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Submitted and Defended by:

Guerfi Sahra and Guettafi Nour Elhouda

Generate and read QR code using Python and Opencv

Board of Examiners:

Ms.	Barkat Aicha	MAA	University of Biskra	President
Mr.	Athamna noura	MAA	University of Biskra	Examiner
Ms.	MEDOUAKH SAADIA	MCB	University of Biskra	Supervisor

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Favorable opinion of the Supervisor

Guerfi sahra

Guettafi nour elhoudA

MEDOUAKH SAADIA

Favorable opinion of the President of the Jury

Barkat aicha

Stamp and signature



SUMMARY (English and Arabic)

Abstract:

QR codes are an important part of today's world. They are used in many modern applications to store large data visually easily. They are nowadays used in many money transaction apps for easily getting the information by scanning the QR Code. They are also used by applications to give authentication to another device by scanning the Code easily. QR code is a two-dimensional bar code consisting of some black squares on a white background. Due to QR codes' ability to store more data and fast readability over traditional barcodes and the technology is "open source", that is, it is available to everyone, it gained huge popularity. In this work, we study how to generate and read QR codes programmatically using Opencv, Python and Zbar.

Key words: QR code, barcode, opencv, Zbar

ملخص:

تعد رموز QR جزءاً مهماً من عالم اليوم. يتم استخدامها في العديد من التطبيقات الحديثة لتخزين البيانات الكبيرة بسهولة بصرياً. يتم استخدامها في الوقت الحاضر في العديد من تطبيقات المعاملات المالية للحصول على المعلومات بسهولة عن طريق مسح رمز الاستجابة السريعة. يتم استخدامها أيضاً بواسطة التطبيقات لمنح المصادقة لجهاز آخر عن طريق مسح الرمز بسهولة. رمز الاستجابة السريعة هو رمز شريطي ثنائي الأبعاد يتكون من بعض المربعات السوداء على خلفية بيضاء. نظراً لقدرة رموز QR على تخزين المزيد من البيانات وإمكانية القراءة السريعة على الرموز الشريطية التقليدية والتكنولوجيا "مفتوحة المصدر"، أي أنها متاحة للجميع، فقد اكتسبت شعبية كبيرة. في هذا العمل، ندرس كيفية إنشاء رموز QR وقراءتها برمجياً باستخدام Opencv و Python و Zbar.

الكلمات المفتاحية: رمز الاستجابة السريعة، الباركود، opencv، Zbar

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Dedication

I thank God Almighty for the strength and patience that He has given me to accomplish this work. I dedicate this work to my parents, my dear father, the light of my eyes, the light of my path and the approach to my life, my dear mother, who helped me in every step of my life and gave me the desire to overcome everything in life. I also take this opportunity to dedicate this message to my beloved brothers and sisters, Khadija , Amin , Kaltum , Muhammad, Salih, Iman, Abd al-Haq and Rudaina , each in his name. To the pure, tender hearts and innocent souls, the children of my sisters Rayan, Siren and Muhammad. To all the extended family and friends and everyone who helped me in life or supported me even with a smile. To my friends whose pictures and voices resound the most beautiful moments and days I lived (My friends are my dearest) To all my companions who I shared the journey with them, may God protect them and take care of them.

Nour Elhouda Guettafi

Dedication

*It is a beautiful thing that a person strives to achieve and obtain success,
and the most beautiful is to remember who was the reason for this, so I
dedicate the fruit of my effort.*

*For those who stayed up at night to sleep with a clear eye, for those who
planted in my soul the seeds of ambition and perseverance, dear father*

*For those who carry the smile of roses on her lips, the splendor of love in
her eyes, and the paradise of my Lord under her feet, my dear mother.*

*For those whose love runs in my veins, for those who gave me their trust,
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To my beloved grades companion, and my second mother, my aunt Malika

*To my brother whom I find in a time of difficulties, my sister-in-law, Karim
Rezig*

*For whom God made my days happy with him and gave me the pulse of his
love so that he would satisfy me for my grandfather, may God protect him.*

*To the two candles that light up the corners of our house, and two flowers
that perfume our days, to my nieces, Aya and Nour.*

*To the families of Guerfi and Maaoui, and to the family tree, no matter how
long its veins are, without exception.*

To all my comrades, my friends and my loved ones

*To the one with whom I drank the cup of friendship, and who is a sister
without lineage or breastfeeding. Nour, and to all your family, the family of
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To all those mentioned by my heart and forgotten by my pen

To all my classmates 2022

Sahra Guerfi

Table of contents

General introduction.....2

Chapter01: Overview of the QR code

1.1.Introduction	5
1.2.Barcode:.....	6
1.2.1.What is barcode?.....	6
1.2.2.History of the barcode.....	6
1.2.3.barcode component.....	7
1.2.4.barcode type.....	8
1.3.QR code:.....	10
1.3.1.What is a QR code?.....	10
1.3.2.A brief history	11
1.3.3.Types of QR Codes	11
1.3.3.1.Static QR Codes	12
1.3.3.2.Dynamic QR Codes.....	13
1.4.Reading and Creating QR Codes.....	15
1.4.1.Reading QR code	15
1.4.2.Creating QR code.....	16
1.5.advantage and disadvantage of QR codes.....	17
1.6. Examples of QR code application.....	19
1.7.conclusion.....	20

Chapter02:Generate and read QR code

2.1.introduction.....	22
2.2. Definition of QR code	23
2. 3.Types of QR Code.....	27
2. 3.1.QR Code Model one and Model two.....	28

Table of contents

2. 3.2.Micro QR Code.....	28
2. 3.3.IQR Code.....	29
2. 3.4.SQRC.....	30
2.3.5.LogoQ.....	31
2.4. INFORMATION CAPACITY AND VERSIONS OF THE QR CODE.....	31
2.5. Create QR codes (generate).....	33
2.6. Method of scanning a QR code.....	35
2.7.conclusion.....	39
Chapter03: simulation and result	
3.1. Introduction.....	41
3.2. Hardware	41
3.3. Software.....	41
3.3.1. Python.....	41
3.3.2. opencv.....	42
3.3.3. PyCharm.....	43
3.3.4. Numpy.....	43
3.3.5. ZBar.....	43
3.4. Structure the generate of QR code :.....	46
3.5. structure the read of QR code:.....	50
3.6. The results of the difference in the data.....	53
3.7. The results of the difference in the version.....	54
3.8.the results of the read of QR code.....	57
3.9.Errors not reading the QR code.....	57
3.10.Conclusion.....	59
General conclusion.....	61

List of Figures

Chapter01: overview of the QR code

Figure 1.1:barcode.....	6
Figure 1. 2 : The components of the barcode in detail.....	8
Figure 1.3:QR code	10
Figure 1.4:type QRcode (static vs dynamic).....	12
Figure1.5: exemple type of QR code.....	15
Figure1. 6: QR code to Appalachian State University.....	17.
Figure1.7:exemple application of QR code.....	19

Chapter02: Generate and read QR code

2.1.Structure and components of QR code and bar code.....	23
Figure 2.2 : components of QR code.....	24
Figure 2.3: finder Pattern.....	25
Figure 2.4: Alignment Pattern.....	25
Figure 2.5: Timing Pattern.....	26
Figure 2.6: Quiet Zone.....	26
Figure 2.7: Data Area.....	27
Figure 2.8: illustrates difference QR Code and Micro QR Code.....	29
Figure 2.9. Comparison of regular QR Code and IQR Code.....	30
Figure 2.10. An example of LogoQ.....	31
Figure 2.11: QR Code Version[9].....	32

List of Figures

Figure 2.12: exemple detail QR Code Version.....32

Figure 2.13: Organigram of the Create QR codes.....33

Figure2.14: exemple scan QR code.....38

Chapter 3: Simulation and result

Figure 3.1. logo python.....42

Figure 3.2. logo opencv.....43

Figure 3.3. logo pycharm.....43

Figure 3.4 .logo zbar.....44

Figure 3.5.Understand the structure of barcode / QR code.....45

Figure 3.6.Organogramm structure of the generate QR code.....46

Figure 3.7.Organogramm structure of the read QR code.....50

Figure 3.8.QR code of the site with different version.....54

Figure 3.9.QR code of the information personel 01 with different version.....55

Figure 3.10.QR code of the information personel 02 with different version.....55

Figure 3.11.QR code of the image with different version.....56

Figure 3.12. Errors not reading the QR code.....57

List of tables

Table 1.1: types of barcodes.....	9
Table 2.1. Types of QR code	28
Table 3.1.results of the difference in the data.....	53
Table 3.2. results of the read QR code.....	57
Table 3.3. results of the not read QRcode.....	58

General Introduction

General Introduction

In the sixties of the last century, when Japan entered a period of great economic growth, stores began selling a wide range of goods, such as food, clothing, and others. Then the cash register was used in those stores to order, and the price of the goods at checkout was run manually, which caused some trouble to the merchants. The invention of the barcode provided a solution to this problem where the price of the product is displayed on the cash register automatically when the barcode on the item is scanned by the optical sensor with the information of this product being sent to the computer at the same time that the barcode appears circulating. Then the barcodes were developed so that they could provide more information by the developer team Denso Wave, and a 2D code was created, QR code, a two-dimensional code that can store data information and is designed to be read by smart phones. The idea behind QR code development is to limit the capacity of barcode information.[1]

QR stands for "Quick Response" which indicates that the contents of the code must be decoded very quickly and at a high speed .QR codes are developed in ways that allow companies and individuals to quickly and easily sell or market their products, skills, and events. The icon can be used to represent data such as a web address or a map location that can be quickly scanned by a mobile device such as a smart phone. Tracking inventories and marketers were among the early adopters and users of QR codes due to the ease of deployment and low development cost. The QR code system consists of a QR code encoder and decoder. The encoder is responsible for encrypting the data and generating the QR code, while the decoder decodes the data from the QR code [2].

Usage QR has grown rapidly among individual users who want to pass on information such as sending an invitation, providing details about an event, or even announcing the birth of a child. While there are many advantages to using QR codes (such as : if damaged QR codes can be read easily), there is a downside (such as: It requires a phone with a camera and the installation of QR code reader software or app) that has led end-users to stop using them. [3]

Reading a QR code is simple. One option is to use a reading device such as a handheld scanner, hand tip, or stationary scanner. The most common and convenient devices for

reading QR codes are smart phones or tablets with a camera. In addition to reading a QR code created by someone else, it is not difficult to create a QR code on its own. It is recommended to generate the code on a laptop, as this will make it easier to scan the new code using the QR code reader of the smart phone. Of course, it is also possible to generate a QR code with a smart phone, and each method has its own advantages. The way we will discuss in our topic is to generate a QR code in Python using a set of libraries, including: `opencv`, `qrcode`, `zbar`. [4]

We have chosen to organize our study around three main chapters as follows:

- The first chapter, A general presentation about the QR code, its fields and applications,
- The second chapter, We have conducted a special study of the QR code, its types and how to create and read it in detail
- In The third chapter, Displays the experimental results obtained using Python and a library `opencv`. We will end this work with a general conclusion and the perspectives.

Chapter 01:

Overview of the QR code

1.1.Introduction

Barcode technology is one of the most important parts of Automatic Identification and Data Capture (AIDC); we can obtain decoded data through the analysis of a barcode. According to the encoding type of barcodes, we divide barcodes into two categories: one-dimensional barcodes and two-dimensional barcode QR[3]. A QR code can store data information and designed to be read by smart phones. QR stands for “Quick Response” indicating that the code contents should be decoded very quickly at high speed. The code consists of black modules arranged in a square pattern on a white background. The information encoded may be text, a URL, or other data The QR code was designed to allow its contents to be decoded at high speed. The popularity of QR codes is growing rapidly all around the world. Nowadays, mobile phones with built-in cameras are widely used to recognize QR Codes [5].

In this chapter, we presents in detail how the QR code appeared, what this code is, its types, and how it is used.

2.Barcode

1.2.1.What is barcode?

