Quick Response Code for Fast Detection and Recognition of Information

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Abstract—"QR" stands "Quick Response", A Quick Response code is a two dimensional barcode which is readable by QR code scanners, smart phones with a camera. QR code which is widely used in automatic identification field and this will increases the speed of recognition by the decoder so as to integrate this algorithm into mobile terminals. In this paper, discussed mainly about how securely information can be hidden and how fast it can be recognized the information which has been hidden under the QR code. QR codes are mainly used to hiding the information and it can be used to link to any URL (Uniform Resource Locator). As mobile technologies become increasingly prominent in our daily routine, mobile tagging with QR codes in the business field is prevalently in many parts of the world. QR code can be able to store more information or data than existing Barcode technology and QR code can be able to read or scan from any direction. As the creator intended the code to allow its contents to be decoded at high speed. This paper demonstrates how system mainly follows phases i.e., generating the QR code and scanning (decode) the QR code. QR code provides some features which are high capacity to encoding the data, small printout (output) size, dirt and resistant to the damages, scan from any direction.

Keywords—Quick Response code, Binarization, recognition, smartphone.

I. INTRODUCTION

QR code is the 2D (two-dimensional) matrix barcode which is designed by Denso-Wave Corporation of Japan in 1994. The main purpose of this technology is to high-speed recognition, strong error-correcting capability and all-directional recognition.

QR codes are very popular now a days in case of matrix codes (2D bar codes). They are getting an increasing popularity from smartphone users. The QR codes or matrix codes are being used in different fields to store the meta-data information which is attached to the real world objects. These matrix codes are to be designed first so as that they would detected in images where they cover a essential portion of the image and where they are not deformed by perspective projection. But, their detection of high-resolution images of complex portions are desirable. And these views would involve rotation, perspective deformation and other distortions of the code.

Here, previous research was done on 2D barcode recognition technology, where recognition of 2D barcodes is very difficult in various conditions like highlight spots, skew projections low contradistinction, non-homogeneous lighting, and various mixed conditions.

Sun et al [4]. Introduced an algorithm to analyse and correct distorted image of QR code. This algorithm consists of grayscale image transformation, edge detection, external counter finding, inverse perspective transformation and cell grid generating. Here, the recognition time will be cost more because there is no binarization phase in this method, here image is processed in all steps of algorithm. The gray image processing takes more time to process it than the black and white image processing.

A. History of the QR Code

The QR code system was invented in the year of 1994 by Denso wave. The main purpose was to track the vehicles at the time of manufacturing. Basically it was designed to obey the high speed component scanning. Even though initially it was using for tracking parts in manufacturing of vehicles, these codes are now used in larger context, Both commercial tracking applications and convenience-oriented applications focused at smart phone users. QR codes are used in displaying of text to the users, to add to vCard contact to the user’s device, to open the uniform resource identifier, to compose an email or text message. Users can generate their own QR code, take a print and placed it in a public to access by the smartphone users, then that will encodes the image and fetches the information or link associated with that, then that accessed link will automatically connected to the web and fetches the related information.

A. QR Code Generator

QR Codes are two-dimensional bar codes in which information is represented by black and white dots (“square data dots” or “data pixels”). It is also possible to use colours if the contrast between foreground and background is high enough and the image is not inverted. 2D barcodes can be compared to one-dimensional barcodes, In contrast to these barcodes, QR code can contain up to 3000 characters on a small space.
The information for the QR Code is encoded according to the high density of information and many reader applications make QR Codes an ideal marketing instrument. QR code scanners are available for the smartphones with camera. So this camera is going to scan the QR code and decode the image and fetches the information.

II. STRUCTURE OF QR CODE

Fig.1 shows, a QR code symbol is a grid like structure or a square array which consists of some square modules. It includes encoding region and function region (it has finder patterns, separator symbols, timing patterns and alignment patterns). For the encoding of data the function region is not to be used. The surrounding region of QR code symbol is blank space. Three corners of the QR code symbol includes the finder pattern to assist in easy location of its position, size and inclination. There are some separator symbols width as a module between each probing pattern and the encoding region and all are consists of light modules. The timing patterns are determining the density and version of the QR code and it is providing the reference positioning.

