

Research on the Structure and Coding of a Novel Double Z Two-Dimensional Bar Code with Large Capacity

Wei Wang^{1, a, *}, Jing Jin^{1, b} and Keyi Wang^{2, c}

¹ Hainan Technology and Business College, Information Engineering College, Haikou 570203, China.

² Liaoning Province Government Procurement center, Liaoning, China.

^{a,*} fiemkx@163.com, ^bjinjing31201@163.com, ^c pluser007@163.com

Abstract. With the rapid development of internet technology and intelligent equipment, the dissemination and recognition of information has become a necessary technology in modern society. As a relatively concerned and widely applicable means of information dissemination, although the two-dimensional bar code has the advantages of low cost, convenient transmission, high reliability, strong security and anti-counterfeiting, but the social demand for information is growing, the traditional two-dimensional bar code needs to be constantly improved to meet the people to transfer and store more information requirements. In this paper, a new type of two-dimensional bar code with large capacity is designed based on double Z structure, it not only has the characteristics of simple coding and high information density, but also easy to identify and promote. Results showed that our new code can increase the storage capacity by 4 times in the same format. The experiment showed that the double-z code designed in this paper can store 1500 characters or 700 Chinese characters in a 1-square-centimeter format with 600dpi resolution. In contrast, the information image generated by the usual binary QR code can only store 35 numbers, 9 Chinese characters or 21 letters. It can be clearly seen that the storage capacity of double Z codes under the same format has been greatly improved, which can meet the application scenarios with high information capacity of two-dimensional codes.

Keywords: Double Z; Two-dimensional bar code; Large capacity.

1. Introduction

With the rapid development of internet technology and intelligent equipment, the dissemination and recognition of information has become a necessary technology in modern society. Bar code is a kind of automatic identification technology widely used in business, postal, book management, storage, industrial production process control and other fields. There are many types of bar code, such as one-dimensional bar code, two-dimensional bar code, and three-dimensional bar code. Both one-dimensional code and two-dimensional code are printed on the graph of the plane, which are the codes of two-dimensional space [1].

Common one-dimensional bar code includes EAN code, UPC code, interleaved 2 of 5, code 39, code 128 and so on, it generally has data verification function. Common two-dimensional bar code includes QR code [2-3], PDF417 code [4], Data Matrix code [5], Chinese signal code [6], LP code and so on, it generally has data correction function.

As a relatively concerned and widely applicable means of information dissemination, although the two-dimensional bar code has the advantages of low cost, convenient transmission, high reliability, strong security and anti-counterfeiting. At the same time, it has also played a great role in promoting society informatization in China. But the social demand for information is growing, the traditional two-dimensional bar code needs to be constantly improved to meet the people to transfer and store more information requirements. The fact is that the current application in the market of two-dimensional code products is mostly foreign, and it is quite out of keeping with China's position as a major producer and consumer of goods.

Currently widely used two-dimensional bar code has a small information capacity, and the redundant information in the unit area is larger than the useful information, which restricts some application goals and occasions.

In order to store more information in unit area and improve the transmission efficiency with two-dimensional codes, the market calls for large capacity, fast decoding, encrypted transmission algorithm to facilitate the storage of new two-dimensional codes. So, it is our sacred mission endowed by the times to create a new two-dimensional code. This paper intended to develop a new type of two-dimensional code that is different from the popular two-dimensional code system. We call it double Z code.

2. Structure and Code of Double Z Code

The existing two-dimensional code on the market has a complex structure, which is not conducive to popularization and application. As for actual condition, we devised a simple and feasible coding method that needs to be verified in research practice.

2.1 Structure of Double Z Code Mark

The basis of a two-dimensional code is composed of code mark. At present, the commonly used two-dimensional code is sated in matrix form and adopts binary encoding. In the corresponding element position of the matrix, a single black or dark module represents the binary digits "1", and a single white or light module represents the binary digits "0". The permutation and combination of modules determine the meaning represented by the matrix.

For example, to represent the information of an English letter "r", its ASCII code value is represented as "011100102" by the binary code of 8 bits (basic ASCII code is 7 bits, the highest position is 0, and extended ASCII code is 8 bits), and the corresponding code use eight modules of "white, black, black, black, white, white, black, and white", that is, eight modules represent a basic information. The double Z code proposed in this paper is composed of the basic double Z code mark. Since the graph of the Z code mark is like the English letter "Z", which was named double Z code. It is also a kind of matrix two-dimensional code, which is characterized by a symmetrical graphic composed of two letters Z.

