BARCODES

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Outline

- Introduction
- Definition
- History
- 1D Barcode
  - Code 39
  - Code 93
  - EAN Code
- 2D Barcode
  - QR Code
  - Data Matrix code
- Barcode readers
  - Contact wands
  - Active non-contact reader
  - Passive non-contact reader
  - How to use them ?
- Conclusion

Introduction

- Why did we choose this topic ?
- How do barcodes work ?
- Are there many different kind of barcodes ?

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Definition

- « A **barcode** (also **bar code**) is an optical machine-readable representation of data.

  Originally, bar codes represented data in the widths (lines) and the spacing of parallel lines, and may be referred to as linear or 1D (1 dimensional) barcodes or symbologies.

  They also come in patterns of squares, dots, hexagons and other geometric patterns within images termed 2D (2 dimensional) matrix codes or symbologies.»

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History

- 1932 : First idea of identifying products with a code (Punch card by Wallace Flint)
- 1970 : NAFC developed a 11-digit code to identify any product
- 1974 : Creation of code 39 by Dr. David Allais and Ray Stevens
- 1978 : Creation of the UPC (Universal Product Code)
- 1981 : US DoD adopted the use of code 39.
- Today : Use of the EAN (European Article Number) barcode

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1D Barcode – Code 39

- Structure
- Encoding
- Applications

1D Barcode – Code 39 – Structure

- Always starts/stops with a star (*)
- In between, the encoded characters
- Each character is divided into 9 elements and separated with a thin space
- Only two sizes for the elements : thin or wide

AALBORG

1D Barcode – Code 39 – Encoding

- Encode A-Z characters, 0-9 digits and 7 special characters (-, $, %, . , /, +,)
- Each element is either W, w, B, or b

1D Barcode – Code 39 – Applications

Code Details		
Char	Format1	Format2
*	NwNnWnWnN	bWbwBwBwb
-	NwNnNnWnW	bWbwbwBwB
$	NwNwNwNnN	bWbWbWbwb
%	NnNwNwNwN	bwbWbWbWb
(space)	NwWnNnWnN	bWBwbwBwb
.	WwNnNnWnN	BWbwbwBwb
/	NwNwNnNwN	bWbWbwbWb
+	NwNnNwNwN	bWbwbWbWb
0	NnNwWnWnN	bwbWBwBwb
1	WnNwNnNnW	BwbWbwbwB
2	NnWwNnNnW	bwBWbwbwB
3	WnWwNnNnN	BwBWbwbwb
4	NnNwWnNnW	bwbWBwbwB
5	WnNwWnNnN	BwbWBwbwb
6	NnWwWnNnN	bwBWBwbwb
7	NnNwNnWnW	bwbWbwBwB
8	WnNwNnWnN	BwbWbwBwb
9	NnWwNnWnN	bwBWbwBwb
A	WnNnNwNnW	BwbwbWbwB
B	NnWnNwNnW	bwBwbWbwB
C	WnWnNwNnN	BwBwbWbwb
D	NnNnWwNnW	bwbwBWbwB
E	WnNnWwNnN	BwbwBWbwb
F	NnWnWwNnN	bwBwBWbwb
G	NnNnNwWnW	bwbwbWBwB
H	WnNnNwWnN	BwbwbWBwb
I	NnWnNwWnN	bwBwbWBwb
J	NnNnWwWnN	bwbwBWBwb
K	WnNnNnNwW	BwbwbwbWB
L	NnWnNnNwW	bwBwbwbWB
M	WnWnNnNwN	BwBwbwbWb
N	NnNnWnNwW	bwbwBwbWB
O	WnNnWnNwN	BwbwBwbWb
P	NnWnWnNwN	bwBwBwbWb
Q	NnNnNnWwW	bwbwbwBWB
R	WnNnNnWwN	BwbwbwbWb
S	NnWnNnWwN	bwBwbwBWb
T	NnNnWnWwN	bwbwBwBWb
U	WwNnNnNnW	BWbwbwbwB
V	NwWnNnNnW	bWBwbwbwB
W	WwWnNnNnN	BWBwbwbwb
X	NwNnWnNnW	bWbwBwbwB
Y	WwNnWnNnN	BWbwBwbwb
Z	NwWnWnNnN	bWBwBwbwb

