International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2014): 5.611

Survey on Spatial Domain Dynamic Template Matching Technique for Scanning Linear Barcode

Snehal Jadhav[1], S. K. Bhatia[2]

[1]ME Student, E&TC Department, ICOER, Wagholi, Pune, India

[2]Assistant Professor, E&TC Department, ICOER, Wagholi, Pune, India

Abstract: ***Barcode is vital important element of electronic data interchange. Since it invented, this 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. In today's digital world barcode technology is widely used in various industries. Barcodes represent data with t he width and the parallel lines, and may be referred to as 1D barcodes. 2D barcodes represented as depicted Binary data in geometric patterns such as dots or squares within images. It is used to keep the records of products and also to find the product using barcode. When captured, the original barcode is degraded by blur caused by a bad focalization or a camera movement, in addition to noise, the whole resulting in a blurred noisy barcode. 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. Many models were invented to deal with the reconstruction of blur barcode. In this paper various techniques of barcode extraction like edge detection, methods based on peak detections, blind deconvolution, Bayesian algorithm etc.***

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

1. Introduction

Digital Image leads to processing of a two dimensional picture by a Digital Computer. In a broader context, it means Digital processing of any two dimensional data. Digital Image is an array of real or complex numbers represented by a finite number of bits. An Image in the form of a transparency, photograph or an X-ray is first digitized then stored as a matrix of binary digits in computer memory. This digitized image can be processed and then displayed on a television monitor. An Image Processor does the functions of Image Acquisition, Storage, Pre-processing, Segmentation, Representation, Recognition and Interpretation and finally displays or records the resulting image. Now days digital image processing has many applications, such as Remote Sensing, Medical Processing, RADAR, SONAR & Acoustic Image Processing, Robotics & Automated inspection of Industrial parts.

1.1 Barcode

For Decades barcode technology has found its applications in many industries and has been playing an important part in people's daily lives. Barcodes have been widely used to encode product specification in graphical formats. They are used to keep the track of shipments and price retail items, manage financial and logistical documents, and so on. The use of barcodes is increasing day by day as they are compact and machine-readable.

Multiple generations of barcode scanning systems like LASER Scanners to more recent area Charge Coupled Device (CCD) scanners have been developed. As the location/size information of bars and spaces is of paramount importance for deciphering information embedded in barcodes, modern barcode scanning systems generally have the basic requirement of well-focused barcode signals, which help in the retrieval of location/size-related features by confining the edge interaction between the code patterns. Depth-of-field (DOF) is an important aspect of any specific barcode scanning system. Area CCD scanners have the advantage of reading both linear and 2D barcodes, but have less DOF than that of laser scanners. Linear barcode scanning based services are largely not available on mobile devices with fixed-focus lenses because the barcode images captured by these devices contain excess edge interactions triggered by out-of-focus (OOF) blur. Initially when barcode captured barcode is degraded by blur caused by a bad focalization and a camera movement, in addition to noise, the whole resulting in a blurred noisy signal.

There are many types of barcodes exist, including linear or one-dimensional (1D) barcodes, and two-dimensional (2D) barcodes such as QR code. The focus of this research is on the one-dimensional barcode that encodes data of the object to which it is attached in a graphical form of bars and spaces.

