Introduction
Technology and Computers have made inroads into all aspects of day-to-day life due to their ability to automate various repetitive and monotonous tasks and thus provide people with time to pursue other useful and interesting avenues. The main use of automation is to minimize human intervention and thus speed up the tasks and reduce the errors associated with manual work. Automatic Identification and Data Capture (AIDC in short) refers to various technologies used to automatically identify and collect data related to objects and enter them into computer systems with minimized human intervention. AIDC technologies such Barcode and Quick Response code (QR Code in short) are fairly ubiquitous these days with their use in fast moving consumer goods (FMCG), other retail products and books. Anybody who has seen the usage of a Barcode reader at the point of sale counter in a department store or a shopping mall has seen AIDC in action.

Telephones have come a long way from being mere devices of communication. The Smartphones, Tablets and other mobile devices of today have bundled up the functionalities of various devices like mobile phone, personal digital assistant, watches, camera, handheld computer and a host of other technologies into one. The popularity of the AIDC technology called QR code is mainly due to the proliferation of Smartphones and other mobile devices and their ability to function as QR code reader when loaded with the respective software.

This aim of this article is to introduce various AIDC technologies like Barcode, QR code, Radio-Frequency Identification (RFID) and Near Field Communication (NFC). Of course, the main subject of interest of this article is QR code.

One notable use of QR code is in the Indian Government’s Unique Identification Number project called Aadhar. The Aadhar card has the linear Barcode as well as the two dimensional QR code. This is discussed in further detail in the respective sections related to Barcode and QR code.

Barcode
Barcode is a standard linear/one-dimensional (1D) graphical representation of encoded data (usually numeric) in the form of parallel lines of various width and spacing. These Barcodes are machine-readable using optical scanners like Barcode readers. The Barcode readers can scan and interpret the Barcode and turn it into the data which the Barcode represents and provide this input to a computer to which it is connected. Figure 1 shows the Barcode printed on packages of some retail products. In the retail scenario, the Barcode is used to represent a unique identifier (usually a number) corresponding to the product. This unique identifier is printed on the product in the form of a Barcode. All packs of the same brand, type and size share the same unique identifier and Barcode. An example of two packs of same size and brand sharing the same Barcode can be seen in Fig. 1. At the sales counter in the retail store, the sales personnel scan the Barcode on the product using the Barcode reader. The Barcode reader inputs the unique identifier to the computer. The computer fetches the respective details like the product name, price and discount (if any) from the product database using the unique identifier as the key and inputs the same into the bill. This automatic identification and data capture eliminates any manual entry errors by the sales personnel and is quite faster too.

Coming to the history of Barcode, it was invented by Norman J Woodland & Silver Bernard. Patent No “US 2612994 A” with the title “Classifying apparatus and method” was issued to the inventors on 07-Oct-1952. The patent consisted of Barcode label in the form of series of concentric labels akin to bull’s eye and the technology to scan and interpret the same. The first commercial use of the Barcode label and Barcode Reader was on 26-Jun-1974 in a Marsh Supermarket in Troy, Ohio, USA and was used to scan a packet of Wrigley’s Juicy Fruit Chewing Gum.

There are many types of Barcodes in use. The most popular Barcode symbology in use are the Universal Product Code (UPC) and the European Article Number now renamed as the International Article Number (EAN-13). The most common form of UPC in use is the UPC-A consisting of 12 digits. The EAN-13 is a superset of the UPC and consists of 13 digits. These barcode standards are defined and provided by a not-for-profit organization called GS1. The enormity of the usage of Barcodes can be gauged from the GS1 statistics that at least 5 billion Barcodes are scanned all over the world per day. The consumer goods in India commonly use the 13-digit GS1 Barcode which is the same as the EAN-13. The product number encoded in the EAN-13 is known as the Global Trade Item Number or GTIN in short. The examples of the same can be seen in Fig 1. The 13-digits consist of the GS1 organization prefix (first three digits), manufacturer’s prefix, product code, Check digit. The first three digits represent the GS1 organization with which the company is registered. As can be seen in Fig 1, the Indian consumer products start with 890 since it is the allocated prefix code of GS1 India to which the India manufactures subscribe to.

Another special type of Barcode which we usually come across is related...
to the International Standard Book Number (ISBN in short). It is a numeric identifier used to identify books. ISBNs now have 13 digits and are represented using EAN-13 Barcode. The 13 digits consist of the prefix element, registration group element, registrant element, publication element and check digit. The prefix element made available by GS1 for published books are 978 and 979. 978 and 979 are humorously referred to a fictitious country named Bookland. ISBNs therefore start with either 978 or 979. The registrant group element identifies the language area, country or geographical region. The prefix element for India is 978 and the registrant group element for India is “Raja Rammohun Roy National Agency for ISBN” with the numbers as 81 and 93, so ISBNs of all book publications from India would start with either 97881 or 97893. Registrant element represents the publisher and Publication element signifies the specific edition of a publication.

Another area where the Barcode is used is for identifying and tracking articles shipped via speed post and courier. India Post adopted Barcode symbology named Code 39 for its speed posts and parcels. Code 39 consists of 43 characters containing upper case letters, numeric digits and some special characters.

