**AUTOMATIC IDENTIFICATION AND DATA CAPTURING USING RFID**

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**ABSTRACT:-**

**RFID is an area of automatic identification that has quietly been gaining momentum in recent years and is now being seen as a radical means of enhancing data handling processes, complimentary in many ways to other data capture technologies such as bar-coding.**

**The object of any RFID system is to carry data in suitable transponders, generally known as tags, and to retrieve data, by machine-readable means, at a suitable time and place. Data within a tag may provide identification for an item in manufacture, goods in transit, a location, the identity of a vehicle, an animal or individual. RFID technology yields larger memory capacities, wider reading ranges, and faster processing.**

1. **INTRODUCTION :**

Radio frequency identification (RFID) is a contactless form of automatic identification and data capture. Dating back to World War II, RFID transponders were used to identify friendly aircraft. The RFID system consists of a reader, transponder, and antenna utilizing several frequency ranges. Radio frequency identification is used in access control, asset control, and animal identification. The advantages of RFID are the capability for multiple reads, ability to be used in almost any environment, and the accuracy. The Automatic Identification Manufacturers, International Standards Organization, and the American National Standards Institute are currently developing standards.

RFID (Radio Frequency Identification). In RFID electronic chips are used to store data that can be broadcast via radio waves to the reader, eliminating the need for a direct line of sight and making it possible for "tags" to be placed anywhere on or in the product. One can even write to tags made of semiconductor chips, thus enabling updating of data. This write function introduces new capabilities, such as the updating of the manufacturing process of the attached item.

RFID first appeared in tracking and access applications during the 1980s. These wireless AIDC systems allow for non-contact reading and are effective in manufacturing and other hostile environments where bar code labels could not survive. RFID has established itself in livestock identification and automated vehicle identification (AVI) systems because of its ability to track moving objects.

To understand and appreciate the capabilities of RFID systems it is necessary to consider their constituent parts. It is also necessary to consider the data flow requirements that influence the choice of systems and the practicalities of communicating across the air interface. By considering the system components and their function within the data flow chain it is possible to grasp most of the important issues that influence the effective application of RFID.

**2. BASIC CONCEPT OF AIDC TECHNOLOGY**:--

Automatic Identification and Data Capture (AIDC) is a unique technology by which data is automatically gathered from a person, object, image or sound without the clumsiness of manual data entry that sometimes, is prone to errors.  AIDC applications are seen to increase productivity and can be utilized in inventory management, Logistics, asset management, documents retrievals, security, and access control. It is commonly found in different sectors such as manufacturing, health, transportation, medicine, distribution, government, retail, and many more.

 The primary functions of AIDC devices are to identify, validate, track, monitor, evaluate targets and interface with other systems using various application methodologies. However, setting up frameworks for solutions in AIDC environment varies and depends so much on the platform for implementation. Solutions for barcode, radio frequency identification (RFID), smart card, magnetic stripes, optical character recognition (OCR), biometrics may not be interchangeable. Meanwhile, each of the platforms can stand-alone or can work in combination with the other seamlessly.

**3. RFID*:***

Radio Frequency Identification, or RFID, is a rapidly-emerging identification and logging Technology. Whether or not you have come across RFID systems in your work, you have probably encountered RFID in your daily life, perhaps without even being aware of it. Attheir simplest, RFID systems use tiny chips, called "tags," to contain and transmit somepiece of identifying information to an RFID reader, a device that in turn can interface withcomputers.

To begin understanding RFID, think of conventional point-of -sale barcode reader scanning grocery barcodes. In its simplest form, an RFID system is much the same: it also can identify a package. However, unlike barcodes, RFID tags don't need a direct line of sight: within limits, we can now scan an unpacked skid of boxes. Next, think of RFID tags as mini databases, or as barcodes that can be written to, and that can accumulate information as they travel. At this point, RFID diverges qualitatively from bar-coding, giving it great new potential.

There is difference between Barcode technology and RFID technology in frequency used , data volume , type of communication, range of data readability and cost.

