Performance of ALOHA protocol to enhance the range of Antenna for Efficient RFID Tag reading

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Abstract - *RFID (Radio Frequency Identification) and Wireless sensor network(WSN) are two important wireless technologies that have wide variety ofapplications and provide unlimited future potentials. RFID is used to detectpresence and location of objects while WSN is used to sense and monitor theenvironment.In this paper a small Microstrip patch antenna is introduced .theantenna is designed to function in 2.4 GHz wireless radio band .itachieves return loss -38 dB by the using fr4 substrate under thepatch .the antenna has many practical applications like inWLANWIFI, etc. as illustrated in detail herein .the patch designis simulated in HFSS software .the result showedsatisfactory performance. This technology aims to uniquely identify physical objectattached to a so called tag or transponder. When thereader attempts to identify more than one transponder, itmay face up a simultaneous interfering transmission fromtransponders which may causes a collision as tags arethe same communication channel. For this generic multiaccess communication problem, several algorithms havebeen proposed to identify tags. These protocols areclassified into deterministic approach and probabilisticcollision resolution. The main focus of this work is toanalyze the performance of aloha protocol in the case ofRFID communication system.*

Keywords – *RFID ,Wi-Fi , ALOHA ,medium access collision , Microstrippatch antenna*

1. Introduction

It is now well recognized that future internet will not only connect people and data but also objects (anything). This means most of the traffic will flow between objects thus creating “ the Internet of the things”. Objects connected to network could be a refrigerator connected with grocery stores, laundry machine with clothing, implanted RFID tags with medical equipment’s ,and vehicles with stationary and moving objects. With this it appears that the computers as a dedicated device will disappear, and intelligent objects might be tagged andnetworked. Future Internet will be object-to-object communication rather than machine-to machine communication. An Internet can detect and monitor changes in the physical statusof connected objects through sensors and RFID in real time. The design of an efficient wide band small size antenna, for recentwireless applications, is a major challenge. Microstrip patchantennas have found extensive application in wirelesscommunication system owing to their advantages such as low profile,conformability, low-cost fabrication and ease ofintegration with feed networks. However, conventionalMicrostrippatch antenna suffers from very narrow BroadbandMicrostripPatch Antenna 175 bandwidth, typically about 5%bandwidth with respect to the center frequency.Wireless sensor network has applications in environment, disaster prevention, healthcare, home automation, intelligent transportation, precision agriculture, etc. The sensors are used to collect and transmit information about their surrounding environment. The node collects the information from a group of sensors and facilitates communication with a control center. The software helps the system in collecting and processing of large volumes of data .RFID relates to the technique of transmitting the identification of an object in the form of aunique serial number using radio waves. The basic components of RFID technology are thetags, readers and host computer. RFID reader reads information on the tag and passes it tothe host computer for analysis. RFID software helps in collection and processing the data. WSN and RFID are complementary becauseoriginally designed with different objectives (RFID for identification while WSN for sensing). For these reasons integrations of WSN and RFID provides a significant improvement on monitor.

