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QR Code Analysis

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Abstract: ***Two-dimensional matrix barcodes called "Quick Response" (QR) are used. It must store much information compared to one-dimensional barcodes, and it must be decrypted quickly using any handheld device, including a smartphone. When creating two-dimensional matrix codes, these two considerations are taken into account. The possibility of security becomes a significant factor when a bar code contains sensitive information or private data Users are unsure of whether a QR code will connect them to reliable information or a malicious website because QR codes are simply square bar codes with a distinctive design. Recently, QR codes have been used in numerous application fields, and their use is growing quickly. As a result, more individuals are becoming acclimated to this technology and using it properly. Due to the QR code's increasing popularity as more people use smartphones, it is swiftly acquiring universal acceptance. Given their broad acceptance, the security aspect of QR codes, such as data leakage and data tampering, is critical. The paper offers a comprehensive overview of QR codes and their applications.***

Keywords: QR Codes, QR Code Analysis, Quick Response Codes.

I. INTRODUCTION

With the initial goal of creating a sign that is easily interpreted by scanner instruments at high speed with more knowledge content than standard barcodes, Denso Wave, a Toyota subsidiary, invented the QR Code in 1994. Unlike QR Code, which has decoded data in both the vertical and horizontal directions, the conventional Universal Product Code only carries decoded data in one direction, vertically into bars with houses in between. The amount of information that a QR code can store is greater than that of a barcode, which is even several times as much information.

By using a camera to take a picture of the code and a QR scanner to analyze the image, data can be accessed. The amount of information they can store or share differs significantly between a barcode and a QR code. The same amount of data that a 1-D bar code can hold can be stored in a QR Code in a tenth of the space. While QR codes are 2-D matrix barcodes that can store 4,296 alphanumeric characters, 7,089 numeric characters, and 1,817 kanji characters of information, bar codes are linear 1-D codes that can only hold up to 20 number digits. The code was made up of square-shaped, black modules on a white background. Every image in the QR Code has three specific position-detection patterns placed there. A QR code encoder and decoder make up the QR code system. The encoder is in charge of encoding the data and producing the QR code, and the decoder is in charge of extracting the data from the QR code. As a result of their ability to be read regardless of placement, QR Codes have the distinctive ability to be scanned from any angle. Numerous features, including rapid data reading speeds, filth and damage resistance, small print sizes, 360-degree reading, and structural flexibility of applications, are included in QR codes. The Reed-Solomon Codes (a mathematical error-correction method) is added to the original data to provide the QR Code with its robust error-correction capabilities. As a result, a QR Code image can be scanned even if it is damaged or unclean.

In smartphones, QR codes are quite helpful and speed up work completion. You don't need to manually type the URL into your smartphone; you may open a website quickly merely by scanning a QR code. This is the reason that many website posters now have QR codes. One more common application is on a business card. In today's society, many now add QR codes to their business cards. Therefore, others can easily keep the contact information on their smartphone by scanning the QR code.

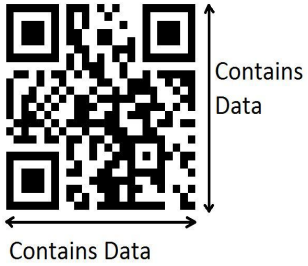


Figure 1: QR Code

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II. LITERATURE REVIEW

The camera on a mobile phone is typically used to confirm the Quick Response code. Through devices like tablets, laptops, and desktop computers, QR codes are easily scanned. The user's ID and password are generated automatically by the system. The distinguishing feature of QR codes is their ability to still be read even when partially damaged. Because they are printed in two dimensions on paper or a screen, QR codes are quite susceptible to several kinds of cyber-attacks. By unintentionally leading you to a page or website that is infected with a virus, it can damage your device. To prevent this, one must confirm the source of a certain QR code and fully comprehend the data nature of that specific QR code. There are numerous attacks employing QR codes and countermeasures.

Due to the fast global use of smart devices by the general public, QR codes are currently highly popular. Clearly superior to the older, more conventional 1D codes, 2D QR codes can hold a lot more encoded information. People use their smartphones to perform authentications, and the best way to do this is with QR codes. Nowadays, a wide variety of QR codes, such as logo QR codes, encrypted QR codes, and iQR Codes, are becoming more and more popular.

