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Application of RFID Based Material Tracking by Automatic Self Assigning of Physical Location of the Tags in Closed Stores for Easy Traceability of Materials

K V V Raju[1] , Deepak Sachan[2]

[1] Deputy General Manager/ Technology Development Lab/ BHEL Corporate R &D / Hyderabad 500093, INDIA

[2]Sr.Engineer/ Technology Development Lab /BHEL Corporate R &D / Hyderabad 500093, INDIA

ABSTRACT

Radio Frequency Identification (RFID) is notably recognized as an evolving and widely used technology since last few years. RFID had been in use many areas like inventory tracking, asset management and material handling etc.in both closed and semi closed stores and also in open yard applications. Organizations all over the world are adapting this technology to maintain optimum inventory and also to facilitate easy tracking/locating of assets in shorter time with less human effort and involvement. Owing to technology related to RFID, it is susceptible and will not yield desirable results particularly in metallic environment. However, the recent developments and few field trial deployments have proved it to be working more consistently even in metallic environment by the use of active and semi-active RFID tags. Different methods of reading tags using fixed and handheld readers are being adapted as per the design configuration of the RFID system. The replacement of tags/material, re-location or un-authorized shifting of tagged material within the store is yet another problem which needs to be addressed scientifically i.e. at any point of time the user must be able to trace the required tagged material within short time and with minimum effort. A novel idea is presented in this paper which uses the important feature called Received Signal Strength Indication (RSSI) value available in the typical RFID based inventory tracking system.

Keywords: RFID, Inventory Management, Self-assigning Tags, Inventory tracking

1. INTRODUCTION

Organizations today, are focusing on effective inventory management system to reduce unnecessary stock levels. They are also facing supply chain problems, timely delivery and reduced cost of operations etc. In order to fulfill this need, new technologies, methods and approaches were evolved to help organizations in optimizing & managing inventory levels. RFID is one such promising technology, which has the potential to provide real time inventory data for stock estimation, production planning, item visibility/traceability, ordering, proof of dispatch etc. The information can prevent or minimize item shortages, over stocking inventory and tracing misplaced items easily leading to saving of useful production time and avoiding cost over-runs. RFID is a way to transfer data from a tag attached to a particular material to a mobile or fixed reader/antennae through wireless communication method for automatic identification and tracking of the materials, within a closed/semi-closed stores [1].

A basic RFID system consists of three components: as shown in Figure 1

1. RFID Tag
2. RFID Reader
3. RFID Antenna

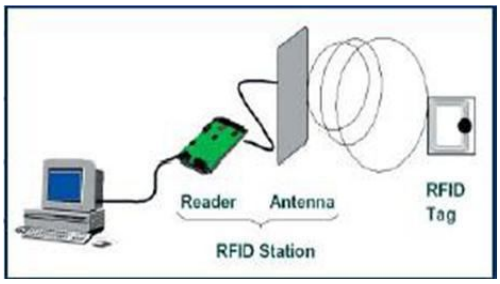

Figure 11 Basic working of RFID

The antenna emits radio signals to activate the tag and to read and write data into it. The RF antenna is connected to a RFID reader to control the communication and data transfer between the tag and the reader. The transponder (Tag) is basically an integrated circuit (IC) with tiny RF antenna. The tag contains its own memory chip and depending on its type, material information can be read, written, re-written into Tag's memory. RFID systems are distinguished mainly based on their frequency ranges, like Low-frequency (30 KHz to 500 KHz), High-frequency (13.56 MHz) systems, UHF system (850 MHz to 950 MHz) and Microwaves (2.4 GHz) [2] .These frequencies gives different read/write ranges viz. Low frequency for lower read range and high frequency for higher read ranges and the type of tags also changes based on the frequency being used like passive, semi-active and active Tags. 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 are in-built with its own battery and always shows its presence by continuously emitting signal regardless of query being sent by the antenna [3]. Active Tags with dry cell battery can sustain for about 3-4 years.

2. CURRENT SCENARIO ON USE OF RFID

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Most of the industries like manufacturing and process industries are adapting RFID technology to track and maintain inventory. Using RFID, the user can create a data bases of material receipts and issues and also relevant information about the material, like material code No, Receipt date /issue date, physical location etc. The system at any point of time gives the actual inventory in stock, item wise. It facilitates user to search any particular material just by using the handheld RFID reader. Since this technology is matured and few pilot implementations shows that it gives promising solutions to inventory tracking problems. Some of the developments are discussed below.

2.1 Application in closed /Semi-closed stores:

In this system, the material in stores are tagged with RFID tag and fixed antennae /reader system tracks them continuously and updates databases and locations. In case of any misplacement or re-location of any material, the system gives an error message showing loss of material.

