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A REVIEW: QR CODES AND ITS IMAGE PRE-PROCESSING METHOD

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***Abstract*— A Quick Response code (called as QR Code) is 2-D Barcode which is specifically designed to be read by smart phones with camera embedded in them .The idea of the QR code is that it is a simple way to access a web address (or URL). A QR code is an image file (it can be a png, jpg, etc.) that when scanned by a QR Code reader or scanner will access the URL linked to it, which basically means it will open a web page.**

This research focuses on the theoretical aspect relevant to the QR Code studying. This QR Code studying involves features of QR Code and the technologies which are using it.

***Index Terms* — QR Codes, Bar codes, Types, Scanning, Image pre-processing, Binarization.**

I. INTRODUCTION

QR Codes are the barcodes which enhance the features and use of 1-d barcode. These codes are now becoming popular because of its good features. QR codes were invented by the Denso Wave Toyota Motors subsidiary (Japan) in 1994 [3].These codes are readable by moderately equipped mobile phones with cameras and QR code scanners. They contain information such as text, URL links, automatic SMS messages, geo-location ,phone number or business-card or any other information that can be embedded in a two-dimensional barcode .QR Codes connect the users to get information quickly [4]. It looks like a small square box with a random series of black and white pixels.

The main features of QR codes are high data density, robustness, readable from 360 degrees at high speed and the ability to encode Alphanumeric, Numeric, Kana and Kanji codes. As compared to a 1D Barcode, a QR Code holds a greater volume of information: 7,089 characters for numeric only and 4,296 characters for alphanumeric data.

Error Correction: They have error correction capabilities which helps in restoring data from distorted or damaged parts of the code [6].It has four levels of error correction level i.e. L, M, Q and H (user has to choose it at the creation time). The highest level corrects up to 30% of error i.e. data from 30% damaged code is restored easily but as the error correction level increase while generating QR code the data storing capacity of code decreases.

Version: The QR Codes have 40 different versions which define the size of QR Code. Versions range from 1 to 40. Version 1 is 21*21 modules and version 40 is 177*177 modules (4 modules increase whenever 1 version increases).

Structure of QR Code: The structure of QR Code [7] consists of different parts such as position patterns, separators, timing patterns, etc which make it different from other 2-D barcodes. These parts are briefed here.

a) Position patterns: QR Code consists of 3 squares present at three corner of the symbol. These squares detect the position and size of the code. It tells about the code that it is QR code or not.

b) Separators: These are white pixels of width one around the position patterns to help them distinguish from data part.

c) Timing patterns: It consists of white and black modules placed alternatively between two position patterns. It helps in determining the central coordinate of each cell in the code. It tracks the time of incoming code.

d) Alignment pattern: This pattern is used to correct distortion occurred during capturing the code.

e) Data: It is the area of QR Code where data is stored after encoding. It also includes Reed-Solomon codes to provide error correction functionalities.

f) Quiet zone: It is the margin space around the code to detect it properly. At least 4 bits are needed for quiet zone.

g) Version Information: These bits tell the version of QR Code out of 40 versions.

h) Format Information: It consists of 15 bits next to the separators and stores information regarding the error correction level and selected mask pattern of code. This section consists of 15 bits and contains the error correction rate and the selected mask pattern of the QR code. When QR code is decoded, it is read first.

