Major Studio I
Name: Zixuan Kevin Fan
NID: N00631555
12.14.17

A Better QR Code

History of 2-D Codes

There are currently two type of two-dimensionally scannable codes in our society: Universal Product Code (UPC) and Quick Response (QR) Code. The UPC code was first invented to be used along with punched cards. In 1932, Wallace Flint used a automated checkout system which would later usher the UPC mechanics (Espacenet). It would soon be applied to the retail industry in Troy, Ohio in 1974 and be standardized as the GSI specification that consists of 12 numeric digits (Nelson, 1997). As the successor to UPC code, QR code was invented in 1994 by a Japanese company called Denso Wave for tracking vehicles during manufacturing (Springer, 2014). It was part of the LEAN manufacturing process and greatly facilitated a faster-speed tracking for car components. QR code has then been introduced to retail, prints and even payment nowadays as we found in mobile payment. QR code gained even more popularity in the graphic user interface (GUI) and Internet 2.0 age, where there is an increasing demand for quick look-up of resources and sharing of images. The technology of QR code has evolved into a complex and stable system, where a total of around 2953-byte data can be encoded and decoded correctly in nearly all devices (QRcode.com).

Figure 1a-b: Examples of UPC code and QR code. Left: Sample UPC Code. Right: Sample QR Code.

QR Code in Current State

It cannot be denied that QR code is one of the finest design products in the past century and has greatly improved the way we interact with virtual objects. Apart from the easy generating of QR code, the system was also designed to be less error-prone, so that even though you are missing part of the code, it is still fairly easy to retrieve the entire encoded message. Since 1994, the QR code encoding scheme has expanded to include characters of numerics, alphanumerics, binary and Kanji/Katakana (QRcode.com). The reality of the QR code right now is that it has grown to this monster wrapper for everything on the Internet, either characters, urls, images and even videos. The resulting problem is that the encoding bitmaps have become larger and larger and are used in every single aspect of our life, even though somewhere it does not necessarily fit the best. Take a beautifully designed poster for example. Designed has spent huge amount of time trying to optimize every pixel on the screen/print, then we impose this black-and-white square at the bottom of the page. It is understandable that people have the promotional needs to use the QR code, yet consumerism has driven us to a point where we now

encounter too much visual pollution. Therefore, how do we design an alternative or substitute to QR code so that the barebone QR code can still excel in its original industrial environment, while this alternative can serve a better link between our virtual cyber world and the physical world?

A Better QR Code

The new QR code I proposed consists of 4 principal colored blocks, encoded with RGBA color system. Each channel in the RGBA system can take values ranging from 0 to 255, which is 1 byte of information each. In total, the four colored blocks can carry information up to 16 bytes. For a standard variable allocation in computer science, one character requires 1 byte of memory. Therefore the tiny 4-block image enables us to share information up to 16 characters, which is a considerable amount of information. Paired with url shortener, we can further link any website with a maximum of 10 characters needed.

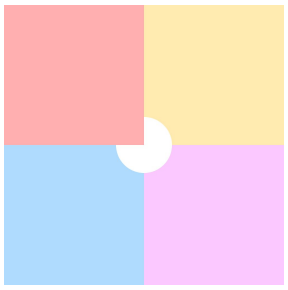

Figure 2: Sample of the new QR code. Four colored blocked is generated with RGBA colors, the light block in the center is used for calibration when display of the colored blocks are not optimal.

The new QR code system will support 84 common characters that are used mostly on the web urls. The detailed encoding scheme can be found below.

Code	Character	Code	Character	Code	Character	Code	Character	Code	Character
0000000	0	0010010	E	0100100	N	0110110	W	1001000	(
0000001	1	0010011	e	0100101	n	0110111	w	1001001	)
0000010	2	0010100	F	0100110	O	0111000	X	1001010	,
0000011	3	0010101	f	0100111	o	0111001	x	1001011	,
0000100	4	0010110	G	0101000	P	0111010	Y	1001100	~
0000101	5	0010111	g	0101001	p	0111011	y	1001101	:
0000110	6	0011000	H	0101010	Q	0111100	Z	1001110	;
0000111	7	0011001	h	0101011	q	0111101	z	1001111	*=
0001000	8	0011010	I	0101100	R	0111110	space	1010000	?
0001001	9	0011011	i	0101101	r	0111111	$	1010001	@
0001010	A	0011100	J	0101110	S	1000000	&	1010010	#
0001011	a	0011101	j	0101111	s	1000001	-	1010011	/
0001100	B	0011110	K	0110000	T	1000010	_		
0001101	b	0011111	k	0110001	t	1000011	.		
0001110	C	0100000	L	0110010	U	1000100	**		
0001111	c	0100001	l	0110011	u	1000101	!		
0010000	D	0100010	M	0110100	V	1000110	*		
0010001	d	0100011	m	0110101	v	1000111	*'		
Total		84							
Number of characters		4x8x4 = 18.2857							

