HiQ: Robust and Fast Decoding of High-Capacity QR Codes

and its Application on AuthPaper

Zhibo Yang, Zhiyi Cheng, Chen Change Loy, Wing Cheong Lau, Chak Man Li and Guanchen Li

Background:

The applicability of QR codes is limited by its capacity.
Thus, traditional QR codes usually only store URLs, which have the following problems:

1 **Expensive**: requires an on-line web service and a dataset deployed on a remote server.

2 **Inconvenient**: requires the Internet access for those devices.

3 **Insecure**: since the data is transmitted behind the scene, it may expose users to malicious attacks and cause private information leakage without users' awareness.

HiQ : high-capacity QR codes

- Optimizes the decoding algorithm for high-density QR codes to afford robust and fast decoding by mobile devices;
- Leverages color to increase the data capacity of traditional QR codes.

1 HiQ binarizes it for detecting the special patterns which are needed for correct the geometric distortion.

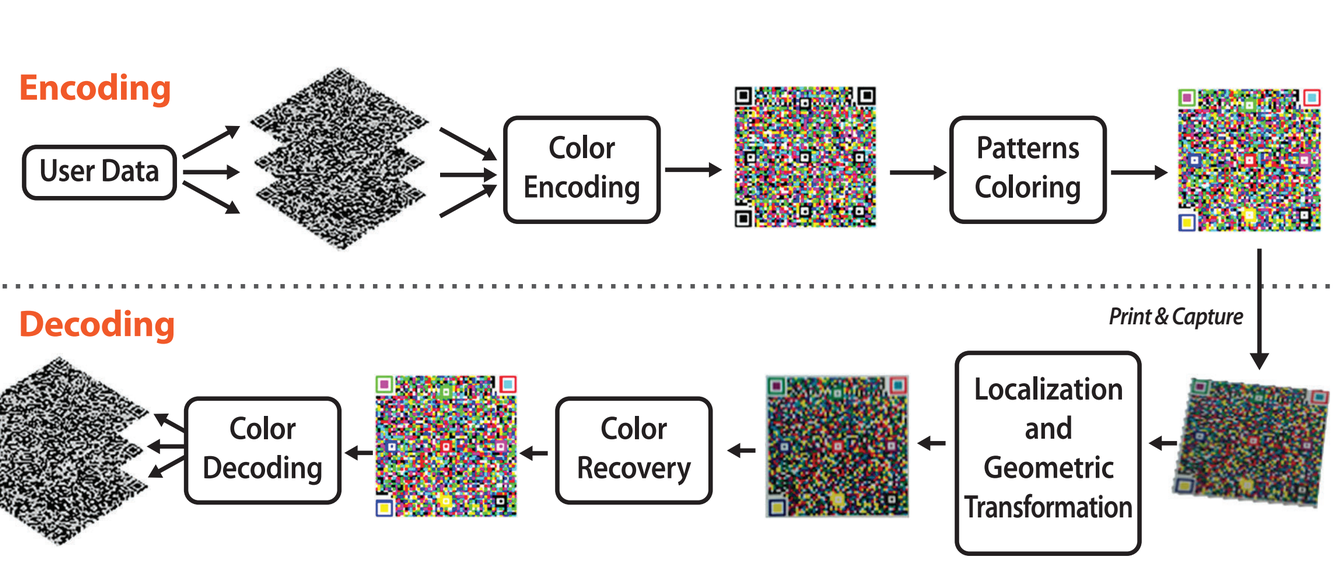
2 HiQ will perform color recovery and use a predefined color codebook to map the color QR code into multiple monochrome QR codes.

3 HiQ uses the existing monochrome QR code decoding algorithm to extract the data layer by layer using the built-in error correction mechanism.

