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Application Of RFID In Closed Stores To Avoid Physical Theft And Locate Misplacement Of Materials

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Abstract:

RFID is an emerging and wide spreading technology in the present era. RFID finds its application in many areas e.g material handling, inventory management, asset tracking, animal tracking etc. RFID is well established in material in inventory management in closed stores. Many companies are using RFID in their closed stores to manage the different kind of material particularly in non metal environment. The rampant theft and misplacement of materials is a big cause to worry about and these basic problems are yet to be solved so that a complete solution for the inventory management can be provided. Hitherto stores are using CCTV camera to avoid these issues but RFID also promises solution to these problems. The present paper illustrates the complete design of an RFID system to avoid physical theft and material displacement.

Key words: *RFID, Inventory Management, Locate misplaced items*

1.Introduction To RFID

Today, organizations all over the world face the challenge of supplying product of highest quality, with lowest profit margin and in shortest time. In order to fulfill this need, new technologies, systems and approaches, have evolved to assist organizations, in classifying, optimizing & managing their inventory. RFID is one such emerging technology, which has the potential to provide real time inventory data for stock estimation, production planning, item visibility, ordering, proof of dispatch etc. Access to this information can prevent or reduce item shortages, over stocking and misplaced components, saving useful production time and preventing cost over-runs. RFID stands for Radio frequency identification. RFID is a way to transfer data from a tag attached to a particular material to a mobile or fixed reader through wireless communication medium using Radio Frequency for automatic identification and tracking of the materials. A basic RFID system consists of three components:

- RFID Tag
- RFID Reader
- RFID Antenna

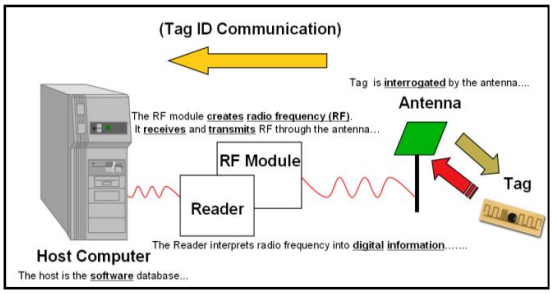

Figure 1: Basic working of RFID[1][2][3]

The antenna emits radio signals to activate the tag and read and write data into it. The RF antenna is connected to a RFID reader, which controls the communication and data transfer functions. The transponder, generally called as a “tag”, is basically an integrated circuit with miniature RF antenna. The tag has its own memory and depending on its type, data can be written, re-written & read up to 100,000 times. RFID systems are distinguished mainly by their frequency ranges. Low-frequency (30 KHz to 500 KHz) systems have short reading ranges and lower system costs. They are most commonly used in security access, asset tracking and animal identification applications. High-

frequency (13.56 MHz) systems, offer higher read ranges as compared to LF systems (greater then 3 feet) and better reading speeds, and are used for such applications as railroad car tracking and automated toll collection. UHF system (850 MHz to 950 MHz) offer read range in excess of 10 meters with very high read rates. Microwaves (2.4 GHz) still gives better read range more than 35 meters. All the frequencies are license free provided by Government of India .Low and medium frequency devices operate as a rule as passive devices, taking the energy needed to communicate from the emitting antenna. Semi passive/ semi Active tags operating at UHF & microwave frequencies have its own battery, responds to the antenna as and when query sent by the antenna. Active tags having its own battery always shows its presence by continuously emitting signal irrespective of query sent by antenna. These tags are now coming with dry cell batteries which last for 3-5 years depending on use and a provision to replace the batteries if the life of the battery is over.[1][2][3]

2.Current Scenario And Problems With RFID

Many manufacturing and process industries are using RFID technology to maintain their inventory. By using this technology, they can create a data base of newly received/issued material with other relevant information of that material e.g ID, date of receipt/issue, location, balance quantity etc. at any point of time. If the user wants to search any particular material, it can be done just by triggering a hand held reader. Since this technology is matured and in advanced stage, it may give promising solutions to inventory tracking problems. The main problems faced in the stores whose solutions yet to be visualized are:

- Theft of a tagged material.
- Misplacement of a particular material from one location to another inside the stores.

3.Solution To The Existing Problems

3.1.Preventing Theft

Theft of materials can be controlled by installing fixed reader set up at the entry and exit gate. These readers will keep track of each and every incoming and out going material by reading the tags while passing through it.

And if somebody has deliberately removed the tag and then theft has been done, then we have to make such provisions so that either the tag can not be removed or it can be removed only by breaking it so that it can be identified that the material is being stolen.

