Linear Barcode Reading by Using Spatial Domain Dynamic Template Matching Technique

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Abstract:
Barcode technology is continuously growing up because of the simplicity of the binary data representation and the efficiency of the reading device in a controlled acquisition environment. Barcode scanning systems like LASER scanning systems and more recently charged coupled devices are used. These systems are costly and the basic requirement of these systems is barcode images should be highly focused. Now a day cell phones come with optical imaging system. These hand held devices with capability to reading barcodes is best alternative to the existing barcode scanning system. Cell phones are easily available to people. This can revolutionize every day shopping experience like retrieving product information, price check comparing product price etc. The dynamic template matching system proposes linear barcode scanning based on a dynamic template matching scheme. This system works entirely in the spatial domain and is able to read linear barcode from low-resolution images containing blur and noise. The blurred barcode scanline waveform and its corresponding symbol values are characterized by directed graphical model. A dynamic programming-based inference algorithm is used to retrieve the optimal sequence of barcode which enables real time barcode decoding on mobile device of low resolution cameras.

Keywords: Barcode, Linear barcode, out of focus blur, Edge Detection, Deblurring Barcode, Graphical model, Dynamic template matching etc.

I. INTRODUCTION
Barcode is fundamental important factor of electronic data interchange. From the time when it invented, this technology is continuously growing up because of the ease of the binary data representation and the efficiency of the reading device in a controlled acquisition situation. There are many barcode types are exists like EAN-13, UPC, UPC-A, EAN-8. EAN-13 and UPC are commonly used barcode types. The International Article Number is also known as European Article Number, which officially called as EAN-13. It is 13 digits barcode symbology, which is original 12 digits Universal Product Code (UPC) also known as UPC-A[1]. Multiple generations of barcode scanning systems ranging from earlier laser scanners to more recent area Charge-Coupled Device (CCD) scanners have been invented and developed [1]. As the location/size information of bars and spaces is of paramount importance for deciphering information embedded in barcodes, modern barcode scanning systems generally request well-focused barcode signals, which help in the retrieval of location/size-related features by confining the edge interaction between the code patterns. But when barcode image is captured with low resolution cameras blur is added. This blur is not able to handle by the laser scanner or charged coupled devices as the basic requirement of these scanners is image should be highly focused. Many techniques have been invented to read the barcode like, edge detection, blind deconvolution etc. but these techniques are not able to handle the blur.

II. PROPOSED METHOD
This project introduces system for linear barcode reading, which is robust to blur. As linear barcode reading is essentially the classification of deformed images to a finite set of possible values, this method treated linear barcode scanning under the binary waveform analysis. This system is designed for EAN-13 barcode. In this system for experimental analysis effect of motion blur and salt and pepper noise are considered. The overall accuracy is calculated in terms of recognition rate and false positive rate. The block diagram of dynamic template matching technique is shown in the figure.

Figure: 1. Block Diagram of DTM
Barcode Localization:

To detect the barcode region from the blur image along with morphological operations edge detection and boundary detection technique is used. The Canny operator is designed for an optimal edge detector. It takes as input as gray scale image, and produces as output an image showing the positions of intensity discontinuities.

Image Restoration:

Image quality degraded by motion blur and salt and pepper noise. To deblur the image wiener deconvolution is used. Also to remove the effect of noise from the image median filter is used.

Barcode Symbol Decomposition:

As each linear barcode symbol is composed of a series of concatenated symbol characters, and each character is discrete valued, we can always decompose a linear barcode symbol into a sequence of state variables \( s = (s_1, s_2, ..., s_T) \). Each state variable is discrete valued representing one or more neighboring symbol characters. If each state variable is chosen to be associated with two symbol characters, then an EAN-13 barcode can be decomposed into \( T = 6 \) state variables. Each state variable takes values in state variable space \( \{1, 2, ..., N\} \) which has one-to-one correspondence with all valid character(s) values at location \( t \).

For example EAN-13 barcode contains 13 symbols including left guard bit as shown in figure.