• Decode this barcode

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1D Barcode – Code 93

- Structure
- Encoding
- Applications

1D Barcode – Code 93 – Structure

- A start character *
- Encoded message
- First modulo-47 check character « C »
- Second modulo-47 check character « K »
- Stop Character *
- Termination bar

1D Barcode – Code 93 – Encoding

- Encode A-Z characters, 0-9 digits and 7 special characters (-, $, %, . , /, +,) just like the code 39
- Each character is divided into nine elements. It always contains three bars and three spaces
- Each bar and space is from 1 to 4 elements wide

1D Barcode – Code 93 – Encoding

Algorithm to calculate the « C » and « K » character

- Associate each character with its weight. The weight goes from 1 to 20 (after 20, it goes back to 1) from the right to the left.
- Multiply the value of each character by its weight and sum them all. Then , divide the result by 47 (don't ask us why ;)). « C » is the rest of this division
- Do the same for « K » but « C » is taken into account in the sum and the weight is limited to 15.

1D Barcode – Code 93 – Encoding

- Code 93 Table

0	0	131112	100010100	28	S	211122	110101100	14	E	221211	110010010	42	%	211131	110101110
1	1	111213	101001000	29	T	211221	110100110	15	F	231111	110001010	43	($)	121221	100100110
2	2	111312	101000100	30	U	221121	110010110	16	G	112113	101101000	44	(%)	312111	111011010
3	3	111411	101000010	31	V	222111	110011010	17	H	112212	101100100	45	(/)	311121	111010110
4	4	121113	100101000	32	W	112122	101101100	18	I	112311	101100010	46	(+)	122211	100110010
5	5	121212	100100100	33	X	112221	101100110	19	J	122112	100110100		Start/Stop *	111141	101011110
6	6	121311	100100010	34	Y	122121	100110110	20	K	132111	100011010		(Reverse stop)	114111	101111010
7	7	111114	101010000	35	Z	123111	100111010	21	L	111123	101011000			411111	111101010
8	8	131211	100010010	36	-	121131	100101110	22	M	111222	101001100			111132	101011100
9	9	141111	100001010	37	.	311112	111010100	23	N	111321	101000110			111231	101001110
10	A	211113	110101000	38	SPACE	311211	111010010	24	O	121122	100101100		Unused	113112	101110100
11	B	211212	110100100	39	$	321111	111001010	25	P	131121	100010110			113211	101110010
12	C	211311	110100010	40	/	112131	101101110	26	Q	212112	110110100			213111	110111010
13	D	221112	110010100	41	+	113121	101110110	27	R	212211	110110010			212121	110110110

1D Barcode – Code 93 – Applications

- Calculate the « C » and « K » character for the word « AAU »

Car	Val	Car	Val	Car	Val	Car	Val
0	0	A	10	N	23	-	36
1	1	B	11	O	24	.	37
2	2	C	12	P	25	Esp	38
3	3	D	13	Q	26	$	39
4	4	E	14	R	27	/	40
5	5	F	14	S	28	+	41
6	6	G	16	T	29	%	42
7	7	H	17	U	30	!	43
8	8	I	18	V	31	#	44
9	9	J	19	W	32	&	45
		K	20	X	33	@	46
		L	21	Y	34		
		M	22	Z	35		

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1D Barcode – EAN Code

- Structure
- Encoding
- Applications

1D Barcode – EAN Code – Structure

- Composed of 8 or more frequently 13 digits
- Structured as the following :

  - 2 or 3 digits for the country code
  - 4 or 5 digits for the manufacturer code
  - 5 digits for the article number
  - 1 digit to check the integrity of the barcode

1D Barcode – EAN Code – Structure

- Examples of some country codes :
  - US : from 000 to 060
  - France : from 300 to 379
  - Uzbekistan : 478
  - Denmark : from 570 to 579
  - China : from 690 to 695
  - Bulgaria : 380
- It does not always represent the production country but it may be the country where the company is based in

1D Barcode – EAN Code – Encoding

- Each character is coded by 7 elements
- Only 12 characters are actually coded, the first one is deduced from the others.