3.2.Locating The Misplaced Items

This is the main challenging problem in stores. This situation occurs when a particular material got misplaced from its original location. If the user wants to search that particular material it becomes very difficult to locate its new position.

So to tackle this kind of situation it is necessary to install the fixed unidirectional antennas in the complete yard in such a way so that they can interact with all the tags continuously or periodically. The main challenge in this web is that how far one antenna should be placed from the other to avoid interference between the two. This web of fixed antenna will depend on radiation pattern of each individual antenna.

3.3.Radiation Pattern Of An Antenna

A radiation pattern defines the variation of the power radiated by an antenna as a function of the direction away from the antenna. This power variation as a function of the arrival angle is observed in the antenna's far field [4].

3.4.The Radiation Pattern Of A Practical RFID Antenna

Mostly in RFID applications we use Dipole Antenna with following specifications (Table11): [5]

Pattern Property	**Value**	**Type**
Vertical Half Power Beamwidth(HPBW)-degrees	57.00	2D
Vertical First Null Beamwith(FNBW)-degrees	140.00	2D
Vertical Tilt (positive means up)-degrees	0.00	2D
Horizontal Half Power Beamwidth(HPBW)-degrees	126.77	2D
Horizontal First Null Beamwith(FNBW)-degrees	148.00	2D

Pattern Property	Value	Type
Vertical Front- to- Back Ratio-dB	39.03	2D
Horizontal Front- to- Back Ratio -dB	39.03	2D
Directivity-dB	11.53	3D
Beam Efficiency-%	99.92	3D
Front Back Ratio-dB	13.07	3D

Table 1: Specification of the dipole antenna

The radiation pattern of a distorted dipole antenna is shown in Fig 2.

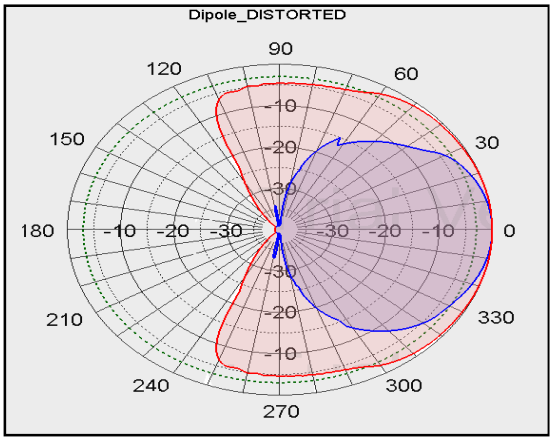

Figure 2: Radiation Pattern of Antenna

The red graph is horizontal radiation pattern and blue is vertical radiation pattern. The horizontal and vertical radiation pattern is shown separately in Fig 3.

The radiation pattern of practical antenna will mainly consist of main lobe, back lobe and side lobe. The main lobe will have maximum gain and the other two will be having lower gain. More the ratio of the main lobe gain to the total gain more will be the directivity of the antenna.

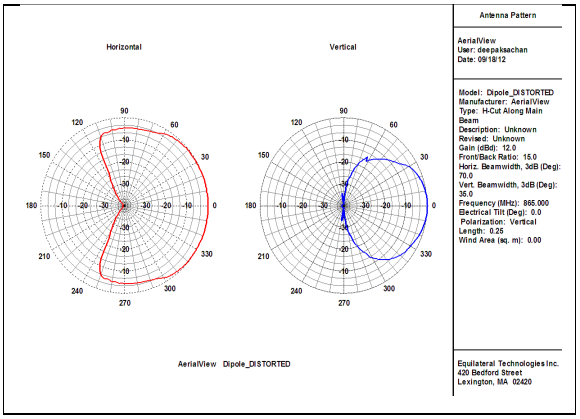

Figure 3: Horizontal and Vertical Radiation Pattern

The gain of the antenna is shown in Fig4.

