2D Barcode Detection Algorithm with Multiple Features Combination for a Long Distance Search

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Abstract

A 2D barcode region localization system for the automatic inspection of a long distance logistics objects has been developed. For the successful 2D barcode localization, variance and frequency of the pixel distribution within average 2D barcodes is modeled and the average model of 2D barcode is combined with the corner features detection to localize the final 2D barcode candidates. An automatic 2D barcode localization software was developed with the multiple features mixture method and we tested our system on real camera images of several popular 2D barcode symbologies.

1. Introduction

1D or 2D Barcode systems are very important in logistics, product packaging and other various commercial applications. Due to the limited capacity of 1D barcodes, 2D barcode systems have been widely used in recent years. In the Two-dimensional barcode symbols, data are encoded in both the height and width of the symbol, and the amount of data that can be contained in a single symbol is significantly greater than that stored in a one dimensional symbol. Obviously, the main advantage of using 2D bar codes is that possibly a large amount of easily- and accurately-read data can "ride" with the item to which it is attached. There are new applications being created for 2D bar code technology every day. More than thirty different 2D-barcodes are currently in use. Common examples of 2D symbologies include DataMatrix, PDF417, Aztec Code, Codeblock, MaxiCode, QR Code. Whereas 1D barcodes are traditionally scanned with rotating laser illumination and linear sensor arrays, 2D barcode systems require imaging sensors for scanning and acquisition. Image-based 2D barcode scanning technologies also have many challenges, but have many efficient functions like very high data capacity and an ability of error recovery.

Many image-based methods for barcode identification have been developed. Ouaviani *et al*. adopted some image processing techniques to segment some of the most common 2D barcodes, including the QR code, Maxicode, Data Matrix, and PDF417 [1]. Jancke et al. [2] introduced a new technique in 2d barcode localization and segmentation, by using a process of thresholding, orientation prediction and then corner localization. Tan et al. [3] develop a recognition algorithm which first finds the location of the finder patterns. Then search for the L-shape guide bar(part of the 2d barcode), and Performing projective mapping to correct symbol distortion to localize the barcode region. Huaqiao et al. [4] localize the barcode region using texture direction analysis and hough transform. Xu and McCloskey focused on solving the localization and de-blurring problem of motion-blurred 2D bar codes using corner feature and motion direction estimation [5].

Most other techniques in literature usually work for single 2D barcode, and rely on finding the unique pattern, or are based on the assumptions that 2D barcodes are close to the scanning cameras. But our researches are focused on to increase the detection rate of 2D barcode area candidate even when the scanning cameras are in distant from the printed barcodes as in practical barcode inspection application systems.

In this research, A 2D barcode region localization system for the automatic inspection of logistics objects has been developed. For the successful 2D barcode localization, variance and frequency of the pixel distribution within average 2D barcodes is modeled and the average model of 2D barcode is combined with the corner features to localize the final 2D barcode candidates. An automatic 2D barcode localization software was developed with the multiple features mixture method and we tested our system on real camera images of several popular 2D barcodes.

2. 2D Barcode Detection System in our approach

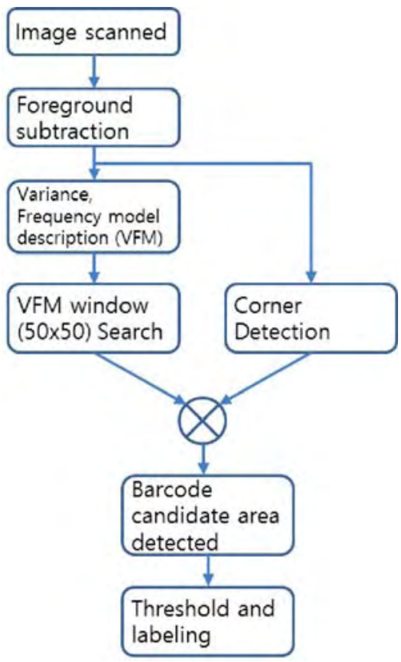


Figure 1. Overall flow diagram of the research

2.1 2D barcode localization

This paper proposes a novel method for localization of 2D QR Barcode images. Firstly, pre-processing like foreground subtraction technique is performed on input image to get the packaged objects moving through the conveyer system in logistics environment. Then variance-frequency model(VFM) of the average 2D QR barcodes is calculated to characterize the normal QR codes based on the variance and frequency of the distribution of the pixels included in 2D QR barcode. And then using the model of VFM features, we scan the whole input image with the 50x50 window to verify the similarity between the VFM distribution and the corresponding scanning area. The detected candidate areas are finally combined with the corner features detected results[5] to increase the detection accuracy of 2D barcode.

2.2 Corner features for 2D barcode localization

We employed corners as low-level features for localizing 2D barcode. A 2D barcode is a pattern comprised of small, rectangular black patches on a white background. As a result, its gradient orientation histogram has two strong peaks at orthogonal orientations. Corner features, whose own localization is determined by orthogonality in local gradient orientation distribution, provides a natural tool for us to localize barcode area from this gradient prior[5].

