Feiyu Xiao

POSITIONING AND CORRECTION OF DISTORTED QR-CODE

This article mainly study about the problems of QR-code decoding from distorted problem, new problems appear due to different camera angle, image external tilt, paper quality, environmental effect, light glare and other environmental effects. In the process of research, getting an effective algorithm to solve the problem caused by the distortion of the QR-code.

INTRODUCTION

The QR-code also known as a quick-response matrix code, is a kind of two-dimensional code. A large amount of information can be stored in a QR-code, which has the advantages of readability, high confidentiality, and strong anti-counterfeiting properties. The QR-code is much more efficient than other two-dimensional codes. With the popularization of two-dimensional code technology, it has become a research hotspot to locate and recognize QR-code effectively. There are many applications where the QR-code is used, and when the code is in a complicated background, it is necessary to locate and extract useful information about the QR-code. Especially when the QR-code is on a non-planar surface, such as a curved surface, the captured QR-code displays distortion. To achieve accurate recognition, the QR-code needs to be corrected for distortion. In order to solve this problem, many methods have been proposed to locate and identify QR-code images with deformation and on complex backgrounds.

I. STANDARD QR-CODE ENCODING AND DECODING

QR-code is a kind of matrix QR-code, which is composed of dark and light-colored square modules arranged in accordance with certainrules,it can split up in to 6 parts.The QR-code is designed with a variety of unique symbolic characteristics, which ensures that the QR-code can be quickly positioned while identifying it.

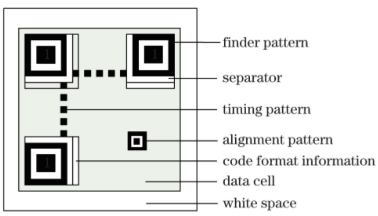

Fig. 1 Structureof QR-code

Each of these six zones described as follows :

Quiet zone: An empty white border which makes it possible to separate the code from other printed information .

Finder patterns: Large black and white squares in three of the corners which make it easy to confirm that this is a QR-code . Since there are only three of them, it is instantly obvious which way up the code is and which angle it is indicating at .

Alignment pattern: The alignment pattern assures that the code can be decoded even if it is distorted .

Timing pattern: This runs horizontally and vertically between the three finder patterns and consists of alternate black and white squares. Version information: There are various versions of the QR-code standard; the version information simply identifies which one is being used in a code.

Data cells: Each individual black or white square that is not part of one of the standard features contains some of the actual data in the code.[1]

II. LOCATION OF QR-CODE

According to the reference decoding algorithm proposed by the QR-code[S] standard, the method of determining the image-seeking graphics is carried out in this way: when the depth and depth pixels are close to 1:1:3:1:1.

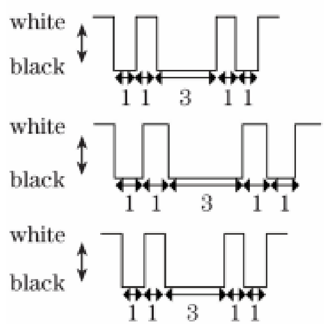

Fig. 2 The ratio of arbitrarydetectionangle

When recording the position of the first and last row and the position of the column, a total of 4 straight lines can be obtained, surrounded by a square, as shown in the figure.Connect the diagonal of the square to obtain the center point of the detection pattern.

Follow the steps above to find the three positions in the QR-code symbol to detect the center of the graphic. At this time, the center points of the three detection graphics can be directly connected to form a triangle.[2]

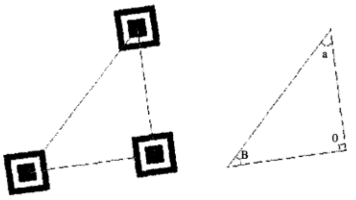

Fig. 3 A trianglecomposedof three detectiongraphics centerpoints

It can be seen that the vertex of the corner with the largest angle among the three corner points corresponds to the center point of the detection pattern symbol in the upper left corner of the QR-code. Therefore, the orientation of the bar code symbol can be achieved by rotating a certain angle.

