

AIDC (Automatic Identification and Data Capture)

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Abstract. This paper is written to create awareness among the library professionals about *AIDC (Automatic Identification and Data Capture)* technologies and their potential application in libraries/information centres. Data entry is an inseparable part of the library operations. This is an repetitive job and slows down the speed of the system as a whole. So, AIDC technologies have been described in this paper as an probable solution. Each technology has been introduced individually and its working has been described. The technologies which have been included are, *bar code, RFID, biometrics, OCR, MICR, magnetic strips, smart card* and *voice recognition*. After that the applicability of each individual technology in libraries has been described briefly. Towards the conclusion of the paper the future of AIDCs have been discussed in view of the changing scenario with the introduction of *born digital documents* and *internet*.

Keywords: Digital Libraries, AIDC, RFID, OCR, MICR, RFID tags, RFID transponders, automatic identification and data capture, radio frequency identification, optical character recognition, magnetic ink character recognition, database, data entry, retrospective conversion, automatic identification, auto-ID, active tags, passive tags, biometrics, biometry, biometric authentication, fingerprint identification, behaviometrics, eye scan, magnetic strips, magstripe, chip cards, integrated circuit cards, memory cards, microprocessor cards, contact smart cards, contactless smart cards, voice recognition, automatic speech recognition, speaker recognition, speaker dependent, continuous speech systems, discreet speech systems, virtual libraries, born digital material.

1. Introduction:

In order to understand the concept of *AIDC (Automatic Identification and Data Capture)* we must first understand two very basic terms, *Database* and *Data Entry*.

1.1 Database:

A Database put in simple terms is an “collection of data in some useable format.” The term *database* originated with the computers themselves, though now it is being used freely in our day-to-day life for non-electronic collection of data also. Data collections are not new for the librarians/information specialists. Their job involves the creation, storage and manipulation of large amounts of data. The traditional Catalogue whether in card, sheaf or book form is a data collection (database in computer terminology). In these databases the data required to be entered manually in writing/typing/printing.

There were many problems with the traditional (documentary) forms of databases. They were bulky, inflexible to modify and time consuming for creator and user alike. With the introduction of computers in the libraries in 1950's and 1960's the whole databases needed to be converted into computer readable format, so that it may be manipulated and processed by the computer. Also, now the databases are not limited to the bibliographic information but they include the documents in digital format as well. So they have grown in size manifold.

1.2. Data Entry:

In a computerized library Data Entry is of two types. *Firstly*, it starts with the very commencement of the Automation Process. The very first stage in the automation of a library is the *Retrospective Conversion*. During *retrospective conversion* the existing records of the library are converted into computer readable format. These records exist in digital form, ready to be manipulated by the computer. *Secondly*, there is routine data entry at the circulation desk, processing section and technical section etc.

Also the Data Entry may vary in magnitude. It may be the entry of only *bibliographic data* resulting into *bibliographic database*, without contents of the resources, describing only the presence and location of the concerned resource. Or it may be the entry of the *bibliographic data* plus the *content matter* of the resource, presenting the whole document in digital format, just a mouse click away.

Once a database has been created it is very convenient to manipulate that data using computers. But creating a database is quite tedious job if done manually. In routine library activities it is very time-consuming process and slows down the overall service delivery,

creating bottlenecks at different points i.e. circulation desk, processing section & technical section etc. It also results in inadvertent mistakes at these points, which further brings in inefficiency in the whole of the system and creates inconvenience for the staff and users alike. It required more men and resources to enter data. This increases the overall cost.

To overcome these problems some automatic technology was required. The solution is *AIDC (Automatic Identification and Data Capture)*.

2. Automatic Identification and Data Capture (AIDC):

Many authorities have defined AIDC in their own way. It is a generic term which refers to the “*process of collecting/capturing data by automatic means and storing that data directly into a microprocessor controlled device, such as computer.*” It is also referred to as “*Automatic Identification*” or “*Auto-ID*”.

There are different families of technologies which are capable of immediately identifying physical objects with 100% accuracy using one of the characteristics of the objects, like, visual, magnetic, electronic, sound or radio waves etc. The data is stored into the objects using some media and is later detected using one of the techniques to identify the object in question. This data is stored into the computer system as input and is further processed as and when required. AIDC technologies allow data to be passed in real time to the computer system. This helps making informed decisions in a very short time. *Bar codes, RFID, Biometrics, Magnetic Strips, OCR, Smart Cards and Voice Recognition* etc. are the major technologies that are considered as part of AIDC.

