Barcode Detection from Barcode Images Captured by Mobile Phones:An Android application

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***Abstract*—**Reading barcodes is a daily need of today's world and normally it requires a scanner. In this paper we have presented a method so that we can read barcodes accurately using mobile phones which are commonly used today. The various problems of binarizing the 2D barcode images clicked by mobile devices is considered in this paper. The poor quality of the images due to low resolution of mobile cameras, noise, non-uniform illumination and distortion of the camera makes the task of binarization more difficult. Most of the binarization techniques makes use of global thresholding which may not have accurate result, hence the technique which finds the threshold for each pixel is presented in this paper. The proposed method can handle objects of different sizes and the uneven illumination problem.

Keywords*-Barcode, Barcode Region of Interest(BROI), QR code,Binary.*

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I. INTRODUCTION

Processing of Barcode images has drawn a great deal of attention recently due to the advancement in mobile phone-based applications. Capturing a barcode printed in a newspaper using mobile phone that subsequently direct to a website is communicative and mobile. However, reading the barcode images captured by mobile phones poses great challenges due to the problems such as small sensor size, lacking of auto fo-cus, shaky hands and uncontrolled lighting environment.

Among the various issues involved in reading the 2D bar-code images, binarization is a key preprocessing step which directly affects the recognition rate. Binarizing the images using global thresholding methods generally cannot achieve satisfactory results for the barcode images due to the varying capturing lighting conditions [1][2]. The image is adaptively normalized by dividing it into four regions to account for the uneven lighting in capturing the barcode images [1]. Thereafter, it is binarized using a global threshold, in which the good quality of the binarized image cannot be guaranteed. Simply using the mean value as global [3] or local [4] thresh-olds does not work well for barcode images. Liu et al. pro-pose to use the clustering technique to binarize the barcode images [5], which may require more computing power.

Section II reviews previous work a in section III detailed explanation of programmers design is given. Section IV describes data flow and data independence architecture. In section V experimental results are presented and finally concluded in section VI.

II. RELATED WORK

A. Adaptive Threshold

Xu Liu et al. [3] proposed a technique which uses adaptive threshold method to separate black pixels from white pixels. In this technique it finds M x N gray scale matrix and uses them as initial two centers. Then it assigns each pixel to either of the two center classes. After that it changes the class centers to the average of the values in the class. Finally it changes every pixel to either 0(black) or 1(white)

Advantages: it uses the adaptive threshold instead of global threshold which is useful for the images which are taken under different lightning conditions. Limitations: though it uses the adaptive threshold it is not useful for the blurred images.

B. Otsu'Method

Changsheng Chen et al. employed otsus [4] method to calculate global threshold. They have defined balancing of white and black pixels. There is threshold given by Otsu's method, i is intensity level which ranges from 0 to 255 for an 8 bit image and h(i) is count for each intensity level.

Limitations: As global threshold is considered this technique is not suitable for the images captured by mobile phones under uneven lightning conditions.

C. Adaptive binarization based on edge structure.

Huijjan yang et al. [5] proposed a adaptive binarization based on edge structure. This technique divides the barcode image into barcode and background region based on mean of the ROS (Region of Support) in the edge map centered at each

pixel. Edge map is obtained by "canny" edge detector in which the edges and background are shown in white ("1") and black ("0") respectively.

Advantages: This technique uses the adaptive threshold technique so it is better technique for the mobile phone captured images under uneven lightning conditions.

D. Dynamic Window Construction

Hujjan yang et al. [6] proposed dynamic window construction for the Binarization of barcode images captured by mobile phones. They suggested choosing window size based on the presence of high gradient pixels in the vicinity

E. Riddler and Calvard method

T. W. Ridler and S. Calvard [7] proposed a picture selection using an iterative selection method. The idea is if a object is located within a square image of pixels without assuming any knowledge of exact location.

Advantages: useful for the text enhancement. Limitations: this technique is not useful for the mobile Phone captured image of low quality

F. J. R. Parker [8] Proposed grey level thresholding technique for badly illuminated images. The purpose of grey level thresholding is to extract those pixels from the images which represent object from the background. After thresholding the image, object pixels have all one grey level and background pixels have another.

