Embedding of color image on QR code with reduced processing time using Genetic Algorithm

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Abstract -Color depends primarily on the reflectance properties of an object. Color image can be modeled as three band monochrome image data, where each band of the data corresponds to a different color. The concept of embedding color image in to the Quick Response code using Genetic Algorithm can reduce the processing time. Halftoning masking techniques are used to take the pixels from the images. After taking the masks window extraction is done parallelly to input image and Quick Response image. Using genetic algorithm good halftone masks can be generated and the time can be optimized and the processing time can be reduced to half of the time taken by other methods. Genetic algorithm is used to reduce the time taken for the processing of image embedding in the Quick Response code. Speedy genetic algorithm is first applied to the input color image and QR code. The results are then fused to generate the QR image. Zxing library dataset is used for the implementation in matlab.

Index Terms – QR code, image embedding, halftone masks, genetic algorithm.

1. INTRODUCTION

Image processing comes under the domain of Artificial Intelligence. Image processing is a form of signal processing. It is the process of giving an image as the input to the processing algorithm and to produce the output. The output may be in form of image itself or a set of characteristics or parameters related to the image according to the algorithm used. There are two dimensional image processing and multidimensional image processing. In imaging science, image processing is any form of signal processing such that the input will be an image, such as a photograph or video frame, the output of image processing may be either an image or a set of characteristics or parameters related to the image.

Quick Response code used intracking and identification method in transport in early days. Now it is widely used in manufacturing, retail industries, accessing website, document management,general marketing and much more. It is just like a barcode to store the information. QuickResponse code can also be defined as a 2D matrix encoding consist of black and white squares called module.Quick Response readers can be used to decode the information that are stored in the Quick Response codes. Quick Response reader have the ability to avoid the local luminance disturbance.

Regions that are mainly consider in a QR code are,

- Finder patterns: finder patterns are used to define location and rotational orientation of the symbol.
- Separators: separators are used to separate function patterns and encoding regions.
- Alignment patterns: It helps to correct perspective, curvature and other distortions.
- Encoding regions: The encoding regions may be defines as the area between 4 finder patterns at the corner of the QR code. The information to be stored is encoded in that area and also decoding details are also stored in the encoding regions.

Figure 1 shows the QR code with regions.

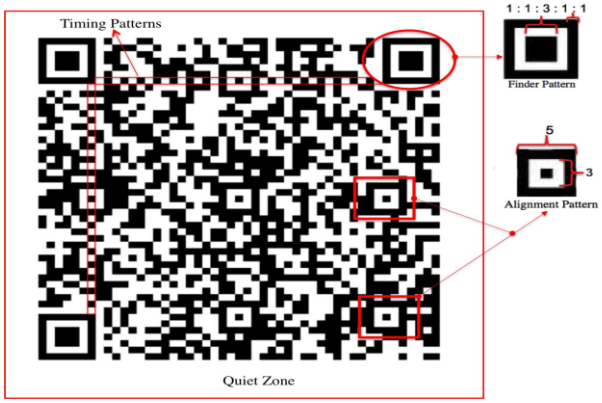

Figure 1 QR code regions

2. RELATED WORK

Quick Response (QR) codes are mainly used in tracking in transport, manufacturing and retail industries. An important problem that is faced by QR codes is it impact on the aesthetics of publicity designs. QR codes mainly comprised of black and white square shapes and that has limited color tolerance, badly affects the integration into billboard designs or printed materials.

A non parametric and supervised method of automatic threshold selection for picture segmentation [2]. This directly deals with the problem of evaluating the goodness of thresholds. An optimal threshold is selected by discriminates criterion so as to maximize the separability of the resultant classes in gray levels. An automatic method proposed Fujita K., Kuribayashi M. and Morii M [4] to embed QR codes into color images with bounded probability of detection error. Experimental result shows the graceful degradation of the decoding rate and the perceptual quality as a function the embedding parameters. Gonzalo J presents optimized image embedding in QR code [3]. QR information bits are stored as luminance values of the image. The processing time of the system is 30 minutes that is the main disadvantage of the system.

