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Enhanced QR: Approaches for QR Code Embedding Techniques

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***Abstract*- In recent years, QR codes have grown more widespread in facilitating digital-based commercial scenarios like product promotion, mobile payment, and product information management. These 2D barcodes are square-shaped matrices of dark or light pixels employed to encode and promptly retrieve data utilizing computer devices. According to the international standards, quick response (QR) codes are considered an advancement from older, unidimensional barcodes. Traditional QR codes are reliable and fast to decode but lack aesthetic appearance to demonstrate customers' visual information. This paper explains various methods of data to embed data QR codes. In order to minimize processing time, the optimization technique considers the mechanics of a standard binarization method, genetic algorithm, etc. These embeddings are suitable with standard decoding and can be applied to any color images with full area coverage.**

***Keywords* – QR Codes, Embedding, QR enhancement, Information Hiding, Beautification**

I.INTRODUCTION

A Quick Response Code (QR) is a Code that is instantly readable by a cell phone. Like the development of diverse technologies, QR Codes were also made out of necessity. The invention of the QR Code was contributed by the Denso Wave and their lead developer Masahiro Hara. Adopting a combination of spacing as a type of Matrix Barcode (a 2-D Barcode), when a QR Code is scanned, it carries a vast multitude of information. While QR Codes and Barcodes are comparable in the application, QR Codes contain more information because they can hold information both horizontally and vertically. QR Codes have a wide range of uses over all types of industries such as retail, marketing, and logistics. With the continued dispersion of the internet and smart mobile devices, Quick Response (QR)code has become one of the most broadly accepted information carriers globally. However, the ordinary QR codes have a visual-unpleasant appearance and consist of monotonic black/white square modules, which are insignificant to human vision.

Despite the extensive use of QR codes for various purposes, one problem with them is that they have low human visualization impact. One approach to tackle this problem is QR code beautification. The most apparent use of QR codes is for product promotions to provide additional messages to consumers about a given product. On the other hand, only limited space is provided for printed QR codes, limiting the version and hence the capacity. When the printing area is limited, a QR code should have product characteristics and stock more product information. So, in this case, the QR code should have a beautified appearance and a higher capacity. Code, it is yet not sufficient for applications that need large storage space. Such data, such as the feature vector of a fingerprint, may exceed the QR code's current capacity.

In this paper, we introduce a novel approach for efficient data embedding schemes using beautification. Beautified QR codes combined with data hiding can be applied to image self-recovery. Information embedded inside the QR code and then insertion of this QR code into cover images provides multilayer security and enhances storage capacity. This paper is organized as follows. In Section II, we present five related works based on some data embedding techniques like half toning masks, lossless embedding, Gauss-Jordan elimination, etc. Section III explains the proposed Enhanced QR embedding system, and in Section IV, we conclude with a summary of our contributions.

II. LITERATURE SURVEY

Numerous studies have, as of now, been completed on data embedding in diverse file types using both color and non-color images. This survey describes the current state of previous approaches, methods, and primary features used. The studies have been dealt with research efforts with an eye of enhancing embedding schemes in various levels using QR code. In this section, we likely to explain some previous data embedding methods on QR codes and information hiding methods.

1. QR Images: Optimized Image Embedding in QR Codes

In this paper [1] develops an Image embedding which involves different optimization-based approach such as, optimization of continuous tone images and optimization of binary images. In these systems, the luminance transformation offered has been defined for the center pixels. For this type of transformation, the center pixels of the module can be sampled reliably. The general formulation of the optimization was based on the minimization of the quality metric subject to the luminance and probability. This method, though, is suitable to generate binary halftones, and no modification for the embedding of color or multilevel halftones was proposed. One of the main disadvantages of these embedding is the limited degrees of freedom to manipulate the code when correlated with the case of grayscale or color images.

2. Halftone QR Codes

This paper [3] intends an approach to produce high-quality visual QR codes, which we call halftone QR codes that are still machine-readable. First, build a pattern readability function wherein learning a probability distribution of modules that can be replaced by other modules. Given a text tag, express the input image in terms of the learned dictionary to encode the source text. It takes an automatic algorithm to create a new type of visual QR code, called halftone QR code, at a controllable readability level. There are two significant components in our approach. One is a representation model that minimally binds to the original QR codes and is flexible to adapt to target halftone images, and the other is an introduction of pattern reliability, which enables control over the level of readability.

