Development of Bar Codes for All Products in Commercial Control System

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***Abstract*—**The proposed system is to develop barcodes for all products in commercial control system. In the business process, procedures are automated to increase productivity and reduce human error by using barcodes. Barcoding is a method of encoding information into a machine-readable pattern of predefined bar and space patterns that can be quickly and accurately read by a scanner and a computer. Part numbers, purchase order numbers, lot numbers, or any other information can be encoded into a barcode. Instead of manually typing a customer identification number into a database, if the information is contained in a barcode, a data entry operator may scan in it. In this paper, there are three logical steps for barcoding: (i) creating barcodes, (ii) labeling and (iii) reporting. The proposed system will present for three barcode types: code 39, code 128 and code 11. C# programming is used to develop the Graphical User Interfaces (GUIs). Microsoft SQL Server is used for storage products database for the purpose of reporting.

***Keywords*—** Barcoding, Barcode Symbology, commercial control system, Check Sum.

I. Introduction

Barcoding is a series of parallel vertical lines (bars and space), that can be read by barcode scanners. It is used worldwide as part of product packages, as price tags, carton labels, on invoices even in credit card bills and when it is read by scanners, a wealth of data is made available at the users and when use with GS1.UCC (Global India one Numbering Uniform Code Council Inc. USA) numbering system. The barcode become unique and universal and can be recognized anywhere in the world. Barcoding is an international concept today. It facilitates unique product identification through using international symbologies/numbering system, promotes brand image and would enable timely and accurate capture of product information. This would result in wide ranging benefits including lowering of inventory costs, lower overall supply chain costs and hence reduced costs for Indian products, increasing efficiency of Indian industry and adherence to stringent quality assurance norms through product traceability [1].

For Micro and Small manufacturing enterprise which have resource constraints but need to compete for global and domestic business opportunities with larger adoption of IT tools to enhance their efficiency and productivity, market accessibility and cost effectiveness is imperative business today. Barcodes are essential for all products in supermarkets.

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II. Related Work

Barcoding has been in use extensively for the past 25 years worldwide and is now finding increase usage as well across industry sector [1]. As far back as the 1960s, barcodes were used in industrial work environments. In the early 1970s, common barcodes started appearing on grocery shelves. To automate the process of identifying grocery items, barcodes were placed on products. The research area focuses only for the products being sold in a supermarket.

Shoprite Checkers was one of the pioneers in the use of barcoding in the South African retail industry. As this method of item identification and tracking has become more and more pervasive over time, the reliance on it for improving not only logistics but also our customers' overall shopping experience has escalated. This has resulted in escalating costs to the Shoprite Checkers Group, degradation in the quality of our customers' shopping experience, and a stumbling block in the path of increased usage of bar codes in automation of the logistics systems throughout the supply chain. There will be no exceptions or any relaxation of standards unless agreed to in writing by Shoprite Checkers Bar Code Quality management.

This paper presents the implementation of barcode generation software for all products in commercial control system. We use only one dimensional bar code types commonly used for commercial products. This system can generate three bar code types: Code 39, Code 11, and Code 128 and label the encoded character beneath the barcode images. Moreover, the system also facilitates reporting function. The report will display the created barcode image and its corresponding information originally stored in products database.

III. Barcoding Fundamentals

A. Barcode Types

Today, barcodes are just about everywhere and are used for identification in almost all types of business. There are two fundamental types of one-dimensional barcodes; width code and delta code [2]. In delta codes, we divide the available interval into modules and assign either 1's (where the modules are painted to form bars) or 0's (forming spaces). In width codes, we assign 1 to a narrow bar or space and 0 to a wide bar or space. We can have either just two different widths or number of different widths (usually a power of two). If we had four different widths we can assign two bits (e.g. 00, 01 etc) to each bar or space, encoding more information.

B. Importance of Barcoding

The following topics explain the importance things for barcoding.

1.) Barcode Printers and Labels

Barcode printers can either use thermal transfer or direct thermal technology. Printers that are available in the market today can be those that are attached to desktop, wireless printers are available as well. Several companies are known for its quality barcode printers such as Datamax, Citizen and Eltron. Zebra. one of the leading providers of quality printers offers a wide variety of high quality desktop and wireless printers [3].

2.) Barcode Software

The main function of barcode software is the generation and creation of barcodes. The selection of barcode software depends on the operating system of the company's computer. Barcode Generator software makes use of several built in alternatives which allow the system to use a variety of combinations and permutations.