***3.1 COMPONENTS:-***

A basic RFID system consists of three components:

- An antenna or coil

- A transceiver (with decoder)

- A transponder (RF tag) electronically programmed with unique information



 Fig(a):-components of RFID

* The antenna emits radio signals to activate the tag and to read and write data to it.
* The reader emits radio waves in ranges of anywhere from one inch to 100 feet or more, depending upon its power output and the radio frequency used. When an RFID tag passes through the electromagnetic zone, it detects the reader's activation signal.
* The reader decodes the data encoded in the tag's integrated circuit (silicon chip) and the data is passed to the host computer for processing.

The purpose of an RFID system is to enable data to be transmitted by a portable device, called a tag, which is read by an RFID reader and processed according to the needs of a particular application. The data transmitted by the tag may provide identification or location information, or specifics about the product tagged, such as price, color, date of purchase, etc. RFID technology has been used by thousands of companies for a decade or more. . RFID quickly gained attention because of its ability to track moving objects. As the technology is refined, more pervasive - and invasive - uses for RFID tags are in the works.

 ***3.2 WORKING OF RFID:-***

The figure Fig(b) shows an overview of a RFID system.  A simple RFID system consists of a RFID reader and a RFID tag.  And, inside of each sophisticated tags there then consists of a radio transmitter and radio receiver.  This enables a RFID reader and a RFID tag communicates each other through a specified radio frequency.  There are three main roles a RFID reader plays other than signaling RFID tag to transmit desired information back to the RFID reader.  Firstly, a RFID reader has the responsibility of keeping RFID tags powered up.  Secondly, a RFID reader demodulates incoming signals from the RFID tag down.  This process slows the incoming signals down enough so that the RFID reader is able to process the signals.  Finally, after the incoming signals are slowed down, RFID then has the responsibility of decoding the incoming signals into the words people can interpret.  Both a RFID reader and a RFID tag can be easily made into almost any desired shape and size.  Because of the versatility, RFID system can almost fit into wherever needs a field needs to identify, track, and manage objects, maybe even people, or animals.



 Fig(b):- Basic RFID system

 **4.RFID TAGS /TRANSPONDER:-**

The word transponder, derived from TRANSmitter/resPONDER, reveals the function of the device. The tag responds to a transmitted or communicated request for the data it carries, the mode of communication between the reader and the tag being by wireless means across the space or air interface between the two. The term also suggests the essential components that form an RFID system – tags and a reader or interrogator. Where interrogator is often used as an alternative to that of reader, a difference is sometime drawn on the basis of a reader together with a decoder and interface forming the interrogator. Generally speaking they are fabricated as low power integrated circuits suitable for interfacing to external coils, or utilising "coil-on-chip" technology, for data transfer and power generation (passive mode). The tag can be Passive and Active .

***Passive tag***: - Passive tags operate without a separate external power source and obtain operating power generated from the reader. Passive tags are consequently much smaller and lighter than active tags (some are grain of rice size), less expensive, and offer a virtually unlimited operational lifetime. The trade off is that they have shorter read ranges than active tags and require a higher-powered reader. Read-only tags are typically passive and are programmed with a unique and limited set of data (usually 32 to 128 bits) that cannot be modified. Read-only tags most often operate as a information pointer into a database, in the same way as linear barcodes reference a database containing modifiable product-specific information.

***Active Tag*: -** Activetags are powered by an internal battery and are typically read/write, i.e., tag data can be rewritten and/or modified.  An active tag's memory size varies according to application requirements; some systems operate with up to 1MB of memory. In a typical read/write RFID work-in-process system, a tag might give a machine a set of instructions, and the machine would then report its performance to the tag. This encoded data would then become part of the tagged part's history. The battery-supplied power of an active tag generally gives it a longer read range. The trade off is greater size, greater cost ($20 or more), and a limited operational life (up to 10 years).

