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Review Paper

A simplified overview of RFID systems and applications

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Abstract

The Radio Frequency Identification (RFID) technology is among the most attractive topics of research in the industrial as well as academic field. Besides several applications several applications the cost efficient and reliable design of RFID systems is one of the co-existent and ubiquitous problems. The different components of RFID systems have been described in this article. The objective of this review paper is to focus on a simplified overview of involving basic concepts and applications of RFID sensor technology with a perspective to identify the crucial challenges involved in RFID systems. A brief exordium to the fundamentals of RFID System, the underlying technologies, followed by the comparison with barcode systems and applications of RFID systems will be useful for novices as a starting point towards developing applications based on RFID.

Keywords: Radio Frequency, RFID Tag, RFID Reader, Microcontroller, Security System.

Introduction

The Radio frequency identification technology allows distant identification where line of sight is expendable. In recent times this technology has been developed profoundly and is part of many day today applications. RFID technique is based on the concept of electromagnetic fields for tracking and identifying tags attached to objects[1]. The tags or the transponders are the devices which send a response when they receive radio frequency signals and can store the information like such as manufacturer, product type, and environmental factors such as temperature.

The devices known as RFID readers energize the tags through radio waves. The readers are used to communicate and collect the information from the tags attached to the objects within their working range. The tags can be passive, semi-passive and active[2]. A passive tag is devoid of an internal power source and derives energy from the reader through electromagnetic field for transmitting information. Semi-passive tags have an internal power source but not a transmitter. Active tags have a source such as a battery and a transmitter and the distance from which they operate is comparatively more than the passive tags. As it does not require line of sight, it can be embedded into the device. The RFID techniques find applications in vehicle identification, toll system, electronic license, vehicle tracking, Electronic cheque book, credit card, identification of an individual, scrutiny, vigilance and medical applications[2]. The reader frequency ranges between 10 kHz to 5.8GHz and the method of coupling the signal to the tag can be electric, magnetic or via electromagnetic fields, with the range varying from a few millimeters to hundreds of meters[3]. A tag consists of a writable memory to store data to be transferred to the RFID readers. The data is then rearranged and handled according to the needs of a particular application[4]. One single RFID system does not suffice all the applications. They may differ in terms of the features such as cost, range etc., and therefore the design of RFID systems is application specific[5,6]. RFID and wireless networking systems can be integrated to develop more sophisticated object identification and tracking systems[7]. The RFID systems can be combined with microcontroller unit also to make it suitable for applications in smart sensing to deal with sophisticated problems[8]. In the next section a brief review of RFID systems is given. In the subsequent sections RFID readers and tags are described, comparison with bar code, applications and an example of RFID systems in security system, are presented. Final part is the Conclusion.

Basics of RFID Systems

The Radio frequency signals range from 10^4 to 10^{12} Hz. As RFID method involves noncontact data capturing and identification it finds wide applications in industrial and process applications. The operating frequencies of the RFID systems can be Low frequency LF (125-134.3 kHz) with a reading range of less than 10 cm, high frequency HF (13.56 MHz) with a range of less than 1 m, ultra high frequency UHF (860-960 MHz) with a reading range between 1 m to 12 m and super high frequency SHF (2.45 - 5.8 *GHz*) with a reading range up to 100 m, these are active type RFIDs. An RFID system mainly consists of a reader, tag and an application system.

An RFID system operation involves the following sequences: i. Reader is energized which produces signals of relevant frequency range and creates electromagnetic field, ii. The tags which are tuned to the frequency of the reader respond to this

signal, iii. Selected tags transmit their data, iv. The data is received by the reader and decodes the data, v. The reader sends the data to application system.

RFID Reader and Tags

The reader is an electronic component capable of energizing tags, read and decode data and transmit data. They are inbuilt with antennas to send and receive radio signals. One such reader and a tag are shown in Figure-1.