A barcode, consisting of bars and spaces, is a machine-readable representation of numerals and characters. Today, stripes as shown below on packages of products sold at supermarkets, convenience stores and other stores are ubiquitous. These are barcodes. A barcode consists of bars and spaces of varying width that can be read with an optical barcode scanner[6].(see figure 01)

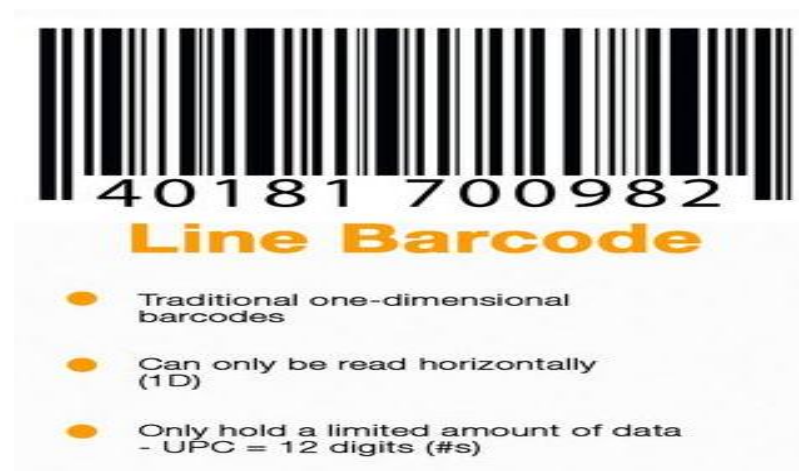


Figure 1.1:barcode

1.2.2. History of the barcode

In 1948, Bernard Silver and N. Joseph Woodland get the idea for emerging grocery checkouts that can mechanically scan products. Woodland tries various different marking arrangements, including lines and circles, marks stimulated by movie soundtracks, and dots and dashes based on Morse code. In October 1949, the two originators refine their system to use bulls eye patterns and apply for a patent, which is granted on October 7, 1952. Their early Barcode-scanning equipment uses an orthodox lamp to lighten product labels and a photomultiplier to read the light reflected off them. In 1951, Joe Woodland joins IBM to work on Barcode technology, though the company declines to purchase his patent, which is attained by Philco (and later RCA). In the 1960s, RCA develops a number of profitable applications until the patent expires in 1969. Work on bulls eye Barcodes continues, but they prove undependable and gradually fall by the wayside. Since 1970, By now, grocery stores are beginning to explore the idea of using their own product coding and marking systems, but different stores are allowing for different systems, and this threatens to

cause difficulties for large food producers who sell branded goods to multiple retailers. Under the guidance of Alan Haberman, executive vice president of First National Stores in Boston, the stores come structured to form the Uniform Code Council (UCC), later known as GS1 US, the organization that now manages Barcode standards world wide .In 1971, engineer George J. Laurer builds on Woodland's ideas to develop the Universal Product Code (UPC)—the modern black-and-white striped Barcode. After examining a variety of different marking systems, Haberman's grocery stores committee settles on IBM's rectangular UPC as the standard grocery Barcode, in 1973. Although he didn't invent the Barcode, Haberman is widely credited with its universal adoption. In June 1974, the world's first grocery-store Barcode scanner goes into use at Marsh's Supermarket, Troy, Ohio in the United States. The first scanned purchase, made by Clyde Dawson, is for a 10-pack of Wrigley's chewing gum. And in 1979, a Barcode scanner is used for the first time at Key Markets in the UK. There are two types of Barcode one is 1D (1-Dimensional) and other is 2D (2-Dimensional). “1D” Barcode is used in normal products like groceries, pen, and electronic equipment’s etc. “2D” is similar to 1-Dimensional Barcode, but it can store more data per unit area as compared to the 1D [7].

1.2.3.Barcode component

Barcodes consist of narrow and wide black bars and white spaces, under which there is a series of numbers representing the product information [8]. The components of the barcode in detail, as shows in the figure 1.2 .

①Quiet Zone (margin)

Quiet Zone is a blank margin located at either end of a barcode. The minimal margin between barcodes (distance from the outermost bar of one barcode to the outermost bar of another barcode) is 2.5 mm. If the width of a Quiet Zone is insufficient, barcodes are hard for a scanner to read.[6]

②Start Character/Stop Character

The Start Character and the Stop Character are characters representing the start and the end of the data, respectively. The characters differ depending on the barcode type.[6]

③Check Digit (Symbol check character)

The Check Digit is a digit for checking whether the encoded barcode data are correct.[6]

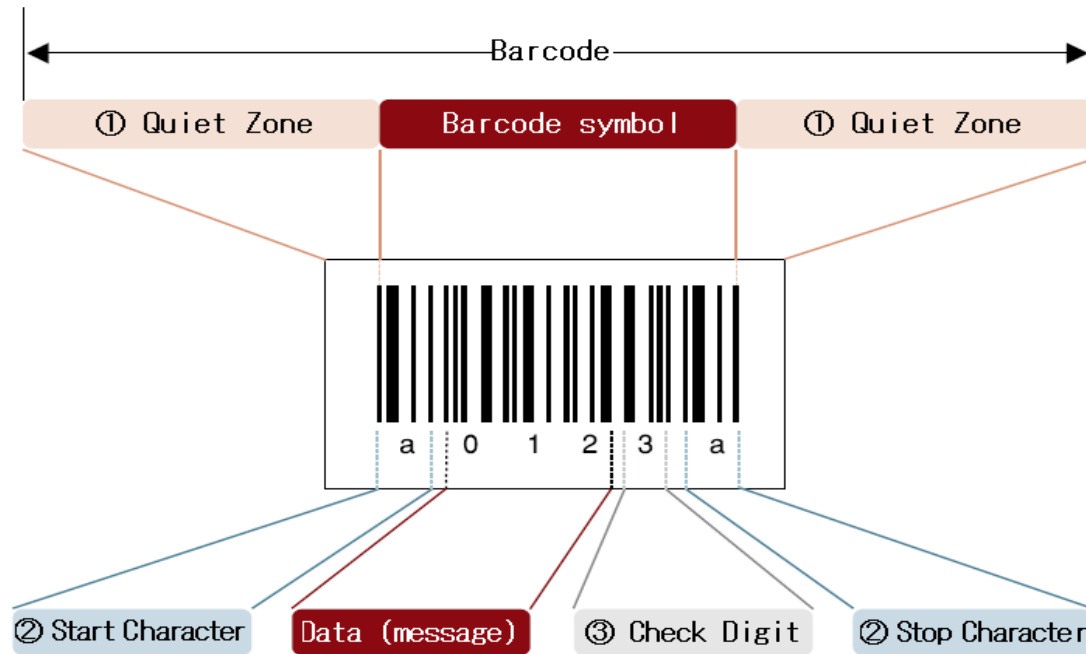








Figure 1. 2 : The components of the barcode in detail[6]

1.2.4.Barcode type

All barcode types do the same thing; they hold and remember data. Barcodes are portable (they travel on paper, plastic, cardboard, wood) just about any surface. The data is secure (it cannot be changed). They are disposable and inexpensive, and they are virtually error-free. The following table provides examples of some types of barcodes.[9]

Table 1.1: types of barcodes[6]

	EAN (JAN)	Interleaved 2 of 5	Codabar (NW-7)	CODE39	CODE128	GS1 DataBar (RSS)
Symbol	 4912345678904	 1234567890	 a123456a	 * CODE 39 *	 C O D E 1 2 8	 (01) 15012345678975
Kinds of characters	<ul style="list-style-type: none"> ● Numerals (0 to 9) 	<ul style="list-style-type: none"> ● Numerals (0 to 9) 	<ul style="list-style-type: none"> ● Numerals (0 to 9) ● Symbols (-, \$, :, /, +, .) ● Start/Stop Characters (a to d) 	<ul style="list-style-type: none"> ● Numerals (0 to 9) ● Symbols (-, \$, :, /, +, .) ● Alphabetical letters (A to Z) ● Start/Stop Characters (*) 	<ul style="list-style-type: none"> ● All 128 characters of ASCII ● 3 Start Characters (1 Stop Character) ● 4 non-data function characters ● 4 code setting selection characters 	<ul style="list-style-type: none"> ● Numerals (0 to 9)
Features	<ul style="list-style-type: none"> ● This is the most prevailing barcode as a common product code. ● It is compatible with EAN in Europe and UPC in the U.S. 	<ul style="list-style-type: none"> ● High-density printing is possible. ● This has been standardized as JIS as the standard distribution code. 	<ul style="list-style-type: none"> ● This has a modular composition that can be easily printed with a printer. 	<ul style="list-style-type: none"> ● Alphabetical characters can be encoded. ● This has been adopted as a military standard of the U.S. Department of Defense (MIL-STD). 	<ul style="list-style-type: none"> ● Various kinds of characters and symbols can be encoded. ● Double-density representation, in which up to two numerals (00 to 99) can be represented as a single letter, is possible. 	<ul style="list-style-type: none"> ● GTIN, which is a new universal product code system, can be represented. ● A barcode can be printed on a small space.
Examples of application	<ul style="list-style-type: none"> ● Common product code (marked on almost all daily necessities) 	<ul style="list-style-type: none"> ● Standard distribution code ● Small labels affixed to noble metal and small products ● Use in the logistics field (e.g., container boxes) 	<ul style="list-style-type: none"> ● Shipping labels for door-to-door delivery service ● Envelopes for photo processing service ● Blood management 	<ul style="list-style-type: none"> ● Use in the factory automation (FA) field ● Used for AIAG, ODETTE and EIAJ tags 	<ul style="list-style-type: none"> ● Utilities collection ● Medical material management ● Electronic part management 	<ul style="list-style-type: none"> ● Preventing medical mistakes ● Ethical pharmaceutical distribution code

3.QR code

1.3.1. what is a QR code?

With the intention of developing symbols with enlarged capacity and reduced size, two-dimensional codes were invented as an advancement of the common one dimensional barcodes. Different approaches can be classified into composite codes, stacked codes, dot codes and matrix codes. QR codes are a variation of matrix codes.[10]

QR Codes are similar to bar codes used by retailers to track inventory and price products at the point of sale. The significant difference between QR codes and bar codes is the amount of data QR codes can hold and share. QR Code contains information in both the vertical and horizontal directions, whereas a bar code contains data in one direction only. QR Code holds a considerably greater volume of information than a bar code. It is referred to as QR codes because of its ability to allow contents to be decoded at a high speed.(see figure 03).



Figure 1.3:QR CODE

1.3.2.A brief history

QR Code technology was created in 1994 by Denso-Wave, a Japanese company, to track Toyota brand auto parts. Five years later, the company that created the code released it under a free license, which has contributed to its expansion in Japan, then in the world, through marketing and advertising, thus allowing new interaction to people. The Japanese adopted it a long time ago. They scan more QR Codes than they send SMS .[5]

QR code is developed as an improvement to the existing barcodes for application in inventory management by Toyota subsidiary Denso Wave in 1994. Since its introduction, the QR code has gained wide acceptance in such diverse industries such as manufacturing, warehousing and logistics, retailing, health care, life sciences, transportation and office automation etc .Now with the explosive growth of smart phones, the QR code is also being used in mobile marketing as a fast and effective way of connecting with customers and providing end user content. Now a days, libraries are also adopting this technology very rapidly in the present scenario .In the western countries like UK, USA, Japan and now in India also using QR codes to cater most crucial user demand for access to information to mobile phones [11]

1.3.3.type of QR code

The content we want users to see is known as target data. Target data could be a website, a word in such a language, a phone number or even an image. The classification of QR codes depends on how this data is encoded. There are two categories of quick response codes[10], **static and dynamic QR codes** (see figure1.4)

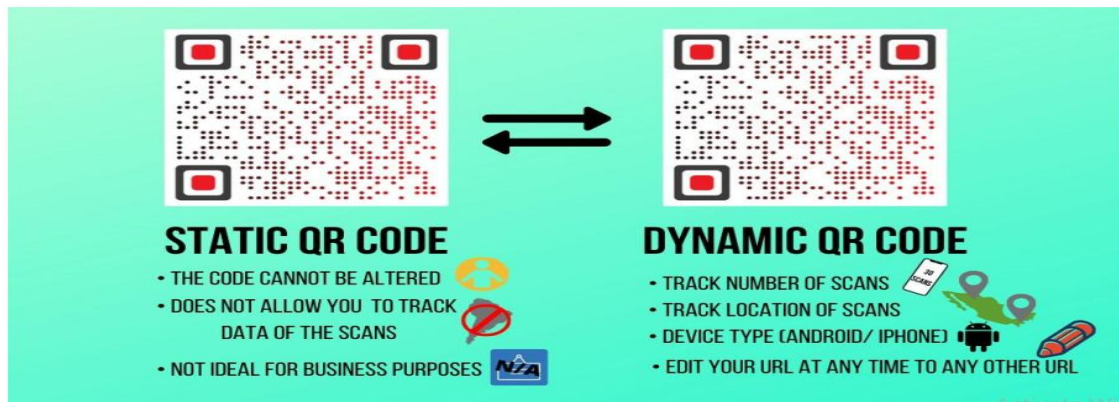


Figure 1.4:type QRcode (static vs dynamic)

1.3.3.1.static QR code

In static QR codes [10]:

- Target data is encoded directly into the code, just as numeric data is encoded into a barcode.
- The more information is encoded, the denser the QR code will become.
- The encoding is permanent, in other words the target data can never be changed.
 - -It is not possible to track scanning activity , static QR can encode the following information in well-structured formats:[13]
 - URL.
 - business card.
 - text.
 - Details of a wifi network.^
 - *phone number.
 - email address.