 ***4.1 Basic features of an RFID transponder:***

The transponder memory may comprise read-only (ROM), random access (RAM) and nonvolatile programmable memory for data storage depending upon the type and sophistication of the device. The ROM-based memory is used to accommodate security data and the transponder operating system instructions which, in conjunction with the processor or processing logic deals with the internal "house-keeping" functions such as response delay timing, data flow control and power supply switching. The RAM-based memory is used to facilitate temporary data storage during transponder interrogation and response. The non-volatile programmable memory may take various forms, electrically erasable programmable read only memory (EEPROM) being typical. It is used to store the transponder data and needs to be non-volatile to ensure that the data is retained when the device is in its quiescent or power-saving "sleep" state. Data buffers are further components of memory, used to temporarily hold incoming data following demodulation and outgoing data for modulation and interface with the transponder antenna. The interface circuitry provides the facility to direct and accommodate the interrogation field energy for powering purposes in passive transponders and triggering of the transponder response. Where programming is accommodated facilities must be provided to accept the data. The transponder antenna is the means by which the device senses the interrogating field and, where appropriate, the programming field and also serves as the means of transmitting the transponder response to interrogation.

A number of features, in addition to carrier frequency, characterize RFID transponders and form the basis of device specifications, including:

* Means by which a transponder is powered
* Data carrying options
* Data read rates
* Programming options
* Physical form
* Costs

***Powering tags***

For tags to work they require power, even though the levels are invariably very small (micro to mill watts). Tags are either passive or active, the designation being determined entirely by the manner in which the device derives its power. Active tags are powered by an internal battery and are typically read/write devices. They usually contain a cell that exhibits a high power-to-weight ratio and are usually capable of operating over a temperature range of -50°C to +70°C. The use of a battery means that a sealed active transponder has a finite lifetime. However, a suitable cell coupled to suitable low power circuitry can ensure functionality for as long as ten or more years, depending upon the operating temperatures, read/write cycles and usage. The trade-off is greater size and greater cost compared with passive tags. In general terms, active transponders allow greater communication range than can be expected for passive devices, better noise immunity and higher data transmissions rates when used to power a higher frequency response mode. Passive tags operate without an internal battery source, deriving the power to operate from the field generated by the reader. Passive tags are consequently much lighter than active tags, less expensive, and offer a virtually unlimited operational lifetime. The trade-off is that they have shorter read ranges than active tags and require a higher-powered reader. Passive tags are also constrained in their capacity to store data and the ability to perform well in electromagnetically noisy environments. Sensitivity and orientation performance may also be constrained by the limitation on available power. Despite these limitations passive transponders offer advantages in terms of cost and longevity. They have an almost indefinite lifetime and are generally lower on price than active transponders.

***Data carrying options :***

Data stored in data carriers invariable require some organization and additions, such as data identifiers and error detection bits, to satisfy recovery needs. This process is often referred to as source encoding. Standard numbering systems, such as UCC/EAN and associated data defining elements may also be applied to data stored in tags. The amount of data will of course depend on application and require an appropriate tag to meet
the need. Basically, tags may be used to carry:

* Identifiers, in which a numeric or alphanumeric string is stored for identification purposes or as an access key to data stored elsewhere in a computer or information management system, or
* Portable data files, in which information can be organized, for communication or as a means of initiating actions without recourse to, or in combination with, data stored elsewhere.

In terms of data capacity tags can be obtained that satisfy needs from single bit to kilobits. The single bit devices are essentially for surveillance purposes. Retail electronic article surveillance (EAS) is the typical application for such devices, being used to activate an alarm when detected in the interrogating field. They may also be used in counting applications. Devices characterized by data storage capacities up to 128 bits are sufficient to hold a serial or identification number together, possibly, with parity check bits. Such devices may be manufacturer or user programmable. Tags with data storage capacities up to 512 bits, are invariably user programmable, and suitable for accommodating identification and other specific data such as serial numbers, package content, key process instructions or possibly results of earlier interrogation/response transactions. Tags characterized by data storage capacities of around 64 kilobits may be regarded as carriers for portable data files. With increased capacity the facility can also be provided for organizing data into fields or pages that may be selectively interrogated during the reading process. Data read rate – It has been mentioned already that data transfer rate is essentially linked to carrier frequency. The higher the frequency, generally speaking the higher the transfer rates. It should also be appreciated that reading or transferring the data requires a finite period of time, even if rated in milliseconds, and can be an important consideration in applications where a tag is passing swiftly through an interrogation or read zone.