All these technologies are not equally relevant in all the fields. Their application varies from area to area. Bar Codes, RFID, Smart Cards and Magnetic Strips etc. are more used in industry and business applications. Biometrics and Voice Recognition have their own more specific application in the collection of scientific data, especially for security purposes.

The advantage of using AIDC techniques is *more efficient run organization; timelier decision-making; efficient use of time, people and material and so on.* The biggest use of AIDC technology is for staff members who are directly involved in the data entry job. These use a combination of some input hardware and software to input data

into the system generally for real time processing. Being automatic, they are very fast and accurate.

Now, let us understand these technologies briefly one by one:

2.1. Bar Codes:

All of us are familiar with Bar Codes. We can see them on almost every packed item. These are printed in the form of images consisting of collection of bars of varying thickness and with gaps of varying length. The bar codes can be broadly divided into three main categories, namely, *linear barcodes*, *stacked barcodes* & *2D barcodes*. These are further sub-divided into more than 300 sub-categories depending on the specifications they are following. The most commonly found are UPC and EAN. The other major types are Codabar, 3D Bar Code (bumpy bar code), Codablock, Code 39, Data Matrix, Planetcode, PDF 417, Telepen, Vericode and Postnet (United States Postal Service Code) etc. A typical bar code looks something like one of these,

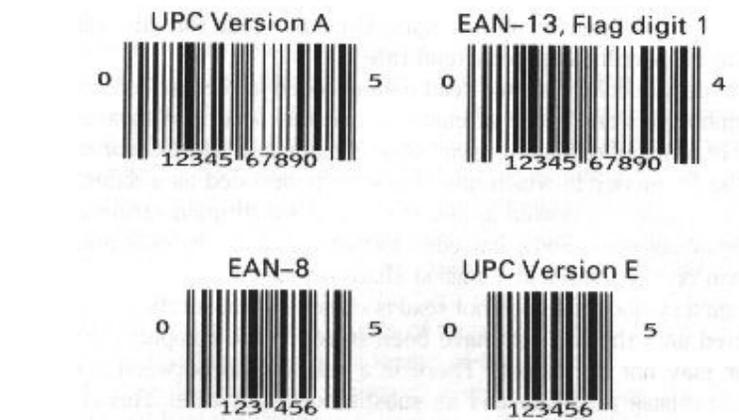


Fig 1. Bar Code levels

Two graduate students Bernard Silver and Norman Joseph Woodland at Dresel Institute of Technology developed the bar codes in 1948. However, the technology can be applied commercially only after 1966 and was a success in 1980s. Originally, bar codes consisted of vertical parallel bars only. But now they come in the pattern of dots and concentric circles embedded in images.

The bar codes are said to be based on *line-of-sight technology*. They are read using optical scanner or bar code reader. The reader reads the bar codes either by scanning a point of light across the symbol and measuring the length of reflections (white gaps) and no reflections (black bars) or capturing the video image of the symbol. The *length*, *reflection* and *no reflection* of symbols is analyzed by the computer software and based on the data captured the information is entered into the computer.

2.2. RFID:

Radio Frequency Identification is an automatic identification technique, which can retrieve remotely the prestored data and pass it on to the computer system. Chip based RFID tags use *silicon chip* and *antennae* and can be attached to the object (product, person and animal etc.). The chip and antenna together are called *RFID transponder* or an *RFID tag*. The antenna enables the chip to pass the information to the reader. These tags are helpful in detecting the object using radio waves. A typical RFID tag looks like this,

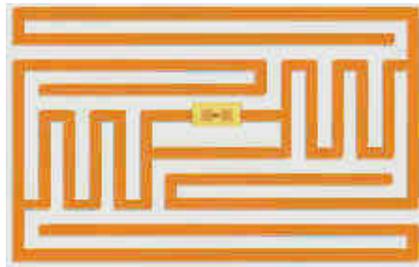


Fig 2. RFID tag

The *origin* of RFID is very controversial and is attributed to different inventions as far back as 1920s. According to one view it has its origin from an *espionage tool* invented by Leon Theremin in 1946 for Soviet Government. Though it was an passive '*covert listening device*', not an identification tag, it is still considered as an predecessor of RFID technology.