Figure 3: Encoding scheme of the new QR code

The results of the new QR code implementation are lower in space requirement, lower in color contrast and more recognizable to humans.

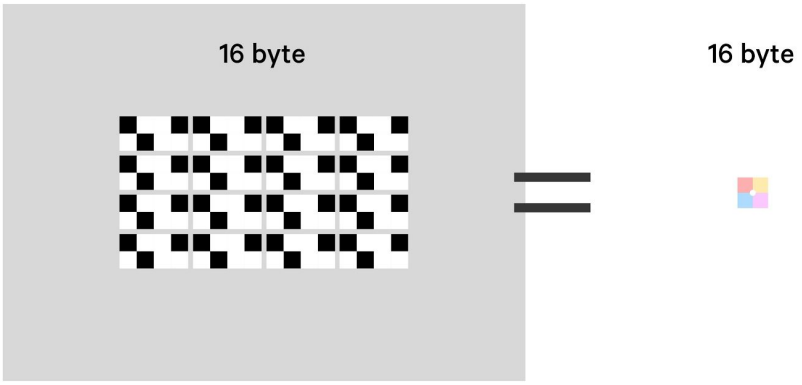

Figure 4: Size comparison of the current and proposed QR code. Both codes offer 16-byte information encoded.

One technique that has been added to the new QR code composition is the center circle used for calibration under sub-optimal environment. By applying the

additive color principles, we can easily recover the original RGBA color encoding from the distorted colored blocks.

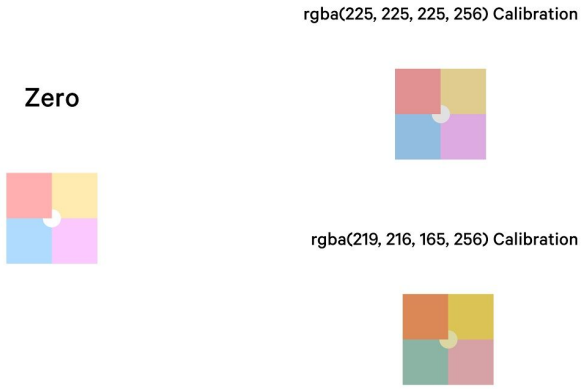

Figure 5: Calibration of the new QR code applying the additive color system.

Implications and Potential Problems

With the introduction of the new QR code, we can expect that the original QR code exits its roles in the domain of art and design, or even our daily life. By implementing this new design of QR code, we can envision a future without abrupt plug-ins of commercial advertising links. The accuracy of the newly proposed QR will increase dramatically with the advancement in printing technology. This new design also serves as an inspiration for better designs of the next generation QR code. There is no reason to accept the fact that we are still using the same coarse industry-standard QR code, as in the 1990s, in our everyday life nowadays. More research of the new QR code has to be done to improve the capacity of the characters encoded; because of the high dependence on color accuracy, we have to develop new techniques to offset the inconsistency in printing the physical copies.

References

"Sample UPC Code." *Wikimedia Commons*, upload.wikimedia.org/wikipedia/commons/thumb/a/a2/EAN-13-5901234123457.svg/1200px-EAN-13-5901234123457.svg.png.

"Espacenet." *Espacenet - Bibliographic data*, worldwide.espacenet.com/publicationDetails/biblio?CC=US&NR=2612994&KC=&FT=E&locale=en_EP.

Handbook of augmented reality. Springer, 2014.

Nelson, Benjamin. *Punched cards to bar codes: a 200 year journey*. Helmers Pub. Co., 1997.

Sample QR Code. www.qrstuff.com/images/sample.png.

"What is a QR Code?" *What is a QR Code? | QRcode.Com | DENSO WAVE*, www.qrcode.com/en/about/.