The next generation is embracing QR codes more and more as they provide far simpler authentication than the conventional user ID and password. Numerous benefits come with QR codes, including increased data storage capacity, quick scanning, 360-degree reading, tiny print size, error correction, support for more languages, and resistance to scuffing and damage. These codes are frequently used by businesses that are relatively new to the online world of commerce instead of the standard login procedure.

A secure QR code technique based on visual cryptography was presented by Xia he Cao to address the security and information issues with QR codes.

Due to the widespread use of QR Codes, there are serious security issues with them, including data loss and data tampering. The QR code is divided into two shareable images that will be sent separately. The pseudo-random matrix served as the foundation for the creation of the two shared images; hence, the pixels in the two shared images are decided by the values of the pseudo-random matrix. Only by stacking the two shared photos can the information be revived. The simulation's results show how effectively and efficiently the QR code's image may be reconditioned.

Peter Kieseberg has investigated how QR Codes might be used to challenge both automated systems and human contact. One cannot tell a good QR code from a bad corrupted one because the encoded data is only intended to be machine-readable. While humans may be vulnerable to phishing attacks, robot readers are significantly more vulnerable to SQL and command injections. The work from Peter Kieseberg is an overview of the QR code as an attack vector, presenting various attack strategies for the attackers to read and consider the ramifications of.

III. METHODOLOGY

A significant part in the development and improvement of new-era technology has been played by scientific study. Research is creation, scientific inquiry, or scientific investigation used to discover the truth or create novel ideas.

Fact-finding inquiries and surveys of various kinds make up descriptive research. The primary goal of descriptive analysis is to describe the existing situation as it is. Either applied research or fundamental research can be done. While the basic study is primarily concerned with generalizations and the creation of a theory, the applied analysis seeks to discover a solution to an immediate problem facing a community or an industrial/business organization. Amount or quantity measurements are the foundation of quantitative research. It applies to situations when there is a quantifiable outcome. Comparatively, qualitative research is focused on the concept of quality. Studies of concepts sometimes incorporate theories or abstract concepts. It is frequently used by theorists and philosophers to generate new ideas or reinterpret existing ones. Inquiry, however, frequently does not take sufficient scheme and theory into account and instead depends solely on knowledge or investigation. It is a data-based study that yields conclusions that may be verified through testing or observation. We used all of these methods to perform QR Code analysis.

A. QR Code Structure

Finder Pattern (1): All corners of the QR Code, with the exception of the bottom right, include three structures that are identical to one another. Each pattern is built upon a 3x3 grid of black modules, which are then encircled by white modules, which are then encircled by black modules. The decoder software can recognize the QR Code and ascertain its precise orientation thanks to the Finder Patterns.

Separators (2): The white separators, which are one pixel wide and improve Finder Pattern detection by separating them from the actual data, are used.

Timing Pattern (3): By switching between black and white modules, the decoder software may identify the width of a single module.
Alignment Patterns (4): The decoder software can be compensated for minor picture distortion by using Alignment Patterns.
There are no alignment patterns in version 1 QR codes. Alignment Patterns are added in greater numbers as code size grows.
Format Information (5): Information on the QR code error correction rate and the chosen masking model are stored in the Formation Information section, which is composed of 15 bits next to the separators.
Data (6): Information is divided into 8-bit pieces and transformed into a bit stream before being saved (known as code words).
Error Correction (7): Similar to the data section, the error correction section stores error correction codes in 8-bit long code words.
Remainder Bits (8): If the data and error-correction bits cannot be divided into 8-bit code words without remainder, this section is made up of empty bits.
The entire QR code needs to be surrounded by the so-called Quiet Zone, an area the same color as white modules, to improve code identification by the decoder software.

