

RADIO FREQUENCY IDENTIFICATION

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Abstract

This paper proposes about radio frequency identification technology which has proved to be a boon to the society. In this paper we have discussed about earlier technology, construction, working, application and issues with respect to RFID. This technology uses the electromagnetic fields for its operation. RFID has various components like tags, antennas, transmitters, receivers and a reader. Today RFID is used in most of the domains for object, animal and person tracking. It uses the tags (active or passive) for identifying these objects uniquely as the tags contain special information.

Keywords- Antenna, Radio Frequency, Receiver, RFID, Tag, Transmitter

1. INTRODUCTION

RFID is radio frequency identification. It is a technology used for identification of objects. Every object can be tracked individually. Tracking of object is done using antennas, transmitter, receiver, reader and transponder. RFID is used in many fields like aeroplanes radar signal, army, electronic product code in inventory system, health, transport, logistics etc.[2]. The figure 1 depicts the overall structure of RFID.

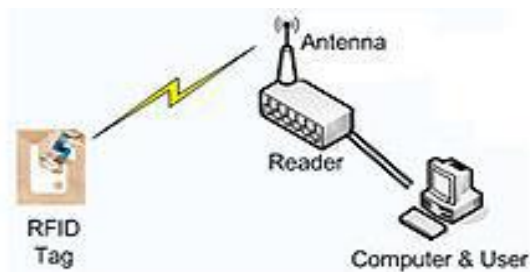


Fig 1. RFID

In this paper, we discuss about RFID and its various terms. Section 1 discusses the introduction to RFID while section 2 focuses on the comparison of previous technology with RFID. Section 3 discusses the construction which includes antennas, transmitter, receiver, transponder, reader and the working of RFID is described in section 4. Section 5 enlists the applications of RFID. Issues with RFID are discussed in section 6 while section 7 is the conclusion of the paper.

2. BARCODE V/S RFID

A. Before RFID was introduced another technology called BARCODE was used. Barcode is an optical and direct machine readable representation of data. The barcode requires line of sight to be read. Barcodes are classified as one dimensional or two dimensional. One dimensional barcodes used parallel lines for representing data while two dimensional barcodes used

geometric patterns like dots, rectangles and hexagons. Barcodes were scanned using an optical scanner called as barcode reader. The main disadvantage of this technology was that it required line of sight to be read and at a time only one object could be read. It cannot be read if it is damaged and also cannot be updated. It required manual tracking which may lead to many errors[9]. To avoid these disadvantages a new technology came into being called RFID.

B. RFID (radio frequency identification) is a technology that uses a coupling. The coupling used may be electrostatic or electromagnetic. This is then used in the radio frequency (RF) portion. It is used to uniquely identify an object. RFID does not require line of sight to be read and multiple objects can be read simultaneously. It also can be read if damaged and can be updated according to the requirements. It does not require human tracking[5].



Fig 2. BARCODE V/S RFID

Figure 2 shows the main difference between BARCODE and RFID where barcodes uses the UPC codes and RFID uses the radio waves.

There are two types of RFID that is low frequency RFID and high frequency RFID. Low-frequency RFID operates at 30 KHz to 500 KHz and have short transmission ranges generally less than six feet. High-frequency RFID operates at 850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz and have longer transmission ranges generally more than 90 feet[10].

RFID has an antenna which can act like a transmitter or a receiver. It is basically used to transmit or receive the electromagnetic waves. It also has a tag also called as transponder. The tag may be a passive tag or an active tag. This tag contains special information which is electronically stored into it. Tags are useful for identifying each object uniquely. It has a RFID reader which is used to collect information from these tags. It has a transmitting coil. Whenever this coil is brought close to the tags, the tags become active and send that piece of information to the reader. The information of the tag will be previously stored in database for the identification of that respective tag. The new gathered information is then stored in respective row of the database from where the information of identification of the tag is retrieved[3].

RFID is mostly used as a medium for numerous tasks. It is used in managing supply chains, passports, infrastructure, human and animal identification, tracking livestock, libraries, preventing counterfeiting, transportation and supporting automated checkout. Many companies like INSYNC, TYBCO, ALIEN and AVERY use RFID in various fields.

3. CONSTRUCTION

RFID has five important components that is antenna, transmitter, receiver, transponder (tag) and reader.