III. PHASES OF ALGORITHM FOR CREATING A QR CODE

Step 1: Data Analysis

QR codes encrypt the string of text. The QR code has four standards for encrypting (encode) the texts that are namely numeric, alphanumeric, byte, and Kanji. Here each standard (mode) encodes the text as a string of bits (1s and 0s), but for converting the text into bits each mode uses a different method, and each encoding method is advanced to encode the data with the shortest possible string of bits. Hence, our first step must be to perform the data analysis to find whether our text can be encoded in what mode like numeric, alphanumerics, byte, or Kanji mode, then we are going to select the most optimal mode for our text.

Step 2: Data Encoding

Here we are already selected the appropriate mode of encoding standard for our text, the next phase is to encode the text. The data encoding phase describes that, this process in detail for each encoding mode. The output of this phase is a string of bits that is going to split up into data codewords that are 8 bits long each.

Step 3: Error Correction Coding

A QR code does error correction means that after we creating the string of data bits that points our text, then we should use those bits to generate error correction codewords and the process is called Reed-Solomon error correction. A QR scanner reads both data codewords and error correction codewords and by comparing the two codewords, the scanner is going to determine the correct data if it reads and it will correct errors if it did not read the data correctly.

Step 4: Structure Final Message

When after generating the data and error correction codewords, we are going to arrange the earlier steps in proper order. For large QR codes, system is going to generate in blocks of the data and error correction codewords, and these blocks are going to interleaved according to the QR code specification.

Step 5: Module Placement in Matrix

Once generating the data codewords and error correction codewords and that are arranged in the correct order, we must locate the bits in the QR code matrix. The codewords are arranged in the grid like structure called matrix in a specific manner. In this particular step, we will also locate the patterns that are common to all QR codes, like boxes on the three corners.

Step 6: Data Masking

Some patterns in the QR code matrix will make it difficult for QR code scanners for reading the code correctly. To overcome this, the QR code specification defines some masking patterns (eight are there), each of which modifies the QR code according to the particular pattern. We should find which of these mask patterns results in the QR code with the less undesirable quality. This is done by validating each masked matrix based on four penalty rules. Our final QR code should use the mask pattern that gives output in the lowest penalty score.

Step 7: Format and Version Information

In the final step, we are going to add format and version information to the QR code by setting pixels in particular positions of the code.
The formatted pixels find the level of error correction and mask pattern which is going use in the QR code. The version pixels encrypt(encode) the size of the QR code matrix and are only used in larger QR codes.

IV. FLOW CHART FOR QR CODE SCANNING AND DECODING

Algorithm for QR code detection in High-resolution images[12].

Input: Image I  
Output: Detected QR codes

1: compute $H_n(T(u, v))$ by edge extraction  
2: compute $H_n(T_l(u, v)), l \in \{2, \ldots, l_{\text{max}}\}$ from lower-level histograms (4)  
3: for all $l \in \{1, \ldots, l_{\text{max}}\}$ do  
4: compute feature vectors $v_l(u, v)$ from the histograms  
5: compute the segments $S = \{S_1, S_2, \ldots, S_k\}, k \in \mathbb{N}$  
6: for all $S_i \in S$ do  
7: compute segment probability $P(S_i)$ (2)  
8: if $C(S_i) == 1$ then  
9: run QR code detection algorithm  
10: end if  
11: end for  
12: end for

A. Steps include:

- Binarization  
- Get the approximate region of QR code, and implement positioning for QR image according to the finder patterns;  
- Implement the accurate positioning as that of alignment patterns;  
- Calculate the angle of inclination to rotate QR image, then implement process of rectification;  
- Get the version number and implement self-adaptive sampling;  
- Decode based on the corrected image and input the standard 2D matrix.

QR Code symbol is scanned by mobile phone with camera, and images are captured in RGB 24bit format. Here, QR Code symbol is a set of black and white pixels. It is no need to deal with colour information and the gray image going to calculate quickly with little space, hence gray conversion is to be done initially and this phase is called gray-conversion phase.

Binarization supports for the QR code decoding and directly affects the recognition speed of QR code. It should keep balance between real-time and effects. Dynamic iterations method will be used here to implement dimensional histogram grey-scale image data and obtain the optimal threshold value and this threshold value will going to use in binarization processing for the image.

Then standard opening and closing techniques are to be applied for the bitmap to removal of noise and the phase is called filtering, edge detection is to be used in most algorithms of recognition. But the QR code is to be specific; three finder patterns, that will provides the quick orientation. Hence here the edge detection will be reduced and recognition speed will increase.