The double Z code adopts the quaternary coding method. A basic code space is represented as a quaternary code mark through the cooperation of the basic code mark space, pixel grid and the axisymmetric condition of "Z" font code mark. Traditional two-dimensional code can only represent two Numbers "0" and "1" in a unit code mark space, while double Z code can represent four Numbers "0", "1", "2" and "3" in the same code mark space. When storing the same information, the double Z code saves more space than other two-dimensional codes; while the storage space is limited, the double-Z code can store more information than other two-dimensional codes.

The double Z code mark space is the equidistant space of a 6 by 6 unit. The unit can be a single pixel or a color block code mark composed of N by N pixels. The double Z code mark includes two sets of parallel and close together pixel filling bars, each pixel filling bar includes three color blocks. When generating a code mark, black color blocks need to be filled in the code mark space, and each color block corresponds to a cell.

The first color block and the second color block of one-pixel filling bar are close to the second color block and the third color block of the other pixel filling bar, showing a "Z" font. The basic code mark space includes four filling modes, which respectively correspond to the "0" code mark, "1" code mark, "2" code mark and "3" code mark.

As shown in Fig.1, rotate the basic code mark ("0 code mark") 90 degrees counterclockwise to form "1 code mark", flip it horizontally to form "2 code mark", and flip it diagonally to form "3 code mark". The "0" code mark, "1" code mark, "2" code mark and "3" code mark correspond to the "0", "1", "2" and "3" of the quaternary number respectively.

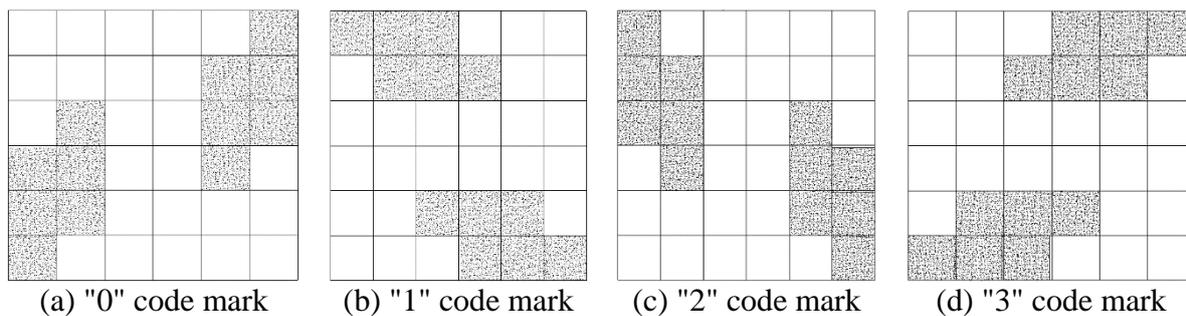


Figure 1. The schematic diagram of four code mark.

2.2 Research on the Encoding Method of Double Z Code

The encoding of double Z code constructed in this paper adopts quaternary code format. Four consecutive double Z code symbols form an information unit, which can be letters, numbers and control codes.

The encoding method is as follows: 1) For example, to represent an English letter "r", where ASCII code is binary sequence "011100102", and then convert to quaternary sequence is "13024"; 2) when a paragraph of English text is to be represented, the corresponding binary code is represented as the quaternary code, and then the corresponding code symbol graph is found. Finally, the high order images are arranged in the front and low order images in the back order; 3) When representing a Chinese character, find the corresponding Chinese character code in the national standard GB 18030-2005 table, then convert it into the quaternary code, and ranked the corresponding code mark from high to low.(Program automatically completes the search. Fig.2 shows part of the double Z code comparison table.

Binary	Dec	Four	字符	DZ 图形	Binary	Dec	Four	字符	DZ 图形
00110000	48	0300	0		01010110	86	1112	V	
00110001	49	0301	1		01010111	87	1113	W	
00110010	50	0302	2		01011000	88	1120	X	
00110011	51	0303	3		01011001	89	1121	Y	
00110100	52	0310	4		01011010	90	1122	Z	
00110101	53	0311	5		01100001	97	1201	a	
00110110	54	0312	6		01100010	98	1202	b	
00110111	55	0313	7		01100011	99	1203	c	
00111000	56	0320	8		01100100	100	1210	d	
00111001	57	0321	9		01100101	101	1211	e	
01000001	65	1001	A		01100110	102	1212	f	
01000010	66	1002	B		01100111	103	1213	g	
01000011	67	1003	C		01101000	104	1220	h	
01000100	68	1010	D		01101001	105	1221	i	
01000101	69	1011	E		01101010	106	1222	j	
01000110	70	1012	F		01101011	107	1223	k	
01000111	71	1013	G		01101100	108	1230	l	
01001000	72	1020	H		01101101	109	1231	m	
01001001	73	1021	I		01101110	110	1232	n	
01001010	74	1022	J		01101111	111	1233	o	
01001011	75	1023	K		01110000	112	1300	p	
01001100	76	1030	L		01110001	113	1301	q	
01001101	77	1031	M		01110010	114	1302	r	
01001110	78	1032	N		01110011	115	1303	s	
01001111	79	1033	O		01110100	116	1310	t	
01010000	80	1100	P		01110101	117	1311	u	
01010001	81	1101	Q		01110110	118	1312	v	
01010010	82	1102	R		01110111	119	1313	w	
01010011	83	1103	S		01111000	120	1320	x	
01010100	84	1110	T		01111001	121	1321	y	
01010101	85	1111	U		01111010	122	1322	z	