1. RFID Basic

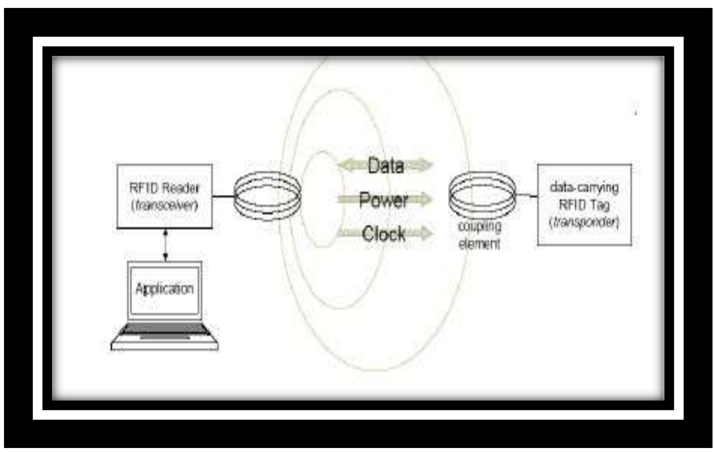


Fig.1 RFID system

RFID system is a kind of wireless communication it consists of three main parts:-A base station (reader): this is the powerful entity which consists of a modem designed to transmit energy to a transponder and to read informationBack from it by detecting the backscatter modulation - One or more transponder: called also tag, it is composedof microstrip antenna that includes basicmodulation circuitry with on board Rectification Bridgeand a nonvolatile memory. Management system: this is a data processing sub system which can be an application or database depending on the Passive tags are energized by a time-varying electromagnetic field (RF) wave (carrier) that istransmitted by the reader. When this RF field passes through an antenna coil, there is an AC voltage generated across the coil. This AC voltage is rectified to supplypower to the transponder at the same time the tag divides down the carrier to generate an on board clock and begins application. clocking its data output transistor connected across the coil inputs .this amplitude fluctuation of the carrierwave is seen by the reader as an amplitude modulation hence it peak detects the amplitude modulated data and process the resulting bit stream according to the encoding and data modulation scheme used by the transponder.

RFID Technology

RFID is an effective automatic identification technology for variety of objects. The mostimportant functionality of RFID is the ability to track the location of the tagged item RFID Technologies comprises tags, reader, and host computer. The tag has anidentification number and a memory that stores additional data such as manufacturer, product type, and environmental details such as temperature, humidity, etc. of an object. InRFID applications, the tags are attached or embedded into objects that are to be identifiedor tracked. The tag may be passive with no battery or active with Read/Write function,wider communication range, and independent power supply. A passive tag reflects the RFsignal transmitted to it from reader. The active tag enables higher signal strength andextends communication range up to 100-200m. Active RFID tag is capable of two-waycommunication where a passive tag is read only. RFID reader is able to read and/or writedata to tags via wireless transmission. RFID communication is single hop, and there is nocommunication among RFID tags. RFID reader reads information on the tag and passes itto host computer for further analysis. RFID middleware helps in collection and processingof the data. RFID reader broadcasts to all tags within range, select a particular tag forcommunication, and exchange information with the selected tag. This process is quit complex when large numbers of tags are within range or when two or more readersoverlap. Additional collision avoidance techniques are needed to ensure thatcommunication is organized in structured way so as to allow all tags to participate in thisprocess. Two types of anti-collision techniques are used. One is reservation based(TDMA/FDMA/ CDMA) which guarantees collision-free communication, while other iscontention based ALOHA which works in decentralized fashion butcollision occurs some times. RFID uses backscatter technique and operates in UHF bandbetween 865-956MHz. It allows range between 3-4m using 30cm long reader antenna.

