ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2016

2L Color QR code - A Novel Approach for Enhancing Capacity & Ensuring Authentication of QR code

Susan P Kurian , Vishnu S Sekhar

M.Tech Student, Dept. of CSE, Mahatma Gandhi University, Mangalam College of Engineering, Kottayam, India.

Assistant Professor, Dept. of CSE , Mahatma Gandhi University, Mangalam College of Engineering, Kottayam, India.

ABSTRACT: Two level color QR code is a novel approach for improving the storage capacity of the QR code and provide document authentication ensuring overall security. QR code which became popular during the recent years due to the wide proliferation of smartphones is an information matrix with large encoding capacity and ease of data recovery. Two level QR code with two storage levels, both private and public was designed for private message sharing and document authentication. The greatest challenge of 2LQR code is that each cell in a 2LQR code, could hold only 1 bit data which is comparatively smaller data storage. As a solution for this, is the two level color QR code, where each cell in a 2L color QR code holds 1 byte of data, which is 8 times more storage capacity than the existing system. This work introduces a new architecture for the QR code, where instead of position tags, random seed which stores random integers are employed, which guarantee that starting from the same seed always results in the same sequence of numbers while encoding and decoding. Use MD5 hashing for document authentication where the document is divided into parts and compute local hash for each part and compare it with QR code. Experimental results show that this technique offers significant enhancement of the data capacity more than 8 times as compared to a 2LQRcode of the equivalent size. Also the signal to noise ratio, which results a higher value, showing that in 2L color QR code, data cannot be easily recovered by an attacker ensuring security upto 20% than already existing.

KEYWORDS: QR code, Position tags, Seed, MD5 hashing, Signal to noise ratio.

I. INTRODUCTION

Quick response(QR) codes which are nowadays frequently used in our daily lives, is an information matrix with greater potential to carry information in a smaller space [2]. These codes cover numerous purposes including commercial tracking, product labeling/marketing, transport ticketing, redirection to websites etc. Significant difference of a QR code from barcode [11] is that, a QR code carry upto some hundred times the amount of information a conventional barcode is capable of and comparing the display of both, a conventional barcode can take upto ten times the total of printing space as a QR code carrying the same amount of information. While a barcode only holds information adequately in the horizontal direction, a QR can do so vertically as well and is capable of being read in 360 degrees, from any direction, thus eliminating any intervention and downbeat effects from backgrounds.

Two level QR code is a new richer QR code that can be used for document authentication and accelerates the storage capacity [1]. 2LQR code that has public and private storage levels, where the public level is same as the standard QR code storage level which is readable by any classical QR code application which holds strong characteristics of the QR code whereas the private level is made by replacing the black modules with textured patterns. It enriches the standard QR code encoding capacity by replacing its black modules by specific textured patterns that perk up the capacities and characteristics of the initial QR code.

This paper propose a novel approach, two level color QR code for compressing the data and enrich the encoding capacity for high speed reading applications securely. It introduces a new architecture for the color QR code where instead of position tag, a seed is used to store random integers. A random seed [20] is a number which is used to initialize a pseudorandom generator. Seed is a initiating point for the sequence which guarantees that starting from the same seed always results in the same sequence of numbers. When random integers are used, it ensures security to the document as it cannot be easily predicted.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2016

Data compression technique reduces the number of bits desirable to represent data ie, fewer bits than the original representation [3]. It saves storage capacity, pace file transfer and shrink costs for storage hardware and network bandwidth. Lossless compression with no information lost, reduces bits by identifying and eliminating statistical redundancy whereas lossy compression trims down bits by recognizing marginally important information and removing it.

Document authentication is another functionality of the two level QR code, that distinguish the original document from a copy [7][12][13]. The proposed two level color QR code also offers local document content authentication based on the recently proposed tamper proofing scenario [5]. The document is divided into parts and compute local hash for each part and stored in 2D bar codes using MD5 algorithm. This will be checked against the original QR code for verification.

II. RELATED WORK

In [1] authors proposed a two level QR code for private message sharing and authentication scenario using the private and public levels. Information is preset using q-ary code with an error correction capacity, where the private level is constructed by replacing black modules with specific textured patterns. Automatic identification and data capture techniques bar code symbology-QR code [2] proposed the certification of QR code performed by International Organization of Standardization (ISO), and its whole specification.

