

Radio Frequency Identification (RFID)

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ABSTRACT: Radio frequency identification (RFID) uses Radio Waves to track objects using tags attached to them. The tags contain information about the object they are tagged to which is revealed using an RFID reader. Active tags have a local power source (battery) and can operate over hundreds of meters from the RFID reader. Passive tags do not have a local power source, hence they are powered using radio waves from an RFID reader. Unlike a barcode, the tag could be out of the reader's line of sight, hence it may be attached as well as embedded within the tracked object. RFID is one of Automatic Identification and Data Capture (AIDC) methods. RFID tags are used in numerous industries, for example, an automobile with an RFID tag tagged to it can be tracked in real time throughout the assembly line; It can be used to track pharmaceuticals in a warehouse; and implanting RFID tags in livestock and pets assist in their tracking and classification.

KEYWORDS: RFID; RFID Tags; Security; Location and Tracking;

I. INTRODUCTION

RFID is one of the Automatic Identification and Data Collection (AIDC) System which uses Radio signals for communication. The data, usually a unique identifier, is stored on chips which can be tagged to any object, both living, or non-living. This unique identifier is called Electronic Product Code (EPC) and can be used to identify or categorise that object. RFID works based on a technique called backscattering, wherein the reader transmits Radio waves which is used by the tag to power and operate the chip. The tag either stores data or transmits it back to the reader without any physical connectivity. RFID tag mainly consists of an electronic chip with an antenna. If required, it might also contain a battery in some scenarios. The tag plays a critical role in any RFID application. The Tags are classified based on their characteristics like power source, frequency and functionality. There are numerous researches pursued to reduce the size of the tag and its form factor. Presently, tags as small and as thin as that of a human hair have been developed. One such tag developed by Hitachi has a size of 0.05x0.05mm (0.002inch) and is called RFID powder [1]. RFID is well established and a versatile technology. If the performance of RFID is considered, the main factors are fast identification, scalability, reliability etc. RFID technology is mainly used in real-time systems where time, cost, memory and mobility are important.

II RELATED WORK

RFID is a wireless communication technology. Radio waves are used by RFID to automatically identify, track, and authenticate items or people. It is not a new technology. It was first used in world warII to identify friendly aircrafts.[1] Radio frequency identification (international journal of computer trends and technology IJCTT 2016 by IJCTT journal). RFID is used to identify people, objects and for monitoring environmental parameters. This paper is about the working, architecture and real world application of RFID. The advantages are, reduced labour levels, enhanced visibility, and improved inventory management.

There are many types of tags and readers available in the market for different types of application which has been described in this Paper. [2] Radio Frequency Identification (RFID) Trends by ChristopyJechlitschek. This paper provides a survey on RFID. RFID tags were developed to replace barcodes in supply chains. Their advantage over barcodes is that it can be read wirelessly and need not be within the line of sight. This paper also presents current research that focusses on locating and tracking objects that move. The RFID tags are widespread and there is a large interest in lowering the costs for miniaturising them. [3] A Survey on RFID Tags by M Ayoub Khan, Manoj Sharma, may 2009. This paper is about a comprehensive survey of various RFID tag technologies and their classification. [4] RFID technology, its applications and classification of security/privacy attacks and solutions. This paper talks about different types of RFID attacks, their significant features, and feasible counter measures. This paper talks about the weakness of RFID communication so that its vulnerabilities can be better understood and appropriate counter measures could be developed to stop these attacks. [5] Transmission control scheme for fast RFID object identification by Floerkemeier, shows techniques to improve RFID reading performance by selection of Frame Sizes.[6] Anti-collision performance of Gen2 air protocol in ran- dom error communication link. In: SAINTW 2006 (2006) by Kawakita, Y., Mitsugi, J shows impact on reading performance from errors. [7] Analytic modelling methodology for analysis of energy consumption for ISO 18000-7 RFID networks. In: IJRFITA 2007 (2007) by Hawrylak, P.J., Cain, J.T., Mickle, M.H talks on power modelling for RFID systems[8] Study of UHF RFID signal propagation through complex media. In: IEEE Antennas and Propagation Society International Symposium (2005) by Fletcher, R., Marti, U., Redemske shows effects pf different materials on RFID performance. [9] Performance benchmarks for passive UHF RFID tags. In: MMB 2006 (2006) by Ramakrishnan, K., Deavours, D. is about performance benchmarks, speed and reliability experiments for static RFID tags. 10] An empirical study of UHF RFID performance. In: MobiCom 2008 (2008) by Buettner, M., Wetherallperformed deeper analysis by utilizing specialized equipment to obtain physical layer RFID metrics such as error rates 11] Assessing and optimizing the range of UHF RFID to enable real-world pervasive computing applications. In: LaMarca, A., Langheinrich, M., Truong, K.N. (eds.) Pervasive 2007. LNCS, vol. 4480, pp. 280–297. Springer, Heidelberg (2007) talks about Specific experimental studies on RFID and ubiquitous computing applications.

