Process control laboratory - bar code system

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Abstract

This paper presents the basic concepts of a bar code system using a PC-based architecture. This system was developed and implemented in the Industrial Engineering Process Control Laboratory. The main objective of this system is to familiarize the students with the basic concepts of this technology. The system consists of a 486 computer with a Starnode PC Interface Board. The terminals are a scanstar 221 that has a light pen and a laser gun connected. The computer also has attached a Zebra 60 printer and an interface box that is connected to a fixed scanner, the scanstar 40. All this equipment is from Comp Identics.

Sinopsis

Laboratorio de control de procesos - Sistema de códigos de barras

Este artículo presenta los conceptos básicos de un sistema de códigos de barras usando una computadora personal. Este sistema se desarrolló y se implantó en el Laboratorio de Control de Procesos de Ingeniería Industrial. El propósito del sistema es familiarizar a los estudiantes con los conceptos básicos de esta tecnología. El sistema consiste de una computadora 486 y una tarjeta de interfaces Starnode. Como terminal usamos un Scanstar 221 con una pistola láser conectada. A la computadora se conecta una impresora Zebra 60 y una caja de interfaces que se conecta a un rastreador de imágenes fijo, Scanstar 40.

Introduction

Bar codes are information that has been encoded in a bar and space format. By varying the pattern of the bars and using different bar widths,

numbers, letters, and even punctuation marks can be represented. In comparison with other means of data entry, such as keyboard input, bar codes are preferred because:

- Bar codes can be scanned and decoded with a high degree of accuracy.
- Bar code labels can be easily attached to most objects.
- Bar codes can be quickly and inexpensively printed using ordinary printing processes (laser printing, dot matrix, etc.)

Bar code symbologies

There are many different bar code symbologies, all of which are formatted in a similar manner. The scanstar 221 and scanstar 40 can read these symbols and the Zebra 60 printer can generate most of them. To recognize the symbology the scanners must be adequately set up. Actually, both are set up to Code 128. Most of the symbologies fall into one of two groups. The first group represents data using only two widths for bars and spaces. Symbologies of this type include the following:

- Codabar

Codabar is the earliest symbology still in widespread use today, dating back to 1972. Codabar is a variable-length symbology capable of encoding 16 different characters within any length message. Codabar can represent the digits 0 through 9, as well as six special nonalpha characters.

- Interleaved 2-of-5/Straight 2-of-5 code

Interleaved 2-of-5 code is another symbology developed early in the history of the commercial bar use. It dates back to 1972 and was developed by Computer Identics. An earlier symbology called Straight 2-of-5 expressed numeric information by using two wide black bars out of

a cluster of five total black bars per character. The white separator bars in this symbology were all narrow. Interleave 2-of-5 used the same coding scheme but allowed the white separator bars to vary in width as well. Two wide spaces out of five total spaces encode a second character, interleaved within the character code in black.Figure 1 shows the number 16, represented in Straight 2-of-5 code.

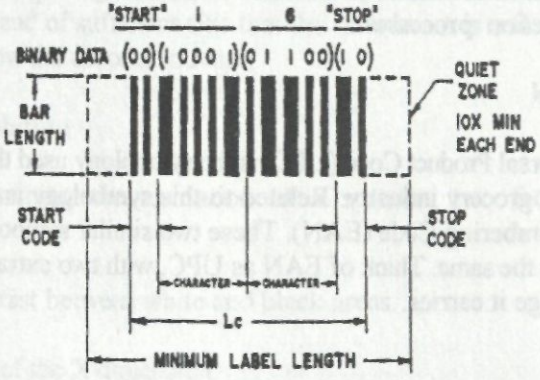

Figure 1. Number 16, in Straight 2-of-5 code.

In these codes, wide bars and spaces represent binary ones, and narrow bars and spaces represent binary zeros. In the second group, up to four widths are used to represent information. Symbologies of this type include:

Code 128

This symbology was introduced in 1981. This symbology has a number of features that set it apart for the older symbologies, making Code 128 the preferred code for most new bar code applications. These special features include the following:

1. Encodes all 128 ASCII characters without cumbersome procedures.

2. Uses the least amount of label space for messages of six or more characters.

3. Is the most easily read code with the highest message integrity, because of several separate message check routines.

4. Contains function codes that can increase the power of complex data collection processes.

UPC/EAN

The Universal Product Code (UPC) is the symbology used throughout the American grocery industry. Related to this symbology is the European Article Numbering Code (EAN). These two similar symbologies will do essentially the same. Think of EAN as UPC, with two extra characters in the message it carries.

