

A Technique to Remove Scratches from QR Code Images

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Abstract— Based on this article in this research paper, our study introduces an advance technique on removing scratch or damage that exists on QR-code. The QR-code decoding algorithm is unable to decode if the scratch that applies on the QR-code is more than Error Correcting Level threshold of current QR-code or the damage applies on some curtain area, which consider as information area of the QR-code. The scratch removal technique consists of several processes. In order to extract scratch from damage QR-code, simulate HSV (Hue, Saturation and Value) is apply and scratch on damage QR-code become more distinctive. Next, Morphological Image processing technique is apply by start with Dilation process that change the image structure and allow scratch become even more obvious. At this point scratch should be obvious enough and able to remove. To increase efficiency of decoding, Median filter is applied by transform image to Binary image to removing noise.

Keywords—2D Barcode, QR Code, HSV, Median Filter.

I. INTRODUCTION

QR-code stand for Quick Response Code, which is well known 2 dimensional barcode industrial as it, have high efficiency in accuracy and reading speed. Since the Blackberry integrate QR-code function on the device as alternative method for inviting people into their contact list. The device allow both encoding and decoding, Which user able to create and convert unique Blackberry pin into their personal QR-code for other user to scan and decode that allow decoded user to add people on to their contact list. QR-code becomes well known for Thai people. QR-code also becomes the international standard of 2 dimensional barcode due to high efficiency and excellent properties. QR-code is continuously developed by Denso Wave company [4], as development today its able to store more information. QR-code is able to store up to 7089 numeric. It also able to store in different type of format such as Numeric Characters, Alphabetic Characters, Kanji Characters, Symbols, Binary and Control Code.

In decoding process their still curtain limitation that interfere with distortion on the image. One type of distortion is scratch or damage that applies to image after encoding process is done. QR-code properties also include Error Correcting Level, which allow correcting up to 30% with limitation that distortion is not apply to some curtain area like information area of the QR-code. Decoding process intend to focus on 2 different color, black and white. The damage that has color close to black, decoding will consider the damage is black and decode as part of decoding process allow data become odd. Result, fail to decode. This is issue become problem and inspiration on this research. The scratch and damage removal experiment include several technique which are HSV(Color Segmentation), Morphological Image Processing, Binary image and Median filter(noise reduction) that present in this research paper.

In the next section, we describe the method description in detail of QR Code. In Section III, we provide method to remove scratches from QR Code, experimental results and analysis. In Section IV conclusion is provided.

II. METHOD

A. The Quick Response (QR Code)

QR Code is a two-dimensional bar code that is in the form of the Matrix Code The QR Code has several advantages over the one-dimensional bar code, as shown in Fig. 1 are more sensitive than in the QR Code Reader. It can hold more data. You can read the data on bar code is not complete.



Fig.1 One-dimensional bar code



Fig. 2 Two-dimensional bar code (QR Code)

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Fig. 3 Structure of a QR code

Fig. 3 shows the structure of the QR Code, which includes

- 1) Finder Pattern is intended to be used to detect the position of QR Code for Application to the decoder.
- 2) Format Area is intended to store data, Data Type and Data Mask, which is involved in transcription.
- 3) Timing Pattern is intended to detect the coordinates of the symbol for decoding.
- 4) Alignment Pattern in the images in the tilt can be read correctly by Decoder Application.
- 5) Data Area is used to store data, QR Code, which is the most space.
- 6) Quiet Zone is a region of the spec demolishing the white space which helps Boost the Finder Pattern to detect quickly.

Components of the QR Code QR Code is based on the Version of the Alignment Pattern is displayed in the Version 2 or later.

B. Error correcting in QR Code

QR Code is the Error Correcting for reading the data to move between the black and white. This classification is in the Error Correcting into four levels.

Error correcting able to restore data even the QRcode contain damage such as scratch. The portion of damage calculate in term of percentage ratio to the area of the QRcode must under the error correcting level in order to restore data. However, that damage must not infect to certain area which is Finding Pattern or Format Area as it contain essential information regard to decoding process. The decoding process halt, if the Finding Pattern or Format Area is damage.



Fig.4 The damaged QR Code

In Fig. 4 QR code is unable to decode as essential area have been damage.

C. Relate Theory

Recording device capture image for decoding process inform of color base. Analyzing process distribute to following method. Image Segmentation, it is basic of separating object. The priority of Image Segmentation is to analyze either

interest object or non-interest object which in this thesis pay attention technique as follows.

1) Image Segmentation using HSV

HSV (Hue, Saturation, Value) [2]. The purpose of the HSV is ease of using color more than standard RGB as the model was created as an alternative shown in Figure 5 and 6. HSV will provide a better definition of the different colors. For example, in a color such as yellow, it is difficult to distinguish group of yellow colors. Light yellow, dark yellow, and even brown in term of Art design point of view, it consider as yellow base. Saturation and hue in those colors are different. These values represent simple differences among color. HSV break down in to three values.