Overview of Data Encoding and Decoding

Color Codebook	
111	Black
001	Yellow
010	Magenta
011	Red
100	Cyan
101	Green
110	Blue
000	White

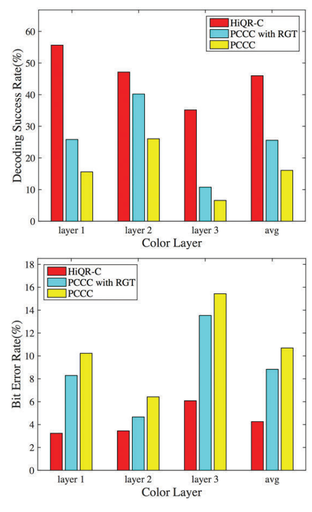
0 and 1 stand for white and black, resp.



Evaluation on a Large Color QR Code Dataset

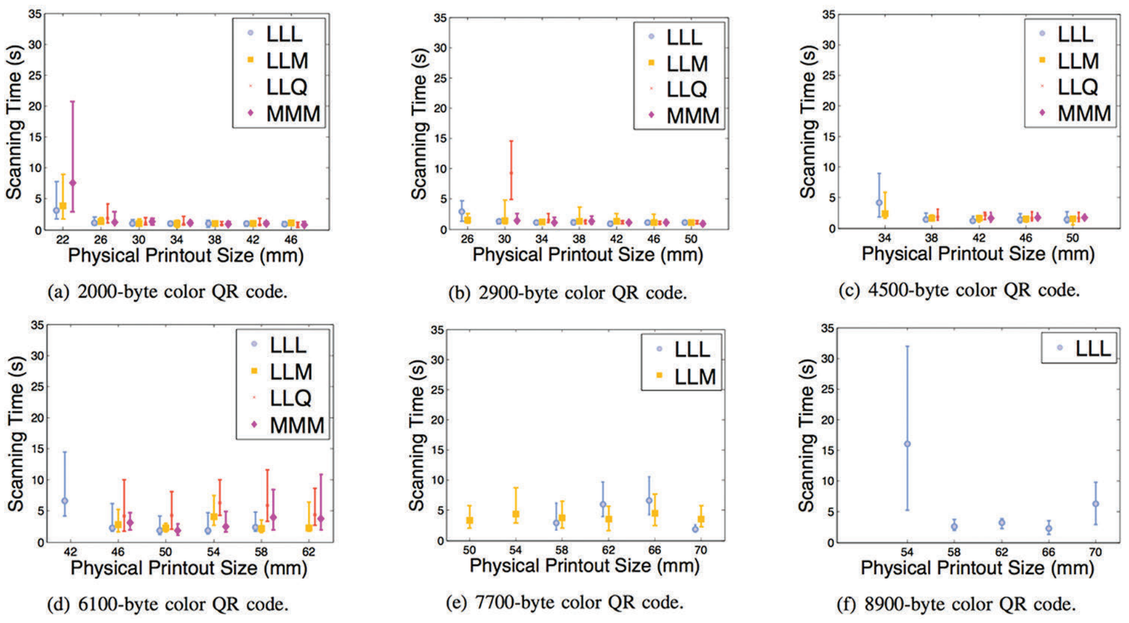
Our method outperforms PCCC significantly : increasing the decoding success rate (DSR) by 286%, and decreasing the bit error rate (BER) by 60%;
RGT improves the performance of PCCC by 159% in DSR and 17.5% in BER.

# of testing samples: 5390
# of undetected samples: 1678 (620 wrong dimension, 1058 undetected)
LSR = 0.6887(3712/5390)



Evaluation on Mobile Device

HiQ can encode 2600 bytes, 4500 bytes and 7700 bytes of data in areas of 24 × 24 mm2, 34 × 34 mm2 and 50 × 50 mm2, respectively, and still guarantee robust decoding within 5 seconds.



(a) 2000-byte color QR code. (b) 2900-byte color QR code. (c) 4500-byte color QR code.

(d) 6100-byte color QR code. (e) 7700-byte color QR code. (f) 8900-byte color QR code.

Application on AuthPaper

AuthPaper provides a cost-effective, secure solution for authenticating paper-based documents / credentials using 2D barcode. HiQ substantially increases the capacity of the 2D barcode. Hence it allows AuthPaper to work on wider range of document data including images, and further reduce the printout size of 2D barcode.