1.3.3.1.1.What Are Static QR Codes Used for?

A QR code with fixed information may sound inconvenient. In the right circumstances, it could even be a disaster. However , there are numerous use cases for a QR code that can't be overwritten:

- **One-time-use codes that needn't be changed.** The information itself becomes obsolete because the use case is temporary. There is no need to edit or update the code. A one-off PR event or marketing campaign is a great example. So is a holiday prix fixe menu or a table d'hôte menu for a special event.
- **Information that shouldn't be changed.** Encoded data like employee numbers, access codes, or other sensitive information. That said, a dynamic QR code can be just as secure as a static QR code while still allowing for flexibility in the future. However, in some instances, it may feel more secure to entirely remove the option of editing the information associated with the code.
- **Personal information.** Personal information tends to be relatively simple and the medium the QR is presented isn't revisited over and over. Think of an email signature or a paper resume. People aren't typically re-reading your old emails or resumes. It is also not necessary to track usage metrics on QR codes with personal information. That is something dynamic QR codes can do and static QR codes cannot.

1.3.3.2. dynamic QR code

The dynamic QR gives more flexibility, in this type we have [10][12]:

- The target data can only be a URL address.
- The target URL is not stored directly in the quick response code. Instead, a short URL (usually provided by the QR Code service) is encoded which redirects to the target URL.
- It is possible to modify the encoded target URL at any time without having to reprint the code.
- It is possible to make meaningful analytics based on QR code scanning activity tracking.
- You can activate or deactivate the code at any time.

1.3.3.2.1. What Are Dynamic QR Codes Used for?

- **Website menu bar codes in bars, restaurants, and hotels** are an ideal use case for dynamic QR codes. The content on menus change constantly, especially if you're menu engineering to drive sales. To account for the kaleidoscope of menu items, descriptions, and prices, the ability to assign a single QR code to an ever-changing list is a huge value. This doesn't apply only to types of restaurant menus, but to spa menus, poolside menus, local activity recommendations, and more. Any menu that's going to change almost demands being digitized with a dynamic QR code.
- **Track QR code usage and scanning metrics.** If you use a dynamic QR code, you can capture where, when, and with what device a code was scanned. The implications for this in marketing campaigns is enormous. Especially for bars and restaurants. The QR code templates and QR code marketing strategy you use can be compared against scanning data. Based on the usage metrics, you can tweak any number of things to increase conversion. Primary among them, where you place QR codes and what your QR code template says. For example, you may find that the QR codes you have placed near "How to Scan a QR Code" visuals get more engagement.
- **Personalized content delivery.** We've seen how a dynamic QR code can change the URL it redirects to. We've also seen how it can track things like time, location, and device. This can all work together. By gathering information about a scan, the QR code can surface relevant information to the person scanning. A good example in hospitality is the same QR code bringing a customer to the lunch menu during the afternoon and the dinner menu during the evening.
- **QR code nutritional information and food uses.** Using QR codes on food packaging is an effective way to initiate conversations about what drives a lot of consumer behavior today: values. They can provide engaging, rich content around nutrition, sourcing, sustainability, and social responsibility.
- **Touchless ordering and contactless payments.** Any QR code that supports advanced functionality like mobile ordering and contactless payments is a dynamic QR code. The

information needed to facilitate features like this is far too complicated to store in a static QR code. It would, instead, be stored and executed elsewhere and the QR code would redirect to it.

There are more QR code uses than what is listed above.

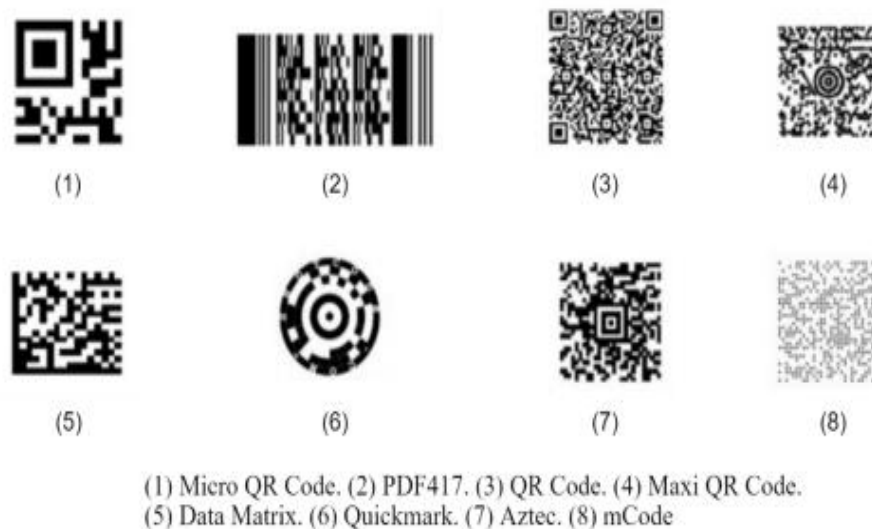


Figure1.5: example type of QR code[13]

1.3.4. Reading and Creating QR Codes

A Quick Response (**QR**) code is a type of 2D barcode that can be used to store and communicate small pieces of information. Typically, a piece of information is stored in a QR code, and that piece of information is then retrieved by a user with a smart phone or barcode scanner.

QR codes might be found on posters, billboards, signs, t-shirts, or bumper stickers. They are most commonly used to direct a physical user to a piece of digital information; for example, when it would be quicker to scan a barcode than to type a lengthy URL into your phone manually.

1.3.4.1. Reading QR Codes

Reading a QR code is simple. One option is to use a reading device such as a hand scanner, hand terminal, or fixed scanner. The most common and convenient devices for reading QR codes are smart phones or tablets equipped with a camera. Reading a QR code on a smart phone involves first installing an app from Google Play for Android or the App Store for iPhone . Searching for

‘QR code reader’ in the search box will yield a long list of apps. All of these apps are free to download, and are compatible with any QR code type. They need to be used on a smart phone that has a camera. After installing the app, selecting the app will activate the smart phone’s camera, with an on-screen framing guide. The QR code can then be scanned with the camera. It may be necessary to hold the camera in one place for a while until a beep indicates that the scan is complete. The smart phone screen will then direct the user to the URL address where the information is stored.[14]

1.3.4.2. Creating QR Codes

QR codes can be created easily and cheaply, often at no cost. If an individual does a search on the Internet for a QR code creator, hundreds of links are found that offer free applications. These tools are simple to use as they allow the end user to easily make selections to create the QR code. The creator can select where the QR takes the reader. It can be to a URL, phone number, SMS, text, maps or other locations. Attributes that may be set within the code include *the size of the QR code, such as S*: One square inch (a perfect size for your business card), and as well as its color. As an example, the QR code below was created using QRStuff.com, a free tool that links you to the website of Appalachian State University.

Creation of QR codes are continually being developed with new inclusions of symbols and different shapes, but issues have arisen such as errors around the decoding process. But there have been successes. A novel image blending method of improving the QR code visual significance for marketing purposes is proposed by Baharav and Kakarala (2013); it improves QR code aesthetics and visual significance by embedding images such as brand logos in full colour, without a negatively impacting the error correction. Furthermore, (Lin et al., 2013a) proposed a systematic QR code beautification framework that allows an individual user to personalize the QR code they create (for example a QR code containing contact details meant to be printed on a business card) by selecting visually meaningful patterns[15]



Figure1. 6: QR code to Appalachian State University[15].

1.3.5.Advantages and disadvantages of QR codes

1.3.5.1. Advantages[16]

The main advantage of QR Codes is their versatility, which makes them very easy to use. They can be used for nearly anything and are beneficial for both customers and businesses . QR Codes can store a great deal of information such as text, videos, advertisements, business card information, personal information, and any other type of digital information . QR Codes also combine different forms of marketing streams, thus maximising business exposure and generating more revenue . QR Codes are extremely cost effective, as there are no start-up costs or monthly fees, and many QR Code generators and readers are free Using QR Codes can save paper, there by displaying content in a green way QR Codes are easily generated, can be customised to suit promotional items, provide an easier way to manage the return on investment of one's marketing presence, and allow effective learning about the audience's interests

1.3.5.2. Disadvantages

People's lack of familiarity with the QR Code is one of the biggest disadvantages. Although QR Codes can be found nearly anywhere, people do not know how to obtain the information they require. The other major disadvantage is that a mobile device or a smart phone as well as a QR Code reader are required in order to gain access to a QR Code [16].

1.3.6. QR code application

One of the first companies to introduce QR-code technology was Toyota, which thus tracked the volume and range of components and optimized the process of interaction with suppliers. Today, the scope of the QR code has expanded beyond the automotive industry. Since the 2000s, QR codes have been actively used by museums to provide additional information about cultural and historical heritage sites, travel agencies that place information on tourist sites and attractions in various languages of the world, etc. QR codes are common in China, Hong Kong, Japan, Korea, and Taiwan. QR codes are not nearly as common outside of east Asia, but they are gaining popularity. They are being used for a wide variety of purposes.[17].(see figure 1.7)

- Companies are placing them on billboards to facilitate rapid online purchasing, on food and beverage containers to provide access to nutritional information (or coupons or games), on movie posters to publicize trailers, in print media to encourage visits to websites, on products to provide ready access to user manuals or instructional videos, on storefronts to link to reviews or menus, and on for sale signs to link to video tours or testimonials. Museums are placing them near displays to provide users with easy access to audio tours.
- Individuals are placing them on business cards or name tags to provide people they meet with a fast way to add their contact details to their phone's address book. Conference bloggers are placing them on bulletin boards to help attendees find their blogs. They are being placed near buildings to help visitors find maps of the building or to help them learn about the building's history. They are facilitating scavenger hunts and historical tours. They are even being used to augment ice-breakers.