3.) Barcode decoders

Barcode decoders are primarily used to read and translate codes into a text format that is readable by any user. The main part of a decoder is its receiver function . Some barcode decoders can also be used in other procedures such as inventory control, product distribution and processing of sales information. Common barcode decoders are laser diode scanners and VLD scanners.

4.) Barcode scanners

Barcode scanners are normally located at checkout counters where the items are needed to be scanned before payment or processing. Once the item is scanned, information stored on the barcode can be readily available. Several types of barcode scanners are very handy and convenient; counter top scanners, scanners for industrial use, laser and CCD imagers.

5.) Barcode verifiers

Barcode verifiers are being used to make sure that the barcodes that are developed by the software is compatible with the designated symbology and would result to a high quality output. They are used to make sure that the barcodes are in compliance with the requirements set by the company and will be applicable for international use as well.

The following sections explains about the barcode types used in this proposed system namely as Code 11, Code 39 and Code 128.

C. Code 11Type

It is used primarily for labeling telecommunications equipment. Fig. 1. shows format of Code 11 type.

The character set includes the digits 0 through 9, a dash (-), and a start/stop code. Each character is encoded with three bars and two spaces. Of these five elements, there may be two wide and three narrow, or one wide and four narrow. Wide elements represent a binary 1 while narrow elements represent a binary 0.Two check digits, named C and K, are used; often only the first check digit (C) is used when the length of the data is 10 characters or fewer. Weights start at the right end of the data and increment towards the left. The dash character has a value of 10 for purposes of check digit calculation.

Character	Bar	Space	Bar	Space	Bar
0	0	0	0	0	1
1	1	0	0	0	1
2	0	1	0	0	1
3	1	1	0	0	0
4	0	0	1	0	1
5	1	0	1	0	0
6	0	1	1	0	0
7	0	0	0	1	1
8	1	0	0	1	0
9	1	0	0	0	0
-	0	0	1	0	0
S/S	0	0	1	1	0

Figure 1. Code 11 Format .

The check digits calculation is as follows:
(The weights for the C check digit range from 1 to 10 while the weights for the K check digit range from 1 to 9.)

1. Starting at the right end of the data, assign a weight to each character starting with 1 and incrementing to 10.
   If the data is longer than 10 characters, cycle back to 1 and continue.
2. Calculate the product of each data character times its weight. For the dash (-), a character value of 10 is used.
3. Sum the products, divide by 11, and take the remainder
4. Append the result of Step 3 to the end of the data as the C value.
5. Starting at the right end of the data which now includes the C check digit, assign a weight to each character starting with 1 and incrementing to 9. If the data is longer than 9 characters, cycle back to 1 and continue.
6. Calculate the product of each data character times its weight.
7. Sum the products, divide by 11, and take the remainder as the K value.

Format the complete barcode by concatenating
a start character + data + C + K + stop character.

Figure 2. Barcode with Code 11 Format.

D. Code 39Type

Code 39 is widely used in many industries and is the standard for many government barcode specifications, including the U.S. Department of Defense. Code 39 is defined in American National Standards Institute (ANSI) standard MH10.8M-1983, and is also known as USD-3 and 3 of 9.

The Code 39 character set includes the digits 0-9, the letters A-Z (upper case only), and the following symbols: space, minus (-), plus (+), period (.), dollar sign ($), slash (/), and percent (%). A special start/stop character is placed

at the beginning and end of each barcode. The barcode may be of any length, although more than 25 characters really begin to push the bounds.

Each character consists of 9 elements: 5 bars and 4 spaces. Each character includes 3 wide and 6 narrow elements. Figure 3 shows barcode with code 39 format. Characters are separated by an inter-character gap which is the same width as a narrow bar. The ratio of wide:narrow bar width may be in the range of 1.8 to 3.4. Barcodes with a narrow bar width of less than 0.020 inches (0.508mm) should have a ratio of at least 2.5. A ratio of 3.0 is recommended. Every Code 39 barcode should be preceded and followed by a quiet zone the width of at least 10 narrow bars.

Figure 3. Barcode with Code 39 Format.

Code 39 does not require a checksum, although a modulo 43 check digit may be appended for increased data integrity (the Mod 43 checksum is seldom used). Code 39 is just about the only type of barcode in common use that does not require a checksum. This makes it especially attractive for applications where it is inconvenient, difficult, or impossible to perform calculations each time a barcode is printed. For example, when performing a word processor merge operation there is generally no easy way to calculated a checksum if one of the merge data fields is to be barcoded.

