ISSN : 2350-0743

www.ijramr.com

International Journal of Recent Advances in Multidisciplinary Research
Vol. 03, Issue 12, pp.2047-2048, December, 2016

RESEARCH ARTICLE

A PRIMER ON RFID

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ARTICLE INFO

Article History:
Received 20th September, 2016
Received in revised form
07th October, 2016
Accepted 28th November, 2016
Published online 30th December, 2016

Keywords:

RFID, Electronic tagging, Chip.

ABSTRACT

RFID stands for Radio Frequency Identification. It refers to technologies that use radio waves to identify objects, animals, or people. Due to its low energy consumption and adaptability to different environments, RFID has found applications in many fields. This paper describes the basics of RFID technology, its applications, and the challenges it faces.

INTRODUCTION

Radio Frequency Identification is a new technology which enables wireless labeling and identification of objects, humans, and animals. It serves the same purpose as a bar code or magnetic strip on a credit card or ATM card. It may work with or replace bar codes. The advantages of RFID systems over bar codes include (Bean, 2006):

- Physical line-of-sight scanning is not needed,
- Several RFID tags can be read simultaneously,
- Information on the tags is dynamic,
- Can endure harsh environment,
- Has a faster response time and process time.

In the same manner as the bar code must be scanned to retrieve information, the RFID card needs scanning to get the identifying information.

Basic Features

RFID uses radio frequency waves to identity and track tags connected to objects. A typical RFID system shown in Fig.1 consists of three main components (Wu and Subramaniam, 2011; Hunt *et al.,* 2007):

***Tags*:** A tag usually consists of a chip and an antenna. The antenna is usually in the form of spiral metal coil. The tag stores information such as serial number, manufacturer code, assembly location, date of installation, country of origin, and other data. It can store information from 64 bit to 8 MB.

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It can assume a variety of shapes and sizes. It may be passive or active. A passive tag is smaller and cheaper because it does not use a power source such as a battery. An active tag is battery-assisted to power up its circuitry and periodically transmits its signal. The tags are attached to objects or persons. RFID tags that do not have chips are called chipless tags. The implementation of chipless tags can significantly reduce the tag price. There are billions of tags in circulation and the number increases yearly. The tags are becoming part of the infrastructure of the Internet of Things.

Readers: These are also known as interrogators. They read and write data on the tags. Readers can be real-only, write-only or read-write. RFID does not require a line of sight to read data on the tags. The tag and reader exchange information wirelessly. An RFID system may consist of several readers. A reader can communicate with more than one tag at the same time. This may require anticollision algorithms.

***Controller*:** This is a host computer to host data. It may take the form of a PC or workstation and control application software. It is the brain of the RFID system. It connects multiple readers and centrally processes information that is collected by the readers. RFID systems operate at different frequency bands.

In the United States, the FCC has allocated four different bands:

- Low frequency (LF), between 30 kHz and 300 kHz
- High frequency (HF), between 3 MHz and 30 MHz
- Ultra-high frequency (UHF), between 300 MHz and 1 GHz
- Microwave, between 1 GHz and 5.8 GHz

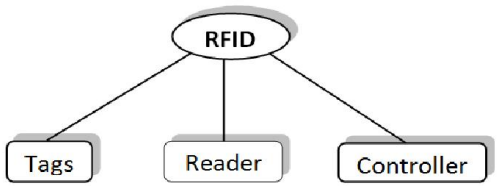

Fig. 1. Typical features of RFID system

Applications of RFID

RFID is used in several applications. Different applications dictate different requirements such as cost, range, data capabilities, etc. (Xiao *et al.,* 2007).

- ***Transportation*:** RFID is used in intelligent transportation infrastructure. RFID tags are used to collect tolls on highways by inspecting a tag attached to the car and to pay for fares on bus, train, or subways. RFID cards can be used for controlling access to public transport. Tags can be attached to vehicles which will automatically allow them entrance into controlled areas.
- ***Healthcare*:** The adoption of RFID in medical industry helps to manage medical equipment. In the hospital, RFID-tagged cards can be used to authenticate staff for having access to medical records without violating privacy. The U.S. Department of Veterans Affairs recently revealed their plan to use RFID technology in hospitals all over the U.S. to improve care.
- ***Libraries*:** RFID has been used to replace barcodes on library items such as books or DVD (Ward, 2003). It can be used as self-service checkout. Libraries can improve efficiency, lessen staffing costs, and enable automated book sorting. Privacy issues have been raised concerning library use of RFID. An unauthorized agent could read RFID tags of every person leaving the library.
- ***Supply Chains*:** RFID is increasingly been deployed for supply chain management. In the supply chains, RFID tags are used at different levels. Many retailers instruct their suppliers to tag objects with RFID tags using the Electronic Product Code (EPC). Retail giants such as Wal-Mart, Target, and Philips Electronics have adopted RFID technology (Wu and C. Subramaniam, 2011; Yuksel and Yuksel, 2011). In addition to using RFID for inventory purposes, it can be used for anti-shoplifting.

Other applications include tracking of objects, persons or animal, toll collection, airport baggage tracking, location positioning, pharmaceutical industry, passports/portal authentication, driver's license, implants, and Internet of Things (IoT). Several commercial companies and governments such as Wal-Mart, Target, Philips Electronics, and U.S. Department of Defense have declared RFID initiatives. Their goal is to make RFID cheap and ubiquitous (Radio-frequency identification, Wikipedia). RFID technology is beginning to be integrated into U.S. government's infrastructure: homeland security, law enforcement, and corrections (Drumm and Brooks, 2009).

Challenges

Widespread adoption of RFID is limited by privacy, security, and lack of standards. As RFID makes individual item tagging a reality, privacy becomes an issue. RFID technology can impact privacy protection. It can undermine consumer privacy since it can monitor consumer activities and transactions. As RFID shares radio medium, eavesdropping and unauthorized tag reading pose threats to privacy. Encryption algorithms can be used to protect patient information and prevent unauthorized persons from accessing information from the tags. Security of RFID technology is important because of the sensitive information available on them. RFID tags hold some information about the objects attached to them. Authentication and data encryption are security measures that will prevent external attacks. Another problem is lack of standards from government and industry. Standards are important in RFID adoption. RFID systems are made by different vendors and they need to interoperate with each other. However, some organizations have developed standards for RFID. These include the International Standards Organization (ISO) and the International Electrotechnical Commission (IEC). Another standard organization in the U.S. that produces RFID standards is EPCglobal. The benefits will come when RFID can operate from company to company or nation to nation.

Conclusions

RFID is an emerging non-contact identification technology which is designed to enhance the bar code technology. It has the advantages of high precision, high reliability, great adaptability, and strong anti-interference. It has the disadvantages of being susceptible to electromagnetic interference and being an invasive technology. It is unlikely that RFID will replace bar codes. The two will coexists for many years to come. As the cost of RFID falls, smaller companies and organizations will be able to afford using it to enhance their competitiveness. The latest on RFID can be found in a new journal: The IEEE Journal of RFID, that will first appear in March 2017.

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