Radio Frequency Identification: A Bright Future, In The Right Hands

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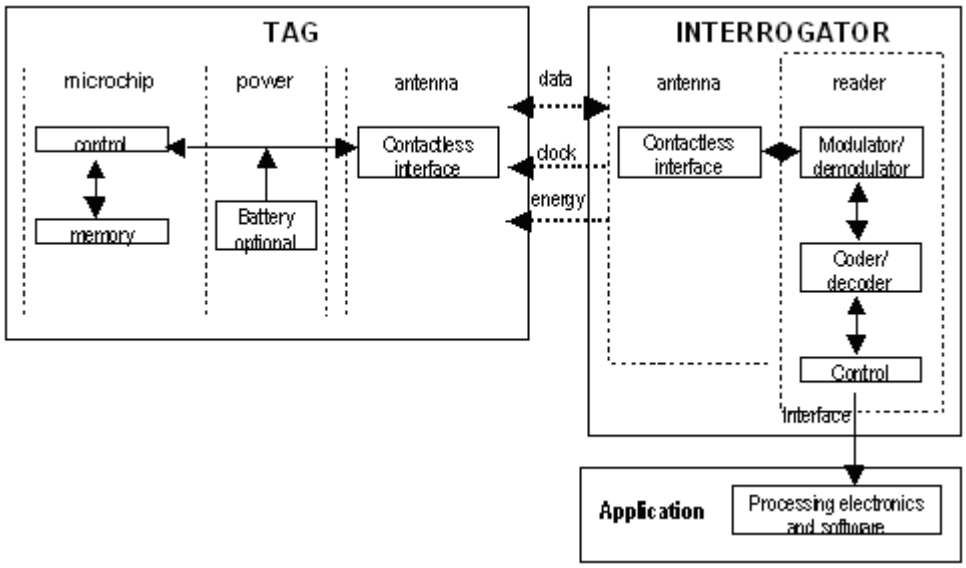
ECE 399H

Introduction

What is RFID?



Types of RFID devices

Passive

Passive RFID devices have no power supply built in. Electrical current transmitted by the RFID reader inductively powers the device, which allows it to transmit its information back. Since the tag has a limited power supply, its transmission is much more limited than an active tag, typically no more than simply an ID number. Similarly, passive devices have a limited range of broadcast, requiring the reader be significantly closer than an active one would.

Uses for passive devices tend to include things such as inventory, product shipping and tracking, use in hospitals and for other medical purposes, and anti-theft where it is practical to have a reader within the five meters or so of the RFID device. Passive devices are ideal in places that prevent the replacement of a battery, such as implanted under a person's skin.

Active

Active RFID devices are self-powered. These contain a battery to power the transceiver, which broadcast the stored data continually. Since they contain a power supply, the potential range and information broadcast is much greater than in a passive tag. A feature that most active tags have and most passive tags do not is the ability to store data received from a transceiver. The battery life potential has greatly increased over the years, currently having an upper bound of several years.

Active tags are ideal in environments with electromagnetic interference since they have a stronger signal broadcast and in situations that require a greater distance between the tag and the transmitter.

Size Difference

The additional space taken up by a battery in an active device necessitates that the active devices are substantially larger, at their smallest, than the smallest a passive device may be. To date, passive tags may be commercially available as small as 0.4mm square and thinner than a sheet of paper. In contrast, commercially available active tags are still only as small as a coin, which means that active tags are around 50 times the size of passive ones.

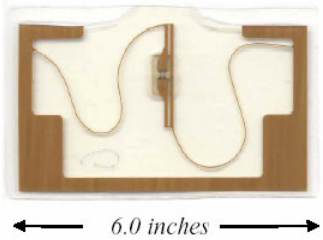
Antenna Types

The antenna type for a given device can be customized for its specific purpose. In the customization, there are limitations, which include the physical size of the antenna, the materials used for packaging, what the product is, and

where on the package it will go. The readability of the tag is affected by all of the above limitations, especially the location of the antenna relative to the reader.

Circular

Circular antennas are directionally independent; they work equally well regardless of their positioning relative to the transmitter. While this type of antenna can work in most any situation, it is particularly effective in uncontrolled environments and those in which the RFID tags are not in uniform positions.



Used on:

Bar Soap, Paper Products

Linear

Used on:

Cases, Shampoo Bottle, Aerosol Cans

Linear antennas are orientation dependent. The tradeoff for the directional dependency is a higher level of performance. A linear antenna is preferable when the environment is controlled and the RFID tags are carefully and uniformly positioned.