X-Dimension

One of the most important characteristics of a bar code is the width of its narrowest element, the "X-dimension" (fig. 2). The X-dimension is the common factor between the printed symbol and the optical performance of the scanner. The width of all other bars and spaces in the code are multiples of the narrowest bar. Likewise, all the widths of the spaces are multiples of the narrowest space.

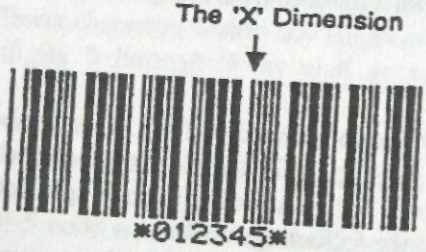

Figure 2. Location of the X-dimension

Quiet zones

Blank (white) areas, typically 10 times the X-dimension, are found at each end of the bar code. For example, if the X dimension is 13 mils, the quiet zones at each end of the label should be 130 mils long. The quiet zone allows the decoder in the scanners microprocessor to initialize and reset properly. As figure 1 shows, quiet zones must not contain printed material; they must be blank, white, and of sufficient size that the laser beam is reflected back long enough to allow the decoder to reset.

Scanner resolution

In determining the resolution of a scanner, two factors must be considered:

- The contrast between white and black areas.

- The size of the X dimension.

To ensure good color contrast, bar codes must be printed at the highest black/white density available. If the bar code is flawed (i.e., the code is light, or the ink has splattered so that white voids are not distinct, or black printed bars run together), it is difficult to read.

Also, bar codes should be printed so that the length of the bars is greater than the width of the bar code. Other points to consider in bar coding are the following:

- Verify that labels are printed to specification.

- Avoid placing tape over the bar code label or any part of the quiet zones.

- Avoid placing the bar code label beneath a layer of shrinkwrap. If this can not be avoided, ensure that the shrinkwrap is stretched as tight as possible (no wrinkles, especially over the bar code label). Wrinkles can refract the

laser beam and cause bad reads. If shrinkwrap is unavoidable, position the scanner at 15 degrees from the vertical so that light reflection from the shrinkwrap does not confuse the optical receiver lens.

Avoid placing bar code labels near the edges or corners of a carton box. If the carton is damaged, the bar code can be folded or otherwise damaged so that it can not be read. In general, place the label on a broad, smooth, flat surface of the carton box.

The X-dimension of the bar code is critical to determining the appropriate scanner resolution. The scanner' s resolution is set for an X-dimension of the code, the narrow bars and spaces will appear as "grey".

Bar code labels should be large enough to ensure that the scanner can reliably read the bar code symbology. The following variables can also affect the accuracy of a scanner:

- The speed of the conveyor (For the fixed scanner scanstar 40, in case you are using a conveyor)
- The laser scan rate
- The tilt of the bar code label
- The location of the conveyor in relation to the scanner.

Positioning the scanner

The presentation of bar code labels (that is, the orientation of the label in relation to the scanner) can be an important factor in achieving fast accurate reads. In the laboratory the students will have the opportunity to determine which is the best position of the scanstar 40.

Two terms that should be discussed are tilt and skewness. The tilt of the bar code is its placement with regard to the X (horizontal) axis. The skewness

of the code is its placement with regard to the Y (vertical axis). Of these two factors, tilt is more important to the success of bar code readability. Several other terms should also be discussed (fig. 3)

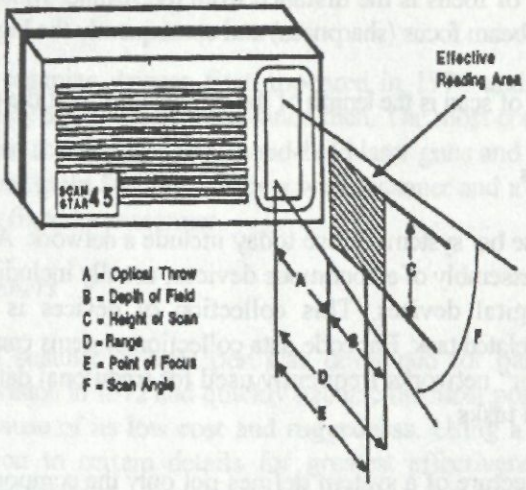

Figure 3. Illustration of terms associated with scanning

- The depth-of-field is the difference between the minimum distance and the maximum distance at which the bar code can be read. Generally, the depth-of-field is equal to about 50% of the range for a bar code of a given X-dimension

- The optical throw is the distance from the front of the scanner to the beginning of the depth-of-field. That is, it is the distance from the scanner to the beginning of the point where a label can be accurately read and decoded.