3.1 Antennas

Antennas are divided into two types that is tag antenna and reader antenna. These work in coordination to obtain the information. Antennas differ according to its applications. Antennas are also sometimes selected on the basis of distance between the tag and the reader. These antennas can be made with different materials depending on the working frequency of the tags. Figure 3 shows the basic construction on an antenna.

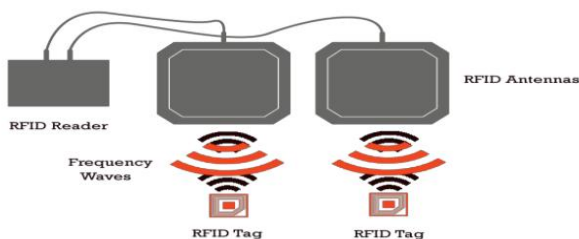


Fig 3. ANTENNAS

Tag antenna are placed within the tags are used to collect energy and transfer this energy to the chip, to turn it on. These antennas could be large or small in size; larger the antenna more energy would be collected. Tag can contain

one or dual antennas. Dual antennas are efficient and can connect with the reader without any inconvenience.

Reader antenna are placed within the reader and are responsible for converting the electric current into electromagnetic waves which are radiated and are used to locate the tag antenna. These again get converted into electric current by tag antenna. There are two main types of reader antenna that is linear antenna and circular antenna[1][4].

3.2 Transmitter

A transmitter is used to generate radio waves. These radio waves contain important information. This information may consist of audio, video or digital data. Transmitter has various components that work together for generating the radio waves. The various components of a transmitter are power supply, oscillator, amplifier, modulator and antenna which are shown in figure 4.

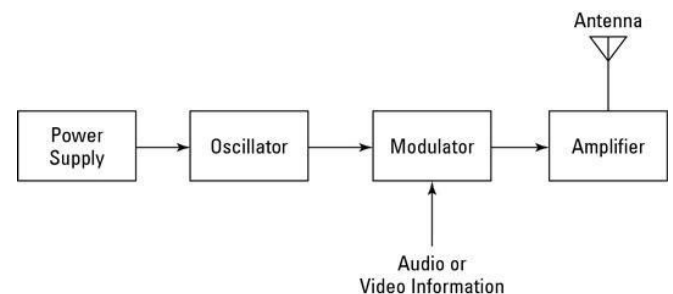


Fig 4. TRANSMITTER

Power supply provides the required electric energy for the operation of the transmitter. Oscillator generates the AC current for the frequency at which transmitter transmits the data. Modulator is responsible for adding useful information to carrier wave. Amplifier then amplifies the modulated signal and the antenna converts this signal into radio waves which are transmitted by the transmitter[6].

3.3 Receiver

Receiver is the counter part of the transmitter. Receivers consist of antennas, amplifier, tuner and detector which is shown in the figure 5. Antennas capture the radio signals transmitted by the transmitter. Amplifier amplifies the weak received radio frequency signal and the tuner extracts the respective frequency from a mix of frequencies. This frequency is given to the detector to separate the carrier signal from the original signal. This signal is then read by the device for the actual data[6].

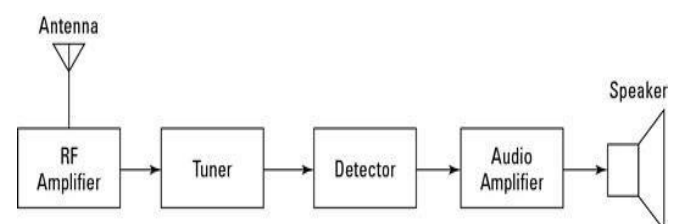
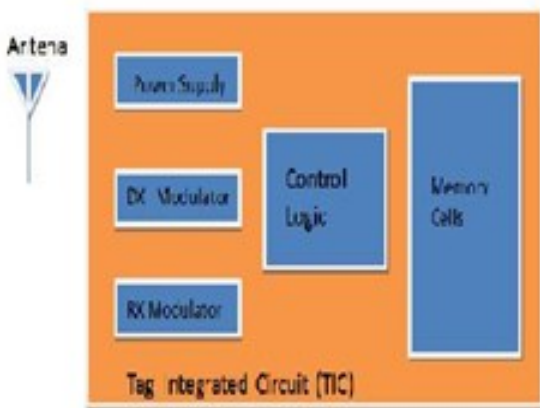


Fig 5. RECEIVER

3.4 Transponder



BLOCK DIAGRAM OF TAG

Fig 6. BLOCK DIAGRAM OF TAG

The transponder also called as tags are comprised of an integrated circuit as shown in the figure 6. The tag consist of a modulator, demodulator, memory, control logic and power supply. The tag has memory of 16 bits which can be extended according to the requirement. The tag has a separate memory bank used to store item’s unique tracking identifier called as electronic product code (EPC). There are two types of tags that is active tag and passive tag. Active tags have a battery and are larger in size. They require low signal. These are read/write tags that is the system user can read as well as write these tags. They can store up to 128 kb of data. They can last up to 5 to 10 years. Passive tags don’t have a battery and are smaller in size.