Custom

4.5 inches

Used on:

Cases, Dog Food, Coffee Cans

Custom antennas are optimized for the given conditions that that device will be used in. Depending on the level of homogeny in the antennas' placement and the amount of money available to customize the antenna, alterations to the antennas shape and size are made until the desired performance is achieved.

Radio Frequencies and Corresponding Range

Low frequency tags

The frequency of these tags is between 125 and 134 kilohertz, which requires short read ranges and a low reading speed. These are relatively inexpensive and are frequently used for physical access to places, inventory tracking, and animal identification.

High frequency tags

The frequency at which these tags are broadcast is 13.56 megahertz. This frequency also allows for only fairly short distance reads. It, too, is fairly inexpensive to produce, and has a medium speed for reading. These tags are also frequently used for access control. Smart cards and unit and shelf reads are another couple of typical uses for high frequency tags.

Ultra high frequency (UHF) tags

UHF tags broadcast between 868 and 956 megahertz. Longer distance reads are possible for these frequencies with a high reading speed. The expense of these tags is substantially higher than the abovementioned tags. Case and pallet reads are an example of uses of such tags. Door and conveyor readers typically operate at such frequencies due to the possible distance between the RFID chips and the reader itself. A problem exists with these UHF tags though; there is currently no single set of global regulations on its use, so they cannot yet be globally implemented.

Microwave tags

Microwave tags operate on a frequency of 2.45 gigahertz. These share similar costs, reading speeds, uses, and range with UHF tags.

The above classifications are simply that, classifications. There are eight frequencies that are standards and commonly used around the world currently, which are identified by the frequency number rather than the classifications low, high, UHF, and microwave.

Memory Type

Read Only

Read only memory contains the data or identification number which is set when it is produced. It is not possible to change, add, or remove this information from a device containing this type of memory. Read only memory

is usually the least expensive type of memory. However, they require a readily available database of pertinent information in order to be meaningful to the reader.

Read/Write

Read/write memory may be updated by adding additional information to it. This type of memory is more expensive, though commonly used when there isn't the infrastructure with the strong database available.

Write Once Read Many (WORM)

WORM memory, unlike read only, is not defined in its production. The user sets the identification number the first time it is used. Once it is defined, there is no changing or adding to the memory. The cost of WORM memory falls in-between the price of the other two, and also necessitates the pertinent database that is easily accessible.

Interference

Interference is a problem with RFID devices, especially if there are multiple systems running on the same frequency. There are few ways to deal with this, the main way being shutting off or suspending one of the systems while the other communicates. The other main option is to change the frequency of one of the systems.

History/Background

The idea behind radio frequency identification (RFID) has been around for an unrecorded length of time. Radio waves and the theory of induction have

been explored and experimented with since the 19th century. Heinrigh Rudolf Hertz, a German physicist, was the first to transmit and receive radio waves. Radar was an expansion of the knowledge of radio waves, first introduced in the early 1920s. Radar can detect the location of an object and its speed, but little more.

A need for more information about an object prompted the development of a system of self identification arose during World War II. There was a need for a means of identifying friendly aircraft and foe. Theoretical papers and research into possible solutions to this problem were done in the following couple of decades and RFID technologies began taking root. By the 1960s physical devices began to appear. The systems could only detect the presence or absence of the tags, and were used predominantly as anti-theft devices.

The 1970s saw much time and effort being spent on furthering the RFID technology for a variety of uses. Animal tracking, toll collecting, factory automation, vehicle identification, and vehicle tracking were areas of interest for this technology. People were not only starting to realize the potential in RFID, but also working on making the potential of the technology a reality.

The 1980s were also years that held much RFID research and development and the more time that passed, the more frequently RFID was used. Around the world RFID chips and readers were being implemented in a variety of settings, on toll roads, in manufacturing plants, in daily life to track pets, and also in daily life for individuals to gain physical access to buildings and areas.

During 1990s, RFID was put more and more frequently into use in a variety of locations. In the United States alone, there were a good number of toll ways that automatically charged the fee for use to each vehicle passing through without the driver needing to stop, dig up change, and pay. Other car related uses for RFID began in this timeframe as well. These included electronic parking permits, access to gated communities, and business campus access. Ski passes were another use for RFID chips that began to be used in the 1990s.

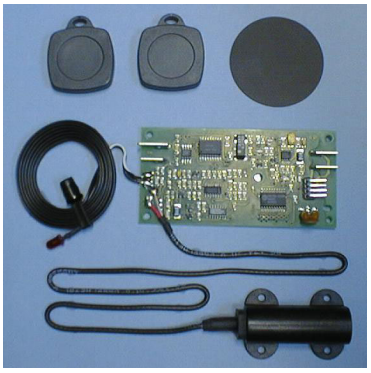
Current Applications

Commercial

There are currently many commercial applications of RFID systems. Many companies frequently use case, pallet, truck, and trailer tracking. The removal of much paperwork that used to be involved in such tracking can save the company both time and money. Beer kegs are tracked using low-frequency RFID tags, while things like apparel items, bookstore items, airline baggage, library books, and ID badges are tracked using high-frequency tags (RFID).