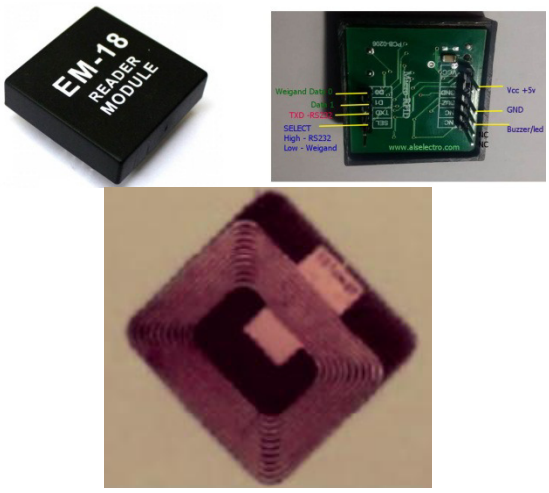

Figure-1: An example of RFID Reader and tag.

An RFID tag is alternatively known as a transponder. The tag reader powers and communicates with a passive tag[1-3]. A passive tag consists of an antenna, a chip attached to it and encapsulation[1]. For transferring power from reader to tag two approaches are used namely, magnetic induction and electromagnetic wave capture. Two types of couplings exist near field coupling and far field coupling. The basis of near field coupling is faraday's principle of magnetic induction. In near field RFID, when an alternating current is passed through reader's coil, it sets up an alternating field, if now the tag coil comes under the influence of this field, a voltage is induced. This voltage is rectified and is used to energize the chip. When the tag coil is systematically loaded according to the data of the tag, the current is drawn in the tag coil according to the load of the tag coil and creates its own field that opposes the reader coil's field. These changes are proportional to the load and hence the method is known to be load modulation. The reader recovers the data encoded and obtains the content in the tag.

In far field RFIDs, the tags are located beyond the near field range of the reader coil and load modulation cannot be used, rather a method known as back scattering is used in which, using impedance mismatching the signal received by the tag coil from reader's coil is reflected with tag's information encoded in it. Tags come in various size and shapes that can suit different applications. Passive tags are cheaper but have poor ranges. But the active tags are costlier with an advantage of higher range of coverage. The recent advancement is development of chip less tags. Though, chip less tags are lighter and cheaper, they suffer the draw backs, such as shorter radio range and lower storage capacity.

Comparison with barcode

The bar codes are printed in terms of marks and spaces and are used for tracking objects, they however require line of sight and have lower range. These problems are overcome by the RFID systems. But, the bar codes are cheaper as compared to the RFID systems. The main aspect that adds to the cost of RFID systems is the tag[5]. The significant points of comparison are shown in Table-1.

Table-1: Comparison of Barcode and RFID systems.

RFID Systems	Barcode
Data is transmitted through RF signals	Optical data transmission
No line of sight required	Line of sight required
Comparatively faster response	Slow
Capable of reading multiple tags	Capable of reading one tag at a time
Effectually expensive in comparison with the Bar Codes	Less Expensive
Reclaimable	Non-reclaimable

Applications

There can be numerous applications of RFID systems. Some of them are marketing of goods, access control in which RFID based electronic keys can be used for secured access of important equipment, on/off control, access of secured locations like offices, safes, etc., smart cards, baggage control, animal tracking, vehicle tracking, biometrics, libraries, electronic toll collection, health monitoring and many more[2,4,9]. Some of the challenging set -backs of RFID systems are cost, Reliability of operation in all environments, counterfeiting, interference, information leakage and hacking, development of middleware for a particular application.

An example of an application system

In this section, a typical application using RFID and microcontroller ATMEGA328 for the secured access/ secured equipment on/ off control is described. This application also can be used as a security system for domestic places like home and office to prevent trespassing into important room or chamber by using the technique of radio frequency identification. When the information in the RFID tag is read, it gives the unique ID contained in it. Further, this ID can be sent to a microcontroller to check the correctness of the card and enable a suitable

security action. If the correct match is found by comparing with the original information, entering into a room or access to an equipment is allowed, otherwise a buzzer can be used to indicate that an unauthorized person has tried to enter or tried to access the control of a critical device or equipment. Figure-3 shows the schematic.