Lin Y., Chang Y. and Wu J.,in Appearance based QR code beautifier [5]presents an optimization based halftoning technique that consider the structure and tone similarities between the original color and the halftone images. Optimization of objective function includes both the structure and tone metrics, the produced halftone images consists of sensitive texture details as the local tone.

J. Souvola and M. Pietikainen [9] proposed a method for adaptive image binarization. Two new algorithms are applied to determine a threshold value for each pixel. Algorithm utilizes test images having ground truth, evaluation metrics and also synthetic images and a light based ranking procedure for the final result presentation. The method used here is adaptive binarization. The advantages of this approach are it is robust, less degradation, good adaptation to defects such as illumination, noise and resolution changes. The execution time is high because threshold value for each and every nth pixel has to calculate separately.

Adaptive methods such as the one presented in [6] by Ono S., Morinaga K., and Nakayama Shas shown the better binarization accuracy. The image captured by the camera of the cell phone contains external elements in the surrounding area of the code, such as text, icons, option buttons, the phone screen frame, and other elements appearing on the screen.Present a genetic algorithm [8] that automatically generates halftone masks optimized for use in specific printing systems. Experiments show that genetic algorithms are effective in finding improved halftone masks and that two methods of reducing the search space to particular subsets of possible halftone masks greatly enhance the search performance.

QR code security presented by Narayana [1], examined more about attacks on QR codes and the possible consequences. Since QR codes are only machine readable the author explored the various ways of anti-phishing and showed the different kinds of attack strategies from the attackers' point of view. The vulnerability of the QR code depends on the type of the attack and its characteristics.

3. PORPOSED MODELLING

Embedding of QR code into a color image to enhance the visual tolerance of the QR code, QR code contains the black and white modules which store the information. The processing time for embedding the QR into color image will consume more time. Genetic algorithm can be used to reduce the processing time. Genetic algorithm [10] is used to generate the halftone masks which can be applied to the color image to make it to bi-level image. After applying the halftone mask to the images, then intermediate images are fused to get the result. Figure 2 represents the block diagram for the new approach.

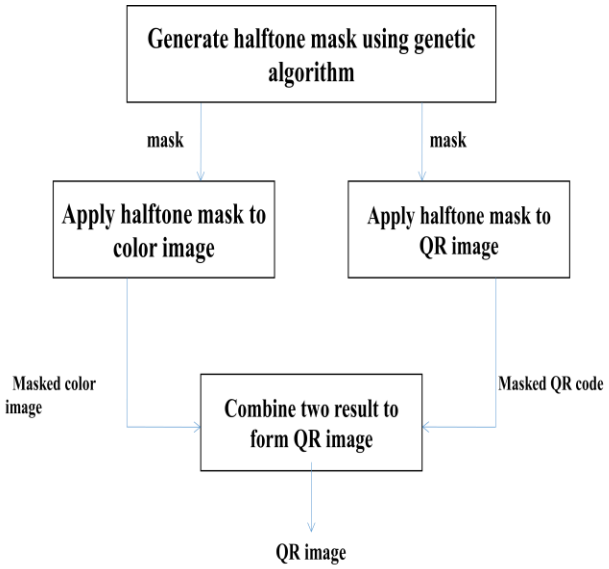

Figure 2 Block diagram for the image embedding using Genetic Algorithm.

3.1. Halftone Masks

Automatic generation of halftone masks can be generated using the Genetic Algorithm. Genetic algorithms are effective in finding improved halftone masks [8] and that two methods of reducing the search space to particular subsets of possible halftone masks greatly enhance the performance of the GA.

The fitness function should be high so that the visual response for the halftone mask will be high. Objective is to select halftone masks with high fitness value.

Equation (1) shows the fitness function of the problem. The calculation of x value is represented using the equation (2)

$$F(x) = \text{sum}(x, 2) \quad (1)$$

$$X = \text{rand}(\text{popsize}, \text{len}) < .5 \quad (2)$$

Steps for the process is

Step1: select possible *N* solutions for the problem.
Step2: find the fitness value *Fv* for each of the masks in the population.
Step3: Repeat the steps until sufficient offspring is generated.
- 3.1 select two parents P1 and P2 which have highest fitness value.
- 3.2 crossover the parents to create children.
- 3.3 mutate the child if necessary and use the two children for the next generation.