They require high signal. These use radio energy transmitted by the reader. These are read only tags which means that the system user can only read them and not write. They can store 128 bytes of data. They can last up to 20 years[7].

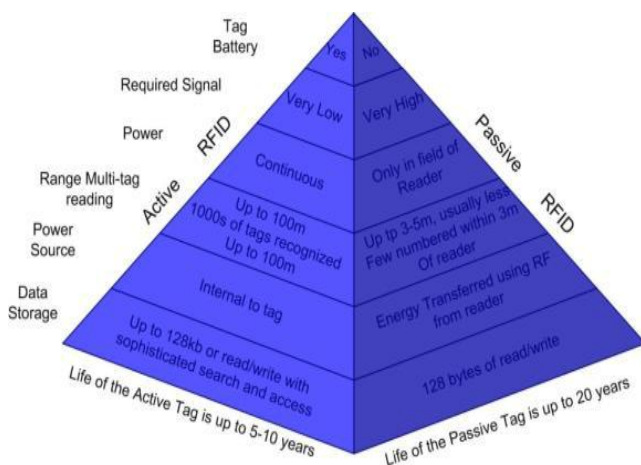


Fig 7. RFID TAG

Figure 7 depicts the main difference between active tag and passive tag.

3.5 Reader



Fig 8. RFID READER

RFID reader is also called as interrogator. RFID readers can read as well as write information to the tags. Reader connects the tag data with the system software that needs the information. Reader connects to the tags which are nearby its operating frequency to read, write, update or alter tag data. The reader uses an antenna for its operation which records the data collected from the tags and passes this information to the computer for processing. The readers can be placed in a stationary or a mobile object.

4. WORKING



Fig 9. RFID WORKING

RFID is radio frequency identification. This technology proved to be a boon for the society. With this technology, all objects can be uniquely identified. Each object can be tracked irrespective of their type. A system database is used to store information prior to its operation. This information is then referred by the reader to store the next respective data.

Five components contribute to the working of RFID. They are antennas, transponders (tags), transmitters, receivers and readers which is depicted in figure 9. The working principle of RFID is based on the transmissions of radio frequency waves. The reader and the tag consist of the transmitter, receiver and antennas. The transmitter consist of power supply, amplifier, modulator and oscillator which are used together for generating radio waves. The receiver consist of antenna, amplifier, tuner and detector to capture radio waves. The tags may be of passive type or active type. Passive type of tags are widely used as they do not require battery and last up to 20 years on an average while the active tags are very rarely used as they use battery and are larger in size and last up to only 5 years.

The transmitter in the reader transmits the signals. The nearby transponder will receive this signal with the help of

its receiver. The transponder will again transmit the data in the form of signal with the help of transmitter which will be received by the receiver in the reader. This will activate the logic controller which will decide the respective action to be taken. In this case the reader and the transponder may not necessarily have a line of sight. Any transponder in the range of the reader can be read or written without the line of sight[8].

Signalling or connecting the tags with the readers have ample ways. Tags operate either on low frequency band or high frequency band. The high frequency bands are widely used as they are more efficient and transmit or receive data at a faster speed[5].



Fig 10. RFID EXAMPLE

5. RFID APPLICATIONS

RFID, emerged from the technology called barcode is widely used in many fields as an efficient way for object tracking. RFID is used in many applications like managing supply chains, passports, infrastructure, human and animal identification, tracking livestock, libraries, preventing counterfeiting, transportation and supporting automated checkout. Many companies like INSYNC, TYBCO, ALIEN and AVERY use RFID in various fields.

5.1 Public Transport

RFID cards are used for access control in public transport. These cards are widely used in buses, trains, ferries and cars.

5.2 Infrastructure

Many companies have used RFID technology for monitoring the gas pipelines, sewer pipelines, and communication and networking cables.