The system is developed around ATMEGA328 microcontroller. The key features of the controller are: i. A High-performance, AVR 8-bit Microcontroller with Low-power consumption. ii. Advanced RISC Architecture. iii. 32 8-bit GP registers. iv. 3 8-bit I/O ports. v. 32 Kilo-Byte flash memory. vi. 1 Kilo-Byte EEPROM & 2 Kilo-Byte SRAM. vii. On chip 10 bit A/D converter. viii. 16-bit timer. ix. Maximum Operating Frequency 20 Mhz.

The operation of the security system is described as follows:

Power Supply is given through a Battery to RFID Reader and Microcontroller At mega 328. The RFID Reader activates RFID Tag. The RFID Module is synchronized to operate under a frequency of say, 125 KHz by using a RFID tag. The data read by RFID Reader is fed to the Microcontroller. This RFID Reader sends say, a 12-bit RFID tag signal to the Microcontroller. Microcontroller gives the output through its 4 I/O Pins. The tag information is assumed to be stored in memory of the microcontroller for comparison. If the information matches, the signal is sent to activate the device. In case, if the information does not match a buzzer/ alarm is activated.

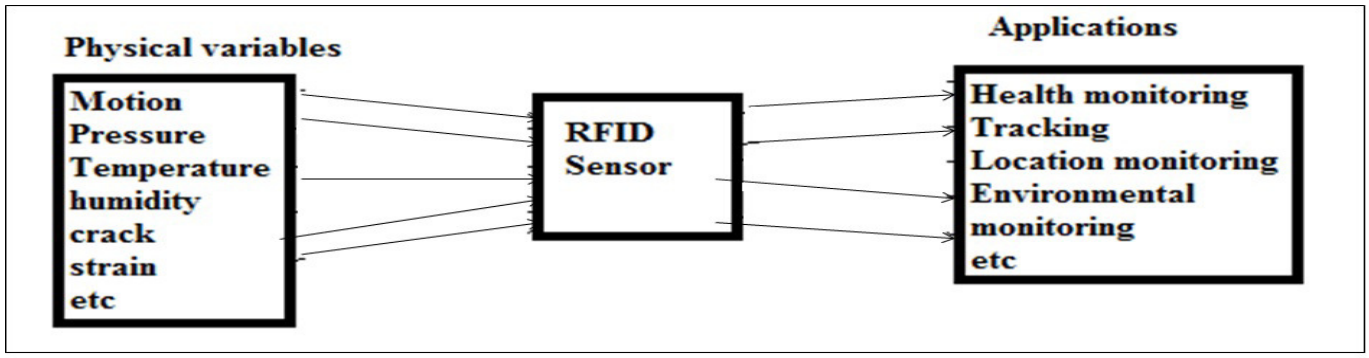

Figure-2: Applications of RFID systems.