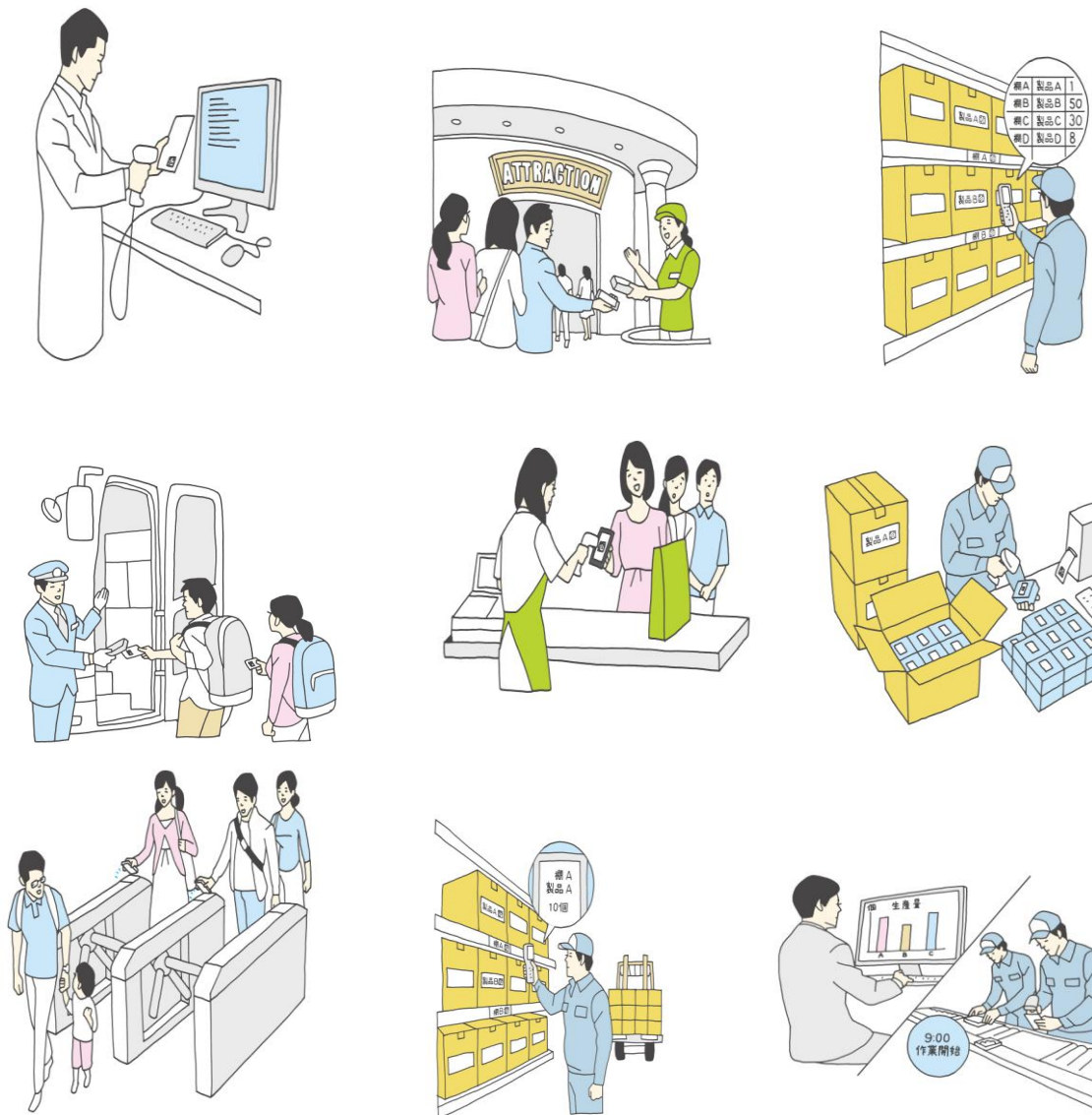


Figure1.7:exemple application of QR code

1.4. Conclusion

In this chapter, we concluded that a QR code stores more information than a BAR code. QR Code stores an information matrix form that stores information on both horizontal and vertical axes. QR code has many advantages being free to generate and free to scan QR codes. More secure than a BAR token, it stores many types of information .QR codes can store contents such as text, URL links, automated SMS messages, or any other information that can be embedded in a two-dimensional barcode. This programmed data can be decoded by scanning the barcode with a mobile device equipped with a camera and QR reader software. Although QR codes are very flexible and have been around for more than eighteen years, their use in many areas such as medicine, business, education, and security is still in its infancy

Chapter 02

**Generate and
read QR code**

2.1.Introduction

QR (quick response) codes are two dimensional images that when scanned by a smart phone's camera, prompt the smart phone to open a web-page or display an image, video, or text. QR codes are, therefore, essentially pictographic hyperlinks that can be embedded in the physical environment. This technology has the potential to revolutionize the way libraries deliver instruction, connect patrons to information about library materials, and market their services. Although use of QR codes has not yet become prominent in Kansas communities, there are several reasons to believe that it soon will be. These reasons include burgeoning popularity of QR codes on the coasts, rapid increases in smart phone use in our communities, and expected enhancements in cellular data capacity in much of Kansas. By implementing QR codes now, academic libraries in Kansas can help expedite the adoption of this exciting technology and can concomitantly enhance their reputations as user-centered, innovative, sites for discovery and exploration. In this paper I describe how individuals with smart phone scan download free QR code reading applications and use their phone's camera to read the code; show several examples of creative ways libraries and other organizations are using QR codes to provide rich, point-of-need information to patrons, customers, and prospective user; describe in detail the process of creating QR codes and distributing them throughout physical and online environments; and highlight some of the recent literature discussing the relevance of QR codes for libraries and for education in general.[18]

2.2 Definition QR code

Quick Response code or QR code is a two dimensional (2D) bar code developed in 1994 by Denso Wave Corporation; QR code got this name because it was developed to improve the reading speed of complex structured 2D barcodes. This type of code was initially used for tracking inventory in vehicle parts manufacturing. QR code is established as an ISO standard ,it has been defined in the Information technology Automatic identification and data capture techniques QR code 2005 bar code symbology specification(ISO/IEC18004). QR code is free to use and the technology is open since its specification is disclosed and the patent right owned by Denso Wave is not exercised.

The main characteristic of a QR code compared with a traditional bar code is that it contains information in both the vertical and horizontal directions, while a bar code contains data in one direction only (see figure 1). For this reason QR code holds a considerably greater volume of information.

In addition, it can encode several types of data including symbols, control codes, binary data, and multimedia data .The typical barcode holds a maximum of 20 digits, while the maximum data capacities of a QR code are 7,089 characters for numeric data, 4,296 characters for alphanumeric data, 2,953 bytes for binary data, and 1,817 characters for Japanese Kanji and Kana data.[20][24]



Figure 2. 1. Comparison of QR code and Bar code [3].

2.3. Structure and components of QR code

QR code is faster to read than other two-dimensional code, because it contains three large square patterns in the corners that are used for position detection. Additionally, the patterns are used to detect the size, the angle and the outer shape of the symbol. When a reader scans a symbol, it first detects these patterns. Once the position patterns have been detected the scanner can rapidly read the inside code in all directions. The inside code consists of several blocks where the information is encoded [20]. As suits something developed for demanding, fast moving environment, they included generous error correction capabilities and QR codes can be set up to still work even if 30% of the symbol is damaged or obscured [21]. (see figure 2.2).



Figure 2.2 : Components of QR code

The elements contained in a QR code are the following[]:

2.3.1. Finder Pattern.

Three big squares in the corners used for detecting the position, the size and the angle of the QR code. Position Detection Pattern (finder Pattern) Position detection patterns at 3 the corners of the symbol are one of the most distinctive features of QR Code. When scanned, the detection patterns are firstly detected by the reader, which locate the position of the code in ultra-speed. The ratio of the black and white on a line that passes the centre of the finder pattern in any angle . This unique ratio of black and white enables the considerably fast detection of the 3 finder patterns in the symbol. Once the position of the symbol is located, the code size , and orientation are calculated

based on the position of the three finder patterns found. Hence, the finder patterns also enable the symbol to be read omni-directionally. (see figure 2.3).

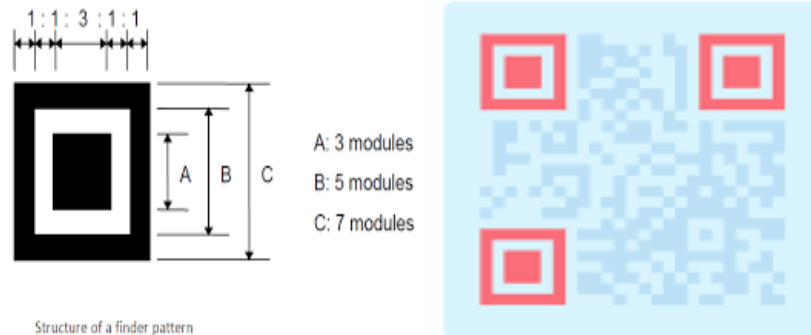


Figure 2.3: finder Pattern

2.3.2. Alignment Pattern

A pattern is used for correcting the distortion of the QR code. These distortions could occur for example when attaching the codes on to a curved surface. Alignment Pattern enables the correction of the local distortion. This can be achieved by determining of the coordinate in the alignment pattern. An isolated cell is allocated in each alignment pattern, which escalates the detection of the coordinates. (see figure 2.4).

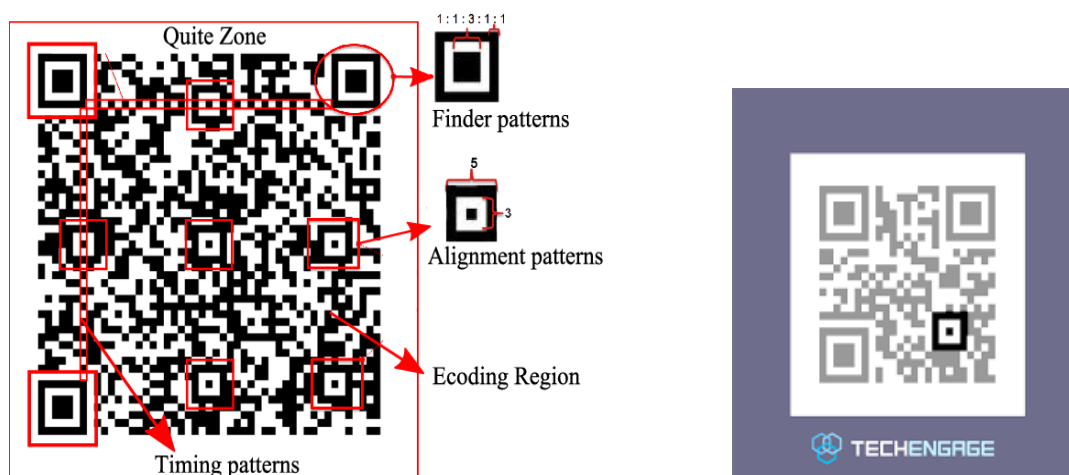


Figure 2.4: Alignment Pattern

2.3.3. Timing Pattern

It consists of white and black modules arranged alternately and placed between two position patterns. It is used to determine the central coordinate of each cell in the QR code. Timing patterns are vertical and horizontal broken borders that are placed between finder patterns. They are used to modify the center of the coordinates of each cell distortion and/or changes in the ratio between the cells are found. (see figure 2.5).

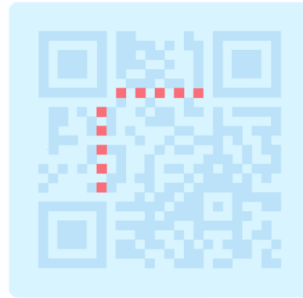


Figure 2.5: Timing Pattern

2.3.4. Quiet Zone

A margin space that makes easier to detect the QR code. At least four cells are required for the quiet zone. Quiet Zone (margin) QR Code requires a four-module wide margin at all sides of the symbol (a two-module wide margin for Micro QR Code). This area allows the symbol to be distinguished from the background, which leads to the accurate, high-speed reading. (see figure 2.6).

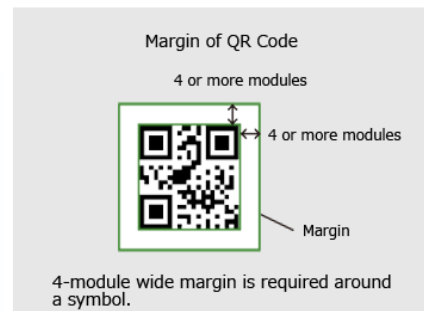


Figure 2.6: Quiet Zone

2.3.5. Data Area

The area in the QR code that contains the data (for example a URL) encoded in binary numbers. The data area also includes Reed-Solomon codes to provide error correction functionalities [1].connected with a real world. The data area is the area where the original data are encoded .Not only the raw data but also Reed-Solomon codes are encoded in this area. Reed-Solomon code is a mathematical error correction method used for music CDs etc. The technology was originally developed as a measure against communication noise for artificial satellites and planetary probes. It is capable of making a correction at the byte level, and is suitable for concentrated burst errors .(see figure 2.7).

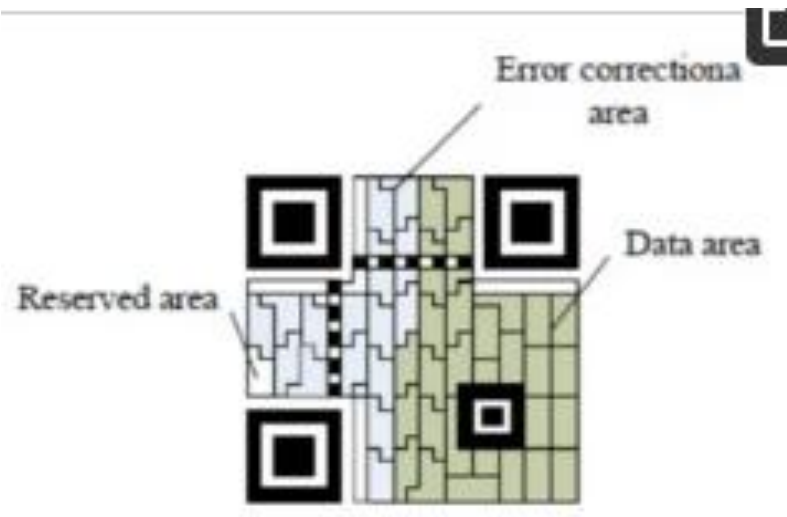







Figure 2.7: Data Area

1.4.Types of QR Code

There is six types QR Code : Model one, Model two, Micro QR Code, IQR Code, SQRC, and LogoQ. In this section, we display these types in table 1.