5.3 Passport

RFID tags are used as passports. These tags comprise of the same information that the passport contains. It also has a digital picture of the owner of the passport. It is an efficient way for monitoring the passengers without human intervention. Every tag has a special pin which is recognized by the reader and that information is then stored in the database.

5.4 Human Identification

In human identification the tags (extreme small chips) are embedded into the body of the human. This may be required for tracking an individual. This is widely used in army, navy or air force for tracking the soldiers.

5.5 Animal Identification

In animal identification the tags (extreme small chips) are embedded into the body of the animal. This is required by the individuals to track their pets. Each animal has its identification stored in the database which is fed into the tags embedded in body as well.

5.6 Hospitals

In hospitals the RFID tags are used to monitor the mobile equipment, patient and staff. Hospitals use both active as well as passive tags.

5.7 Educational Institutes

In educational institutes RFID based attendance system are widely used. Each student is given a RFID tag which is called as identity card. Whenever the student enters the premises the RFID reader will receive the information from this card and then will update the attendance database.

5.8 Sports

The start and end timings of individuals taking part in the race may not be accurate when taken with the help of stop watch and hence the concept of using the RFID came into picture. RFID is used to provide the start and end timings of individuals taking part in the race. Every individual is made to wear a RFID tag. UHF tags are used for this purpose. The antennas connected to these tags provide the accurate readings.

5.9 Museums

RFID is implemented in end user application in museums. Every visitor entering the museum is given a special RFID tag. With this tag the user can get the respective information about the monuments on its phone. Also the user can have access to the website for collecting information. It has access to the website which is linked with the key of the RFID tag.

5.10 Transport Payments

In most of the places RFID tags are used to pay fares for the buses, trains, ferries or on tolls. Each tag has the amount stored in itself. Every time a fare is paid the amount is deducted from this tag. Tag recharge options are available[5][2].

6. ISSUES WITH RFID

Even if the RFID has proved to be a boon for the society it has its own major drawbacks. RFID does not provide global

standardization and security. It has a disadvantage of data flooding as well.

- A. Data flooding refers to collection of unwanted data. In RFID the amount of data collected is very large. It may happen that half of the data collected is not required for any purpose that is it is unwanted data. For example, RFID reads the information of moving the books from one shelf to another which may not be essential. This may result into piles of information collected which may lead to wastage of memory. Hence the collected data should be processed to obtain appropriate information which is essential for the specific operation.
- B. RFID, unlike barcode does not support global standardization. The frequencies used by the RFID differ according to the geographical areas. Hence the frequency used in India for RFID may not be supported in Japan. This means that RFID frequencies are incompatible and cannot be used worldwide. Hence a standard of frequencies should be developed which would be recognized worldwide to avoid this disadvantage.
- C. The major disadvantage of RFID is security. The tags which contain crucial information may be readable by every RFID reader which means there are chances of illicit tracking of RFID tags. This may prove in leakage of confidential information of companies, militaries and countries. RFID are vulnerable to eavesdropping and skimming. Skimming refers to illegal action of a person to obtain the tag information. Typically a person can make the RFID reader of the same frequency as that of the tag and hence this reader can be used to download the tag information illegally.

The security problem can be solved using a method called cryptography. Cryptography refers to a study which focuses on encryption of crucial data. Basically cryptography is a mechanism that restricts the third party to read the crucial data. In RFID cryptography can be implemented to encrypt the radio signals which are transmitted between the tag and the reader. Various protocols are designed for the encryption of these signals. Some of the protocols designed are rolling codes and challenge-response authentication. Rolling codes refer to changing of the codes of tags after it is being read. The content of the tag is automatically changed with the help of system software. The change in the content of the tag depends upon the time the tag is being read. After each scan of the tag the content is immediately altered. While Challenge – response authentication uses a software which takes the encrypted signal from the tag and then verifies it. These protocols use symmetric or public key cryptography.

7. CONCLUSION

Therefore in this paper we proposed about Radio Frequency Identification (RFID). This paper gives a short glance about a technology that proved to be a boon for the society. RFID is an innovative solution which overcomes the disadvantages of barcode. In this we have discussed about the construction, working, application and the issues with respect to RFID. RFID uses the tags and a reader which comprises of antennas, transmitters and receivers. The tags

are of two types that is active and passive which are used in different situations according to the requirements. RFID had drawbacks like data flooding, standard globalization and security. To overcome the issues various methods have been proposed like cryptography, rolling codes and challenge response authentication.

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