4. Appearance-based QR Code Beautifier

In this paper [4] addresses the issues to minimize the visual distortion of the embedding. The method presented defines a quality metric that has been considered for color, tone, and structural similarity employed to select the optimal luminance of modified pixels. To fully leverage QR decoders' characteristics, central pixels in the QR modules play an important role. However, in contrast to these methods, which fix the ratio between central and non-central pixels, the method proposed here allows choosing the number of central pixels and then optimizing the location and luminance of modified pixels to achieve particular error limits.

5. Voronoi tessellated halftone masks

Through this paper [2] present the halftoning technique as a method that distributes the modified pixels of the QR codes for embedding. The technique has been used to distribute the modified pixels of the QR code image and minimize the number of variations in the color image's luminance so that it should not be visible through the naked eye. The embedding of halftones into QR codes was proposed in where the location of binary pixels in the QR modules was optimized to maximize visual quality and decoding robustness. The masks generated by this technique are used to halftone sample images, and quality profiles are generated. The drawback of this method was suitable to generate visual distortion of the QR code, and the image resolution has been limited to 9 pixels per QR module.

6. Strength of Quick Response Barcodes and Design of Secure Data Sharing System

In this work [9], the main idea of steganography embedding is proposed. It was the embedding of secret information into data under the assumption that others cannot know the secret information in data. Another thing to check the logo is embedded in data or not. Based on the nature of the document to be watermarked, text watermarking: line shift coding, word shift coding, feature coding, and visible watermark. The information has been visible in the picture or video. But this has been limited to a certain level were by using line shift coding in the steganography.

7. Visual QR Codes with Lossless Picture Embedding.

The paper [7] states a scheme for losslessly embedding pictures into QR codes. A baseline QR code is to be generated and then improved. Truly, the scheme allows for the lossless embedding of pictures into QR codes, for offering immediate and high-quality visualization effect is proposed. It adopts the PCM based encoding of RS codes. Rapport code bits are computed after the positions, and the values of the control code bits are assigned. The control bits consist of the text message bits and the visualization bits. The visualization bits are set according to the picture to be embedded and the mask. Since the visualization bits do not carry a true message, the effective amount of information is reduced compared to standard QR codes. Another price is that a decoder for rectifying and segmenting the QR image must be inserted before the standard decoder.

8. Use Multiplexing to Increase Information in QR Code

In this paper, [12] commits a novel approach to increase data in QR Code by using multiplexing. There was a QR Code with special symbols introduced. This technique can keep the same space as the original information while increasing the amount of data in the QR Code and keep secret information. The original information is divided to form a string of characters into n parts, where n is the number of QR Code patterns formed by a string of characters in each part in its standard form. Each pattern is encoded or multiplexed and described each module in QR Code with black and white special symbols. At the receiving end, this QR Code with specific symbols multiplexed is decoded to give back the number of QR Code patterns that were multiplexed. The general QR Code reader can read these QR Code patterns, and the data can be concatenated back to form its original information.

III. PROPOSED SYSTEM

In the literature surveys, we explained various existing methods of QR code embedding and information hiding techniques. QR embedding method encodes the information bits of the input QR code image. Such that our proposed method will convert the input bits into the luminance values of the image in such a way that the average luminance is increased for the light region in the code and decreased for dark regions. In this proposed approach, the information which is to be hiding is in the central one-third portion of the QR code. There are two techniques used for embedding namely halftoning and luminance level embedding. The proposed Embedding method is an enhanced technique in terms of the security of information. And also, we allow automatically generate embedding the QR code with a limited probability of detection error.

IV. CONCLUSION

This paper concludes that there are several experiments that are used with QR embedding as we have gone through the literature and examined most of the recent developments in QR codes. This enhanced QR code is more productive in different manners like improved data capacity, increased data security, improved visual appearance, reduced memory requirement, and reduced processing time for the embedding process. These embeddings are suitable with standard decoding applications and can be applied to any color images with full area coverage. This insertion drives benefits of the assistance of QR readers against interruption of image luminance. The vital information in QR code bits is transformed into luminance values of the proposed image, which is to be aimed.

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