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Image Estimation Algorithm for Out of Focus and Blur Images to Retrieve the Barcode Value

K. Sree Dhurga
PG Student
Department of Electronics & Communication
SMVEC, Puducherry, India

Mrs. V. Logisvary
Assistant Professor
Department of Electronics & Communication
SMVEC, Puducherry, India

Abstract

Mobile cameras are being used now-a-days to scan barcodes to retrieve the product details. But the drawback is mobile cameras are made by a charge coupled device which is does not have the ability to handle out of focus and blur images. In this project, out of focus and blur images are restored using a dynamic template matching algorithm using directed graphical model. The directed graphical model is used to determine the relationship between state variable from blurred waveform at specific blur level and observation sequence. A varying program based inference algorithm is used to recover the optimal state sequence and hence the system works in real-time.
Keywords: Out-of-focus, Directed Graphical model, Dynamic template matching, Linear Barcode, Blur Level

I. INTRODUCTION

Modern technologies make use of barcodes widely. Barcodes are used in every product. Most of us are familiar with the barcodes, recently linear barcode or 1D barcode is used. UPC barcodes provide characteristics such as price and model information. Software to scan these barcodes has recently been made available for most cameras equipped cell phones. When a mobile phone with barcode reading software scans a barcode, information is sent to a database which in turn returns whatever data is requested. For example, while shopping for a battery charger the barcode reader app is opened with the phone which scans the UPC barcode using the mobile phone's camera, and waits a few seconds. After a few seconds, the barcode information is sent over the phone's data network to the barcode company's software data center. The type of information returned from data centers includes prices, manufacturer, and locations of stores that have the same charger and also provides links to product reviews.Fig.1 represents linear barcode.

Fig. 1: Linear barcode

The most common problem occurs while using mobile phone's as barcode reader is out-of-focus and blur images. The mobile phone barcode reader software fails to retrieve the correct information from the input barcode. These barcode images can be scanned using this project. Image restoration/image deblurring is the domain chosen in for further research on out-of-focus barcode images. Image restoration is the operation of taking a unclear/noisy image and estimating the clean original image from those images. Corruption may be in these forms like motion blur, noise, and camera misfocus. Image restoration is different from image enhancement in that the latter is designed to emphasize features of the image that make the image more pleasing to the observer, but not necessarily to produce original data from a scientific point of view. With image enhancement noise can effectively be removed by sacrificing the resolution, but this is not acceptable in many applications. For example in a Fluorescence Microscope resolution in the z-direction is bad. More advanced image processing techniques must be applied to recover the object.

Linear barcodes are scanned only in the horizontal direction and 2D barcodes are scanned in both vertical and horizontal directions. Linear barcodes are the one which can be decoded easily. There are various types of linear barcodes. For example, EAN-13, UPC-A etc.The benefits of using 1D barcode systems are summarized as (i) Fast and accurate keyless data entry is achieved (ii) Little employee training is required. (iii) The numbers encoded in 1D barcode are globally unique. It is advantageous in terms of sales and inventory management. (iv) Real-time information can be obtained. This is also useful for both sales and inventory adjustment.

A CCD, which is a semiconductor with a plurality of light-sensitive areas, can have either a single linear set of light- sensitive elements or a light-sensitive area arranged in a two-dimensional array. The former is called a linear or line (sometimes, one-dimensional) sensor, whereas the latter is known as an area sensor. A scanner equipped with an area sensor is necessary to read 2D barcodes; a linear sensor scanner can only read 1D barcode. The information encoded in 1D barcode is vertically redundant. Even if part of a symbol is damaged by defects such as a smudge, spot and tear, the original information can be accurately retrieved from the other part of the bars and/or spaces. Furthermore, human-readable information (e.g. alphanumerical characters) is printed beneath 1D barcode symbols to allow the manual input of data if a decoding error should occur. Unlike 1D barcode, each small cell of the matrix format of 2D barcode symbols has information, and there is no redundancy to overcome printing defects.

