International Journal of Research in Advent Technology, Special Issue, March 2019
E-ISSN: 2321-9637
Available online at www.ijrat.org

RFID Technology and Its Application

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Abstract- Radio-frequency identification (RFID) is an emerging technology, which promises to advance the modern industrial practices in object identification and tracking. Radio frequency identification (RFID) is a generic term that is used to describe a system that transmits the identity (in the form of a unique serial number) of an object or person wirelessly using radio waves. This technology is being evaluated and implemented successfully in different manufacturing and distribution environments and defense installations. The application of RFID is rapidly shifting from tracking objects and targets to monitoring the all conditions of engineering systems. The adjustment of sensors with RF tags (Smart Sensors) enables RFID technology to gather and process sensor data in addition to identifying and tracking the object. The deeper ramification of such RFID systems for monitoring manufacturing systems remains largely unexplored and untapped. The focus of the presentation will be to present the results of our in-depth review of the current and emerging technologies and applications based on RFID and Smart sensors for depot support and logistics environments and for machine condition monitoring.

Index Terms- RFID; Technology; Identification;

1. INTRODUCTION

Radio frequency identification (RFID) is the technology which works on radio frequency. This technology is used to automatically identifying the object and tracking the object. Now here this object could be anything just like book in a library, items which you are purchasing from shopping mall inventory in warehouse and controlling access to restricted areas, ID Badging, Supply chain management. May be it could be your own car. Not only the object but it can be used for tracking the animal as well as birds. RFID technology refers to a technology whereby digital data encoded in RFID tags (transmitting end) are received by a reader (receiving end) via radio waves. The RFID tag is used to get attached with object which you want track. RFID reader is continuously sending radio waves so whenever this object is in range of reader than RFID tag is used to transmit the feedback signal to reader. This is not a line of sight technology. As far as the object is in with the range of reader, object is able to identify the reader and it's able to send the feedback signal back to reader. So using the RFID technology, we can track multiple object with in same time.

The basic RFID system is made up of three main hardware components.
• RFID tags, or transponders, carry object-identifying data.
• RFID readers, or transceivers, read and write tag data.
• Databases associate arbitrary records with tag identifying data.

RFID involves contactless reading and writing of data into an RFID tag's non-volatile memory through an RF signal. The reader emits an RF signal and data is exchanged when the tag comes in proximity to the reader signal.

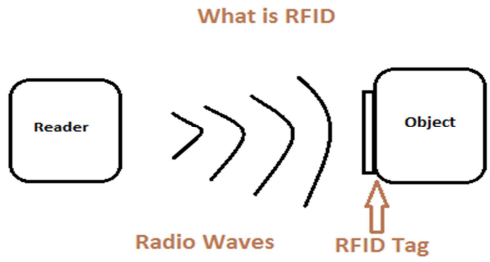


Figure 1: Structure of RFID

2. RFID SYSTEM

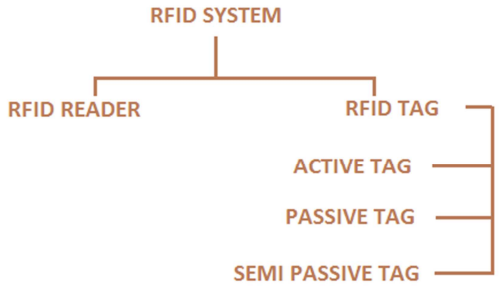


Figure 2: Classification of RFID System

2.1. RFID Reader

RFID reader are available in many sizes and shapes.it could be handheld reader and could be as large as size of a door which you see inside the shopping mall. The RFID readers are able to do deal with concussion and ensure communication with several tags, approve tags to prevent possible misuse and unauthorized access to system and ensure the integrity of data by encryption. [1]

RFID reader mainly consist of three parts.

- RF Signal Generator
- Microcontroller
- Signal Detector

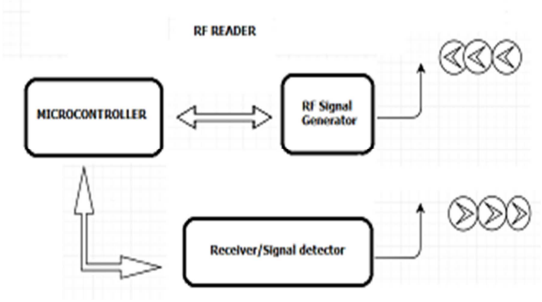


Figure 3: RFID Reader

2.1.1. *Types of RFID tags*

There are mainly three types of RFID tags -active RFID tag, passive RFID tag and semi-passive tag. Active RFID tag has its own power source. A passive RFID tag does not require batteries, it receives power from the receiving reader antenna, whose electromagnetic wave induces current in the RFID tag's antenna. In semi-passive RFID tags, battery runs the circuitry while communication is powered by the RFID reader.