Table 2.1. Types of QR code [21]

QR Code Model 1 and Model 2	Micro QR Code	iQR Code	SQRC	LogoQ
				
<p>[Feature]</p> <p>Model 1 is the original QR Code. The largest version of this code is 14 (73 x 73 modules), which is capable of storing up to 1,167 numerals.</p> <p>Model 2 is an improvement on Model 1 with the largest version being 40 (177 x 177 modules), which is capable of storing up to 7,089 numerals. Today, the term QR Code usually refers to this type.</p>	<p>[Feature]</p> <p>Only one orientation detecting pattern is required for this code, making it possible to print it in a smaller space than before.</p> <p>This code can be viable even if the width of its margin is 2 module-worth (QR Code requires a margin of 4 module-worth at least around it). The largest version of this code is M4 (17 x 17 modules), which can store up to 35 numerals.</p>	<p>[Feature]</p> <p>Code that can be generated with either square modules or rectangular ones. Can be printed as a turned-over code, black-and-white inversion code or dot pattern code (direct part marking). The maximum version can theoretically be 61 (422 x 422 modules), which can store about 40,000 numerals</p>	<p>[Feature]</p> <p>QR Code that has a reading restricting function. Can be used to store private information or manage a company's internal information) Its appearance is no different from the regular QR Code.</p>	<p>[Feature]</p> <p>QR Code that can incorporate high-levels of design features such as illustrations, letters and logos.</p> <p>Since proprietary logic is used in generating this type of code, its readability is not compromised.</p>

2.4.1. QR Code Model one and Model two

Model one is the primary QR Code and it enables encode 1,167 numerals and its highest version being 14. Model two is the edition of Model one promotion, thus Model two can be read smoothly even though it is distorted in some way. Model two can store more than 7,089 numerals with its maximum version being 40.[21]

2.4.2. Micro QR Code

A traditional QR Code has three finder patterns which are placed on the three corners of the QR Code image. Compared with the traditional QR Code, Micro QR Code has merely one finder pattern for positioning. On the other hand, a normal QR Code needs no less than four-module wide margin within a symbol. Nevertheless, Micro QR Code only requires a two-module wide margin. Under this circumstance, Micro QR Code permits printing in areas smaller than QR

Code. Figure 2.8 illustrates difference QR Code and Micro QR Code .In accordance figure 2.8, the Micro QR Code has a finder patterns, whereas QR Code has three finder patterns. Moreover, the Micro QR Code's wide margin is smaller than QR Code. Furthermore, for the capacity of data storage and the size of code, the data can be stored by Micro QR Code in less than 35 numerals data. Micro QR Code not only enables to encode data more efficiently than the regular QR Code, but the size of Micro QR Code also does not need to be made much larger when the numbers of data stored rising. In addition, the standardization of Micro QR Code is made publicly available similarly to QR Code.

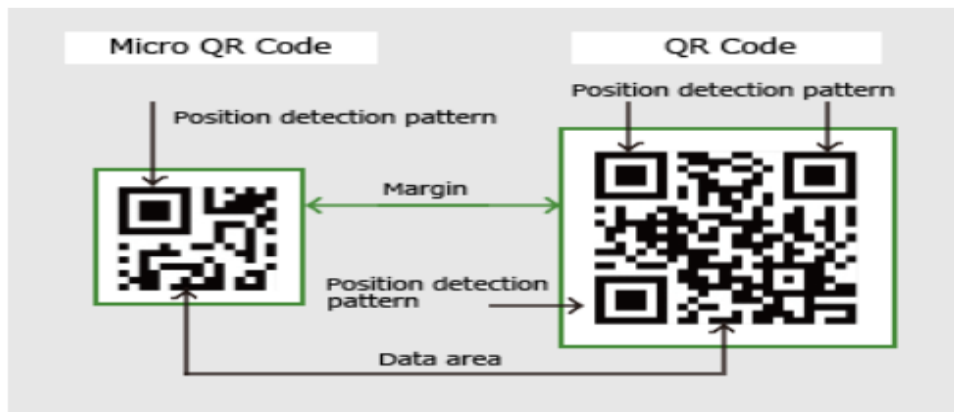


Figure 2.8: illustrates difference QR Code and Micro QR Code

2.4.3.IQR Code

IQR Code is a matrix-type two dimensional barcode and its position and size is read easily. Using IQR Code can be generated more extensive two dimensional barcode. The new two dimensional barcode can be smaller than the normal QR Code and Micro QR Code. Moreover, the new two dimensional barcode also can be a large size two dimensional barcode. Furthermore, IQR Code is able to printout as a rectangular code, and IQR Code supports for turned-over code, black-and-white inversion code and dot pattern code. IQR Code permits a wide range of applications in several fields. Because IQR Code can be generated as rectangular modules, IQR Code enables replace the one dimensional barcode. IQR Code can maintain the codes readability while it printed on cylindrical products, even though square modules are difficult to print on cylindrical. IQR Code has different size of version. Additionally, IQR

Code can instead one dimensional code to printout on product. IQR Code can store more information than the ordinary QR Code. If the size of symbol is same, compared with the ordinary QR Code, the IQR Code capacity of storing information increases to 80% regular QR Code. If the same amount is stored, an IQR Code can be made 30% smaller than the regular QR Code. Figure 2.9 demonstrates the situation of same size and same amount within the regular QR Code and IQR .Figure 2.9 reveals that the size of IQR Code reduces when IQR Code has same amount data as traditional QR Code. IQR Code possesses high data capacity. When the characters are all numerals, the highest version of QR Code can be stored 7,000 characters. By contrast, the number of characters that IQR Code can be hold in its biggest version is approximately 40,000. Besides, IQR Code has high restoration capability which is higher than traditional QR Code. The QR Code error correction highest level is recovered no more than 30% of error in a QR code. However, compared with the QR Code, the error correction level of IQR Code is improved to 50%.



Figure 2.9. Comparison of regular QR Code and IQR Code

2.4.4. SQRC

SQRC is a particular QR Code and it is embedded into reading restricting function. The SQRC concentrates on private data storing and internal data of enterprise managing, nevertheless, this function does not ensure securing of coded data. The aspects and properties of SQRC are similar to the traditional QR Code. In addition, SQRC can be locking up of encode data, merely specific scanners can read it.

2.4.5. Logo Q

A new style of QR Code is Logo Q which combines a QR Code with a picture. Logo Q is designed for the sake of boosting the recognizable ability of vision. Figure 10 displays that colorful combination guides people easy to understand the code base on personal intuition. Because of Logo Q is used an exclusive logic in generating, it possesses design ability and readability. Logo Q has highly designable feature and it is different from the ordinary QR Code.

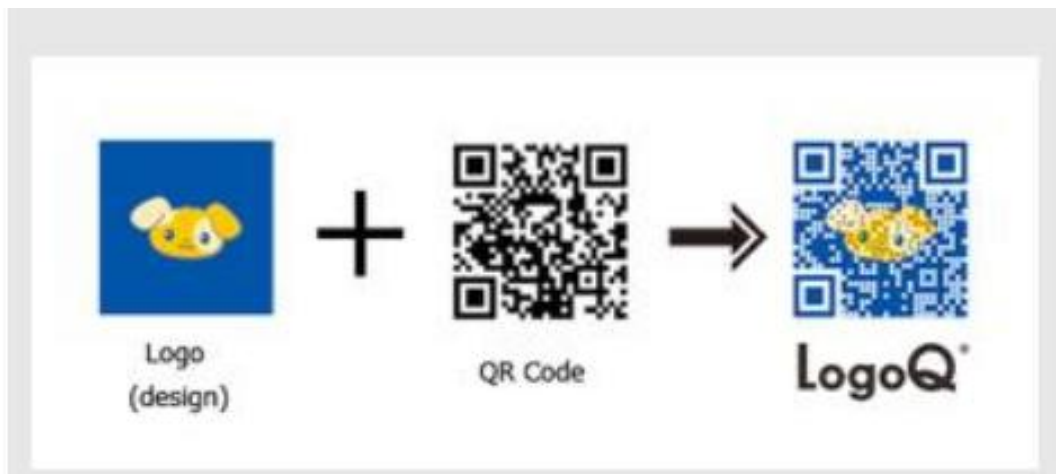


Figure 2.10. An example of Logo Q

2.5. Information capacity and versions of th QR code

A module in QR Code refers to the black and white dots that make up a QR Code. Each version has a different module configuration or number of modules.[22] The symbol versions of the QR Code range from Version 1to Version 40 . Each version has a different module configuration or number of modules. (The module refers to the black and white dots that make up QR Code.)"Module configuration" refers to the number of modules contained in a symbol, commencing with Version 1 (21×21 modules) up to Version 40 (177×177 modules). Figure 2.11 shows the module configuration of the basic QR codes.[23]

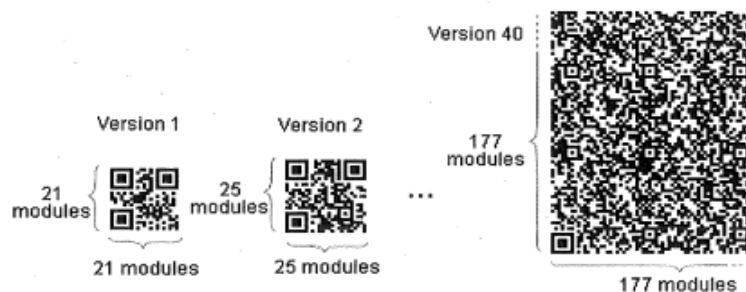


Figure 2.11: QR Code Version[23]



Figure 2.12: exemple detaill QR Code Version

2.6. Create QR codes(generate)

For a general idea of how to generate a QR code, we briefly present the steps to follow [3]. We present these steps by organogram in figure2.13.

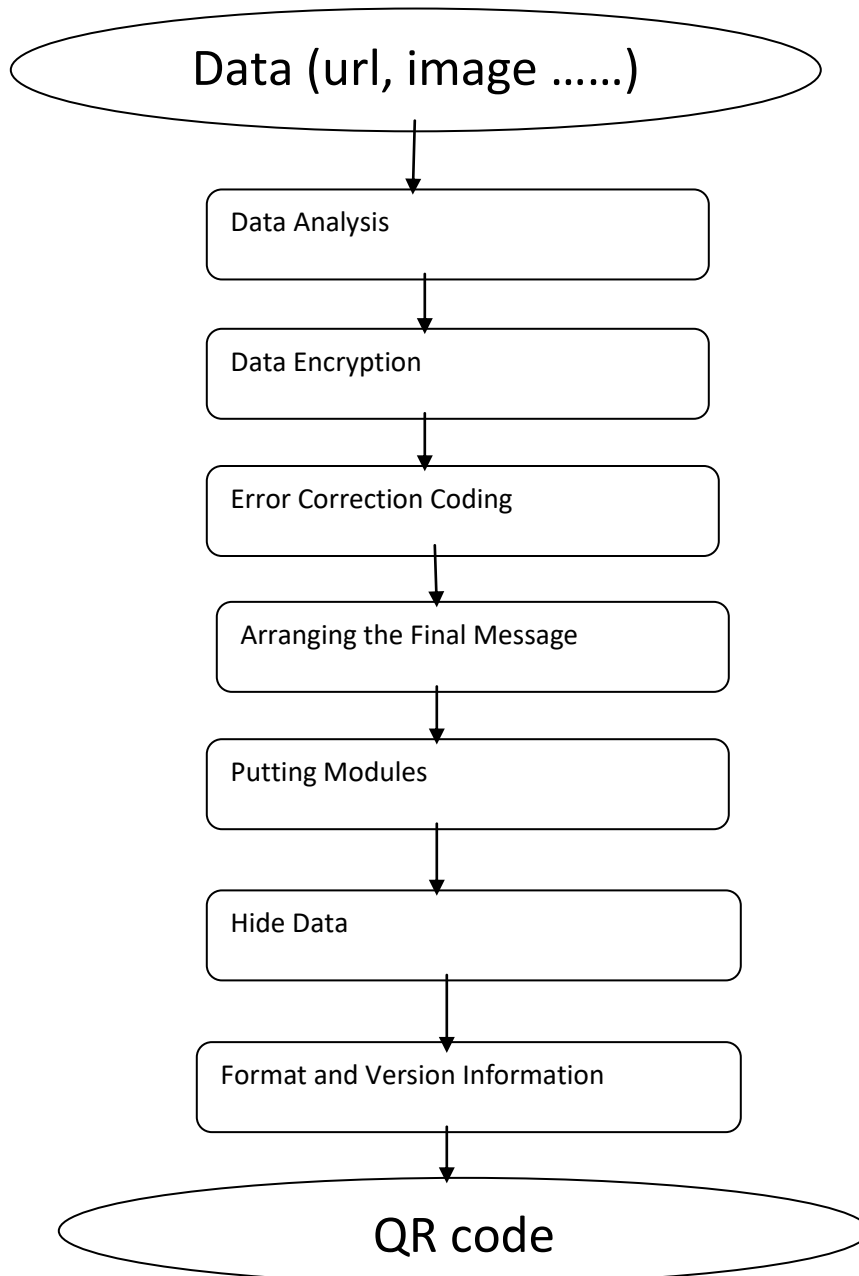


Figure 2.13: Organogram of the Create QR codes

2.6.1. Data Analysis

QR code encodes a text string. QR standard with four text encoding modes: numeric, alphanumeric, byte, and kanji. Each mode encodes text as a bit string (1s and 0s), but each mode uses a different method to convert text into bits, and each encoding method is optimized to encode data with the shortest possible bit string. Therefore, the first step should be to perform data analysis to determine if the text can be encoded in numeric, alphanumeric, byte or kanji mode and then determine the optimal mode for the text [23]

2.6.2. Data Encryption

After selecting the appropriate encoding mode in the previous step, this step is text encoding. The result of this step is a series of bits that are divided into data codewords of 8 bits each [23].