II. OUTLINE OF PROPOSED WORK

Modern barcode scanning systems make use of camera phones and CCD scanners. CCD scanners have the capability to read both 1D and 2D barcodes. Depth-of-field (DOF) plays an important role in scanners. CCD scanners have less DOF compared to laser scanner. This limitation reduced the availability of CCD scanners. In this smart phone generation, all mobile phones are embedded with CCD cameras. Hence people started using mobile phones to get the details of the product by scanning barcodes. If the captured image has incorrect DOF then out-of-focus blur image is obtained due to which the exact product detail is not retrieved. Image restoration/deblurring domain is used to solve this issue. The advantages of this work are

1) It is Memory efficient and real-time processing.
2) This system is fully automatic.
3) Character waveform support expansion and neighboring character waveform interaction under image blur is considered.

The outline of the proposed work in Fig 2 can be explained in five steps they are as follows:

1) Barcode localization
2) Scanline segmentation and observation sequence
3) Standard reference waveform
4) Directed graphical model
5) Dynamic template matching

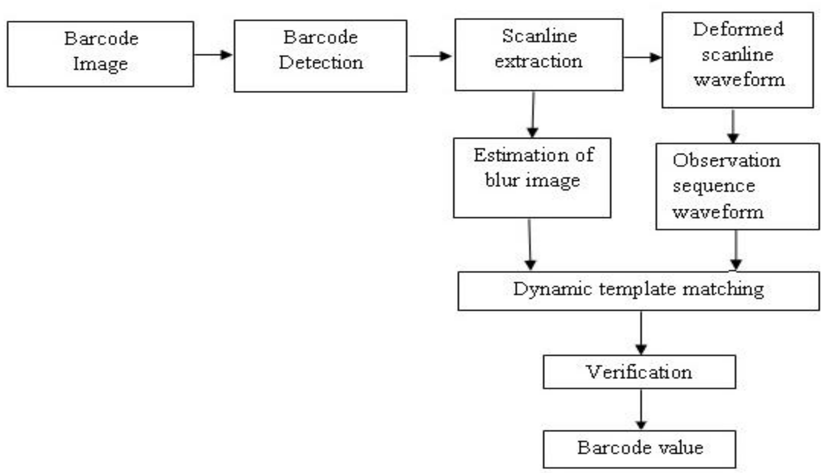

Fig. 2: Shows the outline of proposed algorithm

A. Barcode Localization:

The product is captured along with barcode. Now the barcode have to be cropped properly. If the barcode is not cropped properly then the required information will be lost. Thus, the localization of barcode becomes difficult. The barcode could be rotated in different angles. It could also be enlightened by a flash or covered by a shadow. Barcodes are often printed on products with texts or numbers, which increases the difficulty of barcode localization. On the other hand, barcode is a pattern of parallel lines that looks easily recognizable. In general, the image processing and pattern recognition is complex because a huge amount of data is processed. To gain an optimal speed of localization it is important to operate with as small amount of data as possible.
Localization difficulty also occurs due orientation, scale and position.

B. Linear Barcode Scanline Segmentation and Observation Sequence Modeling:

The barcode recognition performs a search on selected rows of the input image, called scan lines. Prior to recognition, each pixel of the scan line is pre-processed by transforming it into a feature value. The feature value of a pixel is set to a 1, if the pixel is considered black, -1 if it is considered white, and a value between -1 and 1 otherwise. Once all pixels are transformed, the scan line sequences are analyzed. After scan line segmentation, each waveform segment is normalized to zero mean and unit variance. The normalized waveform segments are treated as observation variables, and the deformed scan line is represented by an observation variable sequence. All the observation variables are multi-dimensional random variables. The value of each observation variable is observable and is jointly determined by two consecutive state variables. The two boundary observation variables located on the two sides of the scan line are individually determined by the first and last state variables.

