Image Enhancement for Two-dimension bar code PDF417

Ji Hue Park*, Hong Chae Woo**
*A College of Information of Communication, Daegu University, jhpark@daegu.ac.kr
** A College of Information of Communication, Daegu University, hcwoo@daegu.ac.kr

Abstract - As life style becomes to be complicated, lots of support technologies were developed. The bar code technology is one of them. It was renovating approach to goods industry. However, data storage ability in one dimension bar code came in limit because of industry growth. Two-dimension bar code was proposed to overcome one-dimension bar code. PDF417 bar code most commonly used in standard two-dimension bar codes is well defined at data decoding and error correction area. More works could be done in bar code image acquisition process. Applying various image enhancement algorithms, the recognition rate of PDF417 bar code is improved.

Keywords: image enhancement, two-dimension bar code

1 Introduction

PDF417 is setting new standards for identification. From drivers' licenses to social services and national ID cards, PDF417 has become the preferred means of encoding ID information. PDF417 answers the need to store and transfer large amounts of data securely and inexpensively. A single PDF417 symbol carries up to 1.1 kilobytes of machine-readable data and it can contain biometric data files such as photographs, fingerprints, and signatures, as well as text, numerics and graphics. Symbol's total solution approach to PDF417 includes an extensive line of high performance products capable of reading both PDF417 and 1-D symbols.

2 Symbol structure of PDF417

Each PDF417 symbol in figure 1 consists of a stack of vertically aligned rows with a minimum of 3 rows (maximum 90 rows). Each row includes a minimum of 1 symbol character (maximum 30 symbol characters), excluding start, stop and row indicator columns. The symbol shall include a quiet zone on all four sides.

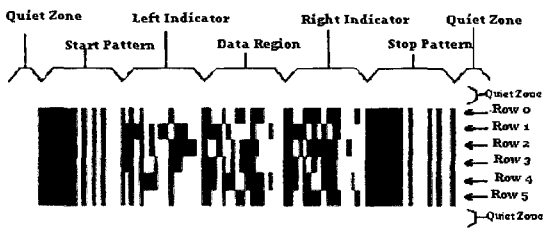


Figure 1. Symbol structure of PDF 417 code.

Each symbol character in figure 2 is 17-module wide which always consists 4 bars and 4 spaces. Each symbol character represents a value ranging from 0 to 928 which is called 'codewords' in the specification [1].

You can adjust the following parameters of a PDF417 symbol:

- Number of Rows
- Width of the unit (X dimension)
- Height of the unit (Y dimension)
- Number of Columns (or Aspect Ratio of the symbol)

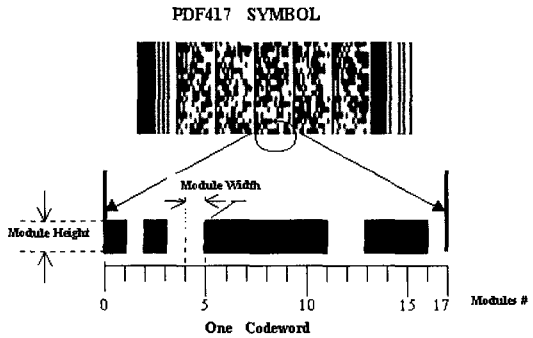


Figure 2. PDF417 codeword structure.

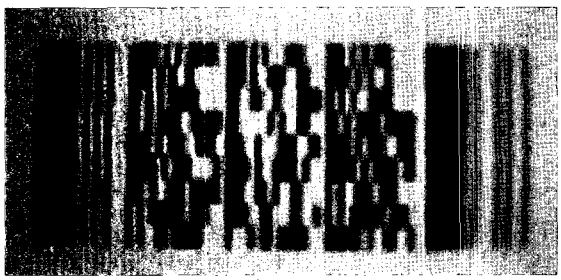
3 Image enhancement for two-dimensional bar code PDF417

3.1 High-pass filtering

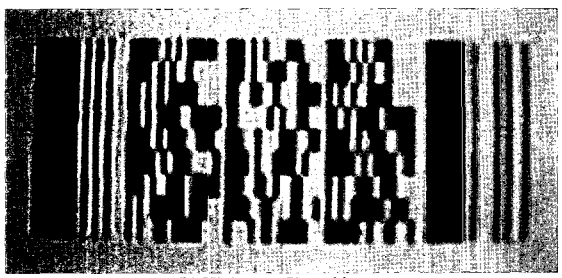
Edges and sharp transitions in gray-values in an image contribute significantly to high-frequency content of its Fourier transform. Regions of relatively uniform gray-values in an image contribute to low-frequency content of its Fourier transform. Hence, image sharpening in the Frequency domain can be done by attenuating the low-frequency content of its Fourier transform.

For simplicity, we will consider only those filters that are real and radially symmetric [2]. An ideal high-pass filter with cutoff frequency r_0 : **(1)**

$$H(u,v)=\begin{cases}0, \text{ if } \sqrt{u^2+v^2} \le r_0 \\ 1, \text{ if } \sqrt{u^2+v^2} > r_0\end{cases} \qquad (1)$$



(a) Blurred image



(b) High-pass filtered image

Figure 3. High-pass filtering in PDF417

As shown in figure 3, blurred image cannot decode the correct bar code, but the correct bar code was recovered after applying high-pass filtering.

3.2 Median Filtering

The median filter is normally used to reduce noise in an image, somewhat like the mean filter. However, it often does a better job than the mean filter of preserving useful detail in the image .

The median filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighboring pixel values, it replaces it with the median of those values. The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value. If the neighborhood under consideration contains an even number of pixels, the average of the two middle pixel values is used. Figure 4 illustrates an example calculation [3].