2.6.3. Error Correction Coding

As explained above, QR codes use error correction. This means that after creating a string of data bits representing the target text, one must then use these bits to generate error-correcting codes using a process called Reed-Solomon error-correction. QR scanners read data ciphers and error correction ciphers. By comparing the two, the scanner can determine if it is reading the data correctly, and it can correct errors if it is not reading the data correctly [23].

2.6.4 Arranging the Final Message

The data and debug code words that were generated in the previous steps should now be in the correct order. For large QR codes, data and debug ciphers are generated in blocks, and these blocks must be interleaved according to the QR code specification [23].

2.6.5. Putting Modules

into the Array After creating the data encoding and debugging ciphers and arranging them in the correct order, you need to put the bits into the QR code array. The encoded words in the matrix are arranged in a certain way. During this step, you will also place the styles common to all QR codes, such as the squares in the three corners [23].

2.6.6. Hide Data

Certain patterns in a QR code matrix can make it difficult for QR code scanners to read the code correctly. To avoid this, the QR code specification defines eight mask styles, each of which modifies the QR code according to a specific pattern. One must decide which of these mask models gives the QR code with the fewest number of unwanted features. This is done by evaluating each masked matrix against four penalty rules. Your final QR code should use the mask style that gave the lowest penalty score [23].

2.6.7. Format and Version Information

The final step is to add format and (if needed) version information to the QR code by adding pixels to certain areas of the code that were left blank in the previous steps. Format pixels determine the error correction level and mask style used in this QR code. Pixels encode the size of the QR matrix and are used only in the largest QR codes [23].

2.7. Method of scanning a QR code:[25]

2.7.1. How to Scan QR Code on iPhone with Built-In Camera App

1. Open the Camera app. You can do this from the Home or Lock screens or Control Center.
2. Point your device at the QR code so the QR code appears on your screen. Just like any other time you've taken a picture.
3. Your device will recognize the QR code and show you a notification at the top of your screen.
4. Click that notification and you'll access the information associated with the QR code.

2.7.2. How to Scan QR Code on iPhone with QR App in Control Center

Skip to step 3 below if you've already got your iOS QR Code Reader added to your Control Panel.

1. Open the Settings app on your smartphone and select Control Center.
2. Choose to include the QR Code Reader in your Control Center.
3. Open Control Center and click QR Code Reader icon.

4. Point your device at the QR code so the QR code appears on your screen. Center it within the white frame.
5. Once the QR code is registered, you'll either be taken to the encoded URL or asked to take an action (search, copy, etc.)

2.7.3. How to Scan QR Code on iPhone with Google Chrome Shortcut

You can also use the QR code scanner in Google Chrome on your iOS device. If you don't already have Chrome, you can download it in the iOS App Store. Here's how to use Google Chrome as a QR code reader:

1. Tap and hold the Chrome icon on your device's desktop.
2. Select Scan QR Code.
3. A Chrome browser window will open. (If it's the first time you're doing this, Chrome will ask for access to your camera and photos. Allow it.)
4. Point your device at the QR code so the QR code appears on your screen. Center it within the white frame.
5. Once the QR code is registered, you'll either be taken to the encoded URL or asked to take an action (search, copy, etc.)

2.7.4. How to Scan QR Code on iPhone with Google Lens on iOS

The Google iOS app leverages Google Lens technology on iOS devices. Here's how to use Google Lens as a QR code scanner:

1. Download the Google app in the iOS app store. (Not Chrome, not Google Photos, not Photo Scan by Google, just the plain old vanilla Google app.)
2. Open the Google App and press the Google Lens icon on the right side of the search bar. It's immediately to the left of the microphone icon at the far right side of the search bar.
3. Allow Google Lens access to your camera.

4. Point your device at the QR code so the QR code appears on your screen. Once Google Lens has registered the QR code, it will show a preview of the URL or content associated with it.
5. Press the magnifying glass icon to bring up a menu of actions you can take to interact with the QR code (visiting the URL, searching the phrase, etc.)

2.7.5. How Do I Scan a QR Code with My Android Phone

If you've got an Android device, there are a few ways you can boot up a QR code scanner and scan a QR code. Keep in mind, though, that some of these steps change slightly with different Android or Google Lens versions.

2.7.6. How to Scan QR Code on Android Phone with Built-In Camera App

1. Open the built-in camera app.
2. Point your device at the QR code so the QR code appears on your screen.
3. Your Android device will recognize that it's a QR code and a banner will appear on your screen.
4. Click the banner and follow the instructions to finish signing in (if you're not signed in) and access the information associated with the QR code.

2.7.7. How to Scan QR Code on Android Phone Using Google Lens in Google Assistant

1. Open Google Assistant on your Android device.
2. Tap the Google Lens icon on the bottom of the screen and share access with your camera if asked.
3. Point your Android device at the QR code you wish to scan. Once Google Lens registers the QR code, it'll show a preview of the content encoded in it.
4. Press the magnifying glass icon to bring up a menu of actions you can take to interact with the QR code (visiting the URL if they turned a link into a QR code, searching the phrase, etc.)

2.7.8. How to Scan QR Code on Android Phone with Built-In Camera App

1. Download the Google Lens app from the Google Play store.
2. Open Google Lens app and allow access to the camera.
3. Point your phone at the QR code you'd like to scan. You'll know Google Lens has successfully read it when a preview of the content appears.
4. Press the magnifying glass icon in the bottom center of the screen to bring up a menu of actions you can take to interact with the QR code (visiting the URL, searching or copying the phrase, etc.).



Figure2.14: exemple scan QR code

2.8.Conclusion

In this chapter, QR code can be considered as a great value for organizations. With the development of QR code, QR code is widely used in a number of fields, for example in newspapers, magazines, public and commercial advertisements, food and beverages, restaurants, clothing stores, social networking applications, enterprises and government. However, QR code is relatively new to most companies. While QR code is a competitive marketing tool today, it can also be considered as providing business opportunities in different business areas in the future. As a result, it was necessary to understand the concept of a QR code for individuals and organizations. QR code can store complex information within a small code . As awareness increases about the usefulness of these codes, we can expect them to be used in more public domains.

Chapter 03

Simulation and Results

3.1. Introduction :

After taking the theoretical knowledge in the previous chapter from the basic principle of generating and reading QR code. In this chapter, we will see the various tools (hardware and software) requirements that are used to achieve generate and read QR code, which is the goal of this project. Moreover, we will implement QR code algorithms using Python, OpenCV , NumPy , and Z bar. The results obtained as well as their discussions will be presented. In order to validate this work.

3.2.Hardware

In order to carry out this work project, a set of the following materials was made available to us: PC Lenovo with the following features:

- Processor Intel(R) Celeron(R) CPU N3350 @ 1.10GHz 1.10 GHz
- Installed RAM 4.00 GB (3.29 GB usable)
- System type 64-bit operating system, x64-based processor
- Edition Windows 10 Pro

3.3.Software

For this project, we used a set of development tools such as: The programming language Python 3.9, The computer vision library OpenCV 4 and PyCharm IDE ,libraries (numpy, z bar).

3.3.1. Python

Python is an interpreted programming language. One standard environment in which students often write python programs is IDLE (Integrated Distributed Learning Environment). This environment offers students two separate ways to write and run python programs. Since the language is interpreted, there exists an option for students to write a single line of python code and immediately see the results. Alternatively, students can open a separate window, put all of their commands in this window first, and then interpret their program. The first method lets students see, in real time, the results of their statements. The second follows the more traditional model of composing an entire program first before

Chapter 03 : Simulation and results

compiling and seeing the results. For learning purposes, the first technique is very useful. Ultimately however, students must develop their programs utilizing the second method.[26]

Python, developed since 1989 by Guido van Rossum and many volunteer contributors, is a dynamic typing language (i.e. the type of objects handled is not necessarily known in advance but is defined from the value of the variable) and strongly typed (i.e. it ensures that the data types used correctly describe the data being manipulated). It is equipped with automatic memory management by garbage collector (no pointer management!!!) and an exception management system.



Figure 3.1 : logo python

3.3.2.opencv

OpenCV is an Image Processing library created by Intel and maintained by Willow Garage. OpenCV is an open source image and video processing and analysis library with interfaces for the main programming languages C, C++, Java, C#, Python..., is optimized for real-time applications, provides low and high level API, provides an interface for the IPP parallel programming language, is used both in research laboratories and in industry. The functions of the OpenCV are: manipulation of images (loading, saving, copying, converting...); manipulation and acquisition of videos; Matrix manipulations and linear algebra; various utility data structure (lists, queues, sets, graphs...); image processing (filtering, detection of discontinuities, mathematical morphology...); image analysis (connected components, adjustment of primitives, distance transform...); vision (camera calibration, stereovision, association search...); Shape recognition (Markov models, ACP...); graphic interface (display of images, videos, event management, etc.)



Figure 3.2 : logo opencv

3.3.3.PyCharm

PyCharm is a tool developed by the company Jet Brains, specialist in the development of IDEs for different programming languages.



Figure 3.3 : logo pycharm

3.3.4.Numpy

NumPy is the fundamental package for scientific computing in Python. It is a Python library that provides a multidimensional array object, various derived objects (such as masked arrays and matrices), and an assortment of routines for fast operations on arrays, including mathematical, logical, shape manipulation, sorting, selecting, I/O, discrete Fourier transforms, basic linear algebra, basic statistical operations, random simulation and much more (NumPy User Guide, Release 1.22.4).[28]

3.3.5.ZBar

is an open source software suite for reading bar codes from various sources, such as video streams, image files and raw intensity sensors. It supports many popular *symbolologies* (types of bar codes) including EAN-13/UPC-A, UPC-E, EAN-8, Code 128, Code 39, Interleaved 2 of 5 and QR Code.

Chapter 03 : Simulation and results

The flexible, layered implementation facilitates bar code scanning and decoding for any application: use it stand-alone with the included GUI and command line programs, easily integrate a bar code scanning widget into your Qt, GTK+ or PyGTK GUI application, leverage one of the script or programming interfaces (Python, Perl, C++) ...all the way down to a streamlined C library suitable for embedded use.[29][32]



Figure 3.4 : logo zbar

3.3.5.1.Install pyzbar (for Python users only)

The official version of Z Bar does not support Python 3. So we recommend using [pyzbar](#) which supports both python 2 and Python 3. If you just want to work with python 2, you can install z bar and skip installing pyzbar.

```
pip install zbar
```

```
pip install pyzbar
```

3.3.5.2.Understanding the structure of a barcode / QR code

A barcode / QR code object returned by ZBar has three fields

1. **Type:** If the symbol detected by ZBar is a QR code, the type is **QR-Code**. If it is barcode, the type is one of the several kinds of barcodes ZBar is able to read. In our example, we have used a barcode of type **CODE-128**
2. **Data:** This is the data embedded inside the barcode / QR code. This data is usually alphanumeric, but other types (numeric, byte/binary etc.) are also valid.
3. **Location:** This is a collection of points that locate the code. For QR codes, it is a list of four points corresponding to the four corners of the

Chapter 03 : Simulation and results

4. QR code quad. For barcodes, location is a collection of points that mark the start and end of word boundaries in the barcode. The location points are plotted for a few different kinds of symbols below.
5. ZBar location points plotted using red dots. For QR codes, it is a vector of 4 corners of the symbol. For barcodes, it is a collection of points that form lines along word



Figure 3.5: Understand the structure of barcode / QR code

3.3.5.3. Python code for scanning barcode and QR code using ZBar and OpenCV

For Python, we use pyzbar , which has a simple **decode** function to locate and decode all symbols in the image. The **decode** function simply warps pyzbar's decode function and loops over the located barcodes and QR codes and prints the data. The decoded symbols from the previous step are passed on to the **display** function. If the points form a quad (e.g. in a QR code), we simply draw the quad. If the location is not a quad, we draw the outer boundary of all the points. Finally, the main function simply reads an image, decodes it and displays the results.