Nancy Victor [3] proposed a technique for data compression which enhances the data capability of QR codes by compressing the data previous to creation of QR codes. B. Sklar [4] proposed the Reed-Solomon error correction code used for data encryption where one of 4 error correction levels has to be elected during QR code generation.

R. Villán, S. Voloshynovskiy, O. Koval, F. Deguillaume, and T. Pun [5] proposed the combination of strong text hashing and text data hiding technologies as an effective solution to authentication and tamper-proofing of text documents. T. V. Bui, N. K. Vu, T. T. P. Nguyen, I. Echizen, and T. D. Nguyen [6] proposed a scheme based on reed-solomon codes and list decoding. Using bit technique, it hides secret information and prevents attacker changing any bit of hidden bits.

A.E. Dirik, B. Haas [7] discussed a copy detection pattern tool to detect copies from original documents and solely focus on counterfeit prevention. M. Querini, A. Grillo, A. Lentini and G.F. Italiano [8] proposed a high capacity colored two dimensional code(HCC2D) with an intention to increase barcode data density. It supports input data of different types and sizes and code dimension is slickly bespoke to the real input size. In [9] authors proposed technique for hiding information into images. Hidden images survive attacks such as Gaussian/median filtering, scaling/aspect ratio change, heavy JPEG compression etc.

III. PROPOSED SYSTEM

A. *2LQR code Generation:*

Two level QR code which has public and private storage levels enables both private message sharing and document authentication [1]. The public level is identical to the standard QR code storage level, read by any classical QR code application whereas the private level is made by replacing the black modules by specific textured patterns.

In 2LQR code black and white modules are represented using zeros and ones. Cell is divided into 24x24 pixel size. Check for zeros and whole of the zeros will be replaced with code. The textured pattern which replaces the black modules is based on the number of zeros available. For example, if there are 5 zeros then 5 squares corresponding to that will be drawn while encoding. During decoding the same 5 squares will be decoded as 5.

B. *2L Color QR code Generation:*

Two level color QR code is a novel approach for improving the storage capacity of the QR code and provide document authentication ensuring overall security. Introduces a new architecture for the QR code, where instead of position tags, random seed which stores random integers are employed, which guarantee that starting from the same seed always results in the same sequence of numbers while encoding and decoding**.** Two level color QR code, can be generated using the 2L Color QR code generation algorithm discussed further.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2016

The 2L Color QR Code Generation Algorithm:

In color 2LQR code instead of position tag, a seed is used to store random integers. A random seed is a number which is used to initialize a pseudorandom generator. Seed is a initiating point for the sequence which guarantees that starting from the same seed always results in the same sequence of numbers. When random integers are used, it ensures security to the document as it cannot be easily predicted.

QR code has a specific structure which usually consist of three position tags used for QR code detection and orientation correction. In 2L color QR code instead of position tags, a seed is used which stores random integers. Two among which are used to random integers and the other used for storing maximum number of bytes as shown in fig.1.

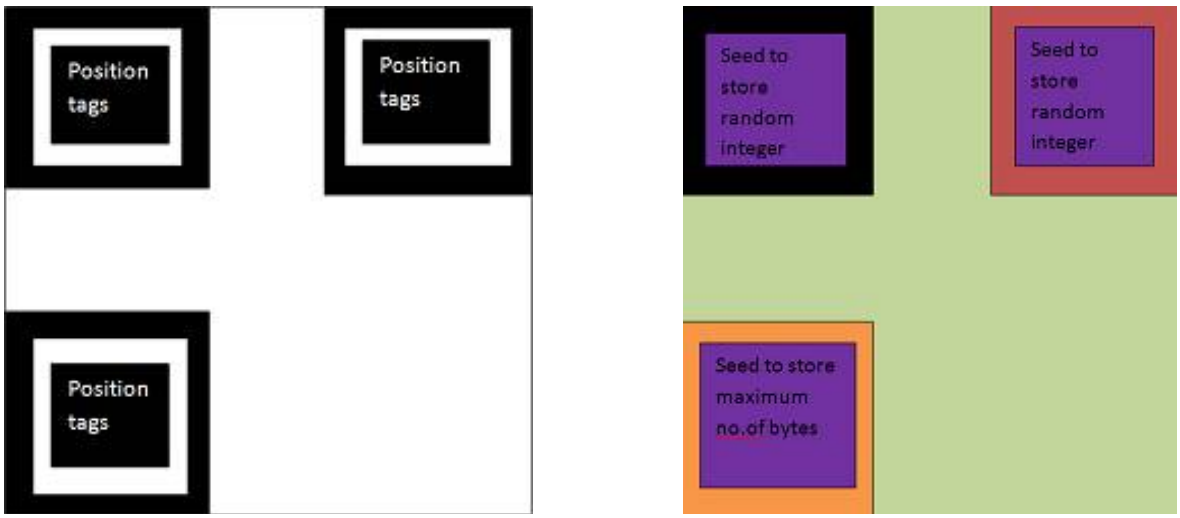

Fig.1. A comparison of specific structure of a) 2LQR code, with b) Proposed 2L color QR code