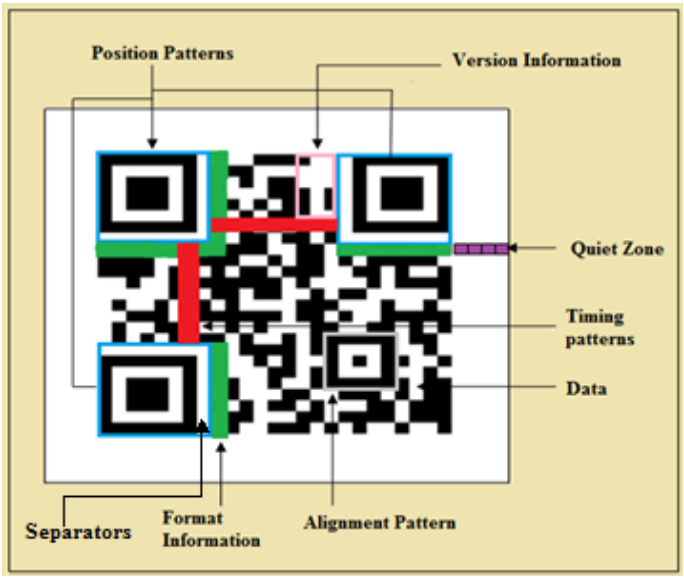

Fig1. Structure of QR code

Application: QR Codes are now used worldwide in different aspect of life .These codes are used in university libraries for book review, in Online banking system in which OTP(One Time Password) is sent encoded in QR code during online transactions ,in Education for conducting examination ,making timetables ,assigning homework, in Business visiting card with Google Maps location encoded in QR code ,in Marketing and Advertising ,in Job search where resume and other details are linked using QR codes.

II. TYPES OF QR CODES

After the introduction of QR Codes studies have been made to make QR Codes better, hence we come across with different types of QR Codes namely Regular QR Code (model 1 and model 2), Micro QR Codes, iQR codes, SQRC codes and Frame QR Codes. These QR Codes have been developed with different features which are discussed below [17].

a) QR Code Model 1 and Model 2

Model 1: It is original QR code and a prototype model to other QR Code types. It has Versions ranges from 1 (21*21modules) to 14 (73*73 modules) and has maximum capacity of 1,167 numerals.

Model 2: It is improvement over model-1 i.e. smooth and efficient reading. It has alignment pattern for position detection (which is not present in model 1).This model has maximum version: 40 (177*177 modules) and maximum capacity of 7,089 numerals. Today's QR Code refers to this model.

It is developed in the year 1994. In year 1997 QR Code is registered to AIMI standard and in 2000 as ISO/IEC 180004 standard.
This type of QR Code is generally considered as typical/regular QR Code. Some of its characteristics are like it requires 4-module wide margin at least around the symbol, it has position detecting patterns at 3 corners of the symbol, it can restore up to 30% of damaged symbol (Level H), etc.

b) Micro QR codes

The Micro QR Code is different from traditional QR Code in many ways. It requires only one position detecting pattern and hence it takes less space for printing. It requires 2-module wide margin along the code (which is 4- module in case of regular one).here encoding of data is also easier. It has four type of version which ranges from M1 (11*11 modules) to M4 (17*17 modules). It has maximum capacity of 35 characters for numeric data, 21 characters for alphanumeric data, 15 characters for byte data and 9 characters for kanji data.
It is developed in 1998.It is standardized as JIS-X-0510 in 2004 and it also get ISO standard as ISO/IEC 10084.

c) IQR Codes

IQR codes can be generated either in square or rectangular modules. It can be printed in different forms like rectangular code, turn-over code, black-and-white inversion code or dot pattern code. Its versions ranges from 1 (9*9 modules) to 61 (422*422 modules.) and have maximum capacity of **40,000** numerals. But point which is to be noted is square IQR codes have 61 versions and rectangular codes

have only 15 versions. The minimum size of squares iQR codes is 9x9 modules and rectangles ones have 19x5 modules.
It is not yet given an ISO specification. Only proprietary Denso Wave products can create or read IQR codes.
IQR codes have wide range of codes in such a way that smaller ones are smaller than traditional QR Codes and micro QR codes and larger ones store more data than them i.e. when you want to store data of same size then regular one stores 34 numerals and it stores 63 numerals near about 80% increase in data capacity and you store same amount of data then IQR code has 30% less size than regular one.
It requires 2-module wide margin around the code like micro QR code. One of the important enhancement in it is that it can restore data from 50% damaged code (which only 30% in traditional one) with an additional error correction level namely Level 'S'. It is easily applicable on cylindrical products and within the same space as of 1-D barcode.

d) **SQRC**

SQRC

SQRC means Secure QR Codes. So it is the QR code with security function. It has a reading restriction function. It has data divided into two types: public data and private data. The public data can be read through any reader such as a smart phone much like a normal QR code. The private data is encoded with a password which unlocks the information. A proprietary scanner is needed to scan the password and reveal the encrypted data.
It also is not yet ISO standardized. These codes are registered trademarks of DENSO WAVE INCORPORATED in Japan and in other countries.