Another technology which claims similar credit called *IFF transponder* was invented by the British in 1939 and was used by allies in WW-II to identify war planes. A major landmark in the development of RFID technology was a paper published in 1948 by Harry Stockman,

entitled '*Communication by Means of Reflected Power*', which attracted attention of many eminent researchers.

Marie Cardullo's U.S. Patent 3,713,148 in 1973 was the first true ancestor of modern RFID. However, the first patent associated with the acronym RFID was granted to Charles Walton in 1983 (U.S. Patent 4,384,288).

There are two *types* of RFID tags, namely, *passive tags* and *active tags*.

Passive tags contain no inbuilt power source and are dependent on the power supplied by the minute electrical current induced in the antenna by the incoming radio frequency signal. So, the antenna has to first collect power from the signal and then reflect back the outbound signal. As they have no source of power, they are very small in size and can be in the form of a sticker also.

Active Tags contain an inbuilt power source. This source is capable of powering the Integrated Circuit which then reflects back the signal. They reflect higher power levels and are more reliable as they have their own power source.

RFID, though, very useful is not without controversy. It is not as fool proof as it was considered initially. It is prone to virus infections also, endangering the entire system. There are religious, ethic and health controversies too.

In libraries, till recent times, mostly Bar Codes were used as data entry technique. But the trend is fast changing now. Bar Codes are being replaced by RFID and smart cards, because they need very little human intervention and are in a sense much more automatic. But the Bar Codes being cheap and easily available still hold the ground and are giving strong competition to the newly emerging technologies.

2.3. Biometrics (or biometry):

The term is the combination of two Greek words *bios* means 'life' and *metron* means 'measure'. It is a technique for uniquely recognizing humans based upon one or more intrinsic physical or behavioural traits. In computer biometric authentication is gaining popularity. New computer systems (PCs and Laptops) come equipped with softwares which can recognize and allow the authorised user only. Its main use is for authentication.



Fig 3. Biometrics

Biometric Authentication is a technology that measure and analyze human physical and behavioural characteristics for authentication purposes. The *behavioural* characteristics which are generally considered are like, signature, gait, typing pattern and voice pattern etc. Some writers also use the term '*behaviometrics*' for behaviour biometric. The *physical* characteristics which are considered for the purpose are fingerprints, eye retina and irises, facial patterns and hand measurements etc. The physical and behavioural characteristics are interdependent. All physical biometric characteristics have behavioural element and vice-versa.

The Biometrics has the capacity to completely replace the password authentication in near future, thus, solving many security based problems. But its use is more limited to security applications only and is not used for any data entry in true sense of the term.

2.4. OCR (Optical Character Recognition):

In simple terms it is the capacity of the computer to recognize and process text from paper and further translate the images into a format that it can manipulate i.e. ASCII codes. The text thus can be easily entered into the computer and edited using some word-processing software.

The OCR systems usually work through a combination of hardware and software. But there are many sophisticated softwares which can do the job single handedly. Further, there are more advanced softwares which can work with a variety of fonts types. But most of these has limitations when deciphering the handwritten text.

OCRs are particularly useful in organisations where there is large amount of documentary data like in libraries. It can help in creating a digital library by converting the existing documentary resources into digital format.

OCR *originated* with grant of patents first to G. Tauschek in 1929 in Germany and then followed by a US patent for the same to Handel in 1933. Tauschek was also granted US patent in 1935. In 1950 David Shepherd, a cryptologist in US Armed Forces Security Agency along with his friend Harvey Cook developed '*Gizmo*'. It was predecessor of the modern OCR systems and was reported in New York Times. Later Shepard went on to establish *Intelligent Machines Research Corporation* (IMR) which developed world's first several OCR systems. The first commercial system was installed at the Reader's Digest in 1955. OCR was used in USA by United States Postal Service in 1965 and later on it was introduced in Europe in Britain General Postal Department.

2.5. Magnetic Strips:

It is also known as '*magstripe*' and consists of a band of magnetic material on a strip shaped card. The card is thus capable of storing data by modifying the magnetism of tiny iron oxide particles. It may be read by using a magnetic card reader either through physical contact or just passing it before the reading head.