3.4. Structure the generate of QR code :

We can understand that the structure of QR code generation is as follows:

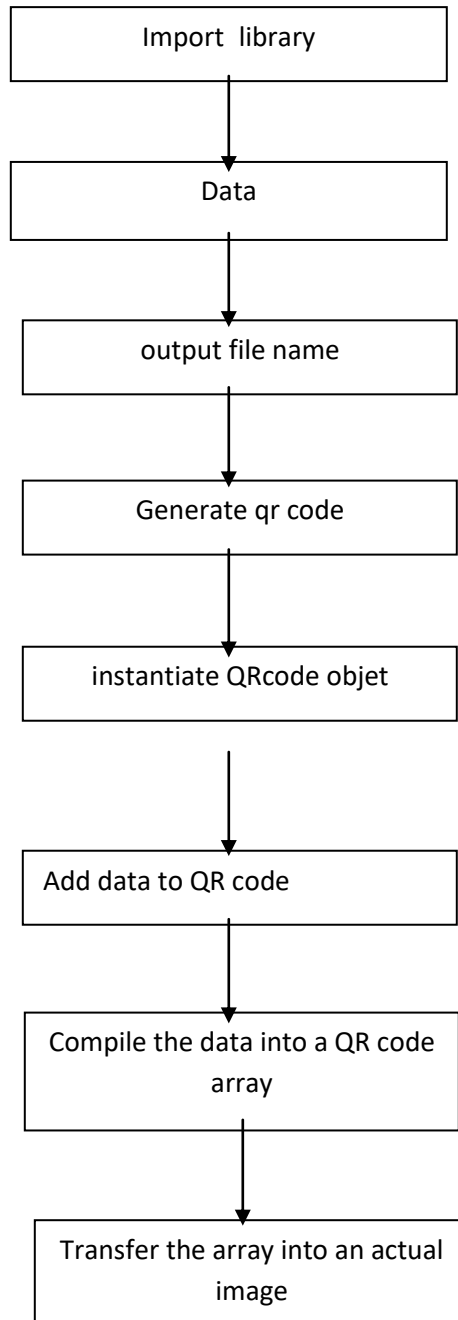


Figure 3.6: Organogram of the generate QR code

Chapter 03 : Simulation and results

3.4.1.Import library[33][34]

First we are importing our required packages so that our model could run (import qr code).

Import the QR code library to help us create it, qr code library works to generate QR code images.

Example :

```
import qrcode
```

3.4.2.Data

To create a QR code, we need data that is encoded into a QR code

example site:

```
data = "https://www.thepythoncode.com"
```

example information personnel:

```
data = "name:sahra  
first name:Guerfi  
age:24  
graduation  
certificate:M2  
télécomunication"
```

```
data = "name:Nour  
first name:Guettafi  
age:23  
graduation  
certificate:M2  
télécomunication"
```

example image :

```
data =  
(cv2.imread('HI.png'))
```

3.4.3.output file name

Label the encrypted data ; example:

```
filename = "site.png"
```

Chapter 03 : Simulation and results

3.4.4.generate qr code

Data encoding using the `make()` function ; example :

```
img = qrcode.make(data)
```

3.4.5.instantiate QR code objet

The version parameter is an integer from 1 to 40 that controls the size of the QR Code (the smallest, version 1, is a 21x21 matrix). Set to None and use the `fit` parameter when making the code to determine this automatically.

The `box_size` parameter controls how many pixels each “box” of the QR code is.

The `border` parameter controls how many boxes thick the border should be (the default is 4, which is the minimum according to the specs).

```
qr = qrcode.QRCode(version=1, box_size=10, border=4)
```

3.4.6.add data to QR code

The `add_data` method will append data to the current QR object

```
qr.add_data(data)
```

3.4.7.compile the data into a QR code array

- **make()**: This method with (**fit=True**) ensures that the entire dimension of the QR Code is utilized, even if our input data could fit into less number of boxes.

```
qr.make()
```

Chapter 03 : Simulation and results

3.4.8.transfer the array into an actual image

This method is used to convert the QRCode object into an image file. It takes the *fill_color* and *back_color* optional parameters to set the foreground and background

```
img = qr.make_image(fill_color="white", back_color="black")
```

3.4.9.save it to a file

Save the image to the file:

```
img.save("site.png")
```

3.5.structure of the read of QR code:

The figure below presents the structure of QR code reading.

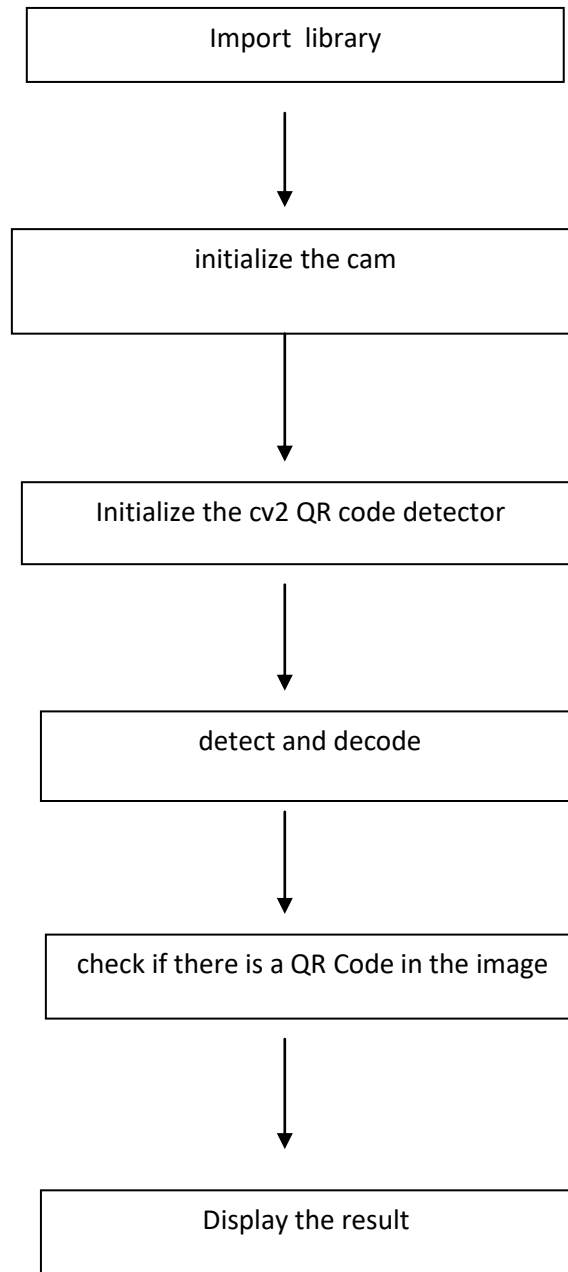


Figure 3.7: organogram structure of the read QR code

Chapter 03 : Simulation and results

3.5.1.Import library[33][34]

Import cv2: For creating the QR code scanner you need to install the OpenCV library on your command prompt. First, you need to import the cv2 and browser library.Cv2 is used for scanning the QR code through a webcam.

```
import cv2
```

3.5.2.initialize the cam

we need to start the camera for capturing the QR code. For that declare a variable called a cap and in this variable pass the instance *cv2.VideoCapture(0)*.

```
cap = cv2.VideoCapture(0)
detector = cv2.QRCodeDetector()
```

3.5.3.Initialize the cv2 QR code detector

The next process is we need to create a variable called detector and in this variable call the object cv2 .QR Code Detector(). This object is a very helpful one for capturing QR codes in real-time.

```
detector = cv2.QRCodeDetector()
```

3.5.4.detect and decode

We create an object of class QR Code Detector. QR code is detected and decoded by using detect And Decode method. It allows to get decoded data and an array of vertices of the found QR code.

```
data, bbox, straight_qrcode = detector.detectAndDecode(img)
```

Chapter 03 : Simulation and results

3.5.5.check if there is a QR Code in the image

This step is very important you need to create a *while* loop and in this loop create a variable called an *img* and this loop will read your webcam screen continuously until this loop breaks

```
while True:
    _, img = cap.read()
```

create a variable called *data*, and this variable is to be used to decode the QR code, and if any data is present in the QR code image it will break the loop and it open the link in your browser. So this is the condition that I inserted here

```
data, bbox, _ = detector.detectAndDecode(img)
if bbox is not None:
    for i in range(len(bbox)):
        m_pt1=tuple(bbox[i][0])
        m_pt2=tuple(bbox[(i+1) % len(bbox)][0])
        cv2.rectangle(img, (0,0), (1,1), color=(255, 0, 0),
thickness=2)
    if data:
        print("[+] QR Code detected, data:", data)
        im_np = np.asarray(data)
        print(im_np)
```

3.5.6.Display the result

Finally, call the object *cv2.imshow* this will produce the output and you've to assign the key to break the loop. Here I assigned the key that is called *q*, when we press the *q* it will stop the video streaming.

And then you've to create the variable, in this variable you need to call the object *web browser .open*(pass the variable an in this object)

```
cv2.imshow("img", img)
if cv2.waitKey(1) == ord("q"):
    break
cap.release()
cv2.destroyAllWindows()
```


3.6.The results of the difference in the data

When you change the QR code data, its shape changes according to the information to be encoded (the size of the information).

Table 3.1: results of the difference in the data

Data	QR code
<pre>data = "https://www.thepythoncode.com"</pre>	
<pre>data = "name:sahra first name:Guerfi age:24 graduation certificate:M2 télécommunication"</pre>	
<pre>data = "name:Nour first name:Guettafi age:23 graduation certificate:M2 télécommunication"</pre>	
<pre>data_1 = (cv2.imread('HI.png'))</pre> 	

Chapter 03 : Simulation and results

3.7.The results of the difference in the version

The variability of QR code versions make them quite versatile. And that affects how your customers interact with your QR codes through their size and load time

Size and load time :The only thing you need to encrypt your QR code is the URL of the information to be encrypted. (Assuming about 50 alphanumeric characters, for example you can use version 3 (29x29) size which will allow us to place the code in smaller spaces.) The ability to use smaller codes means that we can increase their visibility in a number of data modules in a QR code, the longer it takes a QR code reader to read it. Imagine using a version 40 dynamic QR code for a 50-character URL. You are using just over 1% of your available storage space. But your QR code scanner doesn't know that. It will keep checking every single piece of data to make sure it doesn't miss anything. This means that using version 40 in the QR code will have a much higher loading time than using smaller versions. Figures 3.8, 3.9, 3.10 and 3.11, present the results QR codes of many data for different versions.