Seed of random is stored in position tags of cell. Maximum number of bytes which can be stored in a cell is 256 bytes. A seed can be more than 256 bytes, because of which it is divided into two v1 and v2. Seed 'V' divided into 2, v1 and v2 as shown in fig.2. V % 256 = v1; V / 256 = v2. Combining the two numbers (v1+v2) we get the resultant original seed V.

Fig.2. Seed division

Image size is calculated as the square root of total bytes of data to be stored. For example, if to store 10 bytes, then square root of ten, which would be approximately $\sqrt{10} = 3.16 \approx 4$. As a result width and height will be equal to 4 each. Each cell in a color 2LQR code holds 1 byte of data, whereas in the earlier method it could hold only 1 bit data which is comparatively smaller data storage. A seed is assumed to be 4 times than a normal cell. Therefore, 4 cells will not be used from top to bottom and from left to right. ie, width = 4 + 8 =12 and height =4 + 8 =12.

Therefore, total number of cells = 12 x12 = 144 cells. Among which 16 x 4 = 64 cells are unused to hold seed. Remaining cells will be arranged in its order. Following fig.3 shows the representation of QR code.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2016

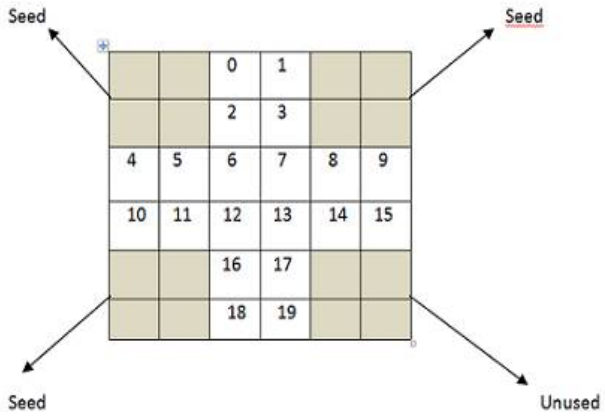

Fig.3 Structure of Proposed 2L color QR code

Data Encoding:

For 2L color QR code encoding, numerical encoding is employed. For each cell, its position could be identified because of this arrangement. In an image a single cell is equal to 16*16 pixels. For example, if 10 bytes to be stored, it should be encoded and stored somewhere within this 144 cells. A QR code uses four standardized encoding modes namely numeric, alphanumeric, byte/binary, and kanji to efficiently store data. For to store the same, in color 2LQR code we use only alpha numerals.

ie, (A– Z) = 26, (0– 9) =10 & space

Total = 26 + 10 + 1= 37

TABLE 1
Encoding Table

Alphanumerals	Values
Space	0 - 6
0	6 - 12
1	12 - 18
.	.....
9	60 - 66
a	66 - 72
b	72 - 78
.	.....

A color is a combination of red, green and blue(RGB). Therefore, the component value of space for red, green and blue will lie between 0 – 6 if drawn with any color. Table 1 shows component values of different alphanumerals.

In 2L color QR code each cell stores one byte of data. For each byte, it has its corresponding color code, using which its color QR code will be drawn. Random has been created from the seed. Using this random, randomly select 10 numbers, if in case 10 bytes are to be stored. For example, if "welcomeyou" is the data to be encoded and stored, then randomly select 10 cells: 3, 9, 10, 12, 7, 5, 4, 11, 6, 15. First data will be stored in the 3rd cell, second data in the 9th cell and so on until complete data is encoded. Here 'w' will be stored in the 3rd cell, which means a square will be drawn corresponding to the color code of 'w' and similarly for all the data its corresponding color QR codes will be drawn.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2016

Data Decoding:

In 2L color QR code decoding, first the random is read from which seed could be obtained. Using this seed again generate random. Maximum number of bytes could be got from a seed. We also know that 1 byte equals 16 pixels. Since we know the size(width & height) number of cells could be found out. ie, width/pixels = number of cells

Since we know that there is a color code encoding, it should be decoded the same way. Using the random seed, generate 10 random numbers. Since we use random seed for color QR code generation, same sequence of random numbers which was encoded will be obtained. When this data is decoded, its color code could be identified and its corresponding alphanumeral could be identified which will be the original data stored.