The magnetic strip card consists of magnetic material in the shape of a band, coated on a card made of some plastic like flexible material. Data can be stored on this card by exposing it to an magnetic field and altering the alignment of the tiny magnetic particles (called *polarization*), which get charged in a particular direction due to the magnetic field. The magnetic card reader reads the card by detecting the direction of the magnetic particles contained in the card from the '*wave form*' of the electrical pulse induced due to magnetism.

Magnetic strip cards are used in many diverse areas, like, financial cards, credit cards, licenses, identity cards, transportation tickets, contactless cards (RFID) and so on. There are a number of International Standards which define standards for physical characteristics of the cards, like, size, flexibility, magnetic characteristics and location of the magstripe etc. There are also standards for allocating card number ranges to different card issuing institutions. Magnetic strip cards look like this:



Fig 4. Magnetic Strip cards

2.6. MICR (Magnetic Ink Character Reader):

It is a combination of optical and *magnetic technologies*. It works on the same principal as the magnetic stripe cards. It uses a special ink containing magnetic particles of iron oxide and can be magnetized. In addition the characters are printed in a very distinctive style. Different standards exist for fonts to be used in MICR, like, E-13B, CMC-7 etc. When such documents are passed through a strong magnetic field, the ink coded characters become magnetized.

MICR technology was *first demonstrated* to American Bankers Association in July 1956. It spread all over the globe within a short span of time and was almost universally employed by 1963. It is much more safer than OCR as it uses a combination of both optic and magnetic technologies..

The characters in magnetic ink can be printed using laser printer that accepts MICR toner. It provides a secure and high speed technique of scanning and processing information. Such a system is mostly used by commercial banks for processing checks, drafts and pay orders etc. A typical MICR string looks like this:

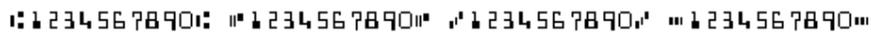


Fig 5. MICR character string

2.7. Smart Cards:

The smart cards look like any other pocket sized card. But it uses a different technology. It uses an *integrated circuit* (chip) to store data. Therefore, smart cards are also known as *chip cards* or *integrated circuit cards* (ICC). The smart cards look somewhat like this:



Fig 6. Smart Cards

There are two *types* of smart cards. The *Memory Cards* contain only non-volatile memory storage, and some specific security programme. *Microprocessor Cards* contain memory and microprocessor capabilities. It is a misconception among the people to consider all standard sized smart cards with some temper resistant and human readable features as having microprocessor capabilities. But it is not true. Some of them are limited to having memory only. Therefore, *all chip cards cannot be considered as smart cards*.

Based on the mode of transfer of data from card to the reader the smart cards can be divided into two types, *Contact smart cards* have a small gold chip about ½ inch in diameter on the front. This gold chip contains data and transfers it to and from the reader by making contact with the electrical connectors when the card is inserted into the machine. Contact smart cards follow standards like ISO/IEC 7816 and ISO/IEC 7810.

On the other hand in *Contactless Smart cards* the chip transfers information to and from the reader without any physical contact through RFID induction technology. They require only proximity to an antenna to complete transaction. They follow standards like ISO/IEC 14443 and ISO 15693 etc.

Smart cards are best suited where a lot of information needs to be contained within the card itself. They are often used when transactions must be processed quickly and hands free, such as mass transit system.

2.8. Speech Recognition:

Also known as '*automatic speech recognition*', '*computer speech recognition*', is a very exciting input system. The system accepts the human voices/speech so that it could form the input to the computer directly without the movement of keys, mouse etc. The spoken input is analyzed and features are extracted from it and matched with pre-stored patterns to identify the input. This technique is used to convert voice signals to appropriate words. The voice signals are input into the system through hardware devices like, a telephone, microphone, radio signals etc.

Voice recognition or *speaker recognition* are two terms which are often confused with speech recognition. But there is a great difference. *Voice/speaker recognition* tries to identify the person *who is speaking*. On the other hand *speech recognition* tries to identify the content of speech (*what is being said*).

Technically, speech recognition follows different approaches. Most commonly used model is *Hidden Markov model*. The others which have been in use in 1980s and 1990s are *dynamic programming approach*, *neural network based approach* and *knowledge based learning approach*.