Figure 2. Double Z code diagram.

2.3 Research on Double Z Code Information Image Verification and Control Coding

In order to achieve the purpose of reliable transmission, the character check code is used to verify the character of the information encoded image when the "line" of code information is formed. It is occupying 1 bit of quaternary code. To distinguish the beginning of each line in the encoded image, the line start code is adopted as the "line" mark. The quaternary number "3" is used as the starting code for each line. Because "3" cannot appear in the first bit of a character encoding, it is most appropriate to select "3" without confusion.

Each line of the specified width is accompanied by a line check code, which is a 2-bit quaternary code. Use it as the end of the line and perform parity check. The quaternary sequence "3131" is used as the end code, indicating the end of a text. If you want to add new text, you can restart encoding and still end with "3131". The quaternary sequence "3232 0101" is used as the completion code. If the maximum number of digits in a line is not reached when generating the DZ code graph, the completion code should be added repeatedly until the end of the graph.

Traditional two-dimensional code was limited by its versions and complex coding methods, so the information storage within the same format is limited. Results showed that our new code can increase the storage capacity by 4 times in the same format. In addition, we also intend to adopt a new method of compressed storage to compress information and then encode it. The encoding width of Double Z code image is variable. Instead of fixed coding widths, we use width control codes to suit the needs of various applications. These width control codes are composed of left vertex code, right vertex code and bottom-line code. The quaternary sequence "00001111" is used as the left vertex code. The reading order starts from row 5 of the first column and ends at row 2, and continues from column 1 of the first row to column 4. The quaternary sequence "03332330" is used as the right vertex code. The reading order starts from the bottom column 4 of the first row to the end of the last column, and continues from row 2 of the last column to the end of row 4. The quaternary sequence "3232" is used as the bottom-line code. The reading order starts from the first column of the last row to the end of the fourth column.

3. Conclusion

Traditional two-dimensional code technology represents 0, 1 in binary number through black, and white geometric figure to realize information storage. Due to the limitation of its own information storage, although it can store digital symbols, it is sometimes not enough to store a large amount of information data, especially Chinese characters in a specified area. The experiment showed that the double-z code designed in this paper can store 1500 characters or 700 Chinese characters in a 1-square-centimeter format with 600dpi resolution. In contrast, the information image generated by the usual binary QR code can only store 35 numbers, 9 Chinese characters or 21 letters. In theory, a book with 500,000 Chinese characters could be stored in a 600 square centimeters double Z code image. It can be clearly seen that the storage capacity of double Z codes under the same format has been greatly improved, which can meet the application scenarios with high information capacity of two-dimensional codes.

Acknowledgments

The research was funded by Natural Science Fund of Hainan Province (Grant No. 617167).

References

- [1]. X.X. Nong, H. Su, X.Q. Li, et al. Barcode technology and application [M]. Beijing: Beijing jiaotong university press, 2014.
- [2]. Z.J. Gan, J.B. Fang, H.Y. Guan, et al. Research and application of binarization algorithm of QR code image under complex illumination [J]. Journal of Applied Optics, 2008, 39(05):667-673.

- [3]. Z.M. Liu, J.J. Lin. A Watermarking Algorithm for Print-Scan Process on QR code [J]. Journal of East China University of Science and Technology (Natural Science Edition),2018, 44(01):97-103.
- [4]. J.X. Li, J.C. Xie, S.X. Zhang, et al. Research of RS code applied in coding and decoding of PDF417 error correcting code [J]. Computer Engineering and Applications, 2007(17):198-201.
- [5]. B.Y. Guan, J.W. Dong, X.F. Ma, et al. Research on Tilt Correction Algorithms of Distorted Data Matrix Code Image [J]. Journal of Harbin University of Science and Technology, 2008, 23(05):100-105.
- [6]. X.Z. Yu, J. Liu, Q.J. Wang. Error Correction Performance Analysis and Simulation of RS Code in Chinese Signal Code [J]. Journal of Nanjing University of Science and Technology, 2011, 35(01):42-46.