With Code 39, however, no checksum is needed; the merge template document must simply add a fixed asterisk (*) before and after the data and print the field using a Code 39 barcode font.

E. Code 128Type

Code 128 provides excellent density for all-numeric data and good density for alphanumeric data. It is often selected over Code 39 in new applications because of its density and because it offers a much larger selection of characters. The Code 128 standard is maintained by AIM (Automatic Identification Manufacturers).

The Code 128 character set includes the digits 0-9, the letters A-Z (upper and lower case), and all standard ASCII symbols and control codes. Figure 4 shows barcode with code 128 format [6].

Figure 4. Barcode with Code 128 Format.

The codes are divided into three subsets A, B, and C. There are three separate start codes to indicate which subset will be used; in addition, each subset includes control characters to switch to another subset in the middle of a barcode. Subset A includes the standard ASCII symbols, digits, upper case letters, and control codes. Subset B includes standard ASCII symbols, digits, upper and lower case letters. Subset C compresses two numeric digits into each character, providing excellent density. Here is a sample that contains 12 digits; compare its size to the sample at the top of the page that contains 12 assorted characters:

Each character is 11 times the width of the narrowest bar; using a minimum bar width of 0.010" each character would be 0.11" wide. Using the 0.010" figure, 20 data characters plus start code, check digit, and stop code would measure 2.55" wide (the stop code is 13 times as wide as a narrow bar). Using Subset C with all-numeric data provides 2:1 compression of the data for a total width of 1.45".

Each character consists of 3 bars and 3 spaces, each of which may be 1, 2, or 3 elements wide (1 element = 1/11th of the character width). The bars always use an even number of elements and the spaces use an odd number. This provides the basis for a character-by-character consistency check during scanning. In addition, each Code 128 barcode includes a Modulo 103 checksum.

Calculating the checksum can be a little tricky. Each Code 128 character has a numeric value from 0 to 102. In Subset A and B, the numeric value of a character is its ASCII code minus 32. For instance, a space (ASCII 32) has a value of 0, the exclamation point (ASCII 33) has a value of 1, etc.

Subset A permits printing of ASCII control characters, those with ASCII codes between 0 and 31. For these characters add 64 to the ASCII code to obtain the numeric value. For example, the value of NUL (ASCII 0) is 64, SOH (ASCII 1) is 65, STX (ASCII 2) is 66, etc.

Subset C prints numeric digits in pairs, and the value of the character for checksum purposes is the numeric value of the pair (00, 01, 02... 99).

To calculate the checksum, follow these steps:

1. Initialize the checksum variable with the value of the start character (103, 104, or 105 for Subsets A, B, or C, respectively).
2. Initialize a multiplier to 1.
3. Starting at the left end of the barcode data, add the numeric value of each character times the multiplier to the checksum. Increment the multiplier after each character.
4. Divide the result by 103. The remainder is the checksum.
5. Convert the numeric checksum into an ASCII character.

The details of converting the numeric checksum to an ASCII character may vary depending on the particular font being used. Special handling may be required in cases where the resulting ASCII character code equals zero or is above 95.

Generally speaking, in Subset A if the checksum is between 0 and 63 inclusive, add the checksum and the ASCII code for a space (32) to obtain the character code. If the checksum is 64 or higher, subtract 64 to obtain the character code. In Subset B, add the checksum and the ASCII code for a space (32). In Subset C, the checksum is the ASCII value of the character.

The check character is a Modulus 103 Checksum that is calculated by summing the start code value plus the product of each character position (most significant character position equals 1) and the character value of the character at

that position. This sum is divided by 103. The remainder of the answer is the value of the Check Character. Every encoded character is included except the Stop and Check Character [3].