***Data programming options :***

Depending upon the type of memory a tag contains the data carried may be read-only, write once read many (WORM) or read/write. Read-only tags are invariably low capacity devices programmed at source, usually with an identification number. WORM devices are user programmable devices. Read/write devices are also user programmable but allowing the user to change data stored in a tag. Portable programmers may be recognized that also allow in-field programming of the tag while attached to the item being identified or accompanied.

***Physical Form :***

RFID tags come in a wide variety of physical forms, shapes sizes and protective housings. Animal tracking tags, inserted beneath the skin, can be as small as a pencil lead in diameter and ten millimeters in length. Tags can be screw-shaped to identify trees or wooden items, or credit-card shaped for use in access applications. The anti-theft hard plastic tags attached to merchandise in stores are also RFID tags, as are heavy-duty 120 by 100 by 50 millimeter rectangular transponders used to track inter-modal containers, or heavy machinery, trucks, and railroad cars for maintenance and tracking applications.

***Costs :***

The cost of tags obviously depends upon the type and quantities that are purchased. For large quantities (tens of thousands) the price can range from less than a few cents for extremely simple tags to tens of dollars for the larger and more sophisticated devices.

Increasing complexity of circuit function, construction and memory capacity will influence cost of both transponders and reader/programmers. The manner in which the transponder is packaged to form a unit will also have a bearing on cost. Some applications where harsh environments may be expected, such as steel mills, mines, and car body paint shops, will require mechanically robust, chemical and temperature tolerant packaging. Such packaging will undoubtedly represent a significant proportion of the total transponder cost. Generally, low frequency transponders are cheaper than high frequency devices, passive transponders are usually cheaper than active transponders.

### 5. RFID READER/ Interrogator:-

### An RFID reader is basically a radio frequency (RF) transmitter and receiver, controlled by a microprocessor or digital signal processor (DSP). The RFID reader, using an attached antenna, captures data from **RFID tags**, and then passes the data to a computer for processing. As with tags, readers come in a wide range of sizes and offer different features. Readers can be affixed in a stationary position (for example, beside a conveyor belt in a factory or dock doors in a warehouse), portable (integrated into a mobile computer that also might be used for scanning bar codes), or even embedded in electronic equipment such as print-on-demand label printers.

### The reader/interrogators can differ quite considerably in complexity, depending upon the type of tags being supported and the functions to be fulfilled. However, the overall function is to provide the means of communicating with the tags and facilitating data transfer. Functions performed by the reader may include quite sophisticated signal conditioning, parity error checking and correction. Once the signal from a transponder has been correctly received and decoded, algorithms may be applied to decide whether the signal is a repeat transmission, and may then instruct the transponder to cease transmitting.

**6. RFID System Categories*:-***

RFID systems may be roughly grouped into four categories:

* EAS (Electronic Article Surveillance) systems
* Portable Data Capture systems
* Networked systems
* Positioning systems

Electronic Article Surveillance systems are typically a one bit system used to sense the presence/absence of an item. The large use for this technology is in retail stores where each item is tagged and large antenna readers are placed at each exit of the store to detect unauthorised removal of the item (theft).

Portable data capture systems are characterized by the use of portable data terminals with integral RFID readers and are used in applications where a high degree of variability in sourcing required data from tagged items may be exhibited. The hand-held readers/portable data terminals capture data which is then either transmitted directly to a host information management system via a radio frequency data communication (RFDC) link or held for delivery by line-linkage to the host on a batch processing basis.

Networked systems applications can generally be characterized by fixed position readers deployed within a given site and connected directly to a networked information management system. The transponders are positioned on moving or moveable items, or people, depending upon application.

