Two Layer QR Code with Picture Embedding

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Abstract - *A Quick Response code (QR code) is a two-dimensional code much the same as a barcode that encodes a message of fixed length. In this paper, we present a variation of QR code, two-layer QR code with picture embedding. It's two-layer structure can show two different messages when checked from two different directions. We propose a strategy to create such two-layer QR codes encoding two given messages in almost no time. The appearance of a conventional QR code pattern is often too obtrusive for integrating into an aesthetically designed advertisement. So we are embedding the QR code in a picture to make it's appearance good.*

Key Words: **QR code, two-layer QR code, barcode, Picode.**

1. INTRODUCTION

Quick Response (QR) codes are two-dimensional (2D) barcode that can contain a wide range of information, for example, numeric and alphabetic characters, Kanji, Kana, Hiragana, symbols, binary and control codes. Up to 7,089 characters can be encoded in one code. It Consists of black and white squares called modules which encodes data, for example, a URL or an instant message. By checking a QR Code using a cell phone, a client can get prompt access to its content. QR codes have been generally utilized in various applications, for example advertising. The important features of QR codes are: high capacity data storage, Kanji and Kana character set capability, small printout size, dirt and damage resistant, readable from any direction in 360 degree.

A QR code can encode just a single message. So that encoding at least two messages is valuable in numerous situations. For instance, a store may give elective installment methods, an application may require diverse download joins for various working frameworks, and an exhibition thing may have descriptions in numerous dialects. While past work [1], [2] has considered joining two messages in one QR code, they target specific applications.

2-level QR[1] code which comprises of two layers of security given to the QR code. The principal level is known as public level and the subsequent level is known as private level. The public level QR code will store the data which can be demonstrated freely. The private level QR code will store the data which is private. At the point when this two level QR code is examined from any standard QR scanner, just the public message will be appeared from the scanner though the private message will be protected, verified and covered up. The second, Zhima code[2] utilizes gadget attributes, (for example, its operating system) to figure out which elective message to recover; the client isn't associated with choosing which elective message is wanted.

We present a variation of QR code called Two-Layer QR code, in which two messages are stored and can be read independently from two different directions. It is an exceptionally planned two-layer structure, with a top layer and a bottom layer. Each layer contains a matrix of modules. The bottom layer modules are black or white, while the top layer modules may be transparent, permitting the code to show up uniquely when viewed from two different directions. The two-layer QR code would thus be able to show two different QR codes, encoding two unique messages, by changing the view. QR code pattern is often too obtrusive for integrating into an aesthetically designed advertisement. So we are embedding Picode[3].

2. BASICS OF QR CODE

The QR code comprises of black and white pattern which comprise of fixed patterns to give the assurance of recognition of decoding robustness. QR code contains position, arrangement and timing pattern. Structure of a QR code is shown in figure 1. QR code likewise utilizes Reed Solomon code for the mistake correction levels, for example, L, M, Q, and H that permit the correction up to 7%, 15%, 20%, and 30% of codewords in blunder. The structure of QR code comprises of Timing pattern, finder pattern and alignment pattern. Finder patterns and alignment patterns are located at fixed positions and are used to locate and orient the QR code when scanning. The finder pattern implies huge square of black and white patterns which is put at upper left, upper right and base left corner. The format information records the error correction level and data masking pattern. A codeword consists of 8 modules and represents 8 bits of data.

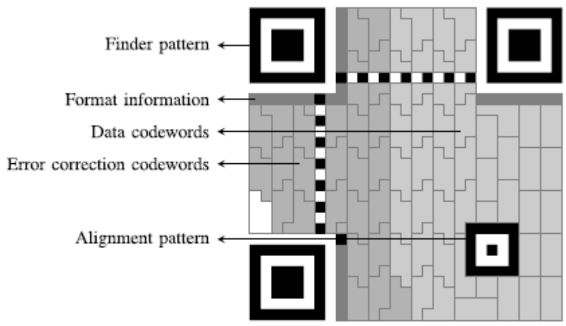

Fig -1: QR code structure

For message decoding, when the QR code is scanned the finder and alignment patterns locate the code firstly and then binarization is used to find the value of each module. Then, data masking pattern and the EC level are obtained from the format information. The bit of sequence of the message may then be recovered block by block, the error correction codewords helps to repair damage and noise.