C. Reference Waveform Segments Generation:

Observation sequence waveform is compared with the standard waveform at a specific blur level for any qualified state variable.The blurring kernel is used to generate the reference waveform. Generally the new pixels of the image are constructed by an weighted average of the pixels close to it. A little square is drawn around each pixel.If 6 neighbors next to a pixel is taken and a weighted average is performed to get the middle pixel.In the Gaussian blur case it breaks down into two one dimensional operations. For each pixel take some amount of pixels next to a pixel in the row direction only . Multiply the pixel values with weights computed from the Gaussian distribution and sum them up. Another way to take dot product between a vector and the weights obtained from the pixel. Repeat this process in the column direction.

D. A Directed Graphical Model:

The state variable sequence is represented by linear barcode symbol value. The observation variable sequence is represented by observed scan line. Now the stochastic relation between the linear barcode symbol value and observed scan line is determined as a directed graphical model.

E. Dynamic Template Matching:

Template matching is a technique used to classify an object. This technique is used to compare a portion of image against one 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. SIMULATION RESULTS

The advantages of the proposed work are dynamic template matching which is memory efficient. In naïve template matching offline templates are generated initially and later each template is compared with original. In dynamic template matching the templates are compared recursively due to which database memory is used efficiently. The results obtained are successfully.

A. Barcode localization:

At the input stage, product with barcode image is given as input. The input image and localized barcode is shown in fig 3.The required barcode is cropped from the image and localized. The localization of that barcode is a difficult process. This localization is done using Otsu thresholding and edge detection.

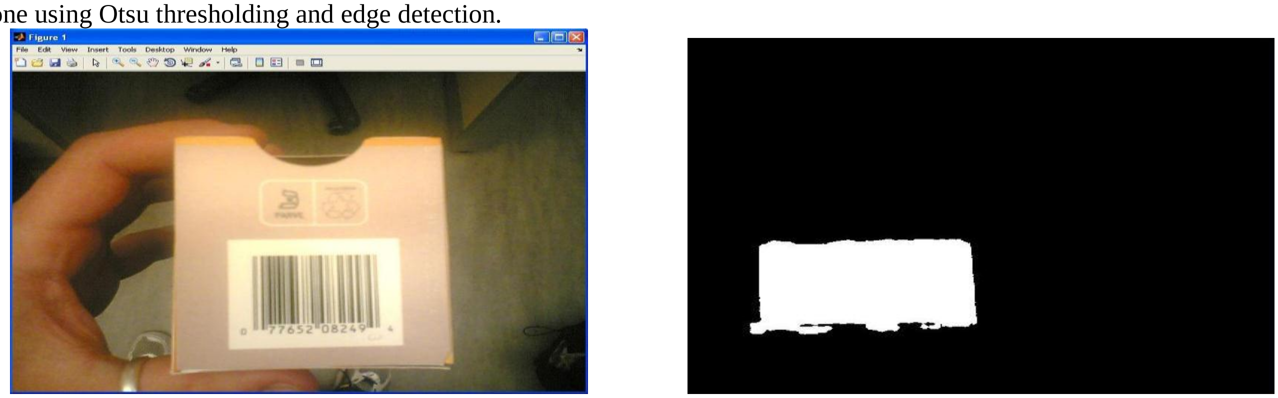

Fig. 3: Input image and localized barcode

B. Deformed Scanline:

The localized barcode region is now segmented. The segmented region is converted into a waveform. If the localized region consists of noise then the required information will not be obtained.the deformed scanline is shown in fig 4.Each segments are deformed as electrical signal. If this process is not done properly then segmented scanline cannot be converted into observation sequence.

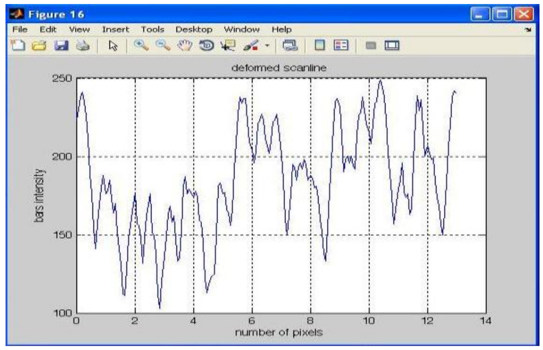

Fig. 4: Deformed scanline obtained from localized barcode

C. Scanline Segment and its Observation Sequence:

The scanline is segmented for each iteration. When all parallel lines of barcodes are segmented then in the next iteration observation sequences is generated. For example a single segment of scanline from first iteration is shown in fig 5.The observation sequence for that segment is shown in fig 5.