C. *Document Authentication:*

The major objective of data authentication in this aspect is to distinguish document from its copy. The MD5 algorithm, a widely used hash function creating a 128-bit hash value can be used for data authentication. It can be used as a checksum for data integrity verification.

Differentiating document authentication from document content(data) plays a major role in ensuring security. Document hash function could authenticate data. The recently proposed[5] tamper proofing scenario enables local document content authentication, where the document is divided into parts and computing local hash for each part and stored in QR codes. This will be checked against the original QR code for verification.

IV. SIMULATION RESULTS

The two level color QR code scheme, improves the storage capacity of the QR code and provide document authentication ensuring overall security. The major objective of data compression technique is that, it reduces the number of bits desirable to represent data and data authentication discriminate a document from its copy.

Table 2 shows data used for storage capacity analysis. It consists of 3 columns namely data size-which illustrate the size of data to be represented, file size1-showing the file size of the existing 2LQR code for storing that data size and finally file size2-the file size of the proposed 2L color QR code for storing the same data size. It clearly illustrates that the existing system requires more file size to store a data, while the proposed took hardly a few space to store the same.

TABLE 2
Storage capacity analysis

Data Size	File Size1	File Size2
15	23	2
80	29	3
178	31	5
249	38	6

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2016

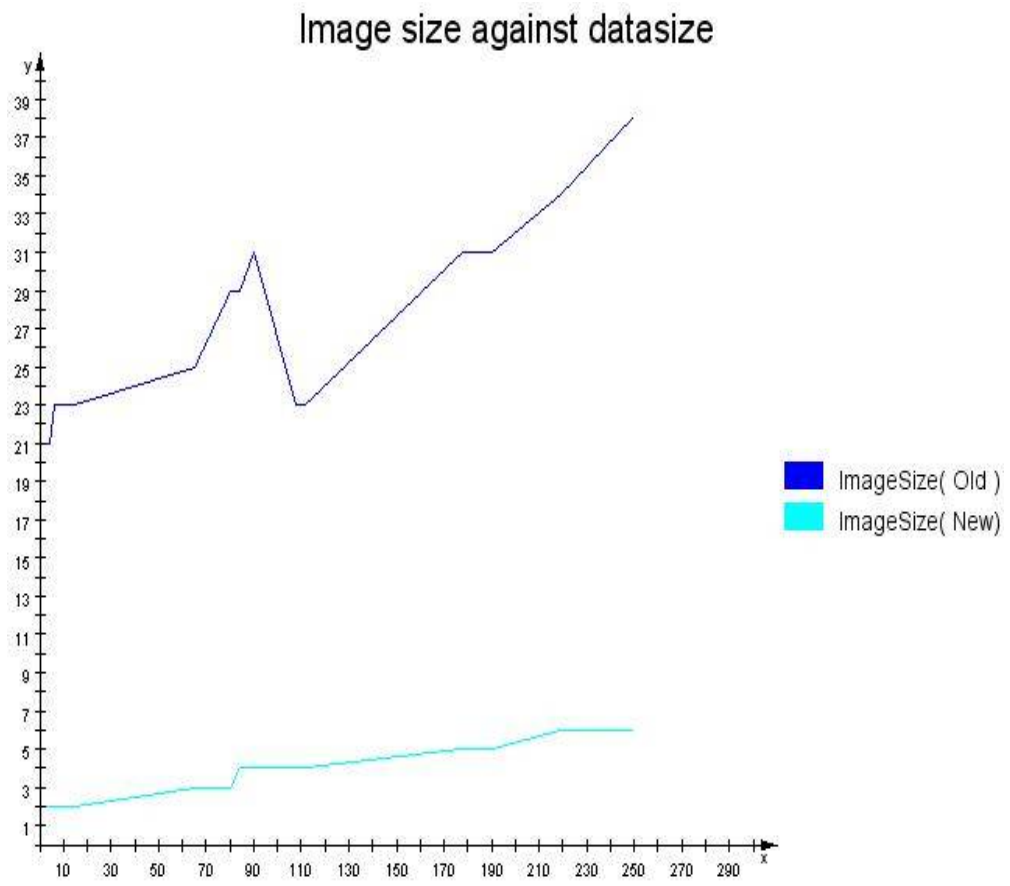

Fig. 4. Image size against data size

Fig 4 shows image size against data size. Image size expressed as pixels and data size expressed in kbs. 2LQR code represented [imagesize(old)] in graph requires more than 8 times storage as required by the proposed 2L color QR code represented [imagesize(new)] in graph. This shows a comprehensible result by attaining motive of such a work to enhance the storage capacity of QR code.