Advantages: Technique is helpful for the badly illuminated images

G. Common Image Representation technique

E. Quaviani et al. [1], proposed a Common image reprsentions technique in term of magnitude and phase of the image gradient. By this representation we can select a few region of interest in which gradient shows some directional characteristics.

Avantages : As this technique uses the gradients it is quite easy to find BROI.

Limitations : This technique gives the approximate results not the accurate one.

H. Corner Detection Method

isaku Ohubuchi et al. [2] proposed four corner detection method which find the corners of the QR code.

Advantages : gives very accurate results for the QR codes

Limitations : this technique is limited only for the QR types of barcodes

III. PROGRAMMERS DESIGN

It is difficult to use a single threshold to binarize the barcode images captured by mobile devices under uncontrolled lighting conditions. Hence, local adaptive binarization such as Niblack's method [17] could be a good choice. A key issue is how to choose an appropriate size of the window. This is especially true for the barcodes such as PDF417 where significant gap exists in size between the start/stop bars with the small modules in the data portion. Our idea is motivated by the following observations. 1) Using a window of fixed size to binarize the entire image cannot handle the size variation of the objects properly. 2) A suitable center location is to be found instead of always centering the pixel to be binarized with a window of fixed size. 3) For effective binarization of barcode images with uneven illumination, a smallest window in a proper location needs to be found such that the number of white and black pixels in the window is balanced. Edge pixels nearest to the candidate pixel are suitable candidates to construct such a window.

A. Mathematical Model

S = {I, F, O}
Where I=Input,F=Function,O=Output
I={ B_1, B_2,……. B_n } Where B is Barcode image.
F={ F_1, ……. F_6} g Where F is Set of Function.
Where F_1=Capture image through Mobile Camera is RGB image.

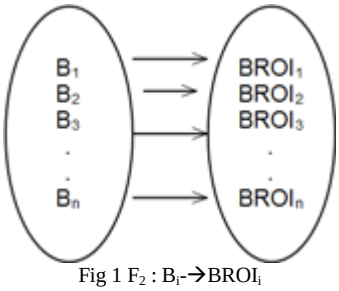

Fig 1 F_2 : B_i->$BROI_i$

F_2=Selection of Barcode region of interest.
F_3=Grayscale image
F_4=Perspective transformation of image.
F_5=Decoding
F_6=Decoded Value
O={ D_1.....D_n } Where D is decoded Value of B_i.
F_1=This is Captured image through Mobile Camera.
F_2 = (I_{22}, O_{22})
I_{22}=I
O_{22}=BROI with {C_1, C_2, C_3, C_4 } Where C_i is Corners of QR Code.
i=1.....4
F3={ I_{33}, O_{33} }
$F3_{(x;y)}$= $0.30R_{(x;y)}$ + $0.59G_{(x;y)}$ + $0.11B_{(x;y)}$
F_4={ I_{44},F_{44},O_{44}}
I_{44} = O_{33}
F_{44} = performs perspective transformation of O3.
O_{44} = Perspective transformed QR barcode
F_5= { I_{55},F_{55},O_{55}}
I_{55} = O_{44}
F_{55} = T
if pixelvalue >= T then

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Pixel value = White

if pixel value <= T then Pixel value = Black

O_{55} = Binary image of barcode

$\mathbf{F_6 = \{I_{66}\ F_{66}\ O_{66}\}}$

$I_{66} = O_{55}$

F_{66} = Decoded using standard Decoder

$O_{66} = O$

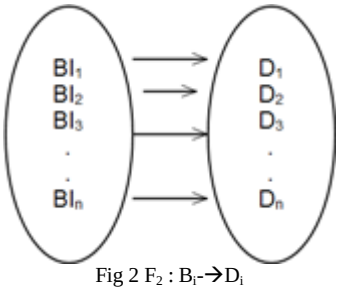


Fig 2 $F_2 : B_i \rightarrow D_i$

B. Dynamic Programming and Serialization

It is firstly discussed how to differentiate the barcode region from that of the background region so that different strategies can be applied. In this section, the image reorganization and processing of QRcode are described. The QR-code, which was developed by DENSO3, is known as a kind of 2D barcode. The features of this code symbol are