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Example: BarCode 1
Message : Start B   B   a   r   C   o   d   e      1
Value      104      34  65  82  35  79  68  69  0  17
Position:   -       1   2   3   4   5   6   7   8  9
Calculate Total: 104 + (34x1) + (65x2) + (82x3) + (35x4) + (79x5) +
                 (68x6) + (69x7) + (0x8) + (17x9) = 2093
2093/103 = 20 remainder 33
33 = A
Final message: (Start B)BarCode 1(A)(STOP)
```

IV. SYSTEM DESIGN

This section describes about the proposed system design.

A. *System Design for Preprocessing Stage*

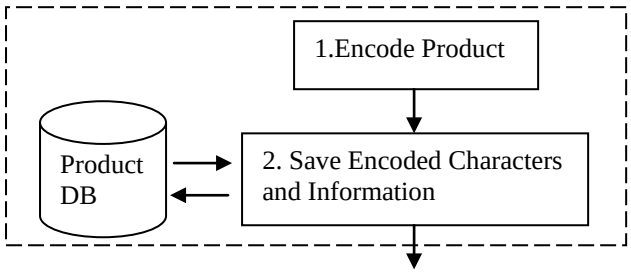

Figure 5. System Design for Preprocessing Stage

This section shows the flow of preprocessing stages. At this stage, we have to encode the products into code values and save them with their respective information into product database for the purpose of reporting. Figure 5 shows system design for preprocessing stage.

B. *Overall System Design*

This section (see in Figure 6.) explains about the overall system design. Firstly, we have to enter the encoded characters to draw its barcode image. The system's draw function will draw the image according to their barcode type. The barcode patterns are already explained in Sections III. After drawing the barcode images, the encoded characters are labeled beneath the barcode and these are stored in barcode images database.

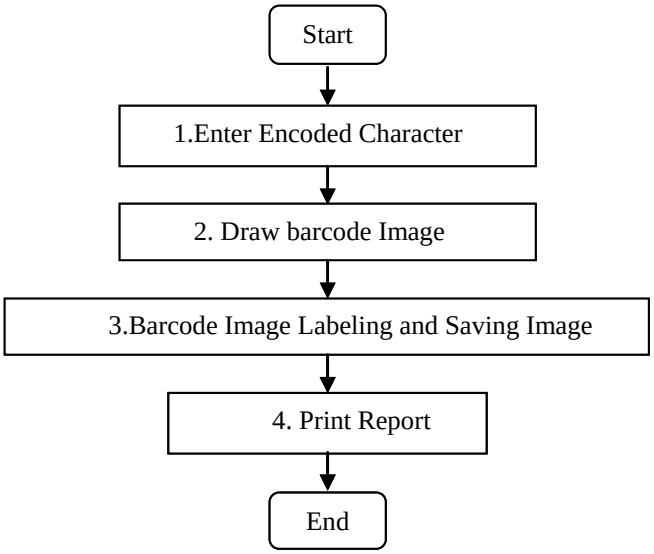

Figure 6. Overall System Design

At the printing report step, we can retrieve the information of barcode images into a report form. We must enter the encoded characters. The system will search the respective information in accordance with this character in product database and retrieve them from database. At the time of writing this paper, we can only generate barcode images with three barcode types and label the encoded characters beneath the barcode images. This reporting function will continue later. Figure 7 shows the idea of flow of reporting process.

C. *System Design (Report Printing process)*

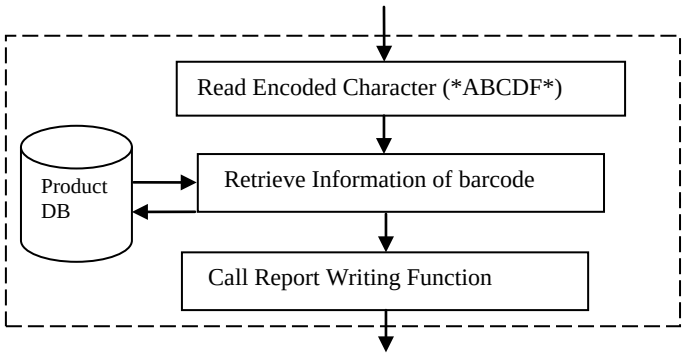

Figure 7. Flow of Report Printing Process.

In this process, the user must enter the encoded character into the system. The system will read this character and search this character in the database and retrieve the information and display the report form.

The next section shows implementation results.

V. IMPLEMENTATION RESULTS