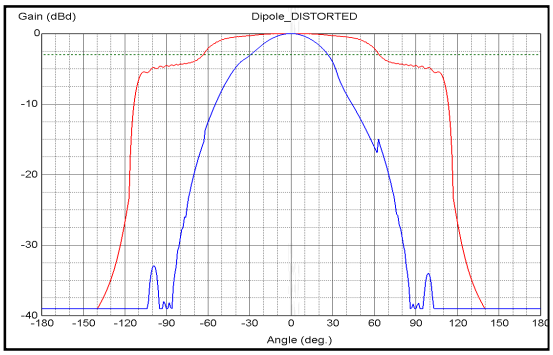

Figure4: Gain of Antenna as a function of radiation angle

Generally the radiation pattern looks like as Fig 5

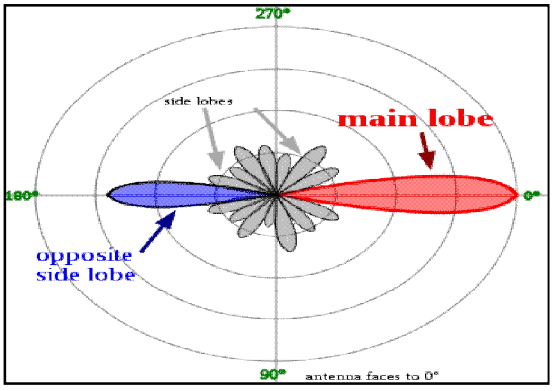

Figure 5: Radiation Pattern

Now if in a closed yard we install a typical 865MHz RFID antenna with read range of 8 meters it will look like as in Fig 6:

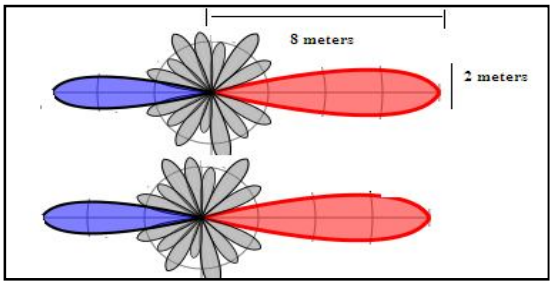

Figure 6: Adjusting the two antennas

In the Fig we can see that the length of main lobe is 8 meters and width of main lobe is 2 meters. This implies that after each 8 meters horizontal and 2 meters vertical distance we have to install RFID antennas in the complete yard. But, due to the back and side lobes there will be some interference. This interference will be avoided by measuring the RSSI value.

3.5.How The System Will Work

First of all divide the yard in small segments of 8X2 e.g (A,B,…) Fig 7. Now stack the tagged material in each segment. Every segment will be having one unidirectional antenna (e.g A,B,…). Each antenna will read its own tag with a unique identity.

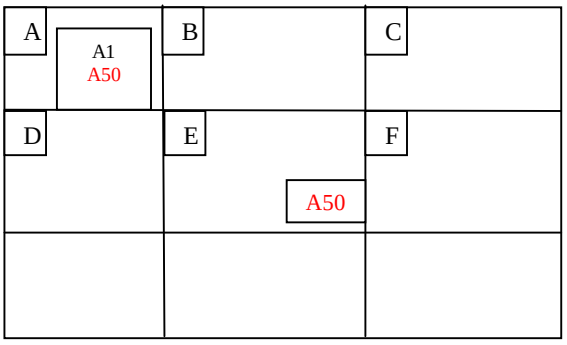

Figure 7: Segmentation of the yard

Now suppose a material (A50) from segment A has been misplaced to segment E as shown on Fig7.

Now the reader A will give an error signal that a tag A50 has been misplaced from its territory. And reader E and F will read a new tag which doesn't belong to their territory. Reader E will read the tag because the tag is found in its own territory and reader F will read due to back scatter signal (as to find a perfect unidirectional antenna is difficult). Now to exactly locate the misplaced tag compare the RSSI (Received Signal Strength

Indication) value of the two readers. And definitely the signal strength of reader E (main lobe) will be greater than that of reader F (side or back lobe). So if the RSSI value of reader E is greater than that of reader F then the misplaced tag is in segment E otherwise in segment F.

And suppose if the two RSSI values are almost equal or comparable then the approximate location of the tag will be known that it is either in E or in F. Now use hand held reader to determine exact position of the misplaced tag.

And if any material has been stolen the respective reader will indicate that a tag is missing from its segment and the exit reader will identify the stolen tag.

By using this method using RFID we can avoid the theft of material and locate the misplaced material.

4.Advantages Of The System

- The search time will be reduced.
- Previously it may take almost 30 min to a complete day to locate a misplaced item and some time it may also happen that the particular item may not be found for ever, it will be loss to the company, but with this system we can locate that particular item within a short span of 5 to 10 minutes. Theft of the material can be avoided. Hence the cost of the system can be recovered within a short span of 2 to 3 years in the form of saving man power, time and material.
- Easy to use.

5. Limitations of the System

- We have to use large number of RFID antennas to cover the complete yard this may increase the cost.
- Some of the area of the yard will remain unreachable to the reader.

6. Conclusion:

From the above discussion it is evident that the RFID technology can be utilized to different kind of applications like automatic tracking, locating of material etc.

Since this system is yet to gain its popularity and user acceptance, pilot scale implementations will enhance our technical capacity and helps in improving our operational efficiency.

7.Reference

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