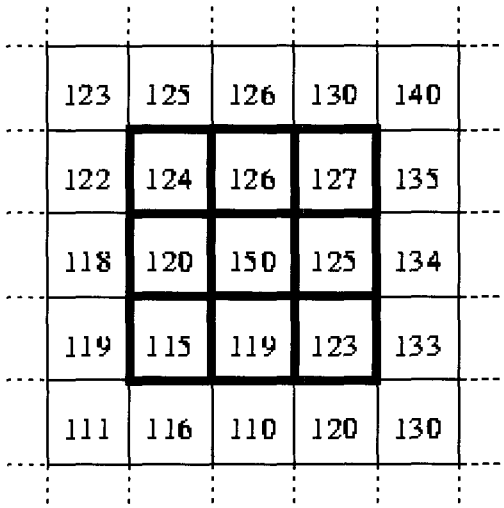
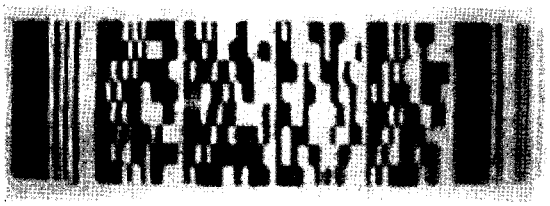


Figure 4. Median Filter

As can be seen, the central pixel value of 150 is rather unrepresentative of the surrounding pixels and is replaced with the median value, 124. A 3×3 square neighborhood is used here, but larger neighborhood will produce more severe smoothing.

(a) Salt & pepper noise added image



(b) Median filtered image

Figure 5. Median filtering in PDF417

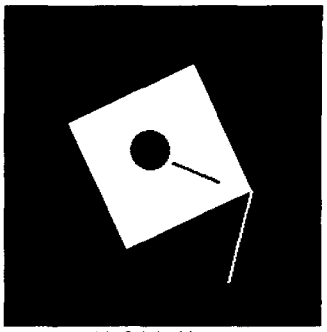
In figure 5(a), PDF 417 image was contaminated with salt and pepper noise and the correct code was not found. After applying median filtering, the code was decode correctly.

3.3 Mathematical Morphology

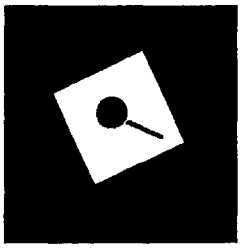
Mathematical morphology for image processing in figure 6 consists of applying basic set operations to an image. Mathematical morphology is based upon Minkowski operators and DeMorgan's laws. It should be noted that Minkowski operations and DeMorgan's laws apply to binary valued sets. Black and white Images can be used here.

Minkowski operators consist of a type of addition and a type of subtraction. Minkowski addition, also known as dilation, consists of taking a set known as a structuring element and applying it to each member in the source set. In the continuous case Minkowski addition can be thought of as a way to grow the members of source set by a method of pseudo-convolution. In image processing it is rare to use the continuous case of Minkowski addition, instead the discrete case is used. To implement discrete Minkowski addition, on an image, the structuring element is applied to each pixel in the source image. Applying the source image to each pixel means that the origin of the structuring element is translated to each pixel in the source image that has a value of one. Note that this is for binary images. Then every pixel where either the source image or the structuring element contain a 'one' the output image pixels are set to ones. This either operation is the simple binary OR operation.

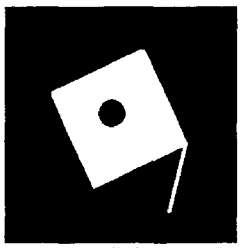
Minkowski subtraction, also known as erosion, consists of taking the structuring element and sliding it about the source image just as in dilation. However instead of ORing the source image with the structuring element the images are ANDed for each translated/shifted movement of the structuring element [4].



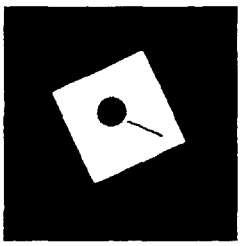
(a) Original image



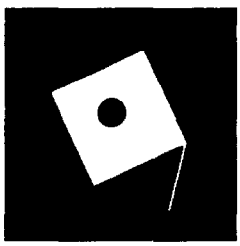
(b) Erosion



(C) Dilation



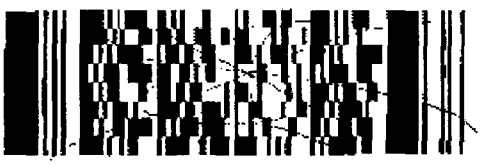
(d) Opening



(e) Closing

Figure 6. Binary image morphology

(a) Scribbled image



(b) Scribbled binary image

(c) Dilation and erosion applying

Figure 7. Scribbling in PDF 417 image

In figure 7 (a) and (b), hand writing was in the images, so that correct bar code was not recovered. After applying morphological operation, the correct code was decoded.

4 Conclusions

PDF417 two-dimensional bar code system is investigated for contaminated images. The blurred bar code image was correctly decoded with high pass filtering. The salt and pepper noise added image was corrected with median filtering and decoded. The scribbled bar code image was correctly recovered after dilation and erosion morphological manipulation.

References

[1] Barcode Introduction PDF417 SYMBOLOGY, Esesoft

[2] Mohamed Ahmed Noman, Frequency Domain Filtering

[3] Bob Fisher, Simon Perkins, Ashley Walker and Erik Wolfart, Hypermedia Image Processing Reference

[4] Greg Simon , Introduction to Morphology