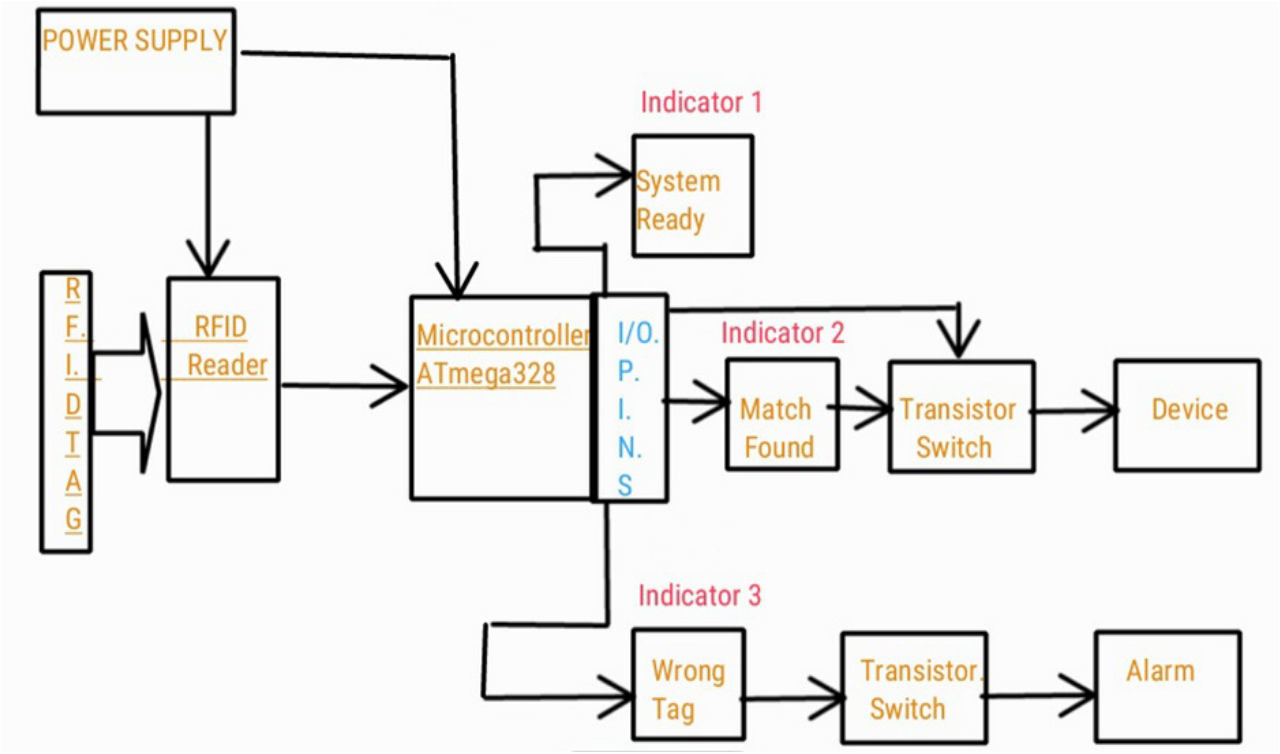

Figure-3: Schematic of a typical RFID based Security system.

Conclusion

In this paper, a very brief review of RFID systems was presented. The underlying basics, the components of RFID system, their operating frequencies, concepts involved were briefly discussed. The comparison of evident features of barcode system and RFID systems was also presented. A typical application of RFID system in security system/ secured equipment control was described. Though, RFID systems have several advantages the design of RFID systems needs to be improved with respect to various issues like cost, technical limitations and reliability through extensive engineering efforts and advancements in technology.

References

1. Want R. (2006). An introduction to RFID technology. *IEEE pervasive computing*, 5(1), 25-33.

2. Chawla V. and Ha D.S. (2007). An overview of passive RFID. *IEEE Communications Magazine*, 45(9).

3. Krishna P. and Husalc D. (2007). RFID infrastructure. *IEEE Communications Magazine*, 45(9).

4. Cangialosi A., Monaly J.E. and Yang S.C. (2007). Leveraging RFID in hospitals: Patient life cycle and mobility perspectives. *IEEE Communications Magazine*, 45(9).

5. Preradovic S. and Karmakar N.C. (2010). Chipless RFID: Bar code of the future. *IEEE Microwave Magazine*, 11(7), 87-97.

6. Preradovic S., Balbin I., Karmakar N.C. and Swiegers G.F. (2009). Multiresonator-based chipless RFID system for low-cost item tracking. *IEEE Transactions on Microwave Theory and Techniques*, 57(5), 1411-1419.

7. Jain P.C. and Vijaygopalan K.P. (2010). RFID and wireless sensor networks. *Proceedings of ASCNT–2010, CDAC, Noida, India*, 1-11.

8. Xiao Y., Yu S., Wu K., Ni Q., Janecek C. and Nordstad J. (2007). Radio frequency identification: technologies, applications, and research issues. *Wireless Communications and Mobile Computing*, 7(4), 457-472.

9. Meng Z. and Li Z. (2016). RFID Tag as a Sensor-A Review on the Innovative Designs and Applications. *Measurement Science Review*, 16(6), 305-315.