Fig.1 shows the structure of linear barcode Symbologies

EAN-13 Barcode   UPC-A   EAN-8

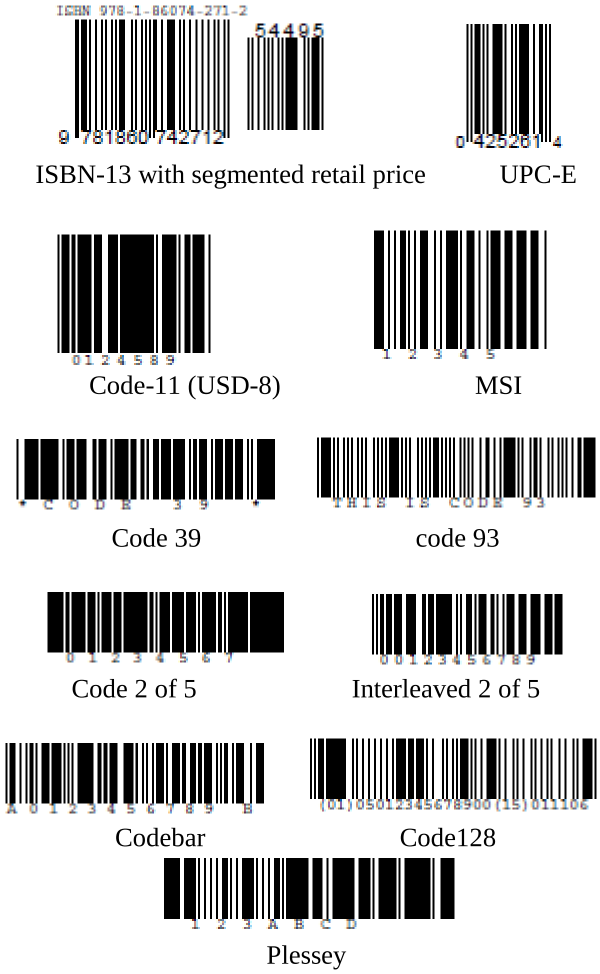

Figure 1: Linear Barcode Symbologies

Fig.2. Two main types of blur can affect the received signal; the optical blur and diffraction phenomena and the motion blur coming from the camera mobility.

Figure 2: Original Barcode and Blurred Barcode

Many models have been proposed for these two kinds of blur such as edge detection for barcode reconstruction, method based on peak detection, blind deconvolution etc.

2. Related Work

This section provides a survey of general techniques and more specialized approaches for the challenges of locating and decoding blurry barcode images. The introduction of barcode technology was written by Pavlidis et al.(1990). It gives overview of common barcode types, information density, scanning noise and distortions, and error correction. The official specification for the EAN barcode can be found in the GS1 General Specifications (GS1, 2009).

2.1 Locating the position of barcode

2.1.1 Blocks with consistent gradients

Shams and Sadeghi (2007) [1] explained that the barcode is located by computing the gradient directions in the input and then finding blocks where the gradient direction is consistent. To find the region of interest (ROI) these blocks are first connected and then the quiet zones next to the barcode are detected. This approach is successful even at very low resolutions to find the location of barcode in given image.

2.1.2 Hough transform

Hough (1962) [2] described a method for detecting patterns by transforming lines to slope-intercept representation. The method was redeveloped by Duda and Hart (1972) to use angle-radius parameters [3] instead of slope intercept to avoid the problem of an unbounded transform space. The Hough transform is a method for detecting the orientation of barcodes in the blurry image, but it is better suited for black and white image than for blurry gray images.

2.1.3 Canny edge detector

Canny (1986) was invented edge detector [4] which is designed to be optimal under explicit requirements of good detection, localization, and minimal response. This edge detector works in four steps: input blurring for noise reduction, computation of gradient intensities and directions, non-maximum suppression, and edge tracing. But this edge detector fails to locate all bars if the input image is very blurry, but the first two stages were used for the implementation of the block-wise approach.

2.2 Distortion and lighting

2.2.1 Distorted geometry

A skew distortion correction method [5] for 2D barcode images was proposed by Xu et al. in (2007). This method derives the transformation matrices based on two vanishing points that are detected from the two sets of parallel lines in the barcode. This method basically works on 2-dimensional QR codes, but the same method with the required necessary adjustment works for linear barcodes too.

2.2.2 Non-uniform illumination

Kim and Lee (2007) [6] describes an iterative method for finding the background brightness across the image, while at the same time detecting the width and distance of the bars, even with some blurring. Their objective is based on the parameterization of a barcode signal and illumination. Though the illumination is regularized using a smoothness penalty, this method is not able to handle excessive blurs.

