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# Identification of QR Code based on Pattern Recognition with Mobile Phones

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***Abstract:*** *Quick Response Code has been widely used in the automatic identification field. This paper proposes a implementation of real-time Quick Response Code recognition using mobile, which is an efficient technology used for data transferring. An image processing system based on mobile is described to be able to binarize, locate, segment, and decode the QR Code.*

***Keywords:*** *Quick Response Code, Binarization, recognition, mobile- Phone*

## I. INTRODUCTION

Bar code is fast, easy accurate and automatic data Collection method. Bar code enables products to tracked efficiently and accurately at speed not possible Using manual data entry System. The bar code reader only be used to recognize the bar code, and the price of two dimensional bar code reader is expensive.

Now mobile phones can implement much new kind of new applications such as taking photos, and movies shooting by using embedded camera device. So and interesting approach is capturing bar-code with their cameras and decoding them with software running on the phone. Recently the mobile industry begins to pay more attention to bar code application in m-commerce because 2D barcodes not only provide a simple and expensive method to present diverse commerce data, but also improve mobile user experience by reducing their input.

Previous research work has shows that recognition of 2D barcode is researching hotspot and very difficult in various conditions. These condition include highlight spots, skew projections low contradistinction, non-homogeneous lighting, and various mixed conditions.

Ohbuchi et al presented an algorithm capable of the real-time recognition of barcodes on a mobile phone. The most important drawback of the method is the fact that it has been hand tailored for one certain hardware device. It relies on access to a powerful but also very specific hardware element, which is not accessible by normal application developers: the built-in signal processor of a device. Besides that, the algorithm proposed by Ohbuchi relies on two specific conditions: Prior to the code's decoding, the barcode's position is detected using a spiral scanning algorithm that runs on the device's signal processor.

This algorithm makes the assumption that the point in the middle of the screen is located in the code. This assumption is not realistic in usually environment. Ying et al presented an algorithm capable of recognizing the PDF 417 barcodes in real time with a mobile phone. This method includes three steps. The first step detects the code region using the Otsu algorithm and the Least Square Method.

The Second method searches for the cut-off rules with a scanning approach. In the third step symbol characters are segmented from the original image. So the successful linearization of the code areas during the first step is the most key step in his algorithm. This is mean the recognition result will rely on the effect of the Otsu method. But the Otsu method could be failed in complex lighting conditions, including highlight spots, low contradistinction, non-homogeneous lighting, and various mixed conditions. so the recognition rate of the algorithm proposed by Ying is not high especially in complex lighting conditions. Additionally, many constraints Are added in this method, so the application scope is decreased.

Sun et al. Introduce an algorithm to analyze and correct the distorted image of QR code. The algorithm consists gray-scale image transformation, Canny edge detection, external contours finding, inverse perspective transformation and cell grids generating. In this method, the recognition time will be cost more than Ying's method because there is no binarization operation; gray image is processed in all steps of Sun's method. The Processing time of the black-white image is less than the processing time of gray image.

## II. THE STRUCTURE OF QR CODE

Quick Response Code is developed in Japan by Denso Corporation in 1994, and later recognized as a standard. QR code has been approved as an AIM Standard, a JIS standard and an ISO standard. So QR Code is used in variety of applications, such as manufacturing, logistics, and sales applications. There are 40 versions in QR Code, four levels of error correction, and the maximum symbol size can encode 7089 numeric data or 4296 alphanumeric data. The Reed Solomon is used in QR Code, and the highest level of error correction allows recovery of 30% of the symbol code words. In addition to, QR Code has a clear feature that a finder pattern in the upper left and right and lower left corners.

Each QR Code symbol consists of an encoding region and function patterns as shown in fig.1. Function patterns include finder, separator, timing patterns and alignment patterns. The Finder pattern located at the three corners of the symbol intended to assist in easy location of its position, size and inclination.

