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An Effective Method for Removing Scratches and Restoring Low -Quality QR Code Images

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Abstract– *Quick Response Code is one types of 2D barcode. QR Code has been widely used in many fields. Here proposes a complete preprocessing system for restoring low-quality Quick Response code images. The system has been designed to deal with low contrast, rotated and deformed code images. If any scratches are present in QR code the decoding algorithm is unable to decode. This removal technique consists of multiple processes. The main advantage of this proposed system is to restore the code properly and efficiently. This system has been assessed on a database composed of 500 images captured by a different cell phones display. After the proposed preprocessing, 97.4 % of the images in the database were correctly decoded.*

**Keywords:** *QR codes, binarization, Median filter, Dilation*

1. INTRODUCTION

Bar code is a fast, accurate and automatic data collection method. Two dimensional barcodes are developed from one dimensional barcodes, the information can be stored both in horizontal and vertical direction. Two dimensional barcode have many advantages: small areas, high capacity, high density, error detection etc. In the case of Barcodes specific scanners were designed to capture code images and decode them. Nowadays, the computational capabilities of cell phones are very increasing, as well as the quality and resolution of the latest embedded cameras. The QR code avoids the use of an ad hoc scanner .They are defined by the ISO/IEC18004 standard [1].This QR codes are two dimensional codes and which are very popular. They are used in many commercial applications due to their high-speed decoding. Now the modern handheld devices can show a barcode on their screen with enough resolution to properly decode this QR code. This QR code is used in many applications: boarding passes, event tickets, retailer loyalty cards, identification systems, etc.

This paper gives the solution for the challenging problem of restoring a QR code image that has been captured by a cell phone. The QR code decoding process is illustrated in Fig. 1.

Therefore, problems are faced at both ends: one arises at the decoding device due to either the limited computational resources or the poor quality of camera in mobile phones; and other coming from the displaying device, such as low contrast or external elements appearing in the surrounding area of the code, such as text, icons, option buttons or any scratches etc. One type of distortion is scratch or damage that give incorrect solution for QR code. This paper gives solution for these above problems.

There have been several related QR code works. The previous works in QR code recognition, such as [2] and [3]. Some recent works are done, such as [4] and [5]. In [6] a blind deconvolution iterative algorithm was proposed to address the deblurring problem in two-tone images.
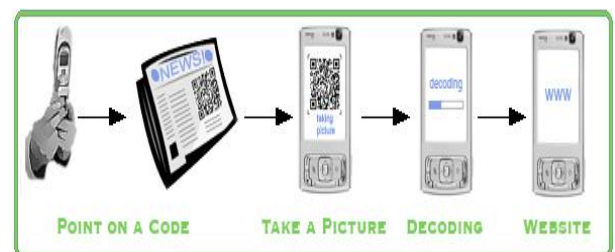
Figure 1: QR code decoding

The rest of this paper is organized as follows Section II provides a brief overview of QR codes. In Section III, the proposed system is described in detail; Section IV describes the design of the quality index. Section V summarizes the conclusions.

2. STRUCTURE OF QR CODES

A QR code consists of black modules arranged in a square grid which are arranged on a white background. This can be read by an imaging device. The basic information unit of QR code is module and it is the minimum square element. The amount of information stored in the code is related to the version of the code. This code has several patterns which is used for fast identification and decoding: finder patterns, alignment patterns, and timing patterns. These patterns are illustrated in Fig. 2.
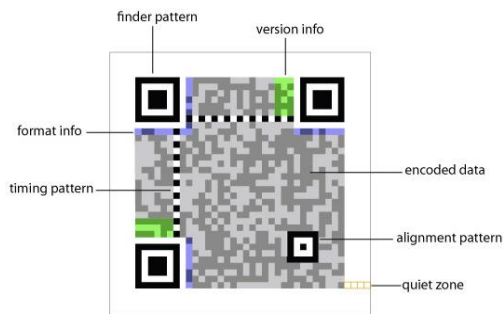

Figure 2 QR code structure

3. SYSTEM FOR RESTORING LOW-QUALITY QR CODES IMAGES

The flowchart of the proposed design is given in Fig. 3. The proposed system [7] is divided into several modules. Every module of the system has been described in detail. First capturing the image by a camera built in a mobile phone.