2.3 Deblurring

2.3.1 Peaks

Joseph and Pavlidis developed a decoder [7] in 1992 that operates on the locations of the peaks of the barcode waveform because peaks are easier to convolve distortion (blurring) than edges. The peaks are located at the midpoints of the dark stripes. This method also able to show that points of high curvature are still present when the blurring is has already removed separate peaks. This method based on the first or second derivative of the brightness across the barcode for this thesis, but they are very sensitive to noise in the digital camera image.

2.3.2 Filters

Joseph and Pavlidis presented a method in 1993 for processing closely spaced edges and accurately restoring their locations. This algorithm basically depends on three interacting edges, forcing the effects of two edges to cancel each other, so that the position of the third edge can be detected. This paper presents different methods to reconstruct edges and estimate the point spread function, then compares different deblurring filters based on these techniques.

2.3.3 Blind deconvolution

Blind deconvolution of barcode signals based on minimizing the total variation [8] was invented by Esedoglu in 2004. Blurring is modeled with a Gaussian kernel, and the iterative algorithm adjusts the blur kernel parameters. In this method each image in six minutes in MATLAB on a Celeron with 2.4 GHz clock rate, so this method is not directly usable for an interactive mobile application.

2.4 Decoding

2.4.1 Selective sampling

Shellhammer et al. (1999) analyze the derivative of the signal from a laser scanner to determine the strength of bar edges [9]. Spurious edges are eliminated with Otsu's thresh old. He also describes edge enhancement filters for improving the detection. These techniques are used in a commercial product called "Fuzzy Logic Scanner" by Symbol Technologies.

2.4.2 Hierarchical method

To process different kinds of uncertain conditions Lu et al. (2006) combine several image filters and feature extractors. The algorithm starts with a barcode quality assessment based on Omni-directional scan lines then it selects methods to improve the results, including contrast adjustment, morphological filters, bi-linear interpolation. This method is able to recover barcode symbols from partly blurred images.

2.4.3 Statistical recognition

Wang et al. (2007) located the barcode region with a wavelet transformation and then segmented into characters. The segmentation is based on the zero crossings of the second derivative of the brightness values in the input. For each character feature vector is extracted. The recognition engine selects characters with the smallest recognition distance, using a modified Generalized Learning Vector Quantization (GLVQ) method. The classifier is trained with more than 1000 barcode images.

2.4.4 Special hardware

Ohbuchi et al. (2004) [10] invented a method for locating and decoding EAN and QR Codes. Algorithm uses spiral scanning to detect linear barcodes and performs an inverse perspective transformation. It can process camera images at more than five frames per second on a mobile phone, but it requires a special DSP chip and hence the system becomes costly.

2.5 Existing applications

This section lists some barcode scanning libraries and applications that are actively developed.

2.5.1 ZXing

ZXing, pronounced "zebra crossing" is an open-source, multi-format 1D/2D barcode image processing library implemented in Java. It supports EAN-13, UPC-8 and several other 1D and 2D barcodes. There's also a port to Objective C for the iPhone, but it supports only QR Code.

2.5.2 ShopSavvy

ShopSavvy is a shopping assistant developed for Google's Android mobile phone platform. It runs on T-Mobile's G1 phone produced by HTC and uses the ZXing library to decode barcodes. The recognition is fast and has a high success rate because the camera uses automatic focus during the barcode scan. The application supports online lookup for price comparison and product reviews.

2.5.3 PDAbar library

Logic Way GmbH in Schwerin produces barcode reader software for PDA devices. It recognizes several different linear barcodes, including EAN-13. The supported platforms include Tablets, Windows Mobile, and recently Android (Java). The decoder requires a camera with automatic focus or a macro lens to reduce image blur.

2.5.4 Delicious Library

Delicious Library is a product management system for Mac OS X. It includes a barcode scanner that uses the Mac's built-in eyesight camera to recognize UPC, EAN and ISBN barcodes. This algorithm uses the vector processor to perform image deconvolution because the camera images are out of focus.