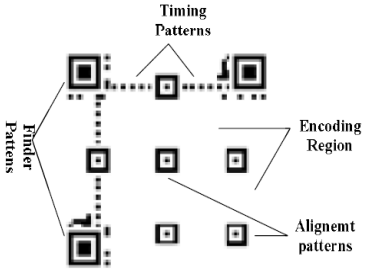


Fig.1.The structure of QR Code

## III. OUR APPROACH

It is proposed to device the recognition algorithm of QR Code which can be used in various lighting conditions. The algorithm consists of steps as gray scale image conversion, binarization, filter, orientation (finder patterns or timing patterns location), alignment patterns location, cell grids generating, error correction and decoding.

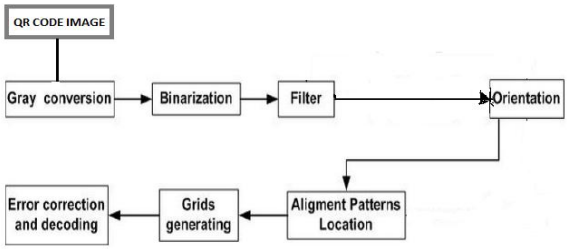


**Fig.2. Flow chart of the proposed work**

### 3.1 Gray Conversion

QR Code symbol is captured by mobile phone with camera, and images are captured in RGB 24bit format by most phones, but QR Code symbol is a set of dark and light pixels. It is needless to deal with color information and the gray image calculated quickly with little space, so gray conversion is needed to do firstly.

### 3.2 Binarization

Selection of a proper binarization method is critical to the performance of barcode recognition system. In binarizing an image, a simple and popular method is threshold. Among more than 20 threshold methods concluded that Otsu's method is the best, which chooses the threshold that minimizes within-group variance. But in our test, Otsu's algorithm is not satisfactory performance in uneven illumination and is not real-time implementation. Ohbuchi [3] propose a global threshold method. First he divided the center 60*60 areas of 320*240 images into nine blocks.

Then calculate the gray histogram for each block, and sort the gray value. The middle value is chooses as the threshold of each block. Finally the smallest value of these middle values is the global threshold of this whole image. This method is existed two drawbacks: (1) the barcode symbol must be in the center of the captured image, otherwise the method will failed. (2) This method Result in excessive segmentation. Separate a part of barcode image as background and lead to decode failure.

Using a global thresholding method, if an image has variable lighting conditions, the resulting binary image will be very bad . In this case, a local thresholding method performs better. The main problems with a local threshold method are hard to set a right window size, eliminate the block effect, and reduce the execution time. However, memory restrictions and embedded system requirements preclude the use of binarization algorithms that require a priori knowledge of the full image and large execution time, thus a number of well-known locally adaptive algorithms cannot be use. So it is difficult to binarize the bar code in various illuminations using one method.

An adaptive multi-level thresholding algorithm is purposed, which integrate the local threshold with global threshold. The algorithm can achieve higher recognition rate under the condition of lower illumination, contrast and uneven illumination. This method including following steps. Firstly, calculate the histogram of gray image. In order to decreasing the effect of noise, filter the histogram, and analysis the feature of histogram peak. If the filtered histogram is bimodal distribution, the lowest of trough or the middle value of flat trough will be used as the global threshold. In common lighting conditions, this global threshold is used to process image with the satisfying result. If the histogram of image is single peak histogram, and single peak area in lower gray area, it means that barcode image is in weak illumination; otherwise the barcode image is in strong illumination. We adopt iterative threshold method, which form the threshold with mean between old global threshold and center of dark area or light area. If histogram shows multipeak distribution, it means that the image is in the case of uneven lighting condition or complex background. The local threshold algorithm is used. The multi-level threshold method integrate global threshold and local threshold method it is meeted the real-time binarization in common lighting condition[1], and also satisfied the binarization in special illumination condition.

### 3.3 Filter

Standard opening and closing techniques are applied to the bitmap to remover noise. After the filter, edge detection is used in most recognition algorithm. But the QR code has its special features; three finder patterns will provide the quick orientation. So the step of edge detection is omitted in our approach as shown in figure this will increase the recognition rate.

