An Image Binarization Algorithm for Scratches Removal and Restoration of QR Code Using Spatial Point Processing Threshold

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ABSTRACT

The QR Code usage is increased every day. The QR Code Images are damaged by scratch or scribbling on it. The intention of this paper is to remove scratches on The QR Code images using Spatial Thresholds. This algorithm is a pre-process of decoding the QR Code. It is to restore the various scratched QR Codes. According to the experimental evaluation, it gives 98% of the damaged QR Code images have been restored and decoded successfully.

Keywords *- Binarization, Enhancement, Image Binarization, Pixels, QR Code, Spatial Thresholds*

I. INTRODUCTION

Bar codes are widely used to store and retrieval information on even tiny objects, because of its size, reading speed, accuracy, 360 degree reading and error correction capability. 1D barcodes have the data only in horizontal direction with limited data capacity. But 2D (QR Code) barcodes can hold data in both horizontal and vertical direction of QR Image. When QR code compares with 1D barcodes, the data capacity is more than 100 times of a QR Code Image. QR Code is invented by Denso Wave Corporation, Japan in 1994. The Quick Response Code (RQC) adapted with many Japan's Company like, Automatic Identification Manufacturers Inc, Automotive Industry Action Group, Japan Automobile Manufacturers Association, Japan Trucking Association, etc. The QR Code is not only the encoding and decoding process, beyond that it is a pure image processing oriented.

A QR code is fundamentally an Image. This image have place many places. This QR Image can store up to 7,089 characters (numeric). QR Code Image is already used in Japan for various purposes as Air Ticket, Processed Food Traceability Chain, and Blood Test Sheet Blood Sheet etc., In India the QR Code Images are found on Government issued documents such as patta-chitta, income Certificates, Aadhar card, etc., from this QR Codes are widely accepted technology for fast access data around us. In present more than 100 websites to generate QR Code for personal or official use with free of cost.

The QRC Image is everywhere around us. It may be damaged or scratched at any time and any place knowingly or unknowingly. This paper is to restore the scratched QRC Image using Spatial Threshold Image Binarization. Binarizing an image symbolizing conversion of the image into black and white, the intensity information will be decreased to only two values either '0' or '1' and this builds the processing easier in the following stages to consider the various components of performing manipulations particularly on QR code image.

II. RELATED WORK

When QR Code is introduced by Denso Wave Corporation, it started using automotive industries. Now the whole word started using QRC Image in even unexpected different places. There is no limitation to use this QRC Image. However it should be used for meaningful places. There are many researcher doing the work on QRC Image Restoration, enhancement, filtering, etc., QRC Image gives researcher to do many real-time application oriented problem.

The Related works on Binarization have done many researchers. Chien-Hsing Chou et al. [1], A proposed method for Binarization by dividing the image into set of blocks and use the machine learning rules to categorize the different blocks of the sub images.

J. Sauvola et. al. [2] had given a method which performs a rapid classification of the local contents of a page to background, images and alphabets using the soft decision and Text Binarization methods.

Bolan Su et al., [3] had developed a method using an adaptive contrast map of input degraded document image. The contrast map is then

binarized and with Canny's edge map to identify the text stroke edges. Efthimios Badekas et al [4], proposed a method for Binarization of colour images using dominant colour features of the image. In each dominant portions of image connected components are extracted and then filtered using grouping procedure. The approach of connection property is used to classify the text and non- text areas of the image.

M. Ramirez et. Al., [5] had developed a threshold-based local algorithm for image binarization. The main aim is to compute a transition energy using pixel value differences taken from a neighbourhood around the pixel of interest. B. Gatos et al., [6] implemented a pre-processing procedure using low pass Weiner filter that performs a rough estimation of foreground and back ground objects of an Image.

The balanced histogram thresholding method [7] is a very simple method used for automatic image thresholding similar to Otsu's method.

III. PROBLEM DEFINITION

There are many methods to convert colour image to Binary Image. It changes only Black and White Image. Otu's method is the Global threshold for all kinds of information. However, Otu's threshold fails when histogram value is low of Image foreground or background. It is essential to have QRC in all the printed objects. Most of the QRC Image is Binary but some of the cases can be two coloured images. When QRC Image is got scratched on it. It is not decidable by the decoding software. Because the image is very sensitive, even it has the 30% of Reed Solomon error correction. The binarization techniques are very complex and are amalgamated from filters and existing process. At the same time many thresholding methods are available. But it cannot be applied to binarization problems particularly to recognize QR code images.