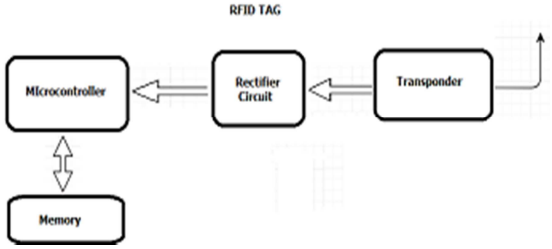


Figure 4:RFID TAG

RFID tag carries not more than 2 kilobytes (KB) of data, including a unique identifier code/serial number data. Tags can be read-only or read-write, where data can be added by the reader or existing data overwritten.

3. RFID TAG DIFFERENCES:

Active RFID Tags- Active tags are usually larger in size than passive tags. Tags have energy that comes from their own source to send strong radio frequency waves to readers/receiver. Active tags can detect low and weak signal strength from receiver because of their on-board battery. Enable active tags is always ready on to receive radio waves from the reader. Active tags can enable readers to detect objects or tracking at distances up to 230 meter away. Reading reliability is very high in active tags. Due to more data storage, tags facilitate less support on a centralized database. The range of up to 100 meters tags operate at set intervals from 433 MHz to 5.6 GHz. Active tag can be continuously tracking and record sensor data like as time, temperature, pressure at high speeds. Active tags need low maintenance such as battery replacement. They are usually attached to expensive or costly items. One example of an active tag is the transponder attached to an aircraft that identifies its national origin [3].

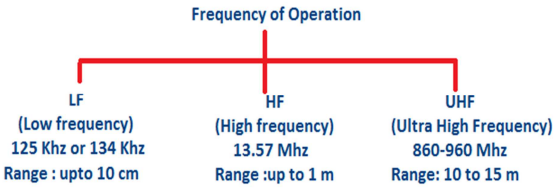
Passive RFID Tags-Passive tags can be so small they can be placed on bees and insect in research. Passive tags have energy that comes from the reader activating an electromagnetic field within the tag. Passive Tags are often read only. Passive tags must be in close range to the reader. Passive tags usually need strong signal strength from reader because tags send low level signals back to the reader. Passive tags is respond only when activated by the reader or receiver end. Reader can read data of passive tags from 1 meter distance approx. Range can vary from few millimeter to more than 100 meter away if tags are specially designed. They operate at low frequencies producing over short distances, operate at set intervals from 125 MHz to 960 MHz up. Passive tag read speed is very slow. They can be read over short distance only. Passive tag are often read with hand-held readers, but readers can also be fix mounted Passive tags are usually attached to common place items that are made to be disposable and need almost no maintenance.

Semi-Passive RFID Tags-Semi passive RFID tags are battery-powered but do not transmit active signals. They can monitor things in a container, such as climate or security breaches. The semi-passive tag operates similarly to the passive tag, using the reader signal to cause a response from the tag. Semi passive tags use a battery as a booster to power the integrated circuit and receiver.

The read range of RFID tags is based on factors including types of tag, types of reader, RFID frequency, and interference in the surrounding environment or from other RFID tags and readers. Generally active RFID tags have a longer read range than passive RFID tags due to the stronger power source .RFID tag uses a read-only or write / read memory in order to store and retrieve data and sometimes to change it. In some tags a battery might be used. [6]

4. RFID FREQUENCIES

There are three types of RFID systems based on dependence of frequency range: low frequency (LF), high frequency (HF) and ultra-high frequency (UHF). Microwave RFID is also available. Frequencies vary greatly by country and region across the different applications.



- Low-frequency RFID systems range limit is 125 KHz or 134 KHz, though the typical frequency is 125 KHz. LF RFID has short transmission ranges, the transmission range can generally read from a few cm to less than 10 cm.
- High-frequency RFID systems range from 3 MHz to 30 MHz, with the typical HF frequency being 13.56 MHz The range of HF RFID can read from a few inches to 1 meter (3 foot 3 inches).
- UHF RFID systems range from 300 MHz to 960 MHz, with the typical frequency of 433 MHz and can generally be read from 25-plus feet away.

The advanced RFID is Microwave RFID and these systems operate at 2.45 GHz. It can be read from more than 30 feet above away. If longer ranges are needed, using particular tags with additional power can boost reading ranges to 250 feet.

5. WORKING PRINCIPLE

The working principle depends on the frequency of operation. The low frequency and high frequency operation, the working Principle is based on the inductive coupling or near field coupling. A transponder (transmitter/responder) and antenna are combined to make an RFID tag [4].The working principle is based on electromagnetic coupling or far field coupling in case of ultra-high frequency . The encapsulation maintains the tag's integrity and protects the antenna and chip from environmental conditions or reagents [2].

