Introduction to Bar Code Reading Technology

Introduction

Most people are familiar with bar codes. These are the bands of stripe lines which can be found on many grocery items and are used by scanning devices to identify them. Within these lines characters and numbers can be encoded . Devices which are used to de-code these bar codes are collectively referred to as Bar Code Readers (BCR) or Bar Code Scanners.

There is a number of methods and technologies which can be used to read bar codes. It is the purpose of this technical note to briefly detail these main technologies.

Elements of Bar Code Readers

The main elements associated with bar code readers are:

- Bar Code Labels

- Illumination

- Focusing system

- Sensor

- Decoder

- Interface

Bar Code Labels

Bar codes contain information encoded in the physical widths of bars and spaces. This is usually in the form of a series of dark and light spaces which are printed on a media, such as paper, in a form of a label. It is the relationship between these dark and light spaces which data is encoded. As there are several means by which this data can be decoded (ie. read), there are also several ways in which this information can be en-coded (ie. printed). The encoding methodology is referred to as the bar code symbology. (refer to UMD Technical Note 104, *Introduction to Bar Code Symbologies* for further details)

The list below outlines some bar code symbologies used today.

- Standard code 39 (Code 39)

- Extended code 39

- Interleaved 2 of 5 (ITF)

- UPC/EAN/JAN

- Codabar

- Code 128

- Code 11

- MSI Code

Each symbology has various features and applications. For example, UPC/EAN/JAN symbology is almost used exclusively for bar coding of food and consumer items.

Illumination

To ensure bar code can be "seen" by the device being read, some sort of light illumination scheme is used. This light is used to illuminate the bar code so its reflection can be "collected" by the BCR. To improve the sensitivity of the reading device particular wavelengths (or colour) of light are used to illuminate the bar code which matches the wavelength or the receiving sensor.

Focusing System

The reflected light from the bar code is collected by the focusing system, which generally can consist of mirrors and lenses. The focusing system converges the light onto the BCR sensor.

Sensor

The sensor is a transducer which converts the light pulses from the focusing system into electrical signals.

Decoder

These electrical signals are then processed by the docoder to decipher the bar code and convert it into data. The decoder typically consist of a microprocessor element performing a complicated decoding algorithm or program.

Interface

The interface consists a physical link between the decoder and the attached device and protocol.

The physical link define the means by which systems are interconnected and the protocol refers to the language used to pass information between the systems. Such standards are important to enable independent systems to be interconnected. Their are also propriety type interfaces which use either non standard interfaces and protocols.

Again there are several standard types of interfaces. The most common of these would be serial, parallel and keyboard wedge using ASCII and keyboard scan codes as the protocol. Details of these interfaces are beyond the scope of this application note.

Bar Code Reading Systems

The most common type of bar code reading systems are:

- Pen or Wand type systems

- CCD type systems

- Laser type systems

This is also typical of the level of sophistication and cost of the various system (ascending order)

Bar Code Pen Readers

These systems comprise of a pen shape input device which houses the illumination system and sensor only. This is attached to a separate module which houses the deocoder and interface unit. Due to electronic miniaturisation, some pen based bar code systems can hold all the bar code reading elements in the pen housing.

Usually a solid state light emitting diode (LED) is used to illumination the bar code and a solid state photo detector type the sensor. Pens usually have a tip (typically made of sapphire to reduce wear) which act to keep the pen tip at a fixed distance from the bar code. This is important as the sensor have a very short focus and small depth of field.

The output from the pen device is referred to as the Bar Image, because the signal is a direct reflection of the bar code light and dark bands.

As the docoding algorithm uses ratio between dark and light bands, amongst other things, to decode the bar code, it is important the pen swipes the bar code in a consistent uniform motion.

An important consideration in selecting pen type bar code readers it the density of the bar code and how the bar code has been printed. These parameters effect the bandwidth or resolution and type of light source used by the pen. Thus pens are available in a variety of resolutions (typically classed as high, medium and low resolutions) and light sources (typically visible and infa-red light sources)

Bar Code CCD Readers

Bar coded CCD readers use Charge Coupled Devices (CCD) as the sensor. These sensor are solid state devices which take are used to take a digital picture of the bar code.

The CCD technology is identical in technology to that used in CAM/CORD portable video recorders. Except that the cam/cord video camera take a digital picture in a square element (eg. 512 x 512 pixels) while the CCD based bar code reader analogously takes a picture in a line. (It is actually a line scan camera).

Thus a "snapshot" of the bar code is taken, which can be converted to a bar image signal suitable for processing by the docoder.

Again solid state light emitting diodes (LED) are used to illuminate the bar code and a very simple lens is used to focus the image directly onto the CCD sensor.

CCD bar code readers are also commonly referred to as "touch" scanner as the head of the bar code reader is placed over the bar code, in touch with it.

An important consideration for CCD scanner is the width of the window. The bar code being read needs to be within the size of this window. Thus CCD bar code scanners come in different window or aperture sizes (eg. 40, 60, 80 and 100 mm apertures).

Typically these systems are available with all bar code elements (sensor, decode and interface) integrated in a compact, light weight hand held unit.

Bar Code Laser Readers

Bar code laser readers are available in either fixed mount or hand held versions. Bother version use the same principles.

They use a laser beam illumination system. Typically a Ag laser tube, for fixed mount systems, or solid state visible laser diodes (VLD) for hand held systems are used. This visible laser beam is projected by either a prism or mirror arrangement onto the bar code. Furthermore the laser beam is manipulated to sweep in a fixed pattern across the surface of a defined area, in which the bar code will cross, at very high speed. Due to humans visual persistence of vision, this scan pattern will appear as a line of light across the bar code (or any other reflecting object).

The reflected laser beam, from the bar code, is focussed onto a sensor via a prism system. Again the reflection will be in a bar image signal suitable for processing by the docoder. The laser beam needs to scan across the full length of the bar code to work successfully.

Hand Held Laser Scanners.

Hand held laser scanners will generate a scan pattern consisting of a single line. This line is visible to enable the operator to position this beam across the bar code.

Fixed Mount Laser Scanners.

In these systems the units are typically mounted into a bench top with the object, with the bar code, passed over the unit. To ensure that the laser scan reads the bar code more than one scan line is generated (eg from 12 to 32 scan lines). Thus if a bar code is scanned across the unit, it will be more likely that one of these scan lines will cross the bar code, regardless of its orientation. Thus various methods and patterns are used to try and maximise the "scannablity" of bar codes in a variety of environments.

In selecting laser type scanners consideration should be given to the type of laser technology used, the scan pattern and scan volume generated, the distance the unit will operate over.