2.2 Application in open yards like power project sites:

RFID is used exclusively for tracking material stacked in the open yards which uses the GSM and GPS technologies. RFID tags are assigned to material and its physical GPS co-ordinates will be captured and stored in the database [2]. This data is merged with satellite images of the site such that the tagged material location is appropriately marked on the map. It becomes easy to the user to identify the location on the map and accordingly user can move to that location with handheld reader to issue material. To trace any un-authorized shifting of material from its existing location, periodic scanning is required to keep track location of all the items.
From the above it is evident that un-authorized shifting of tagged material leads to non-traceability of item and sometimes leads to reporting of a loss even through a full-fledged RFID tracking system is in place. In case of the closed/semi-closed stores handling large number of material/boxes/crates etc., this problem exists due to incoming material flow, outgoing material flow and due to internal physical location adjustments (Relocations of previous positions) of tagged material. It is difficult for any stores manager/user to always update the physical location of tagged material within the store after every transaction of material issues/receipts.
After studying these problems thoroughly and after understanding the features offered by a typical RFID inventory tracking system, it is found that an important feature called RSSI (Received Signal Strength Indication) value will give a feasible solution to the problems discussed above.

3. SYSTEM DESCRIPTION

The boxes of different size and shapes filled with material are stored in the packing shed. To facilitate entry of new stock and removal/dispatch of old stock based on the demand, position of all the boxes changes every time to meet the space constraints within the store. The boxes are kept in parallel rows one over the other using overhead crane available in the shed.
RFID fixed antennae are fixed at a certain height on the columns with antennae facing down wards at 45 degrees facing the stacked boxes/material stacked on the floor (as shown in Figure 2). Antennae on the left side and right side are grouped separately and every two antennae mounted in one line are connected with one RFID reader.
All the antennae are connected through LAN cables and in turn all LAN cables are connected to a LAN switch separately for left side and right side antennae. A desktop PC is arranged in the office room which will be connected to the RFID LAN system.

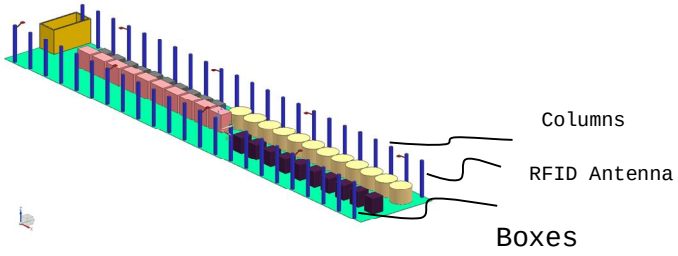

Figure 12 Fixed antenna arrangement

All the boxes/material received in the store will be RFID tagged (The tags can be screw mounted or tied to the material) and database of all entries will be created for the existing and for the newly received items.
All the RFID tagged items/boxes will be dumped (as shown in Figure 3) in to the storage area as per the requirement, convenience and based on the availability of the space within the store.

Figure 3 closed box/material being dumped in the store

RFID fixed antennae will interact with all the tags within their vicinity and the RSSI (Receive Signal Strength Indication) of each RFID tags will be captured by the application software. The application software will automatically assigns the tags to a particular antenna based on the RSSI value (Higher RSSI value indicates closer the tag location to the antennae) and the system shows the number of tags available in a particular antennae area.

If a particular tag already exists then system will ask for updating of the tag details and assigns it to the respective reader automatically. The system will refresh itself in a periodic way, and any addition, deletion, replacement, relocations etc.., will automatically be re-assigned to respective antennae.

User can check location of any item/box any time by logging in to the system by using various search criteria like RFID Tag ID, Box Number, and Item Number etc. which will available in software.

Each antenna will read its own tag with a unique identity. Suppose a box/tag from one place has been misplaced to some other place, the antenna assigned to that place will read that tag automatically system will update the new location of the box. In this way the location of all the boxes/tags is automatically updated by the system based on RSSI value of a particular tag to a particular antenna. Hence the system tracks all the boxes/tags in real time. Sometimes a box/tag in the junction of two antenna ranges may be read by both the antennae with same RSSI value. Under that condition the exact location of that box may be found by using a Hand Held Reader [2]. The process flow is shown in Figure 4.