5.1. Inductive coupling (near field coupling)

RFID is continuously sending radio waves of a particular frequency. Now these radio waves show basically three purposes-

- It induced enough power into a passive tag.
- It provide the synchronization clock to passive tags.
- It act as a carrier for return data from tag.

In case of low frequency and high frequency operation, RFID reader and tag is very closed each other. So the working principle is based on the inductive coupling. The field which is generated by this RFID reader is to get couple with the antenna of RFID tag and because of mutual inductance, the voltage will get induced across the coil of RFID tag. Now the some portion of the voltage is getting rectify and use as power supply for microcontroller as well as memory elements. Now, as the RFID reader is sending the radio waves of a particular frequency, so the voltage of particular frequency across the coil is also induced. This induced voltage is used to drive a synchronous clock pulse for the controller. Now the load is connected across this coil than current will start following through this load.

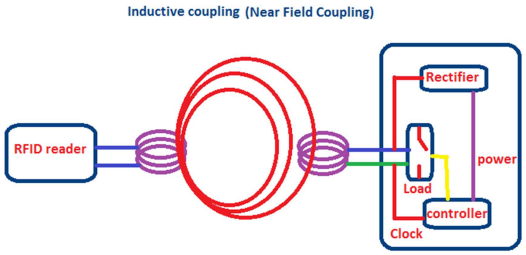


Figure 5: Inductive Coupling

The change in impedance of the load results the change in current that is flowing through the load. Now suppose if this load is switched on and off then the current will also be switched on and off. This switching of current or rate of change of current also generates the voltage in RFID reader. So switching ON

and OFF the load is known the load modulation. Now suppose if switch on and off the load according to the data that is stud in this RFID tag than that data can be read by an RFID reader in the form of voltages. So in this way using the modulation we are changing the voltage that is generated across the reader coil. We are generating the modulation on a carrier frequency .This load modulation technique is used in low frequency and High frequency tags. The data are sent back to the RFID reader.

5.2. Electromagnetic Coupling

In case of ultra-high frequency as the distance between RFID reader and tag is up to few meters, the coupling between the reader and the coil will be far field coupling as shown in figure. The RFID reader is sending radio waves continuously of a particular frequency towards tag. In response, this tag is sending the weak signal to RFID reader now this weak signal which pings sent back to RFID reader is known as backscatter signal. The intensity of the backscatter signal depends on the load matching across this coil. If the load is matched exactly then the intensity of backscatter signal will be more. In this way by changing the condition of load, we can change the intensity of a backscatter signal. If the change of a the condition of load according to data, that is being stored across the RFID tag, then that data can be sent back to RFID reader. RFID reader able to sense this data. In far field coupling the distance between Reader and tag is a few meter .so the initial signal which is being sent by a reader should be stronger. So that the backscatter signal can be retrieved by RFID reader. In case of far field coupling, the signal is send back to reader by using this backscatter modulation technique.

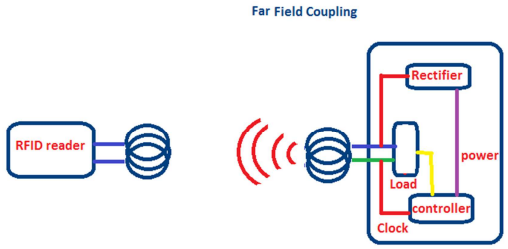


Figure 6: Electromagnetic Coupling

6. APPLICATIONS OF RFID TECHNOLOGY

- Transportation payments,
- Library tracking,
- Pallet tracking,
- Building access control,
- Airline baggage tracking,
- Apparel and pharmaceutical items tracking.
- Identification badges,
- Shipping container tracking, and truck and trailer tracking in shipping yards.
- Car keys.
- Identification and access control
- Healthcare

7. CONCLUSION

A large number of sellers use this technology in order to take care of their products against theft. Some of government agencies also use this technology for monitoring and controlling offenders. [5] Security is of great concern to many in business world today no matter which industry or which nationality they belong to. Performance of a system depends upon the information on the tag, effectiveness of RFID reader position, tag position. And they all depend upon the cost. Developments in RFID technology continue to yield larger memory capacities, wider reading ranges, and faster processing. RFID technology has a big potential to become ubiquitous in the near future. RFID tag that can be read instantly without manual intervention through packaging, without direct line of sight between object (in presence of dirt, heat, moisture and contaminants), which is very valuable for production facility as well as supply chain systems RFID can still involve technological deficiencies, especially in securing privacy data's, international standards of frequency, and storage capacity.

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