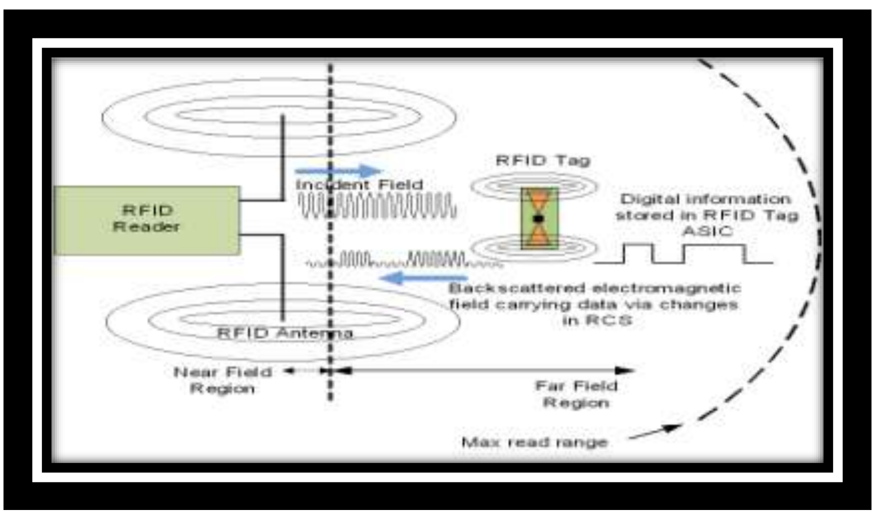


Fig -2 RFID Application

1.Design of Micorstrip patch antenna

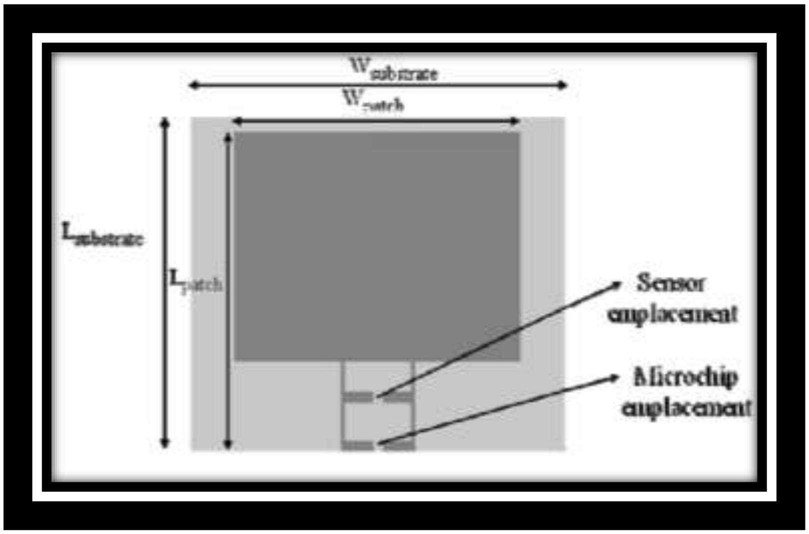


Fig 3- : RFID antenna patch geometry

The basic structure of the proposed antenna, shown in Fig. 3consists of 3 layers. The lower layer, which constitutes thenground plane, covers the partial rectangular shaped substratewith a side of 33×38 mm. The middle substrate, which ismade of FR4 , has a relative dielectric constantnεr=4.4 and height 1.5 mm. The upper layer, which is the patch,covers the rectangular top surface. The rectangular patch hassides 33×38 mm that covers the middle portion of thesubstrate. Two rectangular slots are cut out from the patchnear the feeding Microstrip line for impedance matching Thepatch is fed by a Microstrip line with 50Ω input impedanceSimulations were performed using HFSS .Convergence wastested for a number of times. Once convergence was obtainedsimulations were conducted in order to obtain sweptfrequency response extending from 1 to 4 GHz. Initially westarted with slots symmetrically positioned at the center of thepatch .however it was observed that in order to achieve properimpedance bandwidth slot position and dimensions need to beadjusted accordinglyThere are many analysis methods for the design of antenna From them we use transmission line analysis method for our antenna.

Step 1: Calculation of the Width (W)

The width of the Microstrip patch antenna is given as

$$W = \frac{c}{2 f_o \sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Where, c is velocity of light ,fois Resonant Frequency &εris Relative Dielectric Constant Of course other widths may bechosen but for widths smaller than those selected accordingwidth equation[3] , radiator efficiency is lower while forlarger widths, the efficiency are greater but for higher modesmay result, causing field distortion. In this work uponSubstituting c=3.0×10^(11)mm/s, εr = 4.4and fo = 2.4 GHz,we get: **W = 37.8 mm**

Step 2: Calculating the Length (L)

Effective dielectric constant (*εeff*)

Once W is known, the next step is the calculation of the lengthwhich involves several other computations; the first would bethe effective dielectric constant.

The dielectric constant ofthe substrate is much greater than the unity; the effective valueof ε***eff***will be closer to the value of the actual dielectricconstant εr of the substrate. The effective dielectric constant isalso a function of frequency. As the frequency of operationincreases the effective dielectric constant approaches the valueof the dielectric constant of the substrate is given by:

$$\varepsilon_{re} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

In our design for the above mentioned values the effectivedielectric is found to be **ε*eff*= 3.86**

Effective length (L*eff*)