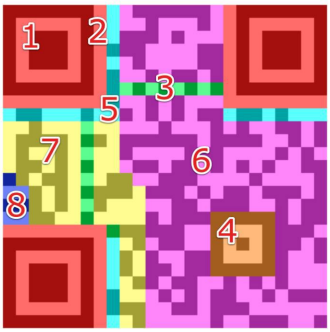


Figure 2: QR Code Structure

B. Working On QR Code

A QR code generator can encrypt data into a QR code (Some of the QR Code generators available online are listed in the later part). By utilizing any free QR code generator and entering the data to be encoded into the sphere provided by the generator, data may be simply encoded into QR codes. In order to support the data, you are encoding, QR code generators may require you to enter information into one or more of the available Data Fields.
When all the information fields have been filled with the necessary information and are in the proper format, the QR code generator can publish the code for the data, which can primarily be in picture format (JPEG, BMP, PNG, etc.). This could be published in print format or used straight on the internet or in emails. In order to add artistic embellishment, it is also possible to rearrange the hue and even include images in QR codes.
Decoding of those QR codes can be done using online QR code decoders linked to any internet-enabled smartphone that comes pre-installed with the QR code Reader software package. If not, the software can be downloaded for free from a variety of websites on the internet (Some of the QR Code readers offered online are listed in the later part).
Online decoders like ZXing Decoder Online, MiniQR, online Barcode Reader, Saint Patrick Wied QR Generator, QR Code Generator, and Recovery can be used to read QR codes. By pointing a good phone's camera at the QR code and scanning it while taking an image, QR codes can also be decoded. Following the decoding of the QR code, the pre-installed QR code reader shows the material as text or in universal resource locator format. Additionally, QR codes inspire activities on your mobile device when it navigates to an internet page, such as dialling a number, sending an SMS, saving reminders, saving a number to the phone book, etc.
Here are the most popular QR code features:

1) Prompt to open the URL directly
2) Bookmark site links
3) Prompt to call from mobile phone
4) Prompt to send SMS from mobile phone
5) Prompt to start email
6) Send vCard
7) Save the date in your calendar (for booking)
8) reply text

9) encryption
10) Record geographic coordinates

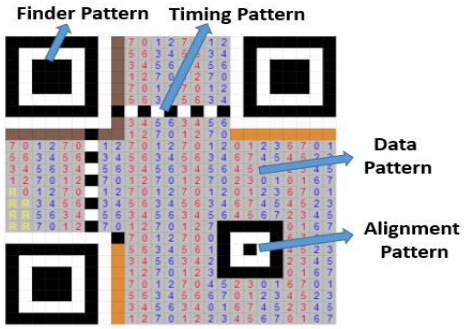


Figure 3: QR Code Structure

C. QR Code Attack

Hacking a QR code entails changing the action without changing the QR code itself. This cannot be done. There are malevolent QR codes that can do bad things. However, that QR code will not be an authentic QR code. There is no such thing as two QR codes that perform the same action. Both QR codes have distinctive patterns that you will undoubtedly notice. So, it's impossible to hack QR codes.

With QR codes, the following security risks are the most typical:

1) *Malware attacks:* Cybercriminals may include dangerous URLs in QR codes that are displayed in public places so that anyone who scans them would become infected with malware. Sometimes just accessing the website can start malware quietly downloading in the background. The infection can then cause a variety of harm to users. It might also surreptitiously steal the target's information and send it to the attackers, opening backdoors for additional malware infestations. These malware infections can occasionally even be ransomware operations that demand a ransom in exchange for your data.
2) *Phishing Attacks:* Another issue known as Phishing is the usage of QR codes in phishing scams. A phishing website URL could be added to a legal QR code by a cybercriminal. Users are then prompted by the phishing website to divulge their personal data, which crooks will then sell on the dark web. These phishing websites are barely distinguishable from real websites, giving the victim the impression that they are trustworthy. With a few small exceptions, they are largely perfect reproductions of the original. For instance, the ".com" in the domain name can be changed to something else, such as "ai" or "in."
3) *Bugs in QR codes:* On sometimes, it might not even be a threat actor trying to take advantage of consumers. Merely a flaw in the reading software for QR codes. The weakness might be used by hackers to access cameras or sensors in phones or other gadgets. Threat actors might also take advantage of a flaw or error in the trustworthy URLs that the QR code connects to. Heinz was involved in this incident back in September 2015 when users were driven to inappropriate websites using their QR codes. When customers arrived at the website after scanning the QR code, they could design their own Ketchup bottle labels. However, consumers were routed by the QR code to a totally unrelated and improper website.
4) *Financial theft:* Bill payment and transaction efficiency have long been made possible by QR codes. Their use has multiplied during the COVID-19 outbreak to encourage "no-contact" means of communication and information sharing. For consumers to pay, eateries and even gas stations use QR codes. Any threat actor can replace a real QR code with a fake one in such public areas to cause the transactions to go to their bank account.