- The range is the maximum distance away from the scanner that the bar

code can be read. Thus, the range is the combined distance of the optical throw and the depth of field. Usually the range of the scanner is equivalent to 1000 times the X-dimension of the bar code.

- The point of focus is the distance from the scanner which provides the maximum beam focus (sharpness) and consequently the highest read rate.

- The height of scan is the length of the scanned beam at the point of focus.

Data networks

Many of the bar systems in use today include a network. A network is an interconnected assembly of autonomous devices, usually including a computer and related digital devices. This collection of devices is assembled to contribute to a related task. Bar code data collection systems can be assembled around "popular" networks frequently used for traditional data collection or communication tasks.

The architecture of a system defines not only the components used, but how these components are configured. There are three system paths to consider in the design stage of a data collection: PC-based architectures, mainframe-based architectures and hybrid architectures. In addition, there is a variation of hybrid architecture to consider called redundant architecture. The network of the Process Control Laboratory uses a PC-based architecture.

The 486 computer has a standard interface board. This board allows the communication between the terminal (scanstar 221) and the computer. Messages can be sent and data can be received. The data collected can be seen on the screen and stored in an ASCII file for later verification or reference. This network includes a Zebra 60 printer, which is a direct thermal printer.

To create a thermal-printed label, heat sensitive label stock passes across the face of a print head the same width as the paper. The print head is called a linear thermal array, and it can momentarily heat any position along its length under digital or computer control. As the timed passage of the label

progresses, tiny dark dots are created under the heated array elements, and these dots combine to produce a bar code, as well as human readable text and graphic label enhancements. This printer has its own language to produce the bar codes . This language (ZPL) can be combined with Basic.

Scanner types

Bar code scanning devices first appeared in 1970 and have steadily advanced in variety and sophistication since then. The most common scanner types are the wand scanner(light pen), hand-held laser guns and the fixed laser scanners. Attached to the Scanstar 221 is a wand scanner and a laser gun. The scanstar 40 is a fixed laser scanner

Wand scanners

The wand scanner or light pen was developed for bar code use by Identicon Corporation in 1972 and quickly became the most popular scanning instrument because of its low cost and ruggedness. Using a wand scanner requires attention to certain details for greatest effectiveness. As in all applications, there should be great emphasis on the printing excellence of the bar code message presentation. First of all, the bar code should be printed to the tolerances for the symbology chosen, and the wand user must be trained to scan a label properly. Proper scanning technique involves starting with the pen tip lightly touching the label, well to one side of the symbol, and moving across all the bars to a position well to the other side of the bar code in one continuous motion. The wand angle is important, too, as the wand should be held at an angle of about 60 degrees above the label surface. This is about the angle one would use to write with a pen. Because the wand tends to flood the bar code with light and collect the image with a lens to create the spot effect, too horizontal an angle will let light scanner into space, and too vertical an angle will bounce more light back to the wand's detector than it is calibrated to handle.

Hand-held laser guns

When contact with the bar code label is awkward or if the nature of the application makes contact impossible, the hand held laser gun is an alternative scanning device to consider. The general design of a laser gun incorporates a HeNe laser tube or a solid state laser diode creating a scan line by projecting a beam of energy off a rotating prism or oscillating mirror. The scan beam then exits through a scanner window to trace across the bar code symbol. While a device of this sophistication is about six times most costly than a wand scanner, it is useful and worth the premium under certain circumstances. Scanning a bar code on a curved or irregular surface or thought multiple layers of stretch wrapping requires a noncontact device such as a laser gun.

Data storage

The purpose of any data collection system is to store data for future reference. In most of the bar code systems the transactions are collected in an ASCII file. The ASCII file can be converted to most of the commercial packages like Microsoft Word, WordPerfect, Lotus 123, Excel and Statgraphics. Many high level languages, like Basic and Fortran, can read the ASCII files.

Conclusions

This system will allow the students to practice with a bar code system that has the basic elements. These elements are the computer, terminals, scanners and printer. All those components in a network environment transmit, receive and store information. In addition, students become related with the most common symbology, bar code characteristics and scanner requirements.