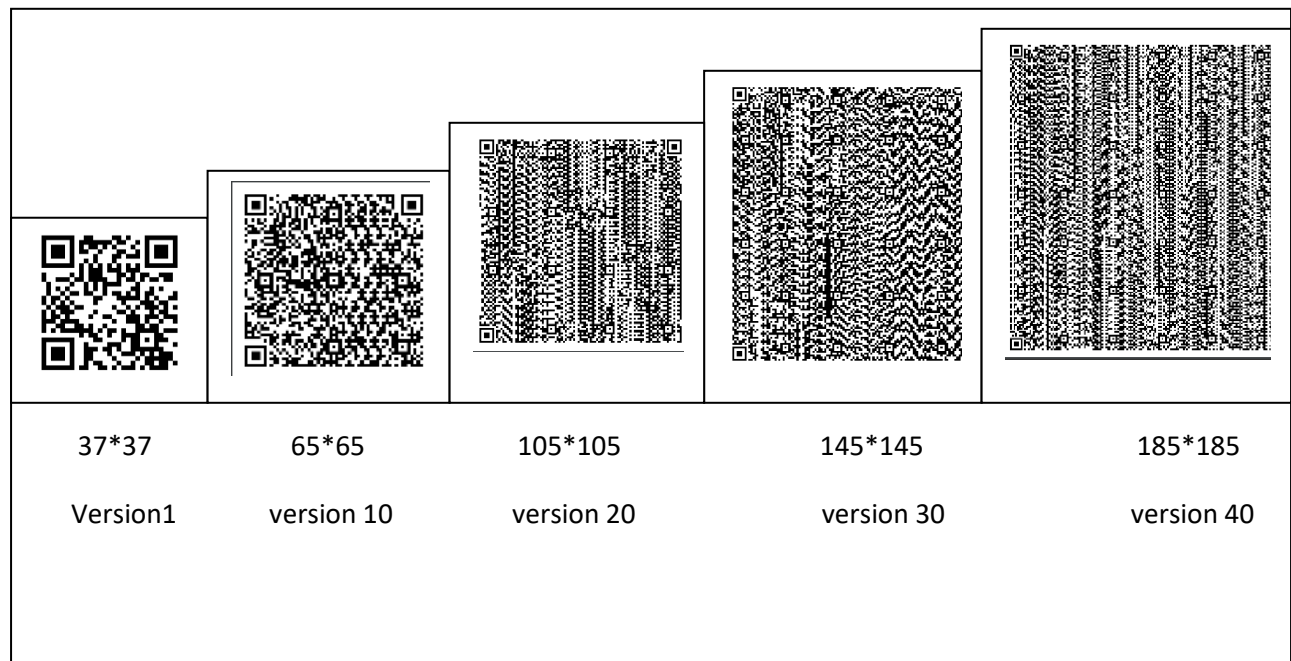


Figure 3.8:QR CODE OF THE SITE (different version)

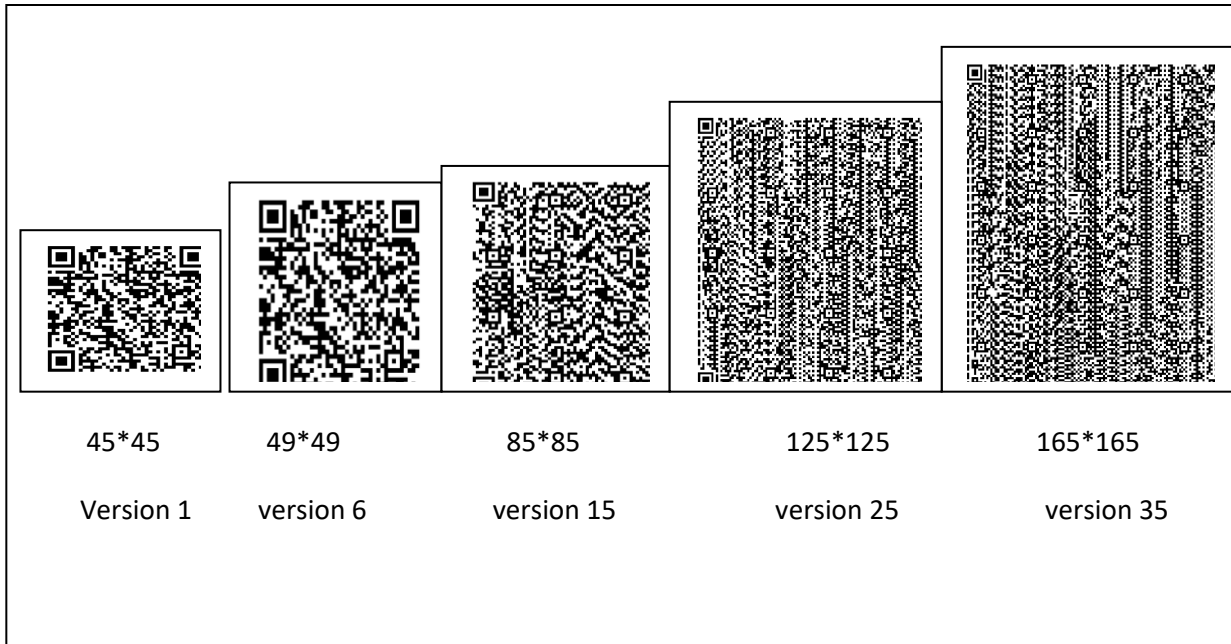


Figure 3.9: QR CODE OF THE INFORMATION PERSONEL 01 (different version)

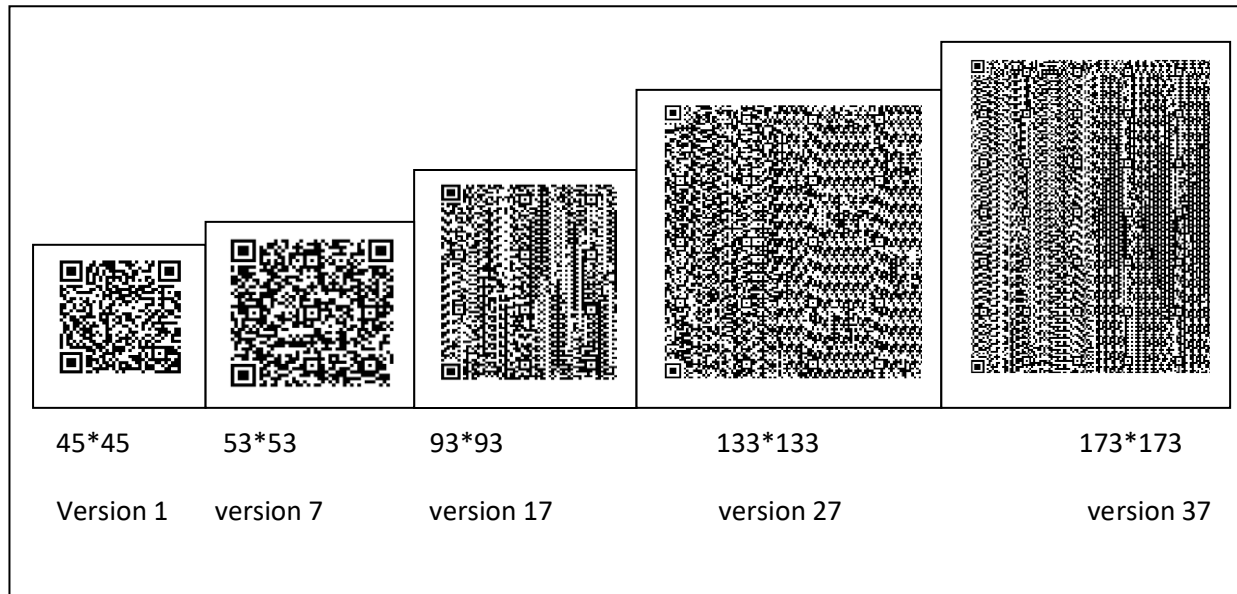


Figure 3.10: QR CODE OF THE INFORMATION PERSONEL 02 (different version)

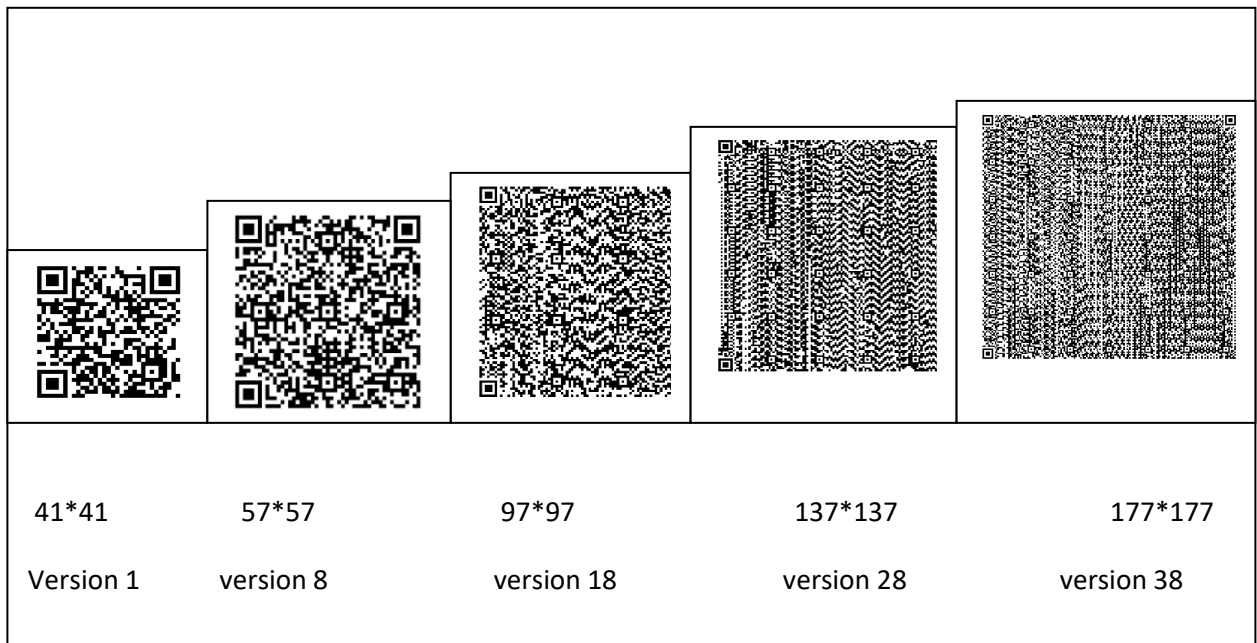






Figure 3.11:QR CODE OF THE IMAGE (different version)

Table 3.2, present the results of the reading QR codes for data.

QR code	Result
	[+] QR Code detected, data: https://www.thepythoncode.com
	[+] QR Code detected, data: name:Nour first name:Guettafi age:23 graduation certificate:M2 télécommunication
	[+] QR Code detected, data: name:sahra first name:Guerfi age:24 graduation certificate:M2 télécommunication
	[+] QR Code detected, data: <PIL.Image.Image image mode=L size=60x60 at 0x1E6083E6BB0>





3.9.Errors not reading the QR code

QR Code has the error correction capability, therefore, QR Code can be stored the code-words maximum 30% when the image is dirty and damaged .When the image of QR Code is contaminated, the error detecting can focus on the place of correct information. Data can be recovered even though a part of the code is dirty and damaged in general situation. Nevertheless, in some situation of the image is dirty and damaged, data may not be restored.[31]

Chapter 03 : Simulation and results

When the correction part of the QR code is distorted, the reading is done correctly. This means that it has the ability to correct the error. When the data part is distorted, the reading is not done. This is proof that the possibility of detecting the error is concentrated on the data part, that is, the important part in reading is the data part.

Table 3.2: results of the not reading and correction QR code

QR CODE	RESULT
	[+]QR Code detected, data: <PIL.Image.Image image mode=L size=60x60 at 0x23C918A6BB0>
	NO READ
	NO READ
	NO READ

	NO READ
---	----------------

3.10. Conclusion

In this chapter we saw the hardware and software used in this project side by side, then we saw QR code generation and reading architecture in Python and we took an overview of their basic steps and then started showing the results of our project. The first results are when we change different data each time and we see a Special QR code. The new generator, where the QR code changes its shape with the change of information, then we change the QR code version of all previous data and we see the results. version) and finally we see the results of reading the QR code and see the errors we encounter in the non-reading. We note that our work gives a good result in creating and reading a QR code.

General conclusion

General Conclusion

General Conclusion

Although QR codes are most popular in Japan and South Korea, their popularity is growing in the United States and Europe as companies and individuals continue to devise new and innovative ways to use them. QR codes also represent another step away from using keyboards as input devices in mobile computing, so although the technology and uses for QR codes are likely to evolve, the new trend in mobile computing that they represent is likely to continue.[35]

A QR code consists of black squares arranged in a square grid on a white background, which can be read by an imaging device such as a camera, and processed using Reed–Solomon error correction until the image can be appropriately interpreted. The required data is then extracted from patterns that are present in both horizontal and vertical components of the image [36].

The aim of our work was to study QR code technology, its benefits, areas of application, and its impact on the technological world. Initially, QR code was developed and used in inventory tracking items, but these days, they are finding applications in many new areas such as marketing, advertising, secure payment systems, educational industries, etc. Features such as high data storage capacity, fast scanning, error correction, direct tagging, and ease of use. [23]

In this work, we have implemented the creation and reading of a QR code algorithm on several data, and we made a comparative study between these data. In addition, we use the widely used high-level programming language Python, the computer vision library OpenCV, ZBar, Qrcode, and the PyCharm IDE. The results obtained show that the generating and reading of QR code with various data and versions are good results. In perspective, we propose the Use of QR codes on new additions in books, book purchase terms and conditions, bookmarks, tabletop signs, library rules and regulations and on the flyer advertising their virtual tour.QR codes in the stacks.The central library directs QR code users to colon classification system to aid browsing the physical book collections.

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