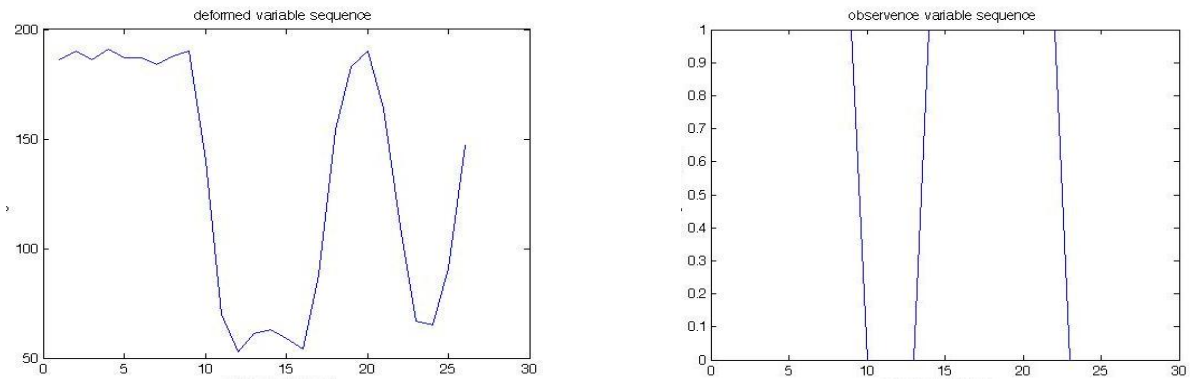

Fig. 5: Single deformed scan line segment and observation sequence

D. Observation Sequence Waveform:

When all segments are converted into their corresponding observation sequences, then the resulting waveform is shown in fig 6. Thus the required result is obtained.

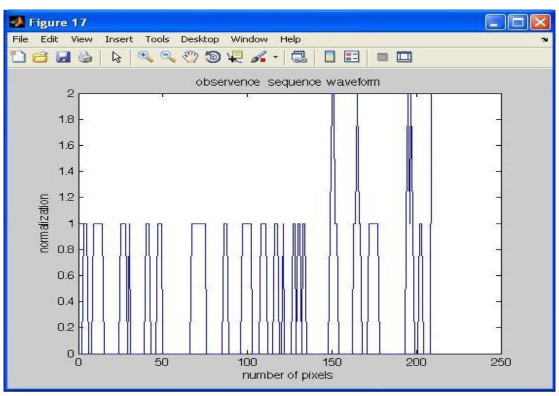

Fig. 6: Observation sequence waveform

IV. CONCLUSION

When an input image is given barcode is extracted from that image. Then the barcode is localized using edge detection and otsu thresholding.For this localized image deformed scanline waveform is generated. This deformed waveform is used to generate observation sequence. The same procedure is carried out for out-of-focus blur image where directed graphical waveform is generated using optimal state variable. In dynamic template matching, observation sequence and directed graphical waveform is compared until they match each other, this process is recursive. Once they match each other the verification is done to retrieve the barcode value. A new logistical approach implementing the use of 2D barcodes and some of the potential methodology for the routine sample analysis. The results presented in this study offer insights regarding the feasibility, usability and effectiveness of using a barcode scanner with all the products. During a recent large project based on the reading of randomized bar code labels, the fact that the vast majority of the reading activity had to take place at night had to be taken into account, especially in relation to the affect that the illumination sources would have on the working environment. Another over-riding factor in the project was that the system had to be totally self-sufficient since health and safety regulations on the shop floor precluded any personnel being in the vicinity of any of the scanning or control equipment.

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