2.3 Variance-Frequency distribution Model

Compared to the other patterns in image, all pixel values within 2D QR codes have obvious gray level distribution of black and white group(they keep uniform variance of the distribution) and they are also keeping very high and uniform frequency in gray level changes). So we describe the Variance-Frequency Model(VFM) of the average QR codes to show the general features of the QR codes.

Given our computed density map of input QR code group, we estimate the barcode region with the above model. First, since a barcode has strong black/white contrast, its appearance will still have relatively high variance. We measure a score S_1 as:

$$S_1 = \mathrm{Var}(P) \qquad (1)$$

where Var is the variance. Second, a barcode region has a very high frequency of black/white rectangles, thus we define S_2 as:

$$S_2 = \mathrm{Freq}(P) \qquad (2)$$

where Freq is the frequency of the pixels value distribution. Third, a barcode region must be a concentration of corners, thus we define S_3 as:

$$S_3 = \sum_{(x, y \in C(P)} M(x, y) \qquad (3)$$

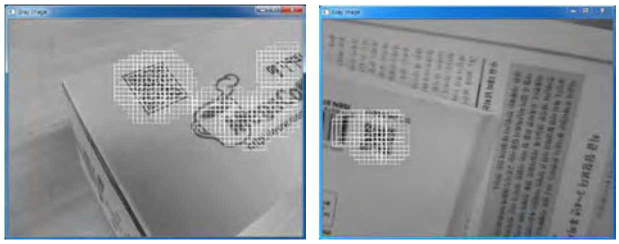
where C(P) is the set of all detected corners in the patch P, M(x, y) is the corner strength (magnitude) map. In our research, the size of QR code basic cell captured has the range of 3~5 pixels because QR code is usually being captured badly from a long distance camera in the logistics environment, therefore we suppose that the size of QR code is more than 60x60 and VFM window is more than 50x50.

2.4 Estimation of final QR code region

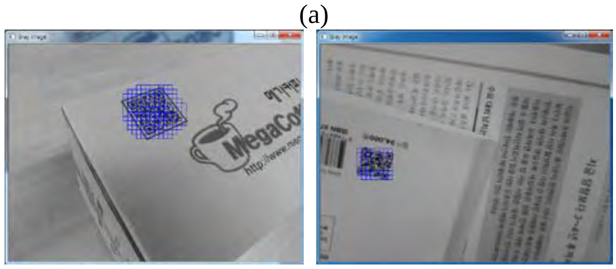
Based on the modeling and score description of QR code candidates region above, we finally estimated the region by simply adding the three scores S1,S2,S3 numerically and we give a candidate definition window only to the region with the all 3 score values.

3. Experiments

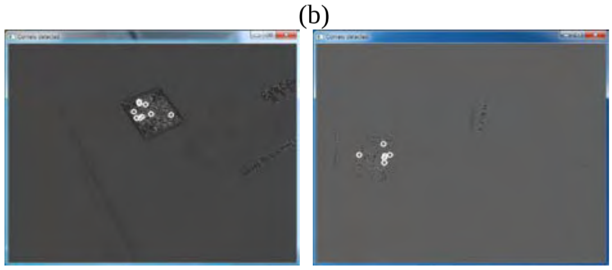
We tested the proposed algorithm on several test images captured in practical packaged objects printed with QR codes and two examples of them are shown in Fig. 2 and the results shows the algorithm is working well even when there are many similar patterns are existing. The proposed algorithm is implemented using Visual C++ programming environments and the test image size is 640x480 and 1280x720 with 24bits color.



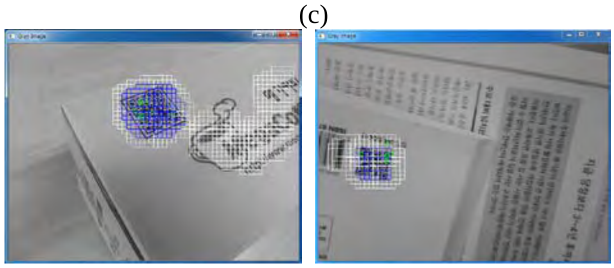
(a)



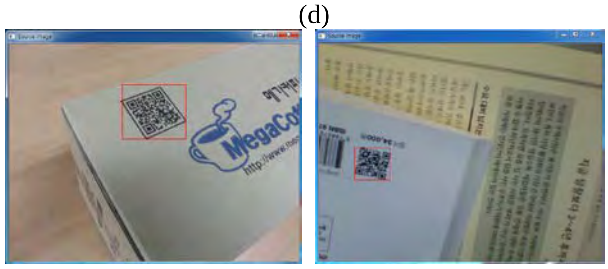
(b)



(c)



(d)



(e)

Figure 2. Experiment for test image 1, 2 (a) detected region with target variance (b)detected region with target frequency (c) detected corner features (d) combined region with VFM and corner features (e) final detected candidate window

4. Conclusions

In this research, A 2D barcode region localization system for the automatic inspection of a long distance logistics objects has been developed. For the successful 2D barcode localization, variance and frequency of the pixel distribution within average 2D barcodes is modeled and the average model of 2D barcode is combined with the corner features to localize the final 2D barcode candidates. An automatic 2D barcode localization software was developed with the multiple features mixture method and we tested our system on real camera images of several popular 2D barcodes.

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