Another well know use of Barcode is in the Aadhar card. The Aadhar card has the 12 digit Aadhar number encoded in the linear Barcode format.

Quick Response Code (QR Code)
Quick Response code (QR code) is a type of two dimensional matrix Barcode. It is usually in the form of a square with black square dots with three big boxes at the three corners. QR code stores information both along the length and width and hence is able to store more information than Barcode which stores information in only one direction. QR code has risen to prominence due to the ability of the Smartphones and other mobile devices to act as QR code scanners. For usual use by general public for scanning QR codes of lesser density (generally used in various public relations campaigns and advertisements), any smartphone or mobile device (like Tablet) with a camera, QR code reader software and with the ability to connect to internet, is sufficient. Dedicated professional scanners on the lines of Barcode readers are anyhow required and available for commercial use for scanning of denser QR codes which store more information.

QR code was invented by a Japanese company named DENSO WAVE in 1994. DENSO WAVE is a company specializing in Automatic Data Captures, Industrial robots and Industrial Controllers. At DENSO WAVE, it was invented by Masahiro Hara and his team member Takayuki Nagaya. It was developed in response to the limitation of the one dimensional Barcode to store limited amount of information and their inability to store Japanese Kanji and Kana characters. Hara and his team developed a 2D code to store a great deal of information to overcome this limitation. In terms of numeric characters, QR code can pack up to 7000 characters in it.

Fast readability is another defining feature of QR code. The three boxes at the corners of the QR codes act as landing sites and aid the scanners to focus on the code better and faster and thus allow them to read the QR code quicker. The three boxes are the position detection patterns which allow the QR code to be read from any alignment.

Another reason for popularity of QR code is that there is no license cost associated with the usage of QR code. DENSO WAVE which is the owner of the patent rights of QR code chose not to exercise it so that QR code can be used by as many people as possible. This was to honor the intent of the inventors of QR code. It first became widespread in use in Japan (in 2002) with the General public when mobile phones with QR Code-reading feature became available.

Another notable aspect of QR code is that it is likely to be scanned and decoded even when a portion of the QR code is slightly damaged, disfigured or marked. This is possible due to the high levels of error correction possible using the Reed-Solomon error correction algorithm.

Due to the amount of information that QR code can store, many innovative and interesting applications of QR code have been developed by the marketing people. It has not just been restricted for usage as a machine readable identifier of objects like the Barcode. The very commonly seen use of QR code is to embed Uniform Resource Locators (URL) in it. When the respective QR code is scanned using a smartphone, it automatically directs to the respective web page. The Fig 2 shows sample QR codes generated for Computer Society of India and Vignan’s Institute of Information Technology. It also shows usage of QR code for a commercial product. The URLs corresponding to the websites of the mentioned organizations have been embedded in the QR codes. When these QR codes are scanned using a smartphone with QR code reader software, it directs to http://www.csi-india.org/ and http://www.vignanuit.com/ respectively. The QR code thus automatically connects the user to the information without the need to manually input the details. These two sample QR codes have been generated using the QR code generator available freely online at http://www.qrstuff.com/ since the usage of QR code is license free. A casual Google search for QR code generator retrieves a list of such sites.

Some other uses, to which QR codes are put to, is to encode information for creating contact information, creating calendar events, creating an e-mail message or populate a SMS on Smartphones.

QR code has also found use in the Aadhar card. The QR code is used to store the citizen related demographic information like name, address, date of birth, gender and name of parent or guardian.

The Smartphone or Tablets can be enabled to work as QR code readers by...
RFID is the AIDC technology which makes use of radio waves. The system consists of RFID tags and readers. The RFID tags are microchips with antennas that store and transmit data. They are used to store the identifiers and data related to the product or object that they are tagged to. The electronic readers can receive the data from the tag readers and transmit the same to computers for further processing. Some of the advantages of RFID are that there is no line of sight required between the tag and the reader and the tag can be read from greater distances since the data is transmitted by radio waves. The reader can read multiple tags at one go and at a faster pace when compared to Barcodes. RFID can store significantly larger amount of data when compared to 1D or 2D Barcodes. One of the reasons why RFID is not as much visible in daily use as Barcodes is the cost. RFID tags and readers are costlier when compared to Barcodes and Barcode readers.

**Near Field Communication (NFC)**

NFC is the latest among the various AIDC technologies mentioned in this article. It is an AIDC technology based on wireless radio communication on similar lines as RFID. The difference is that NFC may not need specialized readers and Smartphones can be NFC enabled. NFC enabled Smartphones can read the information stored in NFC tags when touched or brought in close proximity. NFC tags are designed similar to RFID tags with chip, memory and antenna. NFC tags are passive and have no power of their own. When a NFC enabled device is touched or brought in proximity to a NFC tag, they draw power from the device and use this power to transmit data to the device.

**Conclusion**

Barcode and QR code use optical recognition to read data encoded in 1D and 2D format respectively. RFID and NFC use the wireless radio communication technology to transmit data from the tag to the reader. Barcode is oldest of the AIDC technologies discussed in this article but is still popular due to its ease of use and lower cost. It is expected that wireless AIDC technologies would grow further in popularity in future with lowering costs and due to their ability to carry more data and transmit them at a quicker pace. AIDC also finds application in the ‘Internet of Things’ which is the technology of future.

**References**