SNR-signal to noise ratio [19], a measure for comparing the level of a preferred signal to the level of background noise, expressed as signal power/noise power. Fig 5 shows the signal to noise ratio of the proposed system which results a higher value, showing that in 2L color QR code, data cannot be easily recovered by an attacker ensuring security upto 20% than already existing. Noise represented is the data size and signal represents the information.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2016

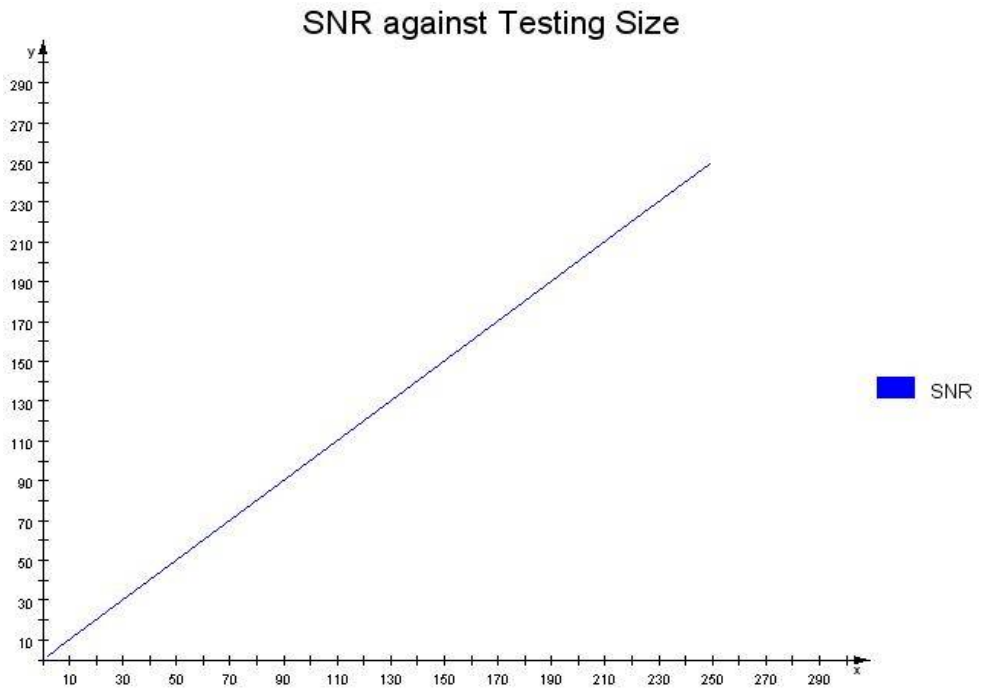

Fig 5. Signal to noise ratio

V. CONCLUSION

Nowadays QR codes have become ubiquitous in many applications and hence its of immense importance to deal with enhancing the storage capacity as well as ensuring security to the same This paper put forward a novel approach for improving the storage capacity of the QR code and ensures security. In the proposed system, each cell holds data of 1 byte, which is more than 8 times more storage capacity than the existing system. It brings a change in the specific structure of QR code by replacing the position tags with seed, storing random integers for enabling encoding and decoding processes easier. Document authentication could be ensured using MD5 hashing. Experimental results demonstrate that the proposed method perk up the QR code encoding capacity and when compared with already existing, the signal to noise ratio shows that the data cannot be easily recovered by any attacker.