Figure: 2. EAN-13 Barcode Symbologies

Scanline Segmentation and Observation Sequence Modelling:

Based on state variable sequence modeling of linear barcode, given a scanline of a barcode symbol, A scanline segmentation scheme is determined to have each created waveform segment jointly determined by only two neighboring state variables, and make it be independent from any other state variables in the state variable sequence, with the exception that the waveform segments located at the left or right boundary of the scanline is solely determined by the first or the last state variable.

\[ g(x) = h(x) \ast f(x) \quad ......(1) \]

Where,
- \( f(x) \) is the standard barcode symbol scanline
- \( g(x) \) is the deformed scanline
- \( h(x) \) is the line spread function
- \( n(x) \) is the additive noise

Referance Waveform Generation:

Once the observation variable sequence is created, the observation variables need to be compared with standard reference waveform segments of the detected blur level for any qualified state variable values [1]

Graphical Model:

In this system, a set of scanline template banks is created offline. Each bank of scanline templates contains templates corresponding to all possible barcode values according to a specific OOF blur level. The scanning process can be accomplished by comparing the deformed scanline extracted from the blurred image with the scanline templates associated with the detected blur level. Once a scanline template which is most similar to the deformed scanline is found, and if the similarity surpasses certain predefined threshold, the barcode value corresponding to the selected scanline template is verified as the output of the scanning system; otherwise, the scanning process fails.

Dynamic Template Matching:

Template matching is a technique used to classify an object. This technique is used to compare a portion of image against another. Sample images are used to recognize similar objects which are found in source image. If standard deviation of the template image is compared to the source image is small then template matching is used. Generally templates are used to identify printed characters, numbers, and other small, simple objects. The matching process moves the template image to all possible positions in a larger source image and computes a numerical index that indicates how much the template matches the image in that position. Usually match is done on a pixel-by-pixel basis. In dynamic template matching technique the unused information is not considered during comparison. The necessary information is selected and compared recursively to get the exact barcode value.

III. EXPERIMENTAL RESULTS

To check the system performance, image is ruined by motion blur and salt pepper noise. Also to take out the barcode area from the image canny edge detection is used. The accuracy of system performance checked in terms of Recognition Rate and False Positive Rate.

For EAN-13 Barcode:

EAN-13 barcode image is degraded by salt and pepper noise. To extract the barcode symbols from barcode image edge detection, morphological operations are applied. Symbol value is detected using graphical model.

Figure: 3. Result of Barcode image degraded by salt and pepper noise
EAN-13 Barcode image is degraded by motion blur. The result of blur barcode image is shown in the figure.

Experimental results are tested in the form of Recognition Rate and False Positive Rate. The RR and FPR values are improved as compared to literature methods. Thus, proposed method attains excellent result.

V. ACKNOWLEDGEMENT

With all respect and gratitude, I would like to thanks all people who have helped me directly or indirectly for the completion of this Project seminar.

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VI. REFERENCES


<table>
<thead>
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<th>Barcodes</th>
<th>Recognition Rate</th>
<th>Data Symbol</th>
<th>DTM</th>
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<tr>
<td>EAN-13</td>
<td>85%</td>
<td>100%</td>
<td></td>
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<tr>
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<tr>
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<td>69%</td>
<td>85%</td>
<td></td>
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<td>95%</td>
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<table>
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<tr>
<td>Overall</td>
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<td>0.005</td>
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The performance of the system is calculated in terms of recognition rate, false positive rate.

I. Recognition Rate is calculated by following formula,

\[ RR = \frac{\text{no. of correct symbols of barcode}}{\text{Total no. of symbols of barcode}} \times 100 \]

Recognition Rate of EAN – 13 barcode from Dynamic Template Matching and from Data Symbol are given as follows:

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The recognition rate ranges from 0 to 1. Ideally value of recognition rate should be 1 i.e. 100% accuracy.

False Positive Rate can be calculated as:

\[ FPR = \frac{\text{no. of incorrect symbols of barcode}}{\text{Total no. of symbols of barcode}} \]

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The false positive rate ranges from 0 to 1. Ideally value of False Positive rate should be 0.

IV. CONCLUSION

Proposed method of reading linear barcode using dynamic template matching is achieved. The proposed method is effective than previous methods.


**Vilbiography**

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