Positioning systems use transponders to facilitate automated location and navigation support for guided vehicles. Readers are positioned on the vehicles and linked to an on-board computer and RFDC link to the host information management system. The transponders are embedded in the floor of the operating environment and programmed with appropriate identification and location data. The reader antenna is usually located beneath the vehicle to allow closer proximity to the embedded transponders.

**7. RFID Frequency *:-***

RFID technology is essentially the use of RFID tags with different RFID frequency embedded in an object which are being incorporated into a product, animal or person for the purpose of identification or tracking (RFID tracking) or security via radio waves using stringently specified RFID frequency.

RFID application has been widespread and the invention of RFID chips which is much smaller compare to RFID technology available in its yester years make it even more attractive to humans. RFID technology is slowly substituting barcode due to its innovative invention and it is more user friendly. The technology in manufacturing RFID scanners is also improving to catch up with fast paced RFID tags.

RFID systems generate and radiate electromagnetic waves and the electromagnetic waves are classified as radio waves. The function of other radio services must not be interrupted or impaired by RFID systems when it is operating. The experts have made sure that RFID system created is not only user friendly but at the same time does not interfere with radios, televisions, mobile radio services, marine and aeronautical radio services and mobile telephones in the vicinity. These have greatly restricted the frequency allowed. For this reason, it is usually only possible to adopt frequency ranges specifically reserved for industrial, scientific or medical applications or short range services to be used as RFID frequency. Low Frequency (135 KHz) has a maximum read range of up to 20 inches. High Frequency (13.56 MHz) has a maximum read range of up to 3 feet. Ultra-High Frequency (868 MHz – Europe & 915 MHz – US) has a read range of 20 feet or more . Microwave Frequency (2.45 GHz) has a read range of up to 1 meter as a passive tag or longer range as an active tag.

Generally, low frequency RFID system have short transmission ranges which is approximately 6 feet whereas high frequency RFID system offer longer transmission ranges that could reach as far as 90 feet. The higher the frequency of an RFID system, the more expensive that system is. Low frequency has lower energy where they transmit data in a slower manner and the range is limited. High frequency has higher energy level and therefore can be used for long range applications. In high frequency, a beam is involved so it can be used for locating smart labels.

Low frequency RFID system is suitable to be used for animal identification and as car immobilizer. RFID system with higher frequency is typically used in smart labels, contactless travel cards and in areas of access and security. UHF frequency can be used in RFID system incorporated in animal tracking and logistics and transportation. UHF frequency offers high data transfer rate whereas RFID frequency in microwave range is used in moving toll.

**8. Benefits of RFID*:-***

The following are the benefits of RFID Systems:

* Non-line of sight identification of tags.
* Unattended operations are possible, minimizing human errors and high cost.
* Ability to identify moving elements that have tags embedded.
* Larger area of coverage. Up to several feet.
* Can be used in diverse environments, including live stock, military, and scientific areas.
* RFID can be used in addition to Bar Code. These two technologies can be complementing each other.
* Automatic integration with back end software solutions provide end to end integration of data in real time.

**9. Disadvantages of RFID:**

* Expensive compared with Bar code
* Bulkier, due to embedding of electronic components in the tag. However, with advanced techniques, it is possible to reduce the size, and weight of the tags to a large extent.
* Prone to physical/electrical damage due to environmental conditions. For example, tags that are subjected to space exploration may encounter extreme temperatures. The tags required to be designed for a given application, and may be costly when designed for use under extreme environmental conditions.

## 10. Applications of RFID*:*

1. Employee Identification and Access Control
2. Airline baggage Identification
3. Wafer Identification during manufacturing process
4. Livestock Identification
5. Parts Identification
6. Identification and Tracking of Vehicles
7. Identification of  widgets through manufacturing process
8. Supply Chain Automation
9. Asset Tracking, and others.

**CONCLUSION*:***

RFID is a leading technology that can provide considerable value in a world in which maintenance cost and labour time is less. The technical issues associated with RFID are likely to be resolved as further investments are made in the technology. Enough progress has been made at this time that trails for the first truly large scale rulers of RFID are beginning.

all other staffs for their kind support & novel ideas given by them to me directly or indirectly.

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