2.5.5 ItemShelf

ItemShelf is an open-source iPhone application that recognizes product barcodes with the built-in camera. It requires a macro lens and uses the ZBar barcode reader library. The application uses Amazon Web Services to look up the recognized products.

3. Proposed System

As linear barcode reading is the classification of deformed images to a finite set of possible values, has treated linear barcode scanning under the deformed binary waveform analysis. The proposed system works in spatial domain. The directed graphical model is design to give the relation between reference waveform and observed waveform. The reference waveform most similar to the observed barcode waveform is found and verified corresponding barcode value is treated as the output of the barcode scanning system.

4. Conclusions

The above existing techniques are not able to handle the out of focused blur in image. Dynamic Template matching is a technique to find small parts of an image which match a template image using direct graphical model and observance sequence. Template matching scheme gives the capability to deal with OOF level. Its capability of real-time processing made possible by directed graphical model.

5. 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.

I express heartily gratitude towards Prof. S. K. Bhatia for guiding me to understand the work conceptually and for her constant encouragement to complete this work and also for providing all necessary information.

I also express my thanks to Prof. P. R. Badadapure**,** Head of the department of electronics and telecommunication engineering for providing all necessary information.

With deep sense of gratitude I thank to our Principal Dr. S.V. Admane and management of Imperial College of engineering for providing all necessary facilities and their constant encouragement and support.

References

[1] R. Shams and P. Sadeghi. Bar code recognition in highly distorted and low resolution images. In IEEE International Conf. Acoustics, Speech and Signal Processing, volume 1, pages I–737–I–740, Honolulu, HI, USA, 2007. IEEE Computer Society. ISBN 1-4244-0727-3.

[2] P. Hough. Method and means for recognizing complex patterns. U.S. Patent 3,069,654, Dec.1962.

[3] R.O.Duda and P. E. Hart. Use of the Hough transformation to detect lines and curves in pictures. Commun. ACM, 15(1):11–15, 1972. ISSN 0001-0782. doi: http://doi.acm.org/10.1145/361237.361242

[4] J. F. Canny. A computational approach to edge detection. IEEE Trans. Pattern Analysis and Machine Intelligence, 8(6):679–698, 1986. ISSN 0162-8828.

[5] X.-W. Xu, Z.-Y. Wang, Y.-Q. Zhang, and Y.-H. Liang. A skew distortion correction method for 2d bar code images based on vanishing points. Machine Learning and Cybernetics, 2007 International Conference on, 3:1652–1656, Aug. 2007. doi: 10.1109/ICMLC.2007.4370412

[6] J. Kim and H. Lee. Joint nonuniform illumination estimation and deblurring for bar code signals. Optics Express, 15:14817–+, 2007. doi: 10.1364/OE.15.014817.

[7] E. Joseph and T. Pavlidis. Peak classifier for bar code waveforms. In 11th IAPR International Conf. Pattern Recognition Methodology and Systems, volume 2,pages 238–241,Sept. 1992.ISBN 0-8186-2915-0.doi: 10.1109/ICPR.1992.201763.

[8] S. Esedoglu. Blind deconvolution of bar code signals. Inverse Problems, 20:121–135, Feb.2004. doi: 10.1088/0266-5611/20/1/007

[9] S. Shellhammer, D. Goren, and T. Pavlidis. Novel signal-processing techniques in barcode scanning. IEEE Robotics & Automation Magazine, 6(1):57–65, Mar. 1999. ISSN 1070- 9932. doi: 10.1109/100.755815

[10] E. Ohbuchi, H. Hanaizumi, and L. A. Hock. Barcode readers using the camera device in mobile phones. In CW '04: Proceedings of the 2004 International Conference on Cyberworlds, pages 260–265, Washington, DC, USA, 2004. IEEE Computer Society.

Author Profile

Snehal Jadhav completed BE from Savitribai Phule university Pune. Currently pursuing ME in signal processing from ICOER Pune.

Prof. S. K. Bhatia is Assistant Professor at ICOER Pune.