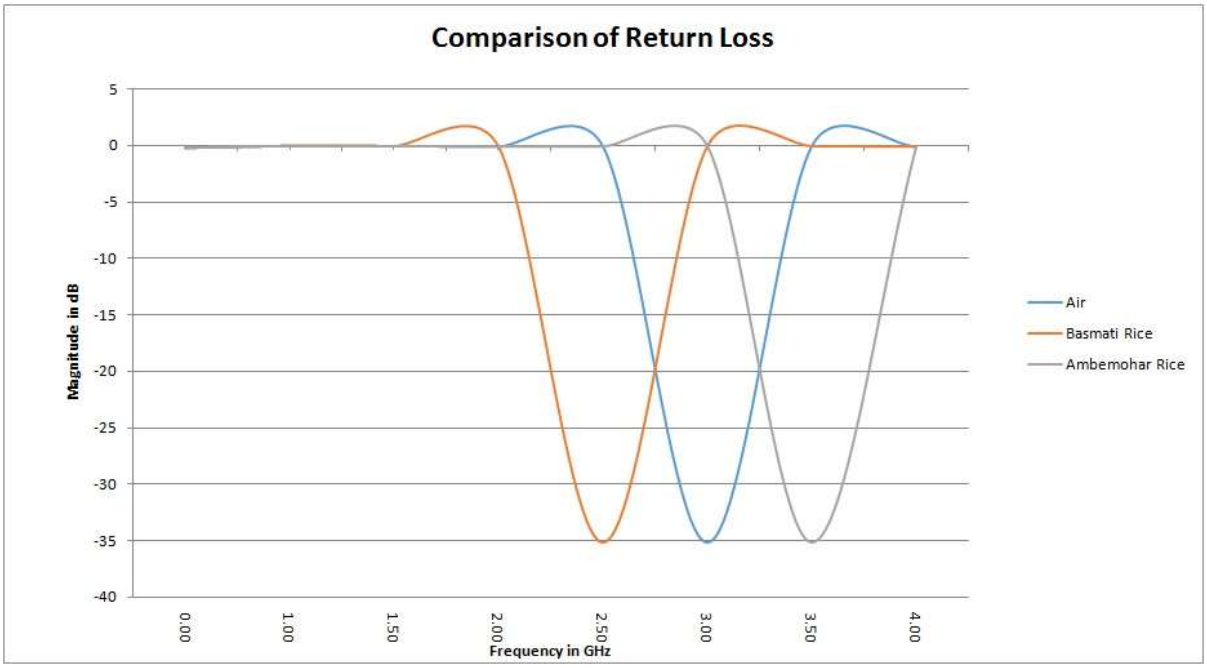

Fig. 6: *Comparison of Different Types of Rice in RT-duroid Substrate.*

RESULTS AND DISCUSSION

The return loss, for the sensors have been measured using the Network Analyser. Before measurements, the single port calibration at the ends of coaxial cable have been done using calibration kits (open, short and load). Various rice samples have been placed over the acrylic holder sensor with a height of 15 mm. Owing to this work is an initial study for rice characterization, the rice samples were blended in powder form to eliminate the air gap between the grain rice and the micros trip line in order to obtain an accurate measurement results. Figures 5 and 6 shows the different magnitude and different frequency at different rice samples on two different substrate which are Basmati rice, Ambemohar rice these are easily available in Indian market. The antenna sensors used in this study have different magnitude of return loss depend on a substrate.

CONCLUSION

This study is the initial step towards developing the sensor using microstrip antenna concept. The actual mill rice grain instead of powder form along with the modelling study will be carried out in future work. Besides moisture content, the quality of rice based on the percentage of crack grain in the rice sample will be also carried out.

REFERENCES

1. Akyildiz Ian F., Su W., Sankarasubramaniam Y., *et al.* Wireless sensor networks: a survey. *Computer Networks.* 2002; 38.4: 393-422p.
2. Kent M. The use of strip-line configuration in microwave moisture measurement. *Journal of Microwave power and Electromagnetic energy*. 1972; 7: 185-93p.
3. Khalid K., Abbas Z. A microstrip sensor for determination of harvesting time for oil palm fruits (Tenera: Elaeis Guineesis). *Journal of Microwave Power and Electromagnetic Energy*. 1992; 27: 3-10p.
4. Tan Y.F., Xing Y.Z., LI J.X., *et al.* Genetic bases of appearance quality of rice grains in shan you 63, an elite rice hybrid. *Theoretical and Applied Genetics.* 2000; 101(5-6): 823-9p.
5. Yeow Y.K., Jalani S.N.A., Abbas Z., *et al.* Application of Bandpass Filter as a Sensor for Rice Charecterisation.

International Conference on Computer Application and Industrial Electronics (ICCAIE); 2010 Dec 5-8; Kuala Lumpur. IEEE; 2010.

6. Mun H.T., You K.Y., Dimon M.N. Broken rice detection based on microwave measurement technique using microstrip wide ring sensor and microstrip coupled-line sensor. *Australian Journal of Crop Science*. 2013; 7(13):2079-90p.