This section describes the implementation results of the proposed system. Figure 8 shows main form of the system. In this figure, three types of barcode namely 'code 11', 'code 39' and 'code 128' are supported and we can choose one of three buttons to draw the desired barcode.

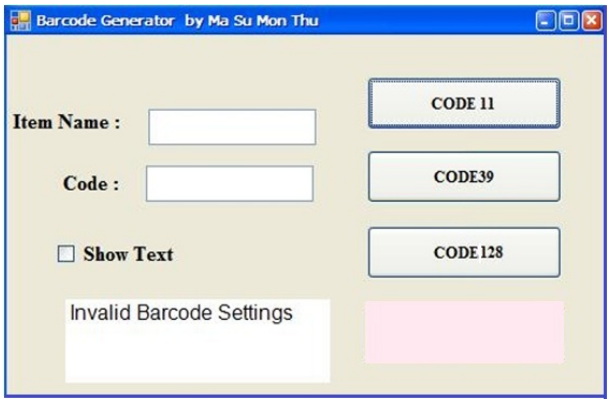

Figure 8. Main Form.

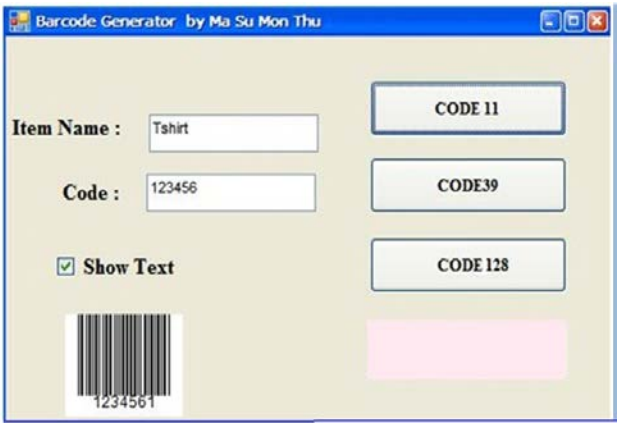

Figure 9. Barcode Creation With Code 11.

In Fig. 9, the input is '123456' and the output label is '1234561' because the latest '1' is the checksum character.

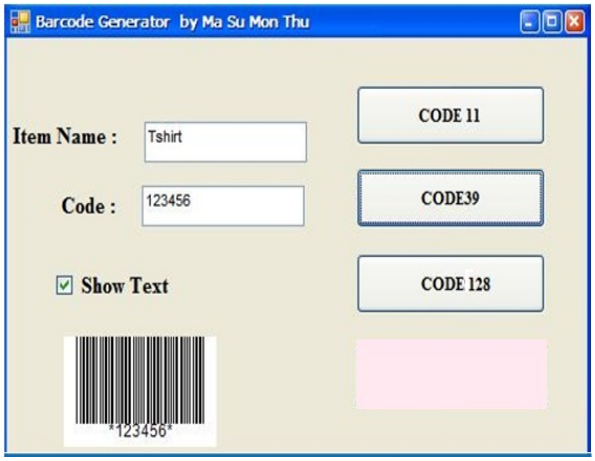

Figure 10. Barcode Creation With Code 39.

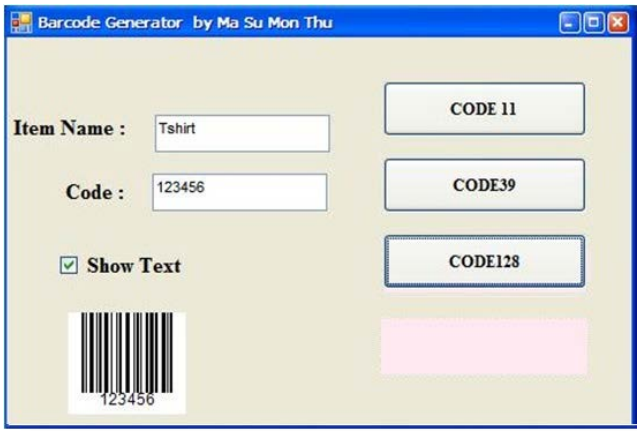

Figure 11. Barcode Creation With Code 128.

Figures 9, 10 and 11 are the barcode image generation with three code types for the same content. Firstly, the user has to type item name, encoded character and select show text for labeling encoded character. After that the user has to choose one barcode type from three code types. And then the user can get one barcode type .

VI. CONCLUSION

By using this system, the user can generate barcode with three barcode types. All these barcodes types are commonly used in commercial applications. After generating barcodes, these barcode images are stored in the image database. Later, the user can search the information of the barcodes such as item name, model, price, color and etc.

The comparative advantages and disadvantages of these barcode types are as follow. Code 11 type is used primarily for labeling telecommunications equipment. It can be easily read by barcode readers. Code 39 has ability to encode virtually any number of alpha as well as numeric characters within a single symbology. But, because Code 39 uses only two module widths, it is not a very dense code (i.e., it takes many elements to make up a single character, hence a larger symbol. If the space for the symbol is at a premium, a Code 39 symbol may not fit. Many industries (e.g., automotive, healthcare, US department of Defence) have adopted Code 39 as a standard. Code 128 is the most space efficient barcode in current existence which offers as large as a character set. But, some older or cheap barcode readers don't read code 128. Writing software to print code 128 symbols can be a bit of a nightmare because of the three character sets. Retail (for cartoon labeling), health care, industrial and commercial uses this type [7].

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