There are 3 different coding tables : A, B and C. The characters after the middle break bars are always coded according to the C table.

The characters before are either coded in A or B set, it depends of the value of the first character according to the following table

1D Barcode – EAN Code – Encoding

1st Number System Digit	Parity to encode with					
	2nd Number System Digit	Manufacturer Code Characters				
		1	2	3	4	5
0	A	A	A	A	A	A
1	A	A	B	A	B	B
2	A	A	B	B	A	B
3	A	A	B	B	B	A
4	A	B	A	A	B	B
5	A	B	B	A	A	B
6	A	B	B	B	A	A
7	A	B	A	B	A	B
8	A	B	A	B	B	A

Parity table

1D Barcode – EAN Code – Encoding

- Coding tables

Digit	Left-Hand Encoding		Right-Hand
	Set A (Odd Parity)	Set B (Even Parity	Set C
0	000101	0100111	1110010
1	0011001	0110011	1100110
2	0011001	0011011	1101100
3	0111101	0100001	1000010
4	0100011	0011101	1011100
5	0110001	0111001	1001110
6	0101111	0000101	1010000
7	0111011	0010001	1000100
8	0110111	0001001	1001000
9	0001011	0010111	1110100

1D Barcode – EAN Code – Encoding

Algorithm to calculate the check digit

- Calculated with the first 12 digits
- They are given from left to right the weights 1 and 3, alternatively.
- Then we sum them all, we take the rest of the division by 10, and the check digit is the complement to 10 to this rest.
- Example for the code 7 6 1 2 3 4 5 6 7 8 9 1

  7x1 + 6x3 + 1x1 + 2x3 + 3x1 + 4x3 + 5x1 + 6x3 + 7x1 + 8x3 + 9x1 + 1x3 = 113

  113/10=10*11+3

  3+7=10 The check digit is 7

1D Barcode – EAN Code – Applications

- Given the parity table and the three tables, create the barcode of this number :

  570 2131 23124

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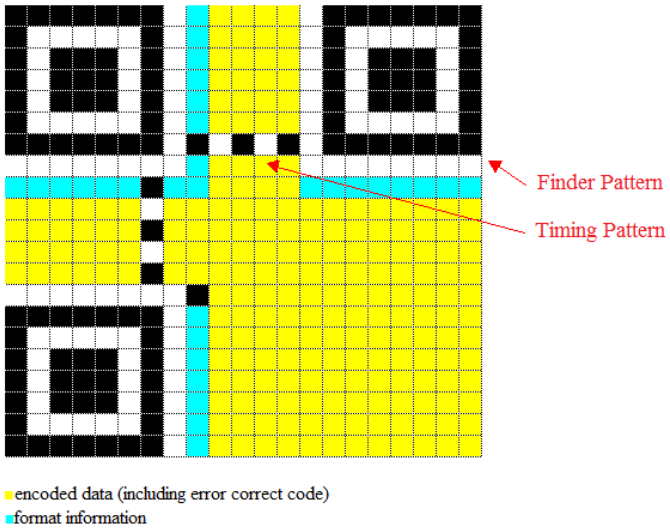
2D Barcode – QR Code

- Structure
- Applications

2D Barcode – QR Code - Structure

- Composed of different zones :
  - Finder Patterns which are used to detect the position of the QR Code
  - Timing Patterns which are used to identify the coordinates of the different symbols
  - The encoded data zone
  - The format information zone which basically contained the error correcting level and the mask pattern.