IV. RESEARCH OUTOMES

A. Merits Of The QR Code

1) Omnidirectional and Quick Scanning: There is no need to position the scanner in accordance with the code symbol because a QR code may be read considerably more quickly and within 360 degrees from any angle.
2) Small Size: The QR code occupies less room. One-tenth the space is needed for a QR Code to store the same amount of data as a 1-D barcode.
3) Large Data Storage Capacity: The data storage capacity of the QR code is very great. A single QR Code token can have as many as 7,089 digits (200 times the volume of information storage capacity of the traditional 1-D barcode).

4) Numerous Data Types: The QR Code can handle binary data, letters in Japanese, Chinese, or Korean, alphanumeric characters, and numbers.
5) Error correction: The QR code's error correcting method makes it possible to successfully decode the code symbol even if up to 30% of the data is corrupted or filthy.
6) Everyone can construct their own QR codes based on their needs; for example, a user may do so to generate a QR code for the URL of their own website for promotional purposes.
7) Numerous Possible Uses: QR codes have a wide range of potential applications. They can be used to improve the user experience on websites, at restaurants, and more.

B. Demerits Of The QR Code

Despite the fact that QR codes provide a lot of benefits, there are some drawbacks as well. For example, users must have a QR reader app to read the codes, which has a limited audience. security issues; before scanning a QR code, the scanner is unsure of where the code will take the user; Lack of awareness on the part of the general public; many people are still ignorant of this technology.

V. FUTURE SCOPE

One of the most important aspects of cashless transactions is the use of QR codes. They were already widely used and extremely well-liked in America and Europe, but in recent years, South and East Asia have begun to adopt them as well.
In China, the use of QR codes has even overtaken the use of cash and credit cards. One of the biggest accomplishments for QR codes to date must be this. The use of QR codes is rapidly increasing in India, and a new era of cashless transactions is on the horizon for the nation.
Many people contest the idea that QR codes are only utilized incidentally when doing financial transactions.
In recent years, many users have begun to favor these codes above others.
The biggest drawback of QR codes is that they are just intended to send users to another webpage or website; they do not independently gather any data. If these codes begin to gather data and initiate a two-way transaction in this very data-driven environment, the technology market will undoubtedly stabilize for the upcoming years.
Another restriction on the use of QR codes is that in order to scan and read the data included in the QR code, one must have a QR code reader or scanner installed on their smartphone or tablet. Instead of doing this, we may design and incorporate QR code readers inside the smartphone camera itself, eliminating the need for any additional third-party applications.
Although many technologies and security experts have questioned QR codes, the general public still loves and accepts them in a wide range of situations. When it comes to promotional events, they have literally been employed everywhere. Examples include mobile payments, coupons, flight ticket coupons, business cards, and promotions for new business profiles.
Although new technologies have emerged in recent years that are superior to or more secure than QR codes, many people in developing nations have already adapted to them, therefore QR codes will continue to be used for a very long time to come. It is therefore unlikely that people will adopt new technology once more after taking so long to get accustomed to QR codes.