3.1 Contrast Enhancement:

When images capture using the camera, that image may be degraded due to some light sources. There are many contrast adjustment techniques are present, but here using a simple histogram equalization.
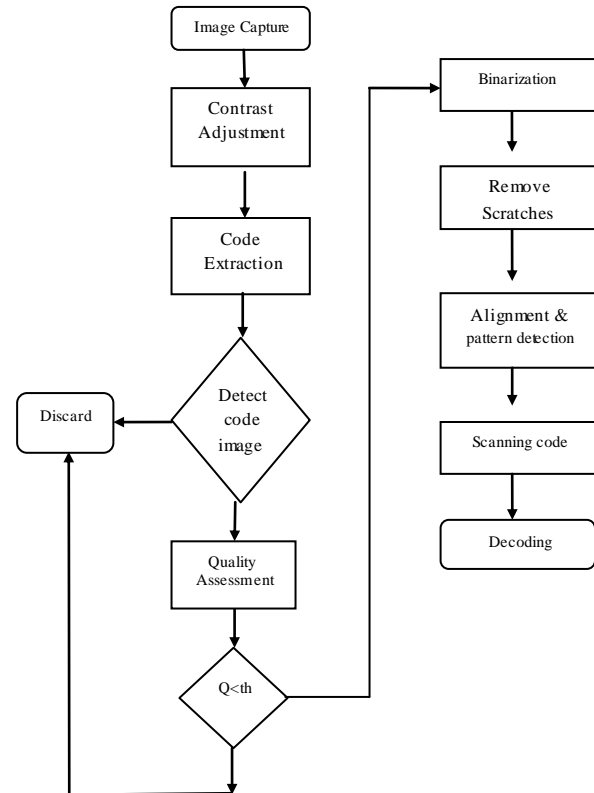

Figure 3 Flowchart of the system

3.2 QR Code Extractions:

The main goal of this module is to determine the area which QR code is located. The surrounding of the captured image contains some external elements such as text, icons, option buttons etc.

First perform the binarization then detect the edges using canny edge detector. Then performing some morphological operations such as dilation and closing. These operations are ensuring that the whole code is included. Then remove the text, spots, and other artifacts adjoining the code are removed.

3.3 Discarding Low Quality Images:

Here calculating the quality of the image. Then set a threshold value. If the quality is less than the threshold value then that image is discarding. This module is more demanding because to reducing the computation time. For calculating the quality of the input image here proposing an equation Q, is the mean value of the gradient magnitude at each image pixel $i, j,$

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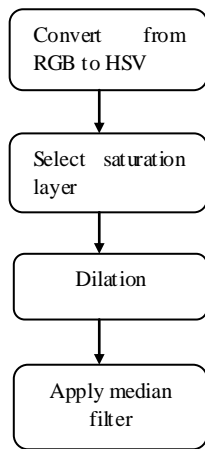
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$$Q=1/A.B\sum_{i=0}^{B-1}\sum_{j=0}^{A-1} MG\,(i,j)\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

When W and H represent the width and height of the image, respectively and MG is the gradient magnitude, the MG is defined as

$$MG\,(i,j)=\sqrt{I_\alpha^2\,(i,j) + I_\beta^2(i,j)}\ldots\ldots\ldots\ldots(2)$$

Where I_α and I_β denote the horizontal and vertical gradients, respectively.

3.4 Remove Scratches

**Figure 4:** processes for separating scratches from QR Code

Figure 5: The damaged QR Code

3.4.1 Convert from RGB to HSV:

The main advantage of converting to HSV is ease of using color more than standard RGB. HSV stands for hue, saturation, and value.[8] Hue is the main properties of the color. S is the intensity of color, when color intensity increase, saturation value also increase. Value is defined as the relative lightness or darkness of a color.
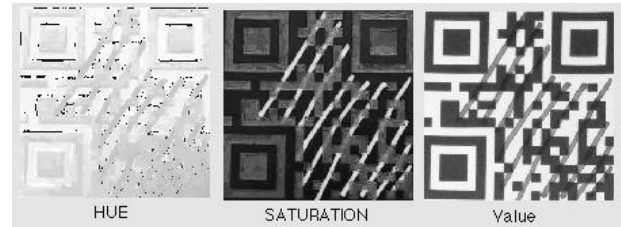
Figure 6 Images in HSV Model

3.4.2 Morphological Processing

Here a dilation technique is used as morphological operation. This technique is removing the scratch on the image. This is techniques is focus on binary image. This is performing by white spot and reducing black spot.