III. SYSTEM DESIGN

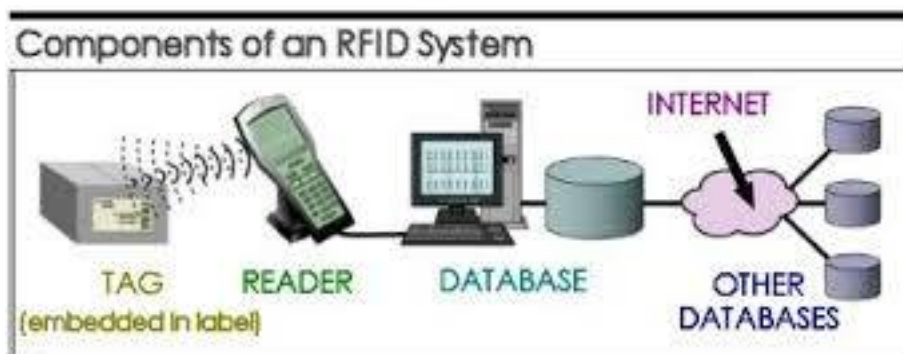


Fig .1 Components of RFID System

RFID Tags

RFID Tags are the building block of RFID technology. Tag component emits radio signals and is a combination of microchip and antenna. Each RFID tag contains a unique identification number which is stored in the microchip of tag. This microchip is built with the integrated circuit, sensors, I/O ports and embedded logic on a silicon chip. Tags antenna is used to transmission of radio waves. Sometimes RFID tags is also known as transponder. RFID tags are available in different shapes and sizes according to the environment and application, they will be used in.

RFID Readers

RFID Readers act like the heart of the RFID technology. Reader is the main component that is responsible for operating and controlling the RFID system with a particular frequency. Reader consists of a decoder and a transceiver. The transceiver is used to receive and transmit radio signals, the decoder is used to decode received radio (analog) signals to digital form. The reader range depends upon what frequency is used, basically reader range is some inch to 200+ feet. After decoding the radio waves into bit stream, it gives the information to the host computer or a device controller.

Host controller

Host controller uses the information provided by the reader to asses or forward it for further processing depending on the type of application. Host, also called system software, are combination of four components, Edge interface: Establishing communication and data retrieval from reader is the responsibility of the Edge interface. Middleware: Filtering, counting of tags, control and manage the reader is the responsibility of the middleware. Enterprise back end interface: Enterprise back-end.

Working principle of RFID Technology

Radio waves are transmitted by RFID Tags, which is received by a reader and converted to meaningful data to identify or locate the tagged object within the working area of the entire system.

There are three types of tags,

1. Active tags
2. Passive tags
3. Semi-passive tags

Active tags have their own power supply to power on-board Integrated Circuit and to transmit data to the reader. They are more expensive compared to passive tags. Their working range is 10 to 100 meters.

Passive tags have no internal battery power. The microchip of passive tag will be in sleep mode, until the tag is in the reader range. Reader sends electromagnetic waves which is used by the tag to power the on-board Integrated Circuit and transmit data. Passive tags are less expensive compared to active tags. Their working range is just a meter.

Semi-passive tags lay between active and passive tags with respect to both price and capabilities. It is called both as semi-passive or semi-active tag. Semi-passive tags use a battery to power the signal, but only respond when they are in range of the reader. They provide an energy efficient RFID system as they don't drain the on-board power supply, like the active tags do, but retain the advantage of its Working Range over Passive tags.

Some Terminology of RFID Technology

Different frequency ranges: RFID tags use different types of frequency bands according to the type of environment its working in and type of application using it. Because radio waves behave differently at different frequencies, it is imperative to choose the right frequency band for the specific application. Frequency is the measurement of radio waves. Basically, four types of frequency bands are used as below,

1. LF: Low Frequency.
2. HF: High Frequency.
3. UHF: Ultra High Frequency.

4. MF: Microwave Frequency.

Low Frequency band ranges between 125KHz - 134.2KHz. This frequency band is mainly used by Passive tags. The working range spans usually from minimum 10 cm to maximum 100 cm. The allowed field strength transmission power is 72dBµA/m. It is usually used in animal identification, food traceability, tree implants, item tracking applications. It also performs better in liquids and underwater applications, but requires long antennas and is expensive compared to High Frequency bands.