### 3.4 Orientation

There are three identical position detection patterns located at three of the four corners of QR Code, as shown in figure 1. Three dark-light-dark squares are overlapped in very finder pattern, and the dark-light ratio is 1:1:3:1:1 There is the off chance that similar graphic existed in barcode symbol. So the approximately ration area should be quickly find. But when one of the finder patterns is partially dirty or damaged, we can use the timing patterns. The timing patterns provide the secondary information which can help us to locate the symbol, decide the rotation direction of symbol and the width of module . A, modular distance offset algorithm was used without rotating symbol. After located the finder patterns, the module width and height and the angle of rotation were known. We get the grid moving along the line which connects the central of three finder patterns. This method avoids the rotation and interpolation, increases the computing speed.

### 3.5 Alignment Patterns Location

Different from PDF 417 barcode, in order to correct the contorted QR code symbol, there are many alignment patterns in symbol. With the version increasing, the number of alignment patterns adding, as shown in fig 3. When version is 3, the number of alignment patterns is 1, but when version is 7, the number of alignment patterns is 6. Link the central point of the alignment patterns and three position detected patterns, the small sampling grid is formed. In small sampling grid, distortion is omitted. Therefore, located the central coordinates of alignment pattern is critical for recognition barcode.


Fig. 3 The number of alignment patterns

Using the known alignment patterns and detection patterns can estimate the central coordinate. In international standard of QR Code, a reference method that locates the central coordinates of alignment patterns is provided. But the precondition of this method is estimated the central coordinate just inside of the alignment patterns. A large of actual captured image are tested, the probability of estimated central value inside of the alignment patterns is only 70% . The other 30% image will be located failure using these methods. A new estimated method is provided which used eight directions of the estimated point. The method scan the nearly eight directions of the estimated point to find the central coordinate of alignment patterns point to find the central coordinate of alignment patterns which are satisfied condition. This method expands the scanning range, and 99.3% captured QR code image is successfully decoded.

### 3.6 Grid Generation

When the finder patterns and alignment patterns were located successfully, the segment is easy to do, and the grid is easy to generate. Then the corresponding pixels were getting to ready decoding.

### 3.7 Error Correction and Decoding

The error correction and decoding process is the last step of recognition barcode. It employs the Reed-Solomon error correction to enable accurate reads even when substantial parts of the code are distorted. Decoding is just the reverse of the encoding procedure and the decoding steps can reference to international standard of QR Code.

## IV. RESULTS

A user can scan and decode QR Code using a mobile phone with a built-in camera and Decoder software. After decoding the QR Code symbol, the user is forwarded to product related web-sites or marketing campaigns.The application software developed in java is executed in the computer and when it is ready to process , executable Jar File is copied to the Mobile Phone which is with Symbian Operating System.Then the image on any surface like NewsPaper,on the Computer ,Magazines are captured and Decoded .

| Sr.No | Noise Level in % | Decoding level in % |
|---|---|---|
| 1 | 0 | 100 |
| 2 | 5 | 100 |
| 3 | 15 | 100 |
| 4 | 25 | 100 |
| 5 | 35 | 100 |
| 6 | 45 | 100 |
| 7 | 55 | 100 |
| 8 | 65 | 100 |
| 9 | 74 | 100 |
| 10 | 77 | 87 |
| 11 | 80 | 85 |
| 12 | 90 | 55 |
| 13 | 95 | Decoding failed |

**Table – Result testing report for various noise levels:**

## V. CONCLUSION

With the Mobile Phone with camera device is getting more popular, recognition of barcode based on mobile phone is getting more important and practical, the method mentioned in this paper is a new high–speed, high-accuracy automatic recognition method for recognizing QR Code symbol in various illumination conditions. This method has no hardware specific requirements unlike ohbuchi's method and is able to run as a standard application on most of the mobile phones.

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