REFERENCES

1. Iuliia Tkachenko,William Puech, Christophe Destruel, Olivier Strauss, Jaen-Marc Gaudin and Christian Guichard, "Two-level QR code for private message sharing and document authentication," in IEEE Transactions on Information forensics and security, VOL. 11, NO. 3, March 2016.
2. Information Technology, "Automatic identification and data capture techniques bar code symbology-QR code," ISO/IEC Standard 18004:2000,2000.
3. Nancy Victor "Enhancing the data capacity of QR codes by compressing the data before generation," in International Journal of Computer Applications,volume 60-No.2, December, 2012.
4. B. Sklar, *Digital Communications*, vol. 2. Englewood Cliffs, NJ, USA: Prentice-Hall, 2001.
5. R. Villán, S. Voloshynovskiy, O. Koval, F. Deguillaume, and T. Pun, "Tamper-proofing of electronic and printed text documents via robust and data-hiding," in *Proc. SPIE*, vol. 6505, p. 65051T, Feb. 2007.
6. T. V. Bui, N. K. Vu, T. T. P. Nguyen, I. Echizen, and T. D. Nguyen, "Robust message hiding for QR code," in *Proc. IEEE 10th Int. Conf. Intell. Inf. Hiding Multimedia Signal Process. (IIH-MSP)*, Aug. 2014, pp. 520–523.
7. A.E. Dirik, B. Haas, "Copy detection pattern-based document protection for variable media," IET Image Processing, Vol. 6, Iss. 8, pp. 1102–1113 May 2011.
8. M. Querini, A. Grillo, A. Lentini, and G. F. Italiano, "2D color barcodes for mobile phones," *Int. J. Comput. Sci. Appl.*, vol. 8, no. 1, pp. 136–155, 2011.
9. K. Solanki, U. Madhow, B. S. Manjunath, S. Chandrasekaran, and I. El-Khalil, "'Print and scan' resilient data hiding in images," *IEEE Trans. Inf. Forensics Security*, vol. 1, no. 4, pp. 464–478,Dec. 2006.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2016

10. L. Yu, X. Niu, and S. Sun, "Print-and-scan model and the watermarking countermeasure," *Image Vis. Comput.*, vol. 23, no. 9, pp. 807–814, 2005.
11. *Information Technology—Automatic Identification and Data Capture Techniques—EAN/UPC Bar Code Symbology Specification*, ISO/IEC Standard 15420:2009, 2009.
12. C. Baras and F. Cayre, "2D bar-codes for authentication: A security approach," in *Proc. 20th Eur. Signal Process. Conf. (EUSIPCO)*, Aug. 2012, pp. 1760–1766.
13. A. T. P. Ho, B. A. M. Hoang, W. Sawaya, and P. Bas, "Document authentication using graphical codes: Reliable performance analysis and channel optimization," *EURASIP J. Inf. Secur.*, vol. 2014, no. 1, p. 9, 2014.
14. C.-Y. Lin and S.-F. Chang, "Distortion modeling and invariant extraction for digital image print-and-scan process," in *Proc. Int. Symp. Multimedia Inf. Process.*, 1999, pp. 1–10.
15. Saran R, Sujithra E, P. Yashwant, R. Vignesh, "Image Piracy Alert System in Social Networks Using Watermarking," in International journal for research in applied science & Engineering technology, Vol.3, Issue.5, May 2015.
16. M. Sun, J. Si, and S. Zhang, "Research on embedding and extracting methods for digital watermarks applied to QR code images," *New Zealand J. Agricult. Res.*, vol. 50, no. 5, pp. 861–867, 2007.
17. R. Villán, S. Voloshynovskiy, O. Koval, and T. Pun, "Multilevel 2-D bar codes: Toward high-capacity storage modules for multimedia security and management," *IEEE Trans. Inf. Forensics Security*, vol. 1, no. 4, pp. 405–420, Dec. 2006.
18. I. Tkachenko, W. Puech, O. Strauss, J.-M. Gaudin, C. Destruel, and C. Guichard, "Fighting against forged documents by using textured image," in *Proc. 22th Eur. Signal Process. Conf. (EUSIPCO)*, Sep. 2014, pp. 790–794.
19. https://en.wikipedia.org/wiki/snr.
20. https://en.wikipedia.org/wiki/seed.

BIOGRAPHY

Susan P Kurian, doing M.Tech in Computer science And Engineering at Mangalam College of Engineering, Mahatma Gandhi university. She receives B.Tech degree in 2013 at Mangalam College of Engineering and Technology, under Mahatma Gandhi university. Areas of interest are security, data mining and image processing.

Vishnu S Sekhar, Assistant professor in Mangalam college of engineering, under Mahatma Gandhi university. He receives B.Tech from Mangalam College of Engineering under Mahatma Gandhi university in 2012 and M.Tech from Mahatma Gandhi university as well.