3.2. Halftone Masking

Halftone masking is the process of applying halftone mask in to the image. The mask generated via Genetic Algorithm is applied to the color image to make the image a halftone image. A half toning mask, M, is an array of threshold values used to convert a continuous tone image, I, to bi level B. The values of I and M are numbers in the same range, typically 0-255. The values in B are 0 or 1.A mask half toning process converts I to B using M according to following rule.

$$\begin{aligned} &Ipq<Mpq \rightarrow Bpq = 0 \\ &Ipq>Mpq \rightarrow Bpq = 1 \end{aligned} \quad (3)$$

3.3. Binarization

Binarization using threshold method [7] is applied to QR code to select the pixels for fusion Binary images are obtained by thresholding the gray scale image as shown in the equation (4)

$$I_B[i,j] = \begin{cases} 1 & if\ Y_{i,j} > t_{i,j} \\ 0 & if\ Y_{i,j} < t_{i,j} \end{cases} \quad (4)$$

Where Y is the original color image, ti,j is the threshold assigned to pixel [i, j] and I_B[i, j] is the binary output.

3.4. Image Embedding

Image embedding is the process of combining two images. The QR code is embedded in to the halftone masked color image which high decoding robustness. One of the images will be background image and other image will be foreground. In the proposed system QR image is the background image and half toned color image will be the foreground image. In image embedding alpha factor plays a major role, alpha factor will determine the contribution of background image and fore ground image.If Alpha_Factor = 0.5, the two images mixed equally.If Alpha_Facotr < 0.5, the contribution of background image will be more.If Alpha_Facotr > 0.5, the contribution of foreground image will be more. The alpha factor used is 0.8

4. RESULTS AND DISCUSSIONS

Parameters used in genetic algorithm for the optimization of fitness function are length of genome*len= 500,* population size *popsize = 500,* probability of crossover *probcross = 1*, probability of mutation*probmut = 0.003,* cross over type *crosstype = 2*. If cross over type is 0 then no crossover will occur, cross over type is 1 then one point cross over will take place, if cross over type is 2 then uniform cross over will occur. While performing the algorithm it takes 18 seconds in average to embed the images. In image embedding the alpha factor, which determine the contribution of foreground and background image, is *0.8.* Figure 3 shows the generation of masks and average fitness values for each mask.

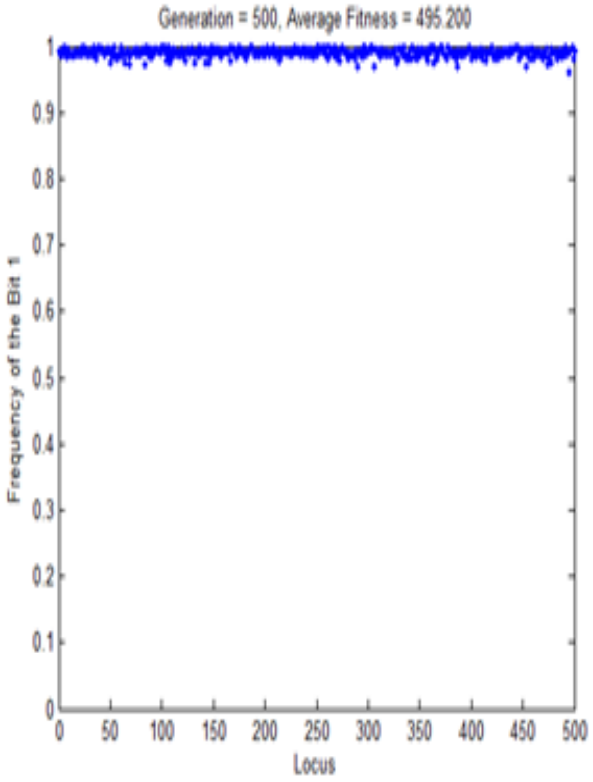

Figure 3Generation of offspring for 500 generation and average fitness values

Figure 4 shows the maximum and average fitness values of the halftone masks generated. X- axis is no of generations and Y-axis is fitness values.