- large capacity
- small printout size
- high speed scanning

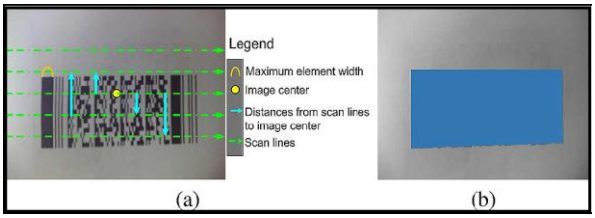


Fig. 3. Barcode Region of Interest(BROI)[1]

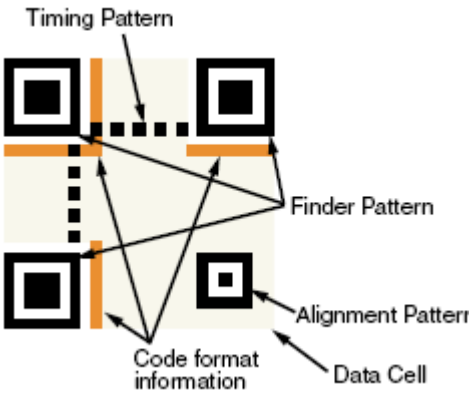
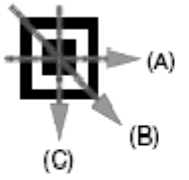


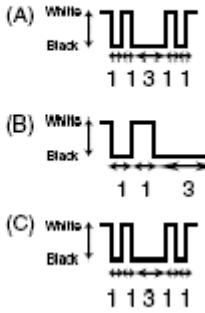
Fig. 4. Structure of QR code [2]

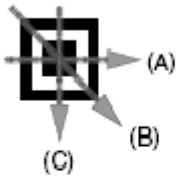
Figure 4 illustrates the structure of QR-code, and this code is comprised of the following patterns:

- Finder pattern
- Timing pattern
- Format information
- Alignment pattern
- Data cell.

This In the specifica is intro-duced, v ent, and this alig rmation. Howeve ction of deforma find the alignme ion and decodin e at the mobile ther 2D code sy the new reorgani







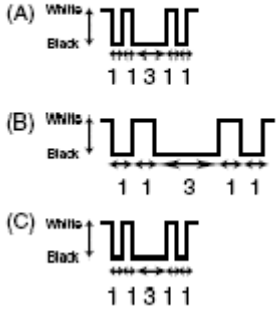


Fig. 5 QR code: Finder Pattern [2]

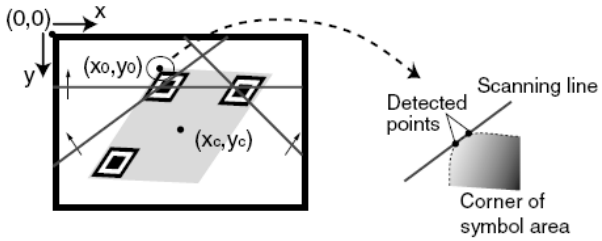


Fig. 6 Three scanning lines are used for the corners detection. [2]

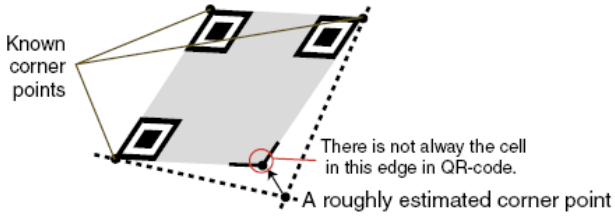


Fig. 7 Forth corner detection method. [2]

Algorithm: Finder pattern Detection:

1) Calculate the position of the gravity center (x_c,y_c) in Figure 6 which is assumed as the center of captured image.

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2) Scan a line from outer to inner in eight directions until the line touches the area.
3) If there are two or more pixels on a line (Figure 3.4 right), their edge points are obtained.
4) After eight direction scanning, we get 16 points at most.
5) The nearest point to (0,0) is one of the targets.
6) Define a vector P as (x_0,y_0)-(x_c,y_c).
7) Calculate the inner product for finding other corner points.