It appears same as regular QR code. It retains the appearance and properties of regular one. These codes are applicable in health care, identity confirmation, security, access control, finance, shipping, promotion and many other disciplines where security considerations are critically important.

e) Frame QR Codes

Frame QR Code

Frame QR code has canvas area in the center of the code to accommodate design and information, where illustration or picture is arranged without damaging its design. The canvas area doesn't interfere with code reading. The Code can be read easily without any interference from the illustrations, photos, etc. in the canvas area. The frame for canvas area is available in many shapes and sizes.
It is not yet ISO standardized but these codes are registered trademarks of Denso Wave Company of Japan.
It is virtually impossible to counterfeit the frame QR codes. The data density of these codes is substantially greater than traditional QR codes. It is efficiently readable with the "Q" Reader.
These codes are used as advertisement and posters, authenticity judgment, business card, entertainment etc.

III. QR CODE IMAGE PRE-PROCESSING METHOD

A QR code is a matrix barcode readable by mobile phones and smart phones with cameras. The QR code images can be scanned in different conditions by mobile devices and to get all information that is stored in the image it has to be scanned correctly. [8]

By scanning of QR Code means the process in which the desired person try to get the information stored in the code. So in means to get access to the information desirer use the scanner app installed in his /her phone or use scanner device and scan the image of the code and as a result the app or scanner process the image and show the information (URL, text, geo-location etc.) on the display screen .This process done by scanner is called QR Code Recognition which consists of Image Pre-processing and QR Code Extraction.

Image pre-processing is an important step in the procedure of QR Code recognition. The results of image pre-processing have a vital impact on the QR Code recognition rate. [9] The general process of image pre-processing is shown in figure 2.

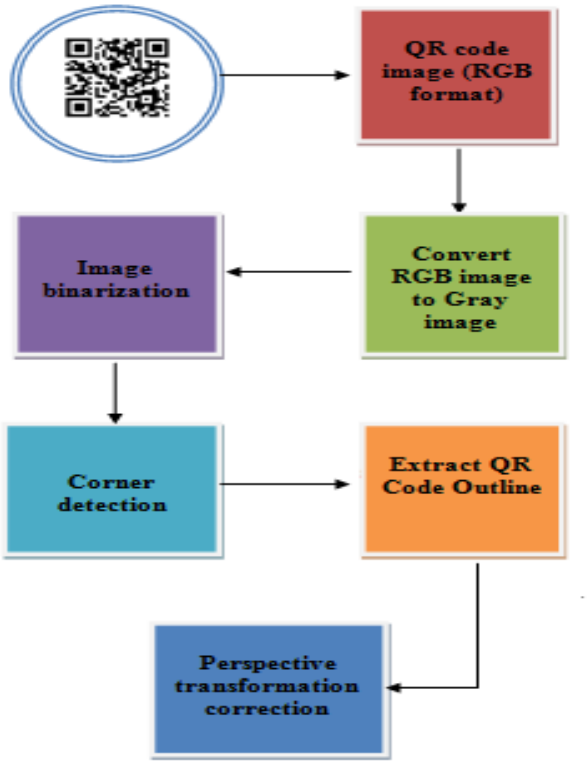

Fig 2. Image Pre-processing flow diagram

The image captured by the embedded system is in RGB format. However, during QR Code detection most of the information in RGB image is redundant, so it needs more storage space and is computationally costly when compared with gray-level image. Thus the first step of image processing is to convert RGB color image into gray-level image. [9] The gray scale image is then binarised. A good binarization method takes a very important role in the entire bar code identification system [10].In real life, due to uneven light in the collecting environment, the brightness is also uneven of the QR code images and it makes difficult to get a proper image of code. Therefore the images need binarization. After graying, binarizing the RGB image of the QR code, corner detection of the QR code image is done in order to extract the apexes and outline of the image. In real life during collecting process, the QR code cannot avoid skewness causing difficulties for later decoding. Therefore the distorted QR code must be corrected. First the four apexes of the QR code image must be obtained and then the skewness needs to be corrected hence the coordinates of four vertices of QR Code is calculated. And in the last perspective transformation is the collected QR code image will get perspective distortion. The distorted QR code image basically maintains the features of irregular quadrilaterals .With the help of quadrilaterals details geometrical distortion is corrected. [11]