The effective length is: which is found to be

$$L = \frac{c}{2 f_o \sqrt{\varepsilon_{re}}}$$

L*eff*= 31.88 mm

Because of fringing effects, electrically the micro stripantenna looks larger than its actual physical dimensions.For the principle E – plane (x-y plane), where the dimensionsof the path along its length have been extended on each by adistance, ΔL, which is a function of the effective dielectricconstant and the width-to-height ratio (W/h).The lengthextension is:

Substituting ε***eff***= 4.4, W = 37.8 mm and h = 1.5 mm we get:

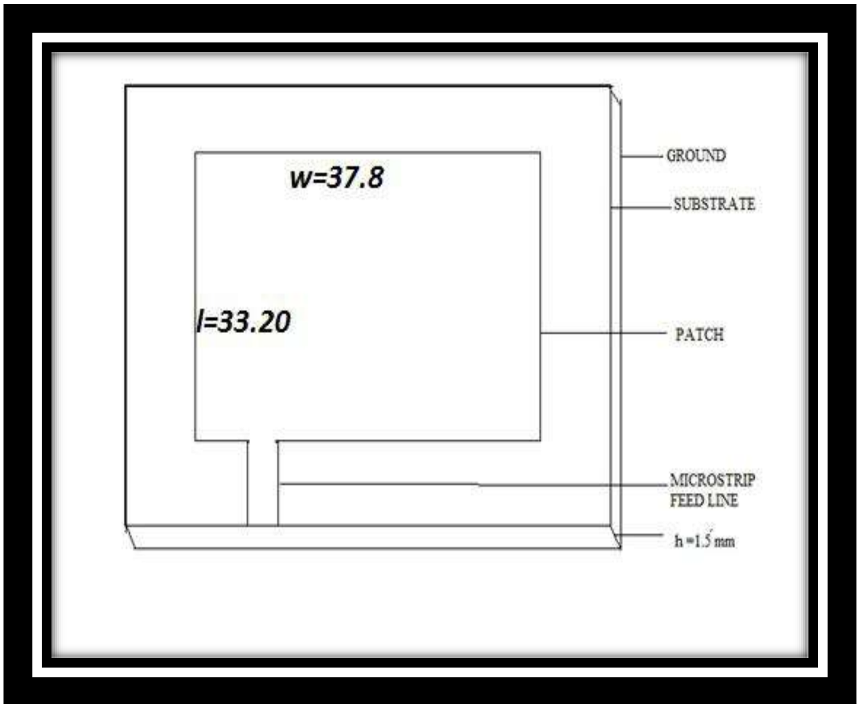
ΔL = 0.661 mm

Calculation of actual length of patch (L)

Because of inherent narrow bandwidth of the resonant element,the length is a critical parameter and the above equations areused to obtain an accurate value for the patch length L.The actual length is obtained by:

$$L_{eff} = L + 2\Delta L$$

Substituting L***eff***= 31.88 mm and ΔL = 0.661 mm we get:



L =33.20 mm

Fig-4 proposed geometry of patch antenna

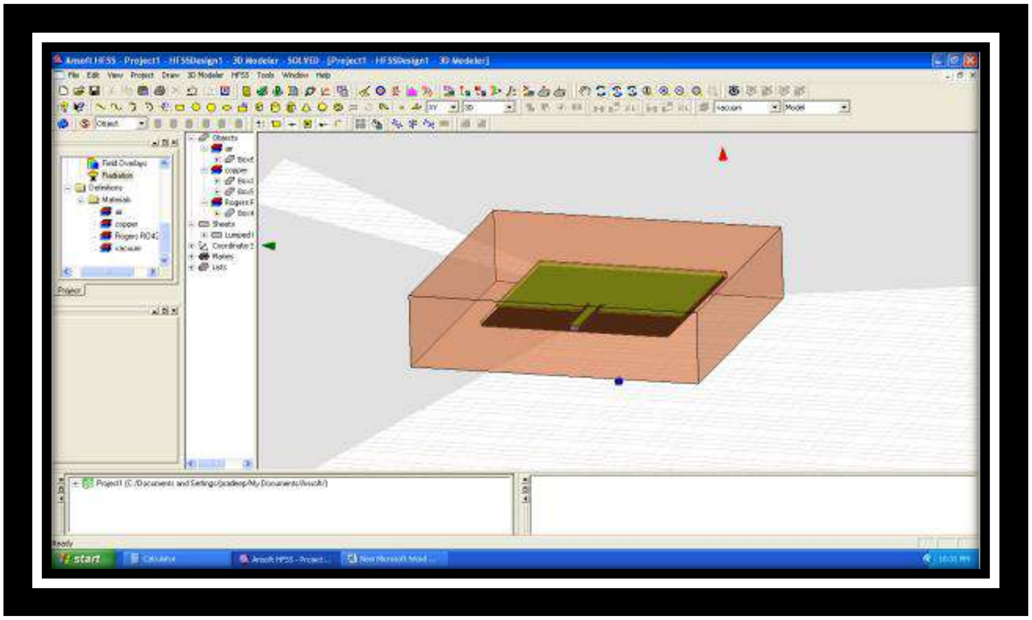


Fig-5 design of patch antenna in HFSS

2. ALOHA PROTOCOL

This protocol was originally developed in the Universityof Hawaii for use with RFID communication . This is a simple protocol where once a tag gets in the powering field (base station interrogation area) itstarts sending its ID according to "Tag talks first" behavior . In the case of RFID systems this protocol is referred to the "Tag-Talks first" family; tag sends its IDupon entering a powering field. Due to the probabilistic behave of this protocol several tags could collide completely or partially. This state causes collided tag toretransmit after a randomly determined delay the inability to detect or sense the channel make this protocol hard to implement in its simplest form Radio frequency identification (RFID) is an emergent technology that requires efficient protocols to enhance tag identification in the fastest delay. In this paper we described a simple scenario for multiple identification tags under the umbrella aloha protocol .Essential Performance metric (utility, collision ratio) was studied. For the next step we will start to use technique to analyze colliding slots. We hope that this simple work could enhance the RFID studies.

SLOTTED ALOHA-

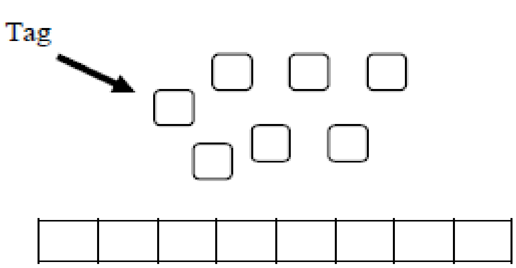


Fig-6Slotted Aloha Example

Each tag selects randomly one slot to transmit, when more than one tag choose the same slot, collision occurs Slotted aloha is a kind of pure aloha by adding aconstraint to the later: time is divided into discrete timeintervals called slot. Each slot has duration long enoughfor the reader to receive a tag response (tag's ID or anyinformation) . The reader generates a request to gettag serial number which consists of N slots. Afterreceiving this information each transponder selects randomly one slot to send its ID. A successfully identification means that a slot is occupied with exactlyby one tag. Since slot allocation is a stochastic processmultiple tags could select the same time slot, a collisionoccurs and data gets lost. Tag collision probability isclosed to the number of transponder **T** and the amount oftime slot **N**; in fact if the number of transponders (**T**) issmall vs the number of slot (**N)** hence the probability oftag collision is low and the time required to identify alltags is short. But when the number of tags increases thisprobability increases and the time required identifying alltags becomes exponential

3. Conclusion

Radio frequency identification (RFID) is an emergenttechnology that requires efficient protocols to enhance tag identification in the fastest delay. In this paper we described a simple scenario for multiple identification tags aloha protocol.colliding slot with rectangular patch antenna at 2.4 GHz with -38 dB return lossis designed on HFSS. Designed antenna has gain=3.954 dB and mismatchloss=-0.042 dB . Simulated results of 2D E plane, H plane patterns are shown. The calculated gain of patch antenna is 3.954 dB.The designed antenna is suitablefor RFID application . We hope that this simple work could enhance the RFID studies.

It opens up a large number of applications in which it is important to sense environmental conditions to obtain additional information about surrounding objects. An efficient and robust collision-free scheduler forboth WSN and RFID network will help in this proliferation.

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