For message encoding, first it is converted to a sequence of bits. Based on message length and desired reliability, suitable values of version and EC level are selected. Then, the sequence is put into data codewords in each block in a specific order, and corresponding error correction codewords are calculated. Lastly, the modules are bit-wise XORed with any one of the eight predefined data masking patterns. The selected data masking pattern should be the one which best avoids adjacent modules appearing in the same color.

3. TWO LAYER QR CODE

Two Layer QR code displays two QR codes when viewed from two different directions. Its special structure has a top layer and bottom layer. The bottom layer consist of black and white modules like a normal QR code. The top layer has the same number of modules but some of them are transparent. It can be used in many real world scenarios where two messages are needed. Figure 2 shows the structure of a two-layer QR code. The space between the two layers allows the QR code to have different appearances when read from different directions.

The design of top and bottom layers are as follows. Top layer has a (N+1)*N modules. The modules may be black, white, or transparent. The bottom layer has N*N modules in which each module may be black or white.

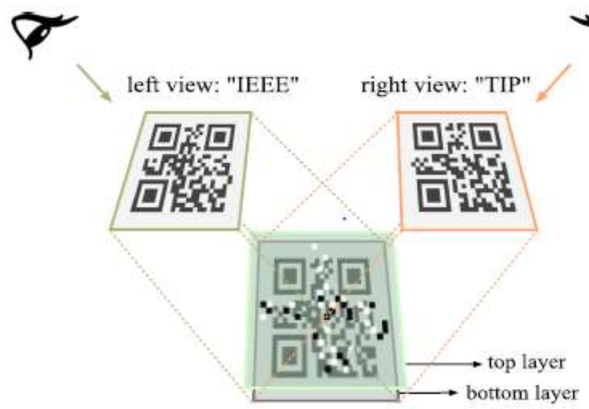

Fig -2: Two layer QR code

See figure 3, let $L_t(i, j)$ be the value of module (i, j) in the top layer ($1 \le i \le N + 1$, $1 \le j \le N$), and $L_b(i, j)$ be the value of module (i, j) in the bottom layer ($1 \le i, j \le N$). The left and right viewing patterns, O_l and O_r respectively, the left viewing pattern $O_l(i, j)$ is equal to $L_b(i, j)$ if $L_t(i, j) = t$ (transparent) or $L_t(i, j)$ otherwise. The right viewing pattern $O_r(i, j)$ is equal to $L_b(i, j)$ if $L_t(i + 1, j) = t$ (transparent) or $L_t(i + 1, j)$ otherwise. An example of a generated two-layer QR code is shown in Figure 4.

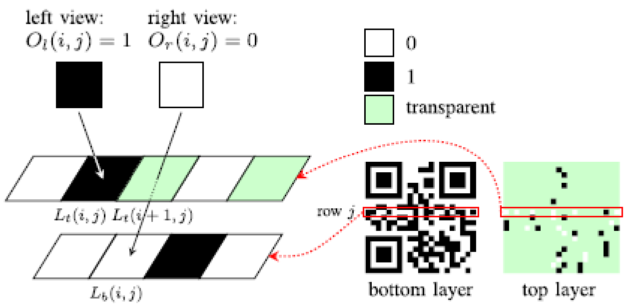

Fig -3: Every module on the top or bottom layer affects two different modules in the viewing patterns. The color of module $L_b(i, j)$ affects the colors of $O_l(i, j)$ and $O_r(i, j)$.

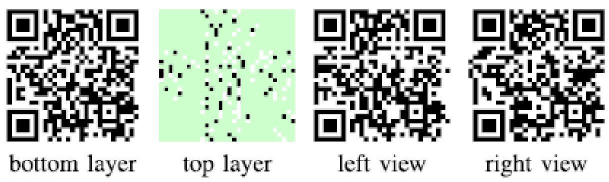

Fig -4: A generated two layer QR code

4. GENERATION ALGORITHM

We first use conventional QR code generation algorithms[4] to convert each message into a standard QR code. Then we have to generate the two layer QR code using generation algorithm.