H (Hue) refers to the value of color such as red, yellow, green, measured as the angle from 0 to 360 degrees. Red, yellow and green colors are different in 60 degrees.

S(Saturation) is the intensity of color. The purity of the color values from 0 to 100. When color intensity increase, saturation value also increase.

V (Value) is brightness of the color values from 0 to 100, by increasing the brightness of picture, result increasing in Value. Regard to any value of Hue with Saturation of 0 and Value (brightness) of 100 will represent a white color. Any configuration with Value (brightness) of 0 will represent as black. Assume that Hue is yellow color with Saturation of 100 with maximum of Brightness will represent yellow where minimum of Brightness value still represent as black.

The advantages of using the HSV model have the least variation with light beam. The value of HSV are more familiar with human Therefore, it is suitable to be used with a QR Code of this research.

2) Morphological Image Processing.

In this research, using the Dilation technique to help in fulfilling the damage or scratch on the image from the Image Segmentation using HSV process to achieve a complete picture of scratches. Dilation technique will focus on binary type image, by adding white spot and reducing black spot using Structure Element lay over position with value 1. All near by pixel is automatically update the value to 1.

3) Binary image

The binary image come with two different levels. Black and white with the values 0 and 1 respectively. There are only two levels of intensity in the binary image. we consider that pixel that have low intensity is an image pixel where high intensity as background pixel. QR Code is a 2-dimensional barcode with only two colors. Black and white in the similar aspect ratio. The process prior to the removal of Noise using Median Filter is required to convert the image to a binary image in order to obtain more effective results.

4) Median Filter

Median Filter is a filter that used mean value of Neighborhood to calculate. Median filter is very popular technique for the removal of random noise and it can significantly reduce the blurring. Median Filter is become very effective when associate with Impulse Noise or been call as

salt-and-pepper noise, white and black spots scattered on the image.

III. EXPERIMENTAL RESULTS AND ANALYSIS

A. Experiment Procedure

The experimental procedure as following

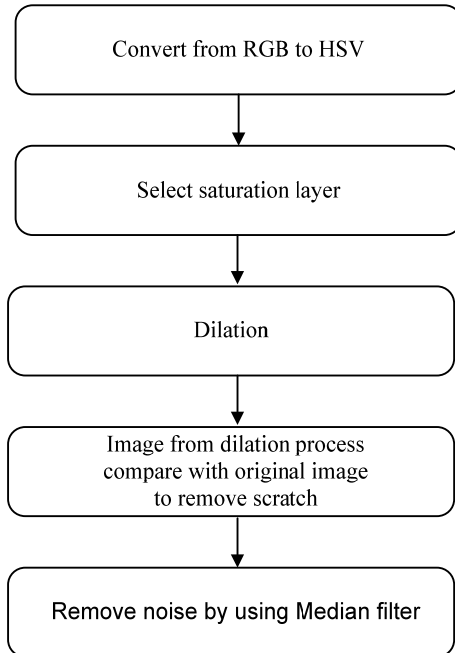


Fig. 5 The process of separating from scratch QR Code

B. Conversion from RGB to HSV

The images were capture and processed by the camera. This is an RGB color value come from the light sources and split into three colors domain: red, green and blue. Since the RGB values contain brightness and combination of light. Therefore need to be converted from RGB to HSV Model. Fig. 6 displays each layer RGB Model and the result of conversion to HSV shown in Fig. 7

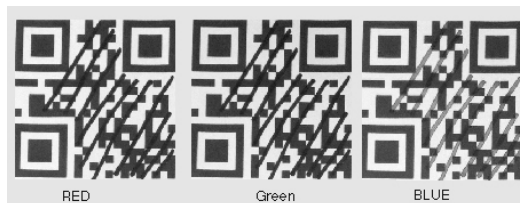


Fig. 6 RGB Model.

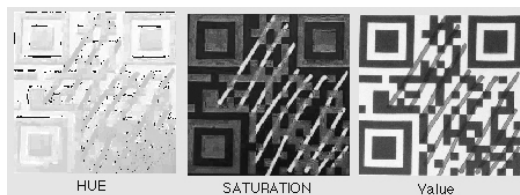


Fig. 7 Image in HSV Model

Fig. 7 shows that in the Saturation Layer boundaries were obviously clear and Value Layer show clear image of the QR Code. The next step is to optimize the Threshold level of Saturation Layer in order to get clear boundaries as possible. Which Histogram provide experiment value of saturation layer as shown in Fig. 8.