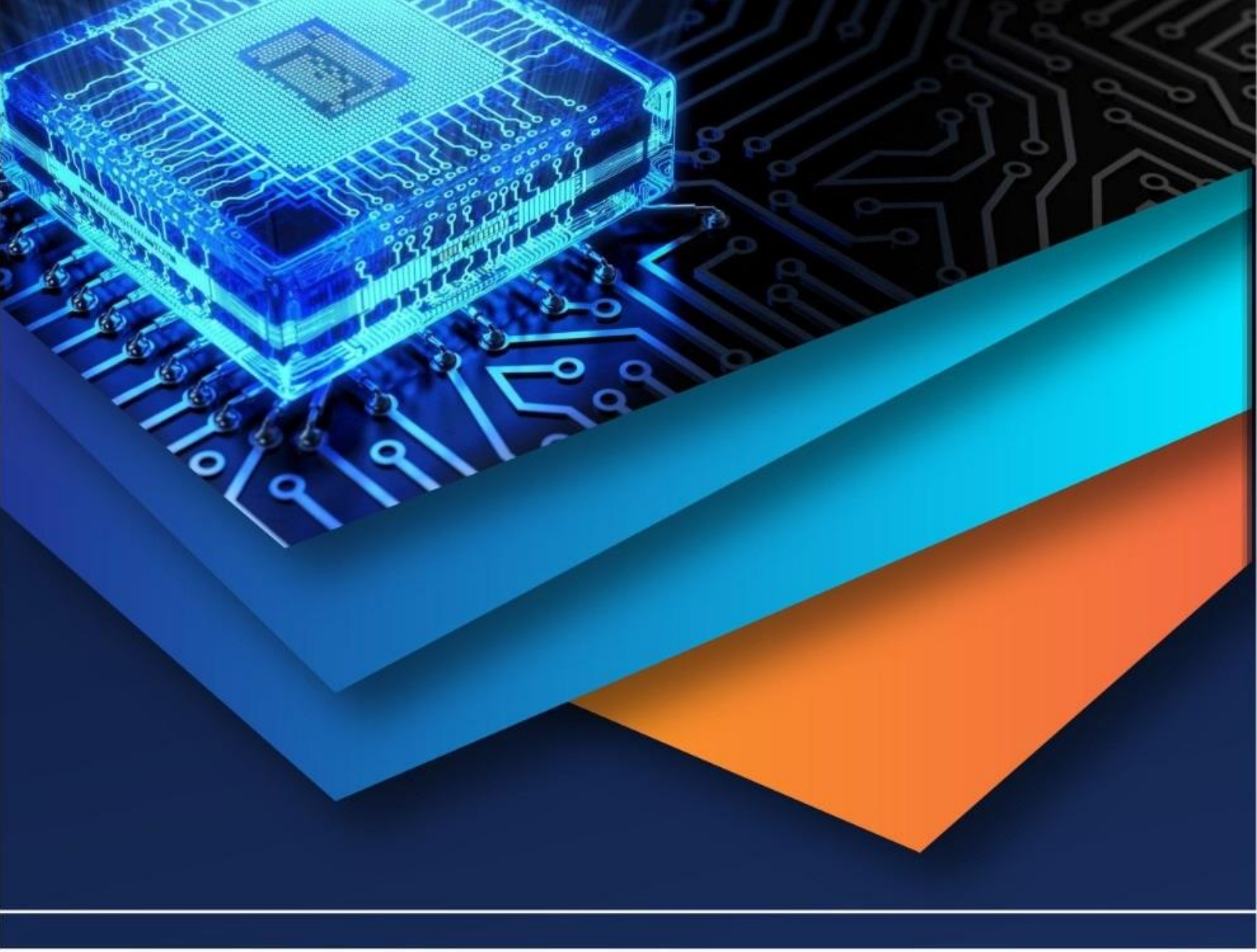
VI. CONCLUSION

The analysis of QR codes and their applications have been covered in this essay. These codes have a large amount of data storage capacity and are also damage-resistant, which helps them get around one of the main security issues. The use of QR codes has rapidly risen over the past few years in public spaces like supermarkets and for educational reasons like book scanning or stationary scanning. As awareness grows, it will continue to flourish in additional industries.
The QR code technique is growing in popularity day by day while also becoming more secure as technology advances. When people are more aware of these codes, a wider range of people will be able to assess their importance. This technology will soon be utilized in several public spaces. Originally, QR codes were meant to hold data about inventory items, but they are now widely utilized in fields including marketing, safe payment methods, advertising, and even educational systems.

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