QR code localization does that it sets the pixels by referring the finder patter which are located at each corner. This phase which scans the pixels of each row and then judges whether it is in black or white colour and sets the pixels. And the same happens at the each column pixels and verifies the points and cross-points of row and column scan line to centre position of black block. then move for the next step.

Geometric rectification refers to the following process that when an image occurs geometric distortion, we use the affine transformation formula with six parameters to implement geometric rectification for QR images, and obtain new image data or information.
Then, once done with the localization of finder patterns, easy to get the height and width of each finder pattern. Then divided by 42 after add them together. The result will be average width of modules. Finally the version number will be obtained. And the phase is called alignment pattern localization.

And then we will get the sampling images of QR code version wise and sampling is implemented in conjunction with alignment patterns. According to the version number of QR code.

**B. Speed of the Method:**

![Graph showing speed of the method](image)

Figure 3: The required time for processing in milliseconds. The graph which shows an average required times for different phases of the algorithm: the overall time consists of candidate search, detecting the code and binary matrix decoding; here code detection then form the segmentation and the creation of the tile hierarchy.

The main idea of using the grid of tiles is to minimize the number of positions to search for QR codes in the whole image. As seen in Figure 3, the code detection itself will takes high-resolution images in an average less than half of the actual required time of the algorithm. As mentioned before, to minimize the speed and computational requirements we also approximated the higher order graphics creation for the grid by subsampling the scanlines. This speedup is highly depend on the distance of the scanlines. Here if we use 10 pixel distance between consecutive scanlines, it means that algorithm has to process approximately 1/5 of the image pixels plus neighbours of the pixels where a gradient will be detected to get the gradient direction.

From Figure 3, which will clears that the major slowing factors that are the creation of tile grids hierarchy and the number of candidate positions that detector is forced to be process.

The grid creation phase initially consists of the gradient detection and vector calculations for each tile. And the segmentation is only done at the grid level and it will not introduce the larger computational overhead. However, quality of the segmentation and the classification has direct effect on the number of candidate positions and consecutively on the speed of the detection part.

**Example of QR Code**

![QR Code Example](image)

**V. DISCUSSION**

**A. Benefits of QR codes:**

QR Codes has benefits to both marketers and consumers, with an unmatched technological capability to quickly provide more information to the consumers who is interested in the brand or company. The approach of QR codes to marketers is clear. QR codes are easy to generate and implementing a QR code into an advertisement is less expensive than a company having to develop its own smartphone app (Patel, 2012). Marketers find value in QR codes because they can be placed generated code anywhere people will have time and a reason to take out their smartphone and scan the code. QR codes also gives versatility as they can be enlarged to the size of a billboard or minimized to the size of a stamp. And by the click of a button on a mobile phone, a QR code provides consumers to interact with the company of the ad they were viewing in a completely different form of media that was presented to them.

**B. Limitations of QR Codes:**

With any technological advancement, there are some disadvantages that come up with providing the innovation as a marketer and receiving the innovation as a consumer. After careful analysis of both the primary and secondary research on QR codes, three foreseeable drawbacks that will affects QR code adoption and usage in the future have been identified. First is the problem that not all the consumers can have the capability to scan the QR code, and they do, may not necessarily have the knowledge of how to use and scan a QR code. Many consumers have trouble understanding is that a user cannot simply take a picture of a QR code on their smartphone; they actually wants the right application installed on their phone to scan and provide content.
The second limitation to QR code adoption is the lack of uniformity among barcode scanning applications available on the smartphone depending on phone service provider and brand. Some smartphones come with a standard bunch of applications that include a barcode scanning app, but some smartphones leave it up to the consumer to download their own apps at their own convenience.

VI. CONCLUSION

As the smartphones with camera device is getting more advanced, recognition of barcode based on smartphone is getting more important and practical; the term here we mentioned that new high-speed, high-accuracy automatic recognition method for recognizing QR Code symbols any conditions. This method is not going to use the hardware specific requirements unlike ohbuchi’s method and is able to run as a standard application on most of the mobile phones. This paper introduces an algorithm steps for generating and pre-detection of QR codes. The algorithm is able to detecting locations with probable occurrences of matrix codes in a high-resolution image and these locations can be able to further process by an algorithm for detection and recognition of QR codes.

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