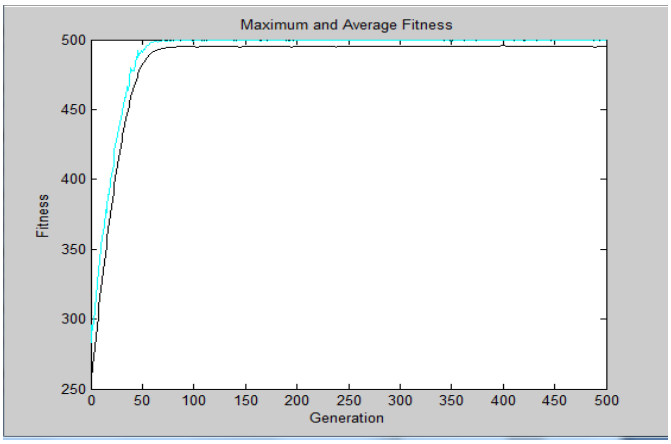

Figure 4 maximum and average generation of masks

Figure 5 shows the input color image before applying the mask. Figure 6 shows image of a QR code.

Figure 5 Color input image of space

Figure 6 QR code

Figure 7 shows half toned image after applying the mask generated via genetic algorithm. Figure 8 shows the QR code image after applying halftone mask. Figure 9 shows the result after embedding the QR code into image.

Figure 7 Input color image after applying halftone mask

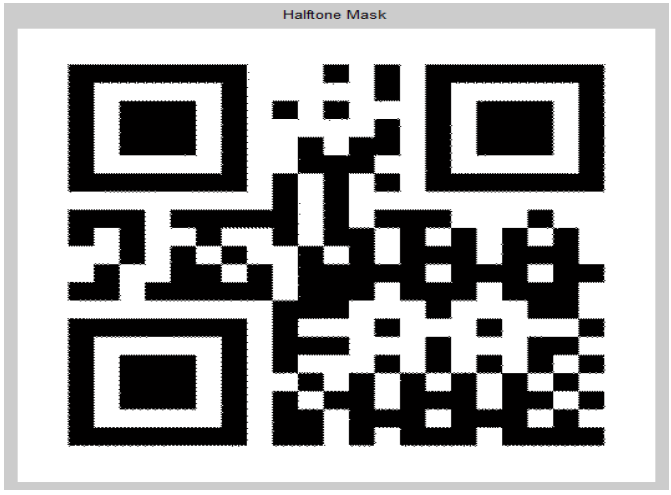

Figure 8 QR code after applying halftone masking

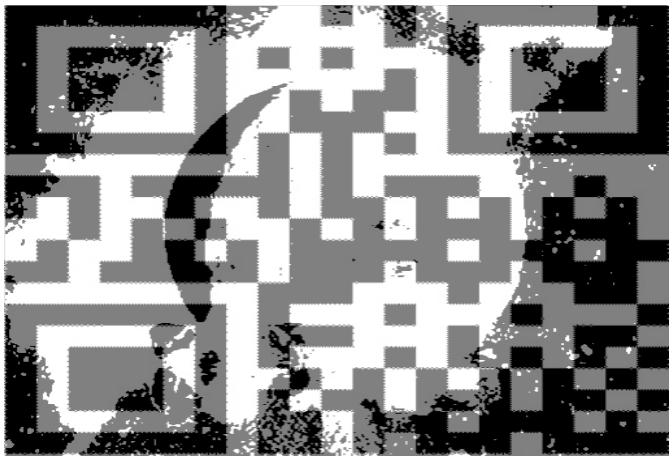

Figure 9 Image after embedding QR code with image

5. CONCLUSION

The proposed system is embedding of color image on Quick Response code with reduced processing time using optimized algorithm is mainly designed to reduce the processing time of the embedding processing that is approximately 30 min for the earlier [7]method. Optimization techniques such as genetic algorithm are used in the proposed method. A Genetic Algorithm is a search technique used in computing to find true or approximate solutions to optimization and search problems. Introduction of genetic algorithm in the proposed method the processing time taken to embed the color image in to Quick Response code is reduced to half of the processing time taken by the previous methods. Genetic algorithms are effective in finding improved halftone masks and also to reducing the search space to particular subsets of possible halftone masks greatly enhance the search performance. The scope for future work is based on finding the performance of the system using various optimization algorithms.

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