Study on Image Processing Algorithms for Data Matrix in Dotted Domain

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ABSTRACT

Dotted Data Matrix two-dimensional bar code is widely used in the field of machinery and electronics, automobile manufacturing, pharmaceutical and medical, military firearm management etc. Compared with the standard Data Matrix two-dimensional bar code, Dotted Data Matrix bar code is composed of solid dots, which has no obvious characteristics of “L” shaped seek border region. The gaps between dotted data matrix modules are too large which increase the difficulty of identification. To solve the problem of the low recognition rate of dotted Data Matrix code, this paper gives the specific processing method which has certain degree of adaptability. This method obtains the size of bar code dotted module mainly by the spot detection algorithm that provides the reference of fixed value for the subsequent processing. Experimental results show that the algorithm can overcome the effects of large clearance, uneven illumination and noise interference in the recognition, and increase the recognition rate.

Keywords: Dotted Data, DPM, Spot Detection, Two-Dimensional Bar Code

INTRODUCTION

The data matrix bar code with a large capacity of coding, high density, information security, etc. (ISO/IEC16022-2006), can contain the most data information compared with other two-dimensional bar code in the case of the same size and density. So the data matrix bar code becomes the most useful barcode in DPM (Direct Part Mark). There is a dotted data matrix bar code (Cheng, 2008) that has been used in many applications, such as automobile manufacturing, medical and military firearm management. Because of its easy generation, it is widely used in metal, glass, hard plastic and other materials. At the same time, because of the diversity of generation method of dotted Data Matrix and the use of materials, it usually leads the code images to have low contrast, noise, complex background, the uneven illumination in the process of collecting. The dotted data matrix is a special type of data matrix with a large gap between point and point.

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At present, the image preprocessing research of the standard Data Matrix code is endless (Liu, You, Sun. 2010), but the relatively research of dotted Data Matrix code image preprocessing is little. Therefore, based on the above problems, this paper presents a series of dotted Data Matrix image processing methods. The main purpose of the algorithm is to do some pretreatment of the initial two-dimensional code image. This method obtains the size of bar code dotted module mainly by the blob detection algorithm (Lindeberg, 1998) that provides the reference of fixed value for the subsequent processing. Firstly, the quality of images can be improved by image preprocessing. Secondly, the bar code will be segmented by the improved Bernsen binaryization algorithm (Yang, 2008) that can solve the problems of reflection and uneven illumination effectively. Finally, dotted matrix Data Matrix code is changed into standard Data Matrix code by dynamic morphology transformation for binaryziation images. The principle diagram of the system is shown in Figure 1.

**BLOB DETECTION**

Dot is the difference area that is between the surrounding color and gray level. Dot often has the same concept with feature points and the key point, as well as the point of interesting. There are a lot of spots in the actual digital image. For example, from a distance, a person, a tree, and a building can be looked as a dot respectively. Unlike the simple corner point, dot represents a small area, so the stability is better, stronger anti-noise ability. Dot detection is generally the following steps: define the operator on the image convolution operation; search the extreme value of local response. There are many dot detection algorithm, such as LoG, DoH and Gilles etc. This algorithm for image pretreatment process is time-consuming. In order to accelerate the speed of operation and increase the stability and accuracy of feature extraction, this paper uses LoG dot detection algorithm to process the two value image.

In 2002, through a large number of experiments, Mikolajczyk found that normalized scale Laplasse of Gauss function \( \sigma^2 \nabla^2 G \) produce the most stable image features by the maximum and the minimum value, Compared with other feature extraction function, for example: gradient, Hessian or Harris corner feature. Therefore, using the Gauss Laplasse (Laplace of Guassian, LoG) operator detect dot feature.

Setting the original image is \( f(x, y) \) through the convolution and Laplace operator get the output image:

\[
h(x, y, \sigma) = \nabla^2 \left( G(x, y, \sigma) f(x, y) \right)
\]  

(1)

In the formula (1),

\[
G(x, y, \sigma) = \frac{1}{2\pi\sigma^2} \exp\left( -\frac{x^2 + y^2}{2\sigma^2} \right)
\]  

(2)

The formula (2) is a two-dimensional space Gauss’s function. In formula (1), \( \nabla^2 \) is Laplasse operation. \( \sigma \) s represents scale space coordinate. And Gauss kernel is the only way to produce multi scale space. Scale is an objective existence, and the form of convolution is Gauss scale...