3.4.3 Median Filter:

This filter used mean value of neighborhood .It is one of the popular techniques for the removal of noise and it can be reducing the blurring. This technique is also applicable for impulse noise and removal of white and black spots scattered on the image.


Figure 7: Comparison QR-Code without/with Median filter

3.5 Code Alignment: Corner and Pattern Detection and Transformation

When images taken that images have some shape deformation are happened. This is caused by lack of precisions. This is removed by applying affine transformation. Find the coordinates of the code corners are the first step of the alignment process. This is done by the line scanning process. Affine transformation is a type of transformation which preserves ratios and straight lines of distances between points lying on a straight line.
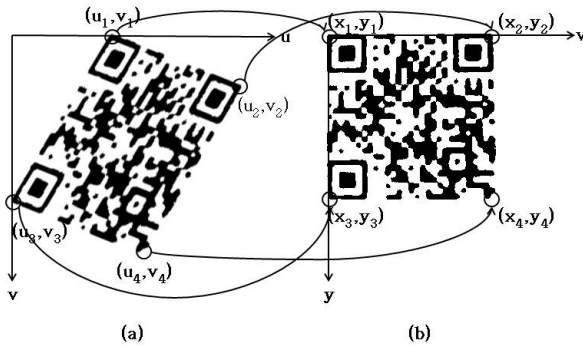
Figure 8: A code alignment example: (a) a shape-distorted QR code; (b) affine-transformed code.

3.6 Module reconstruction

This module is solving two problems they are shifted modules" and "invaded module problem.

3.6.1 Shifted Modules:
Sometimes the result of the affine transformation is not always giving correct result. Because may be shifted from original position to another position. To overcome this problem, calculate the proportion of pixels in disagreement with the predominant color in the module. This proposition is above a vale then that module is considered as shifted. The shifted modules number is estimated then compensating by calculating the number of lines containing a number of mismatched pixels.
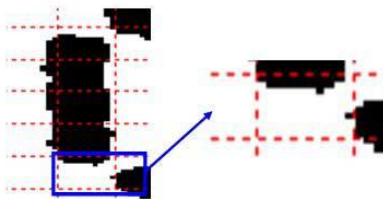
Figure 9 Examples of the shifted module problem

3.6.2 Invaded Modules
Blurring causes a strong erosion of the modules that are surrounded by modules of the opposite color this is called invaded modules. In Fig. 8. Two clear examples are shown.
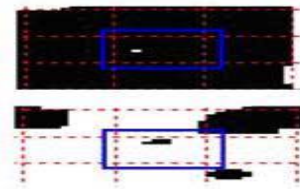
Figure 10: Examples of the invaded modules

To overcome this problem an algorithm is proposed. This algorithm check whether or not the peripheral color could have been inherited from the surrounding blocks the algorithm works as follows, for each module m the proportion of white pixels P_w is computed and the following decision is made:

$$L_m = \begin{cases} \text{White} & \text{if } Pm^w \geq th_w \\ \text{Black} & \text{if } Pm^w \leq th_b \\ \text{Unknown} & \text{if } th_b \leq Pm^w \leq th_w \end{cases}$$

L_m is a label associated with the module *m*, and *thw* and *thb* are thresholds. Here *thw=0.01* and *thb=0.05* are used as threshold. Using these methods a low quality QR code is easily and correctly restored and then decoded it.

4. CONCLUSIONS

Here propose a pre-processing system for restoring low-quality QR code images and remove scratches. QR code are the matrix barcode or two dimensional codes. These codes are mostly used due to its higher information storage capacity and their high-speed decoding. To remove the scratches on the QR code the procedures consist of Image Segmentation. It is performed by HSV, Dilation. Using median filter the scratches can be removed. This is very effective method for QR code decoding.

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