The QRCode is powerful and convenient to store data and read data often, because of its data capabilities and Quick Reading. If it is damaged like scratched or scribbled in any part of QRCode. It cannot be read by the scanning software. It possible to restore by using some photo-edit software tools, however need some more time to spend to do manual restoration. This paper assures with a new approach for Binarization of the Scratched and damaged QR Code images to restore and decode process to a better level. The proposed algorithm is to solve the damaged QRCode Image is able to restore automatically.

IV. PROPOSED APPROACH

The Proposed approach is to restore the damaged QRCode image. The actual QRCode image is small in size, compare to the ordinary picture files. The QRC Image Binarization and restoration process is mainly in three stages. First, it scans the complete damaged QRCode Image as RGB Color Format and converted to Binary image according to the RGB Pixel value. In Second stage, scan the QRC Binary Image pixel by pixel, threshold value is automatically calculated according the neighborhood RGB Pixel values. The Third Step is to build the new Binarized and Restored Image for equal size of the input Image. The figure 1 and figure 2 shows the pixel and neighborhood pixels. But the border of the image pixel does not have pixels around the pixel (in figure 2). The effective Binarization and restoration process has done using the spatial point processing method. In figure 5, the flow of process for the proposed approach is shown clearly.

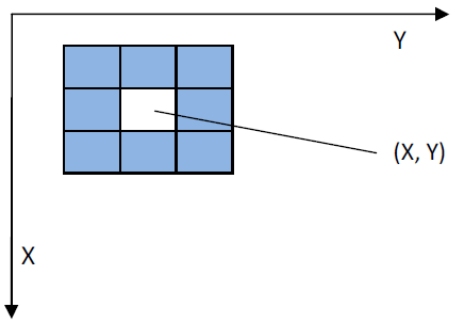


Figure 1: Image Pixels (x, y)

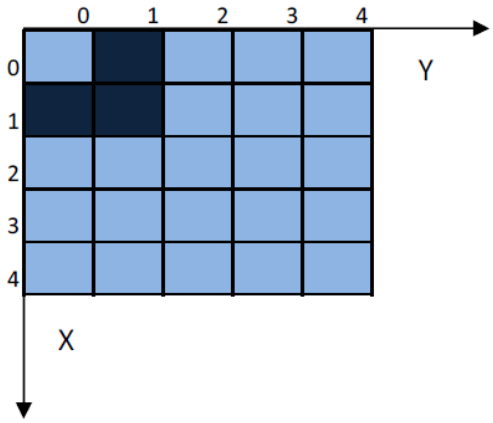


Figure 2: Pixel and Neighborhoods Pixels

Consider the pixel (x,y) of an Image, the neighborhood pixels can be retrieved from the following formulas from its position of the pixel value.

Each pixel has around pixels of (x,y) => { (x-1, y-1), (x-1, y), (x-1, y+1), (x, y-1), (x, y+1), (x+1, y-1), (x+1, y), (x+1,y+1)}.

(x-1,y-1)	(x-1,y)	(x-1,y+1)
(x,y-1)	(x,y)	(x,y+1)
(x+1,y-1)	(x+1,y)	(x+1,y+1)

Figure 3: Calculations of Neighborhood Pixels of (x, y)

(x,y)	(x,y+1)
(x+1,y)	(x+1,y+1)

Figure 4: Neighborhood Pixels of top Left Corner Pixel (x,y)

The figure 3 illustrate the neighborhood pixels around the pixel(x,y) and figure 4 shows the actual beginning of Image neighborhood pixels. The same way neighborhood pixel value is calculated. For Restoration, Scratches Removal and binarization threshold value is deliberate by comparing all the neighborhood pixel values with the current pixel value. The nearest maximum pixel value is taken to actual (x, y) point position.

This is done by sequentially all the pixel value in a QRC Image. Because of the binary image is only in Black and White, the RGB pixel value of Black is -16777216 and White color RGB Value is -1. Comparing these two values the white value is biggest. A QRC Image does not have exactly even numbers of pixel where the Black and white RGB values. The clusters of Black pixels are also having a few white pixels as well as the same in the White cluster. The proposed approach is done on spatial point processing method.