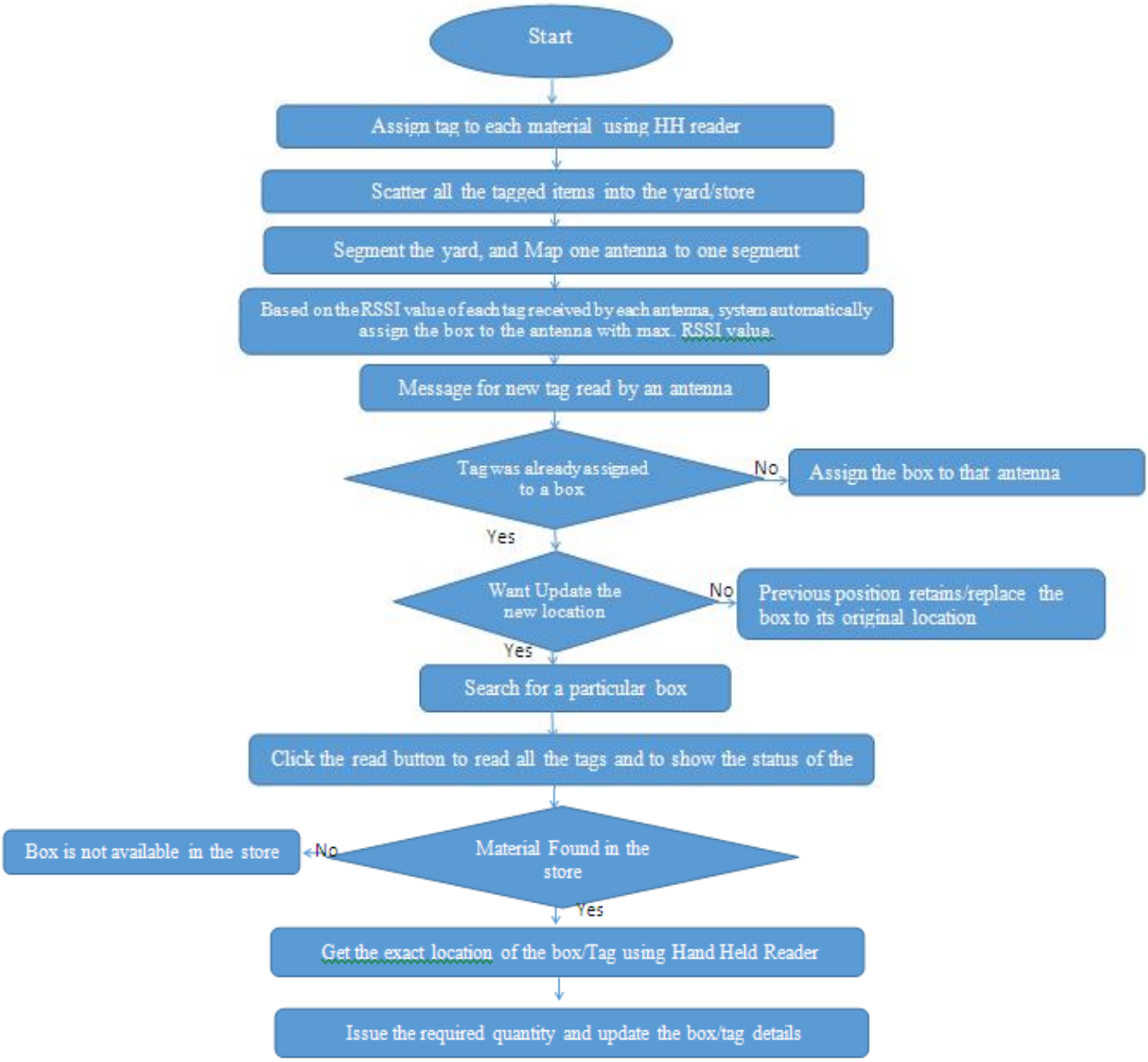

Figure13 Flow Diagram of the process

If user want to issue any item/box for dispatch, the Tag location can be identified from the desktop system and the user can proceed to the location physically with RFID handheld reader. Handheld reader can be triggered using relevant search option so that respective Tag will respond to the query by enabling LED/alarm feature in the Tag.

User need to ensure that the Tag assigned has to be removed physically from the box before being issued/dispatched and the same tag can be re-assigned to any other item/box newly taken in to the stock.

4. ADVANTAGES OF THE SYSTEM

- Automatic assignment of tags leads to cycle time reduction.
- Less human effort.
- Eliminating the tag assignment errors due to automated method of tag assignment.
- Real time material assignment and tracking.
- Reduced search time to locate the position of any particular material.

5. 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.
The automatic assignment of RFID tags to different materials using RSSI value is a novel method of tag assignment that will help in reducing various technical and non-technical difficulties of store management.

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AUTHOR

K V V Raju received the BE (Mechanical Engg) and M Tech (Thermal Engg) degrees from Andhra University and JNTU respectively. He has got 21 years of experience in E&C, Manufacturing, Research & Development and Industrial automation area. He is currently working in Corporate R&D Division of BHEL at Hyderabad. He was involved in design and development of automation systems, RFID based inventory tracking systems and also in development of GPS based consignment tracking systems. His main areas of research are development of RFID based applications, Robotic applications, manufacturing automation, software development and various new technologies like 3D printing, GPS based vehicle tracking system etc.

Deepak Sachan received the B.Tech. Hons. degree in Electronics and Communication Engineering from Madam Mohan Malviya Technical University, Gorakhpur in 2009. He has got 7 years of experience in automation area. Since 2010 he is working in Research and Development division of Bharat Heavy Electricals Limited, a Maharatna PSU of India. He is working in Technology and Development Lab of BHEL R&D. He has developed many RFID based inventory tracking applications and published several papers for the same. His main areas of research are development of RFID based applications, Robotic applications, manufacturing automation, software development and various new technologies like 3D printing, GPS based vehicle tracking system etc.