III. CORRECTION OF QR-CODE

The inverse projection transformation method is used in the correction process. The inverse projection transformation is to project the picture to a new visual plane, also known as projection mapping.This transformation can be used to transform an irregular quadrilateral to the regular quadrilateral.

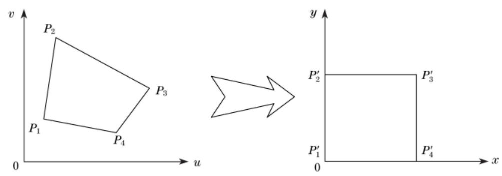

Fig. 4 Inverseperspectivetransformation

The transformation formula and conversion matrix M is:

$$M = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \quad (1)$$

$$x = \frac{a_{11}u + a_{21}v + a_{31}}{a_{13}u + a_{23}v + 1};$$

$$y = \frac{a_{12}u + a_{22}v + a_{32}}{a_{13}u + a_{23}v + 1}. \quad (2)$$

Where (u,v) and (x, y) are the image coordinates before and after the conversion, and aij (i, j=1, 2, 3) is the coefficient of the equation.It can be seen from the equation that there are 8 unknowns Parameters, so at least 4 sets of coordinate points are required. Substituting the coordinates of the four control points of the QR-code that have been obtained into the formula, the parameter solution can be obtained, and the parameter solution can be obtained.

Finally, multiply the coordinates of the original image with the conversion matrix to obtain the corrected QR-code, compare the gray value of each pixel in the picture with the average gray value of the surrounding pixels, if the current pixel When the gray value of the point plus a certain proportion of the average gray value is less than or equal to the average value, the pixel value of the point is set to 0, otherwise it is set to 255.[3]

Where f (x,y) is the gray value of the coordinates (x,y) in the grayscale image, and g (x,y) is the pixel value in the binary image after threshold processing as follows:

$$f(x, y) = g(u, v) * M; \quad (3)$$

$$f(x, y) = g(\frac{a_{11}u + a_{21}v + a_{31}}{a_{13}u + a_{23}v + 1}, \frac{a_{12}u + a_{22}v + a_{32}}{a_{13}u + a_{23}v + 1}). \quad (4)$$

Since the coordinates after the inverse projection transformation are generally not integers, the converted QR code needs to be interpolated.Using bilinear interpolation pair The image is processed and calculated as follows:

$$A = (1 - n) * f(x, y) + n * f(x, y + 1);$$

$$A = (1 - n) * f(x + 1, y) + n * f(x + 1, y + 1);$$

$$w(x, y) = (1 - m) * (A + B). \quad (5)$$

IV. CONCLUSION

This article discusses the correction and positioning methods of QR-code images.First, the image characteristics of the two-dimensional code symbols are analyzed, and the positioning of the two-dimensional code is obtained based on the analysis results; then, the inverse projection transformation is used to perform geometric correction of the acquired image coordinates of the two-dimensional code symbols that have undergone geometric deformation.

V. References

1. Kishor Datta Gupta,Stefan Andrei,Md Manjurul Ahsan Solving QR-Code Distortions using a Recursive-based Backtracking Algorithm//-ResearchGate, 2019
2. Xiao Xiang, Liu Xiaoming, Wang Yunke Research on the correction and positioning methods of QR-code images//-Computer science, 2007
3. Ding Weili, Wang Mingkui, Gu Chao, Wang Wenfeng A fast correction method for multi-target QR-code image //ACTA OPTICA SINICA,2017

Feiyu Xiao, student of department of Information Technologies in Automated Systems Department, BSUIR, feiyuxiao606@gmail.com.

Supervisor, German Oleg, Associate Professor, Candidate of Technical Sciences, the Belarusian State University of Informatics and Radioelectronics, ovgerman@tut.by.