Personal

RFID technology has not yet become a large part of most people's lives, due to legitimate concerns about personal safety and privacy. One application of RFID systems that has popped up in this area is animal and pet identification. The animals are embedded with chips that tie them to their owners so that they can be reunited if the pet gets lost.



Another example of RFID technology in daily life is in automobile fobs and in anti-theft systems. Some Lexus models have a "Smart Key" option that uses an active RFID circuit that allows the driver to unlock the car and start it up with the key still in his or her pocket (RFID).

Scientific, Government, Defense

Scientific sensors collecting data remotely are sometimes read by RFID transceivers. One such example is seismic sensors. It enables remote data collection of areas that might not be able to be so easily monitored. RFID technology also allows for easy record keeping of the data collecting instruments themselves (RFID).

Passports issued in the United States have been approved to contain RFID chips. This is intended to add an additional level of security and proof of validity to the document. It has also been proposed that driver's licenses have embedded RFID devices (Kuchinskas). This push was in large part due to the fact that some of the terrorists involved in the September 11th attacks carried fake driver's licenses. The proposal in Virginia suggested that only a number be stored in the tag and that number correspond to the individual's information in a remote database (Baard).

Toll collection and miscellaneous vehicle passes have emerged throughout the United States in the past couple of decades. The intention here was to

streamline toll collection and vehicle access to certain places, which has seemed to be successful.

Medical

One of the medical applications of RFID technology starts at birth. Many hospitals have adopted one sort of RFID system or another to keep track of newborns. In the Salem Hospital, located in Salem, Oregon, newborns are fitted with Hugs tags. The unique number in the tag is assigned to the infant, mother, and support person in the database. There are readers located near the stairs, elevator, and all exits that alert the nursing staff if an infant is too close to any of them. While there have been no attempted abductions of infants in the Salem hospital in recent years, this system was put in place to deter and if need be, respond to one (Mother Baby Care).

Other hospitals fit the mother with a reader that is similar to the infant's tag in addition to the infant wearing a Hugs tag. This system alerts the mother if she picks up the wrong baby or confirms that she is holding the right baby. Systems like this are potentially lifesaving, not only because they help prevent abductions, but also since diseases such as HIV can be passed through breastfeeding, even just one time.

Another use for RFID systems in the medical world is to keep track of those individuals in need of living assistance. The elderly, those with Alzheimer's disease, and individuals that need daily medications that are living in a monitored environment are kept track of with RFID tags. Depending on the

level of assistance a given individual needs, they are more easily able to live as independently as possible with this technology.

Potential Use

One potential use for RFID devices might be to embed them in all new building materials. If a passive RFID chip were to be put into each piece of building material, it would be much more efficient to find all of those materials that might be found to be dangerous or hazardous to people's health. Asbestos, for example, would be much easier to find and take care of now if these chips had been embedded when they were put into use. A person would only have to take a reader through a building to locate all of the dangerous matter.

Similarly, if in the future it were discovered that a certain lot of steel, lumber, pipe, or other building material had been compromised, it would make the cleanup process worlds easier and faster if the materials themselves could identify where they came from.

Another potential use for RFID technology might be the incorporation into household and industrial appliances. Depending on the design of the machine, there might be either an active or a passive RFID chip for each critical component. If one of those critical components were to fail in a machine with an active RFID chip, the signal would cease to be transmitted. If one of the critical components were to fail in a machine with a passive RFID chip, the device would begin to broadcast its information. Either way, the advantage to appliances and machines containing RFID devices like these is that when the mechanic, electrician, or other repairperson comes to look at the machine, they need open it up only to fix or replace the broken part,

since the machine will either tell them every part that is working or only the part that is currently not functioning.

With the invention of nano-RFID devices, a whole new world of opportunities opens up. One possible use of such technology might be to replace the radioactive cocktail that an individual must be given before an MRI with the nano-RFID devices. It would be immensely useful to find a way for the nano-RFID chips to bond to particular cells, viruses, or molecules. This technology could also be used in a shop setting. If nano-RFID chips were added to oil, coolant, gas, or essentially any other car fluid, it could allow a finer view of the system and aid in pinpointing problems. Similarly, this technology could be used for any wide variety of systems that a person can't otherwise get into.

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