High Frequency band is 13.56MHz. Bath Passive and semi passive tags use this frequency band. The working range spans usually from minimum 10 cm to maximum 1.5 m. The allowed field strength transmission power is 60dBµA/m. It is used mainly in temperature measuring, animal identification and cold chain tracking applications. It uses shorter antennas compared to that of Low Frequency bands.

Ultra-High Frequency band ranges between 860MHz – 930MHz. This frequency band is mainly used by active tags. Its working range spans usually from minimum 3m to maximum 10m. The allowed field strength transmission is 10-100mW. It is usually used in farm machinery, intermodal transformation and crop monitoring. It has a greater range compared to LF and HF. It can work in environments consisting of metal and liquids, but has limited battery power.

Microwave Frequency band is 2.45GHz. Its working range spans from 10 meters to over 100 meters in distance. It can transfer data up to 100 Kbits per second. It cannot penetrate water or metals. Application areas are in highway toll collection and in vehicle fleet identification.

IV. EXPERIMENTAL RESULTS

The experimental setup to gauge RFID performance is as shown below,

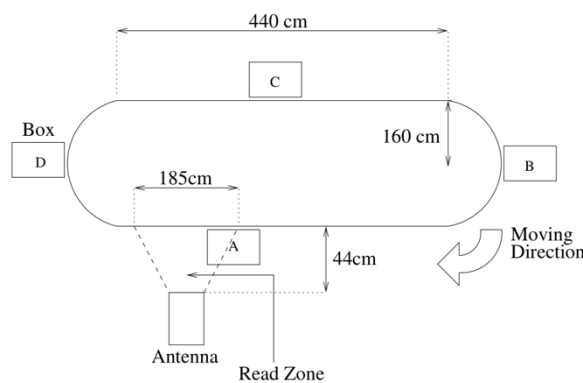


Fig 2 Experimental Setup

The results are for tag densities of 1 tag per box and 10 tags per box with movement speeds of 0.5 m/s, 1.0 m/s, 1.5 m/s, and 2.0 m/s.

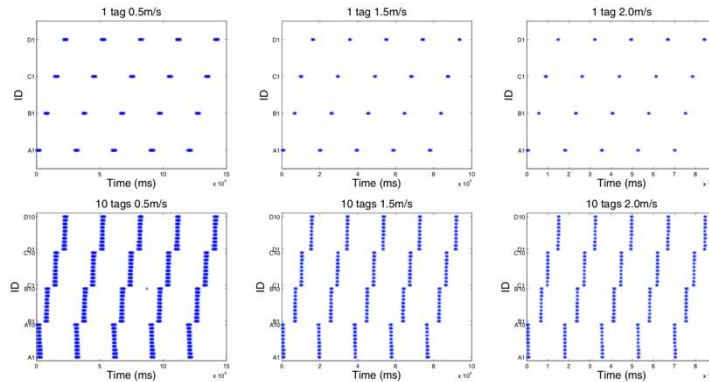


Fig 3 Results for 1 tag and 10 tags for 5 rounds

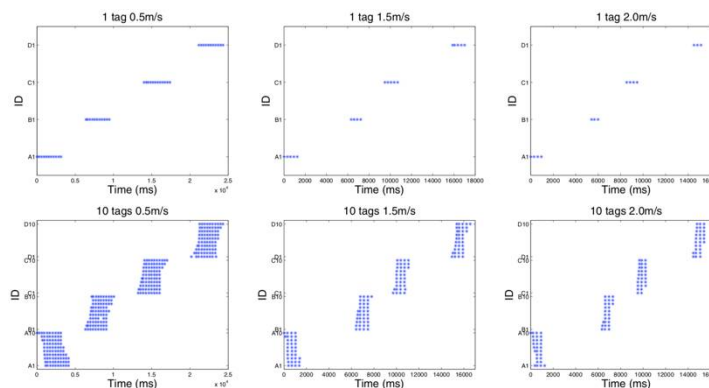


Fig 4 Detailed Results

The metric for RFID performance is the number of reads performed per second as shown below

$$\text{Reads per second} = \frac{\text{Total number of reads}}{\text{Total reading time}}$$

V. CONCLUSION

In this paper, RFID technology, its architecture and various applications has been analysed. It is easy to enjoy the advantages of RFID, such as large memory space, long service life, because it is rewritable. It can also do a non-contact reading within a short time. All these features make RFID quite suitable for the management and operation in various applications, such as RFID Tracking System for Vehicles, Safety Driving Support System and RFID system for security and safety purpose etc. The standardization of RFID is developing rapidly, and its practical applicability will surely give RFID a wider use in various applications.

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