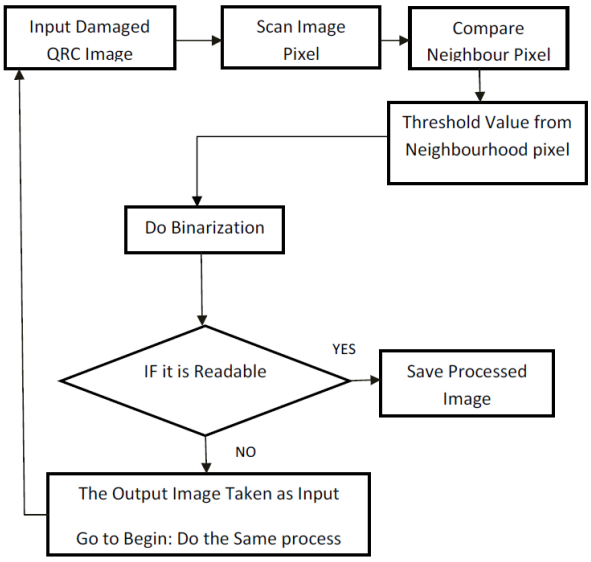


Figure5: the Flow of Proposed Binarization

V. PROPOSED ALGORITHM

Function QRCBinarization(Image img)

INPUT: Damaged image img

OUTPUT: Binarized and Restored QRC Image

BEGIN:

Load Image to Original Buffered Image Object (RGB Image)

Get the size of image: Width as w and Height as h of Image

Declare neighbor pixel array as na[w size]

Binarized Buffered Image Object to Binarized Image (Binary Type)

For each pixel(x,y) in Original w and h do

else if(x!=0 && y!=0) NeighborPixel of original.getRGB(x-1,y-1);

else if(y!=0)
na[1]=original.getRGB(x,y-1);

else if(x!=w-1 && y!=0)
na[2]=original.getRGB(x+1,y-1);

else if(x!=0)
na[3]=original.getRGB(x-1,y);

else if(x!=w-1)
na[4]=original.getRGB(x+1,y);

else if(x!=0 && y!=h-1)
na[5]=original.getRGB(x-1,y+1);

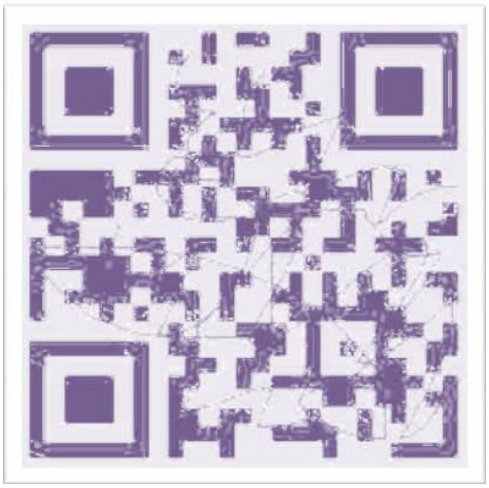
else if(y!=h-1)
na[6]=original.getRGB(x,y+1);

```
else if(x!=w-1 && y!=h-1)
        na[7]=original.getRGB(x+1,y+1);
else
        na[7]=original.getRGB(x,y);
If (NeighborPixels(x,y) ≅ White)
Binarized(x,y,White)
else if(NeighborPixel ≅ Black)
Binarized(x,y,Black)
else  Binarized(x,y,OriginalPixel)
  Next pixel(x, y)
End Loop
Write Binarized Image
END
```

VI. EXPERIMENTAL EVALUATION

The proposed Binarizing method is implemented on Java programming on a personal computer of Intel Dual core 2.66 GHz processor, 2 GB RAMS on Windows7 Ultimate. The experimental evaluation performed on Damaged QRCode Image is created online for free of cost. The QRC Image contains the data "Hi! I am Poompavai". The Input Damaged QR Code Images are shown in figure 6. The Binarized Output Images are shows on figure 7. From the experimental evaluation is clearly shown output images are able to scan QR Code by ordinary QR Code Software.

(a)



(b)

Figure 6: Damaged QRC Images

(a)

(b)

Figure 7: Output Images

VII. CONCLUSION AND FUTURE WORK

The proposed approach is ultimately Restored and Binarized of low quality QR Code Images like Scratched, damaged and illuminated images. The precision of the proposed algorithm was tested on range of 50dpi to 96dpi images and the experimental evaluation showcased that the Restored and Binarized Image. The actual QRC Image is not big size, so it does not take much time to Binarize and Restore it. The image pixels are sequentially scanned and changed. However it performs sensible time duration. The proposed approach can employ the binarization threshold in parallel in future, in order to improve the speed of binarization time taken.

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