After the above process, the positions of corners are refined in the original size of image as follows.
1) Set a line from (x_0,y_0) to (x_c,y_c).
2) Cross-point is in the outer edge of the mark.
3) Start recursive area growing from the cross-point.
4) Get gravity center of outer mark and this is in the inner mark.
5) Restart recursive area growing from the gravity center.
6) Mark center is defined as the gravity center of inner mark.
7) Corner point is defined as the farthest point from the image center.

This process obtains the three corner points using finder patterns, but the fourth corner point has no found pattern, and also the case where there is no corner cell in the fourth corner exists. Because of these features of QR-code, we introduce the new corner detection algorithm for the fourth corner point reorganization.
1) Set line from known corner points to roughly obtained point (Figure 8).
2) Move the cross-point so that line segments are shown by touching the code area (line attachment method).

The calculated code size and recognized code feature by the above processes can be used for the verification of code specification about the code size (code size is always odd), equally both width and height, and position of alignment mark before the decoding

C. Binarization

1) Binary Image: Binary images are images that have been quantized to two values, usually denoted 0 and 1, but often with pixel values 0 and 255, representing black and white.

2) Threshold: It is simplest method of image segmentation, from a grayscale image thresholding can be used to create binary images.

Thresholding process:-Individual pixel in an image marked as Object pixel if their value is greater than some threshold value Object brighter than background)

3) "DW-E" strategy (Dynamic-sized Window centering the nearest Edge pixel): A window with adaptive size of (8 X 8) is chosen and center is found to be nearest edge pixel based on the calculated minimum pixel-to-edge distance. 5X5 grid is selected in the implementation, considering an extreme case that the pixel lies in the middle of the largest object in the image. The size of the window is chosen so that the pixel to be binarized is guaranteed to lie in the window.

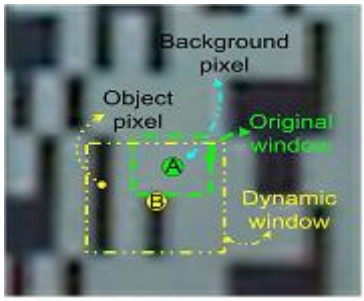

Fig. 8 Dynamic-sized Window centering the nearest Edge pixel[1]

D. Decoding

Decoding of barcode is done by using Zxing Barcode Decoder[14] [Online].Available: http://code.google.com/p/zxing

IV. DATA INDEPENDENCE AND DATA FLOW ARCHITECTURE

Images Captured by mobile phones generally are of the type RGB for Binarization of image we need threshold gray scale value Therefore in order to binarize the image captured by mobile phone. Captured image must be converted into gray scale image

BROI is obtained by using two algorithms

1) Finder Pattern detection
   This algorithm is necessary for finding the three corners of QR code
2) Fourth Corner detection roughly estimates fourth corner

The input image has a deformed shape because of being captured from the embedded camera device; for example, in Figure and we use the inverse perspective transformation to normalize the code shape. Finally the image is binarized to get the clear image and that image is given to standard barcode encoders such as tasman encoder

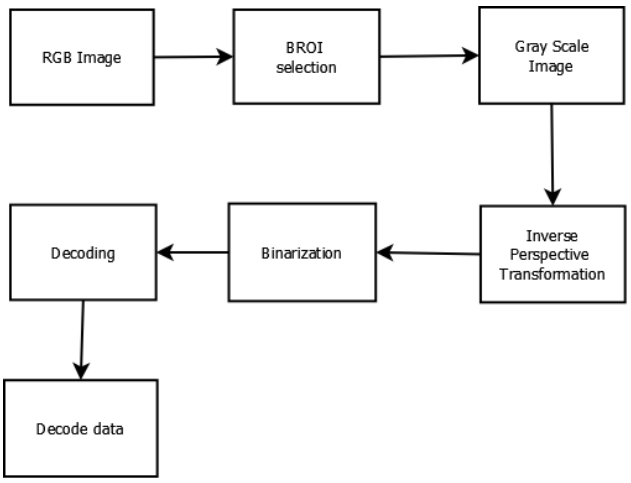

Fig. 9 Data flow Architecture

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V. RESULTS

A. Experimental Results

1) Example1:

Fig. 10. Original Image

Fig. 11 Binary Image

Barcode Value:
Shital Waghmode
ME Computer
VPCOE, Baramati.