These systems are not in wide use. Their main limitation is their limited vocabulary. The speaker has very little choice. Many such systems require extended training sessions during which the computer system becomes accustomed to a particular voice or accent. Such systems are said to be *speaker dependent*. Many systems require the speaker to speak slowly and distinctly and separate each word with a pause. Such systems are known as *discreet speech systems*. The latest ones are *continuous speech systems* that allow the user to speak naturally.

The speech recognition technology is used in medical transcription; pronunciation tutorials; automatic translation; command recognition in computers; dictation; hands free computing and so on.

3. AIDC in Digital Libraries:

In the context of the digital libraries the AIDC techniques are not equally relevant. Some have gained popularity in the libraries and some others have a very limited use, as part of the security system at the entrance.

3.1. Bar Codes:

Of the above mentioned techniques of automatic data entry the Bar Codes are the oldest and are used for the routine data entry. They are still in use in many libraries. In a developing country like India where there are many libraries which are still in their very initial stages of automation generally go for Bar Codes. They are used for storing bibliographic information related to the library resources. The reason for their popularity is that they are easily available and cheap.

3.2. RFID:

RFID technology is fast replacing the Bar Codes. These have reduced the human intervention in routine processing still further. The bar code labels from the books are being replaced by RFID tags. These have proved to be much more efficient as compared to the bar codes. They can be detected by the radio antenna automatically and so can detect the removal of the book from the shelves and can issue it to the user without any human operator. The tags can store bibliographic information about the resources and also the information about the library users in their *Identity Cards*. So RFIDs come integrated into the more sophisticated library softwares like, Virtua, developed by VTLS, USA and being implemented at JNU library. Their portable scanners do the tedious job of stock verification by just being passed slowly along the library shelves, without handling each item individually. But the greatest limitation of the RFID technology is that it is still very costly, each tag costing about Rs.28.

RFID and bar code use different technologies and have different applications which sometimes overlap. The big difference between the two is bar codes are line-of-sight technology. The bar code must face the scanner to be read. In contrast, radio frequency doesn't require line of sight. RFID tags can be read as long as they are within the range of a reader.

3.3. OCR:

OCR is the next very useful technology in digital libraries. It is being used to convert the existing resources in documentary form to digital form. The books, magazines and periodicals etc. are scanned using some optical reader and saved in digital format either in computer itself or onto some secondary storage device like floppy or CD. This saves

time that would have been wasted in typing the whole document. It also saves (as they are) different font formats and images etc.

3.4. Biometrics:

Biometrics technology in libraries mostly consists of *fingerprint identification* software and hardware. However some systems also use *eye scan*. These are mostly used to provide access to library resources including computers, internet, building, doors and material. It also helps to monitor self check system, employee time and attendance etc. All such systems using biometrics exist in western countries due to their high security needs and trend towards more and more of automation.

3.5. Magnetic Strips & MICRs:

These have very limited application in libraries. These techniques are mostly used in user *ID cards*. They help the security systems at the entrance to allow only the authorized users in and get the material issued to them.

3.6. Smart Cards:

Smart Cards are used along with RFID technology as user *ID cards* and perform the function of providing access to the authentic users and issuance of material. These are costly and are not much in use.

3.7. Speech Recognition:

In libraries the use of speech recognition technology, as it is, is very limited. It is very rarely used to convert data from textual to digital form.

4. Conclusion:

All the above mentioned technologies are part of AIDC. All these are automatic to varying extent and need little or no human intervention. They can enter data into the computer system directly at a very high speed and with great accuracy. They all have their own applications which may sometime overlap with each other. It is not easy to say which technology will be replaced by some new one. In this computer age newer and newer technologies are emerging promising much more sophisticated applications.

The modern libraries are modifying themselves at a very fast speed. They are adopting the latest technologies almost instantly. They have come a long way from traditional documentary libraries through automated and digital libraries to the latest *virtual libraries*. In this changing scenario nobody can predict the form of data entry techniques. The trend is that the new documents are either born digital or have an electronic version along with traditional digital one. All such digital documents are available over the internet. The librarians need no effort to create a database of such material. So, *internet* is said to be world's biggest *digital library* or *virtual library*. The only problem in this emerging scenario is the arrangement of material over the internet. The amount of information is growing with each passing moment and searching relevant documents is becoming a major problem.