2D Barcode – QR Code – Structure



2D Barcode – QR Code – Applications

- Manufacturing :
  - Order/Product Scanning System for Automotive Parts
  - Process Control System for Electronic Circuit Boards
- Logistics :
  - Control System for Food Products
  - Shipping Control System for Garment Products
- Sales :
  - Sales Management System for Contact Lenses

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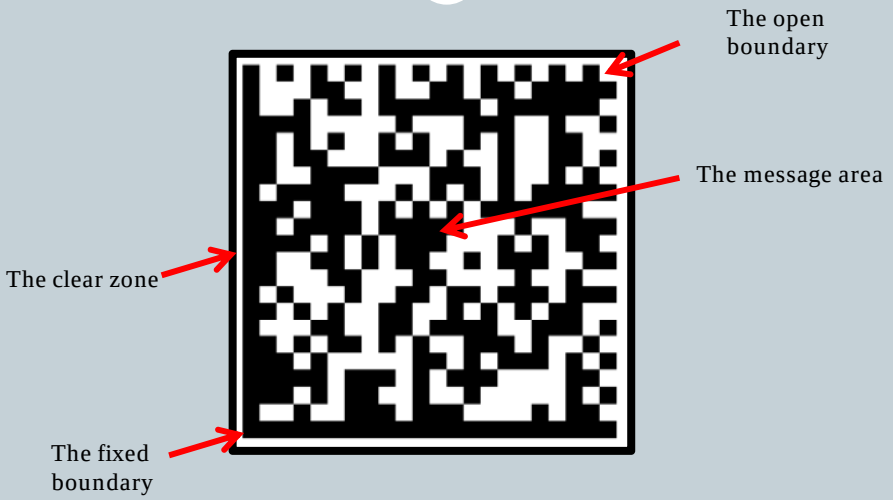
2D Barcode – Data Matrix Code

- Structure
- Applications

2D Barcode – Data Matrix Code – Structure

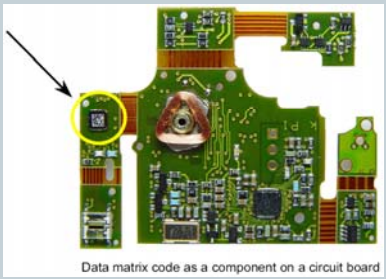
- Consists of 4 main components :
  - The fixed boundary line (ie corner) used for calculating the rotational position of the data matrix code
  - The open boundary (ie opposite corner) used for identifying the number of rows and columns (also referred to as the "matrix density")
  - The encoded code area, also known as message area
  - The "clear zone" surrounding the data matrix code. Useless but can be found on some products

2D Barcode – Data Matrix Code – Structure



2D Barcode – Data Matrix Code – Applications

- Reading of permanent direct labels (on tools, surgical/medical instruments)
- Incoming/outgoing goods inspection
- Electronic circuit boards
- Mail, letter, document tracing


Data matrix code as a component on a circuit board

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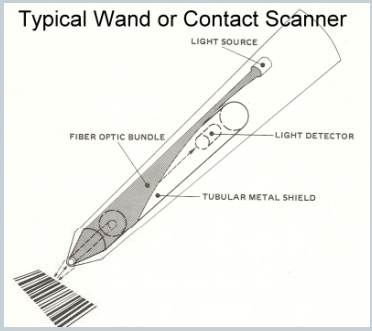
Barcode Readers – Contact wands



- Least expansive device
- Must be placed in contact of the barcode and moved across it
- Has a focal distance
- Used with LED (630 to 720 nanometers)

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Barcode Readers – Active non-contact reader

- Use of helium-neon gas lasers as a light source
- Light is coherent (single frequency)
- Can detect the orientation of the symbol (using figure-eight or starbust)

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Barcode Readers – Passive non-contact reader

- Use a light source and a single photodetector
- Operates like a video camera
- The image of the bar code is focused on to an array of photodetectors, usually a charge coupled device (CCD)

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Barcode Readers – How to use them ?

- Print your QR code with : PsQREdit FR
- Download the software to read on your camera, for example :
  - Nokia : http://mobilecodes.nokia.com/scan.htm
  - Iphone : Iphone Apps – QuickMarkLite or 2D Sense
  - Google Android : Android Market place – barcode scanner

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Conclusion

- Barcodes are very useful and used all over the world
- With the common use of mobile phone, 2D barcodes will become the most spread ones
- Not only will they be used to identify products but also to communicate (SMS, MMS, address, contact cards)

Conclusion

Thank you!

Questions?