IV. RELATED WORK

S.No.	Author	Technique/Method	Process
1.	Qichao Chen, Yaowei Du, Risan Lin, and Yumin Tian	Fast QR Code Image Process and Detection [9]	They focused on how to improve the recognition rate of the QR Code in embedded systems of typical CMOS camera, and gave an efficient pre-processing and detecting method for QR Code images which have complex background or uneven light and an algorithm on image binarization which is based on image blocks. They proposed perspective transform matrix which used finder patterns and alignment pattern of QR Codes for correcting QR Code images which have geometric distortion or rotation.
2.	Yunhua Gu and Weixiang Zhang	QR Code Recognition Based On Image Processing [10]	They proposed to solve the QR code recognition problem caused by ordinary camera collection. They put forward the recognition algorithm based on image processing. Based on other recognition algorithm, some improvements are presented in the image tilt correction and its orientation and normalization process and so on to speed up the image processing and to achieve more simply.

3.	Kong Suran	QR Code Image Correction based on Corner Detection and Convex Hull Algorithm [11]	His paper put forward the algorithm which combines corner detection with convex hull algorithm. Experimental verification made that the algorithm raised by the paper can correctly find the four apexes of QR code and achieved good geometric correction. It will also increase the recognition rate of seriously distorted QR code images.
4.	Jeng-An Lin and Chiou-Shann Fuh	2D Barcode Image Decoding [12]	They presented a method for 2D Barcode image decoding in Automatic Identification and Data Capture. In their paper, they revised the traditional decoding procedure by proposing well designed image preprocessing method. The decoding procedure consists of image binarization, QR code capturing, perspective transformation and resampling process, and error correction. By these steps, they tried to recognize different types of QR code images.
5.	Yue Liu, Ju Yang and Mingjun Liu	QR Code Recognition with Mobile Phones [13]	They proposed a novel implementation of real–time QR Code recognition using mobile, which is an efficient technology used for data transferring. An image processing system using mobile is described which is able to binarize, locate, segment, and decode the QR code. The experimental results show that these algorithms are robust to real world scene image.
6.	David Pintor Maestre	QRP: An improved secure authentication method using QR codes [14]	He presented the design and implementation of QRP, an open source, authentication system that has authentication using two factors - a password and a camera-equipped mobile phone which act as an authentication token. QRP is highly secure as all the sensitive information stored and transmitted is encrypted. It can be used securely in untrusted computers and is able to successfully authenticate even when the phone is offline.
7.	Bhupendra Moharil, Vijayendra Ghadge, Chaitanya Gokhale and Pranav Tambvekar	An Efficient Approach for Automatic Number Plate Recognition System Using Quick Response Codes [15]	They proposed an efficient approach for automatic number plate recognition system using quick response codes. Their contribution towards ANPR was the attaching the QR codes with the automobiles which fine-tune the detection technique. This approach provides quick response and overcomes the issues related to noise in image processing and simultaneously fine tunes the detection technique.
8.	Manoj S. Rewatkar and Shital A. Raut	Survey On Information Hiding Techniques Using Qr Barcode [16]	They presented the survey on information hiding techniques which shared security information over network using QR barcode. Information hiding methods which are being surveyed are information hiding method using QR barcode using Hash function, information hiding method using QR barcode using TTJSA symmetric key algorithm, information hiding method using QR barcode using SD-EQR and information hiding method using QR barcode using reversible data hiding.

V. DISCUSSION

This paper firstly gives the overview of QR code its features, error correction level, versions which show us how it is better than the traditionally used 1-D barcode. Then comparison is made between the different QR Codes which are now used in today's world. Secondly, it discusses QR code recognition method which is based on image pre-processing, which including image graying, image binarization, image correction, image orientation, image geometry

correction so that information hidden in QR Code can be accessed accurately. When shooting QR code images under natural conditions, the geometric distortion caused due to deviation of shooting angle has great impact on the recognition of QR codes. Therefore in order to get information from QR Code proper QR Code recognition algorithm should be used.

VI. CONCLUSION

As QR Code is a new leaf in the world of bar codes so it has so many aspects in which researchers can work like enhancing error correction

or increasing data capacity or providing good security or better and fast recognition. The method proposed here will be used to enhance the scanning process of QR Codes.

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