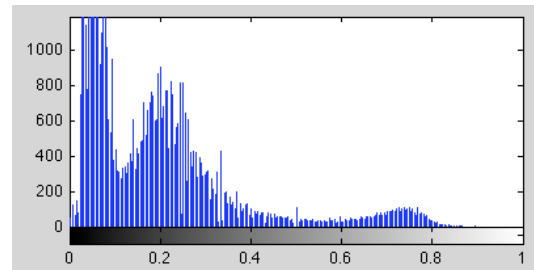


Fig. 8 Histogram of Saturation Layer with scratches.

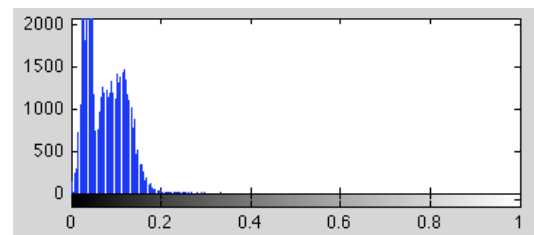


Fig. 9 Histogram of Saturation Layer of the QR code with no scratches

The comparison of the Histograms from the experiment provides enough detail to help optimization Threshold level with ease. Image with scratch would contain the Saturation value between 0.5-1. Optimization Threshold with experimental data result shown in Fig. 10

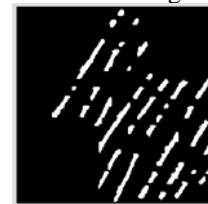


Fig. 10 Image with scratch after optimize threshold.

C. Dilation

The scratch marks on the image are yet to complete. The scratches that occur on the paper would effect from the ink that soak in the paper layer as Fig. 11. Therefore, in order to achieve clear scratch require Dilation process and the results are shown in Fig. 13.

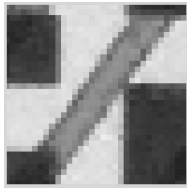


Fig.11 Magnify image of a scratch.



Fig. 12 Without Dilation process.

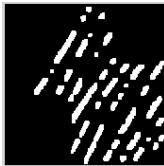


Fig. 13 With Dilation process.

D. Compare damage QR code with the result to remove scratch.

QR Code is usually composed of white and black. Selecting image from the Value layer after converting the HSV, as the image for scratch removing process. Scratch removing process is carry the position of the scratch and try to match the scratch on selecting image from Value layer as shown on Fig. 14.

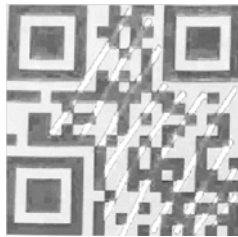


Fig. 14 Result from scratch removing process

E. Convert binary images

The QR code image that able to be decoded by decoder must compose of only black and white. The QR code image from scratch removing process is not yet ready for decoding as the image is not clear enough for decode. Therefore, conversion to binary image is requiring converting image into only 2 domains which is black and white as 0 and 1 respectively. Result shown in Fig. 15, binary image is able to be read and decode by decoder. By using the QR code reader software in modern cell phone [3].



Fig. 15 Binary image

F. Remove noise by Median filter

To maximize the quality of QR code, Median filter is require as it give satisfaction result on binary image. Fig. 16 show the result of 3x3 Median filters.



Fig. 16 Comparison QR-Code without/with Median filter

G. Experiment result.

5 sample of QRcode is taking in to account as for experiment. Each of the image consist of different pattern of the scratch locate on the surface of the image. Result shown as following.

TABLE I
COMPARISON BETWEEN SOURCE IMAGE AND OUTPUT FROM
IMAGPROCESSING PROCEDURE

Images	Source images	Output
A		
B		
C		
D		

TABLE I (CONTINUOUS)
COMPARISON BETWEEN SOURCE IMAGE AND OUTPUT FROM
IMAGPROCESSING PROCEDURE





Images	Source images	Output
E		
F		

TABLE II
SUMMARY OF THE BER OF EACH IMAGE

#	Images	BER
1	A	2.5232
2	B	2.3632
3	C	2.5312
4	D	2.4320
5	E	2.8640
6	F	0.3840

From the experimental result, compare image F result with non-scratch image giving the average BER(Bit Errors Rate) value of 2.54. The result of image A,B,C,D, and E are capture by cell phone's camera and test with the cell phone software. The software able to read through all of the image and decode with efficiency.

IV. CONCLUSION AND FUTURE WORK

This paper used benefit of image processing technique to achieve into next level. The procedures consist of Image Segmentation by HSV, Dilation, Binary Image and noise reduction by Median Filter. In the experiment, researcher prepare sample of damage QR code with scratch which the QR code software on the cell phone is not able to decode with current circumstance of the image. The damage QR code sample is apply with technique which research have well study. As the result of the experiment, image that been optimizing with the image processing technique is able to be decode with standard cell phone QR code software without any information lost. The image processing technique and procedure is efficiency enough to be used as Pre-processing of QR code. However, if the scratch color intercity is close to black or threshold level is not well adjust, the significant value could be increase.

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