A. Problem definition

We have two target messages, then we use conventional QR code generation algorithms to convert each message into a standard QR code, which we refer to as left and right target patterns. It is practically impossible to match the viewing pattern exactly like the target pattern. But the messages decoded from the viewing pattern should be similar to that of target pattern. Also we should maximize the ability of viewing patterns to decode correctly in case of damage.

B. Fixed Modules and Segments

Fixed modules are modules whose value can be directly set without optimization. An interleaved row is formed by interleaving modules in a row of the top layer with those in the same row of the bottom layer. A segment is an array of contiguous modules in an interleaved row terminated by fixed modules. See figure 5. Each segment may contain mismatched modules, resulting in mismatched code-words. These form its partial mismatched codeword set.

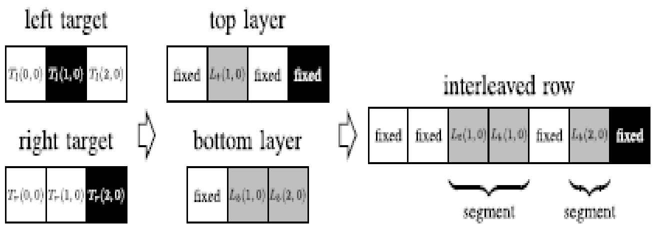

Fig -5: Fixed modules and segments.

C. Two step Optimization

Two step scheme is used to solve optimization problem. It greatly reduces the solution space by storing only unique code word sets and by removing duplicates.

1) Candidate Family: A *candidate family* is the set containing all partial mismatched codeword sets for a segment. firstly, we obtain a candidate family for each segment, by iterating through all combinations of a segment's module values. In a candidate family, we only store unique partial mismatched codeword sets.

2) Optimization on Candidate Families: Secondly, we determine a combination of partial mismatched codeword sets, i.e. to select one partial mismatched codeword set for each segment from its candidate family. These give the full mismatched codeword set.

D. Merge and Reduce

To reduce solution space and accelerate optimization merge and reduce operators are used.

1)Reduce operator: Given a candidate family S, let $P1$ and $P2$ be two different partial mismatched codeword sets in S. If $P1$ $P2$, $P2$ is a redundant partial mismatched codeword set in S, since choosing $P1$ would always give fewer mismatches than choosing $P2$. Then $P2$ can safely be ignored. Reducing a candidate family means removing all such redundant mismatched codeword sets.

2)Merge operator: The input to a merge operator is two candidate families as and it combines them into one candidate family. Given two candidate families $S1$ and $S2$, the merged candidate family S is given by: $S = \{ P1 \cup P2 | P1 \in S1, P2 \in S2\}$. If atleast one identical codeword is contained in two candidate families, then they are mergeable.

E. Simulated Annealing

It is a probabilistic technique for approximating the global optimum of a given function. For problems where finding an approximate global optimum is more important than finding a precise local optimum in a fixed amount of time, this method may be preferable. Here, even after the merge and reduce operation the solution space will be too large. We use simulated annealing to obtain a solution quickly.

F. Beautification

QR codes are of binary appearance which is not attractive and are obstrusive when added into a colourful advertisement. Two layer QR code support beautification. Here we are using picode[3] for QR code beautification. It provides a QR code with picturesque appearance.It is the extension part of the existing beautified QR code. It is way better than the existing techniques. Picode will give a more clear appearance to the image and is simple and really easy to use.

5. CONCLUSION

Two-layer QR codes can encode two independent messages. They can be decoded separately by changing the viewing directions. It is very useful in real case scenarios. For QR code beautification Picode can be used. It can be used very easily than all other existing code beautification techniques. It provides the best perceptual quality in preserving aesthetic appearance of the embedded image & also maintains the decoding robustness. It is very successful in real world applications.

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