2) Example2:

Fig. 12 Original Image

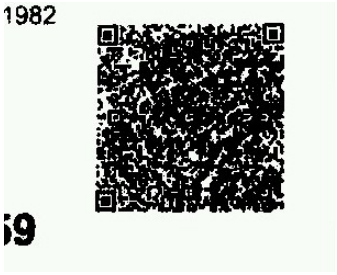

Fig. 13 Binary Image.

Barcode Value:
<? version="1.0"
encoding = "UTF-8"? >
<PrintLetterBarcodeData1
Uid="495401652059"
name="Avinash Jagnnath
Kokare
gender="M"
DOB="1982"
lm="Near Grampanchyat"
loc="Patil Wada"
vtc="Bori"po="Bori"
Dist="Pune" Subdist="Indapur"
State="Maharashtra"
pc="413104"/>

3) Example3:

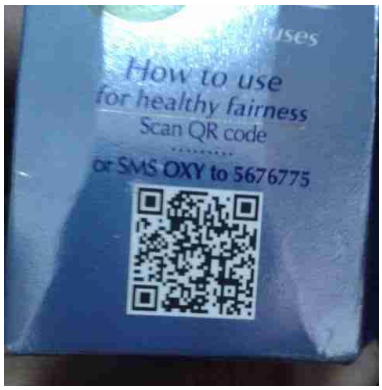

Fig. 14 Original Image

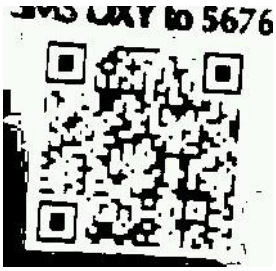

Fig. 15 Binary Image

Barcode Value:
http://www.youtube.com/user/oxylifeskincare

B. Result Comparison

Following table shows the result comparison of presented system with existing techniques. The purposed technique is compared with Niblack's method, Riddlers method, Rats

method and Parker method. The Result comparison shows that proposed technique gives best results as compared to other techniques in both indoor and outdoor environments.

Decoder	Method	Indoor	Outdoor
		Samsung	Samsung
Zxing	Niblack	99.00	100
	Riddler	68.00	100
	RATS	96.00	96.43
	Parker	98.00	100
	Proposed	100	100

Table:II Recognition rates for the barcode images binarized using DWE strategy evaluated using by choosing different window sizes and evaluated using (zxing decoder)

C. Graph

The graphical comparison of results is as shown in the following graph. The scale of the graph is x axis showing the methods of binarization and y axis shows the successful decoding percentage. Blue bar shows the results for indoor images whereas red bars shows the results for outdoor image

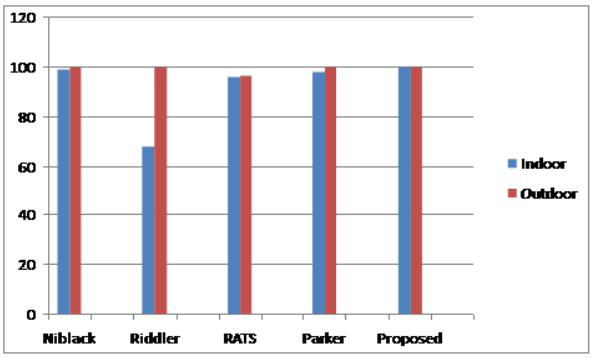

Fig. 16. Graph Recognition rates for the barcode images binarized using DWE strategy evaluated using by choosing different window sizes and evaluated using (zxing decoder)

VI. CONCLUSION

In this paper we have presented two algorithms for Barcode Region of interest selection which works accurately for QR code. Inverse perspective transformation is explained which regains the deformed image because of camera angle. Most important in barcode detection is binarizing the image. to binarize the image Dynamic window algorithm is suggested. This algorithm works better than other binarizng techniques as it calculates threshold value for each pixel to b binarized

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