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A Sustainable Medical Image Authentication Technique in Spatial Domain Using Multiple QR Code

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ABSTRACT
Nowadays there is a need to protect our health related information for authentication and privacy purpose. In the proposed work multiple QR codes are watermarked inside a single color medical image using Variable Bit Replacement (VBR) technique. Three different 128 bit session keys are used to watermark QR Codes in three different color components (R, G and B) of a single color medical image. The QR Code is embedded in between moderately significant bit (MdSB) and least significant bit (LSB). The watermarked extraction process determines an invisible watermark in the image by reversing the embedding process. Results show that the process is robust against different attacks and imperceptibility is quite good.
Keywords - QR Code, VBR, Session based, Multiple Keys, DCT, Image Watermark

I. INTRODUCTION

Health related information is always very sensitive and private to all of us. Maintaining the integrity and protecting such information is a challenging area in the field health related service. The rapid development in the field of information technology in recent years has made the situation worse as data can be tampered very easily, since most of our health related information are now stored in digital image format. Therefore, through some well defined method we need to authenticate those images and make sure the image belongs to the intended patient hence the image's integrity is maintained. Thus call for a good and strong authentication system. Security researchers in this field are looking for a better way to meet the stated challenge.

Digital watermark [1, 2, 3] is one of the appropriate solutions to meet those problems and challenges. In Digital watermark the main objective is to communicate securely so that the sensitive information is not exposed to the observer or viewer. The most two important issue related to digital watermark are:

*Imperceptibility***:** The visibility of the secret and sensitive information to the human eyes.

Capacity: Volume of secret and sensitive information that can be embedded inside the medical image.

I.1 Medical Imaging**:** In order to monitor, diagnose, or treat medical condition for human body we used medical imaging. Numerous diverse technologies are used in medical imaging to provide different information related to the area of the body being studied or treated. Thus one can easily measure the effectiveness of medical treatment, injury, disease etc through the use of medical imaging. Fig 1 illustrated the hepatic portal venous gas of a patient.

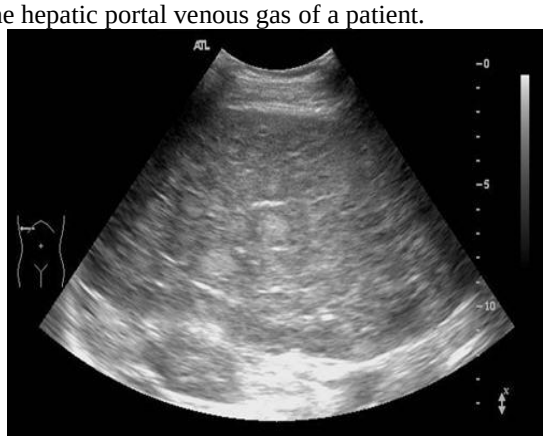


figure 1: A Hepatic portal venous gas of a patient. (800 X 600)

I.II QR Code: [4, 5, 6]. records information of an item in the form of a machine-readable label which is encoded and can be attached to that item. Message with in a QR Code can be known through standard QR Code reader or by using the smart phone. To store or encoded information within a QR code we can make use of four standardized modes of data such as alphanumeric, byte or binary, numeric and kanji.

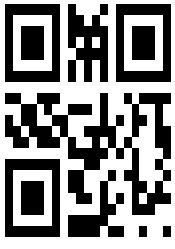


figure 2: QR Code

Advantage: The QR Code system has become popular due to its fast readability and greater storage capacity compared to standard UPC barcodes.

Limitation: If the size of the QR Code is about 100 characters or more, it seems likely that most smart phones or reader will have trouble while reading QR Code.

II. LITERATURE REVIEW

Spatial Domain Model**:** In spatial domain technique, the embedding of secret messages is done directly. Some of the popular spatial domain embedding methods is:

II.1 Least Significant Bit (LSB)

LSB [7] replacement scheme is the simplest method which is capable of communicating large payloads and imperceptible to human eye. Limitation of LSB is that it can be easily detected by the histogram analysis or if the watermarked image is distorted by means of noise

II.II Bit Plane Complexity Steganography (BPCS)

BPCS [8] was proposed by Rosanne English which is much more efficient than the LSB technique. In this scheme the image is initially decomposed into eight different layers. Based on complexity, every block is further subdivided into noisy, artificially informative or naturally informative layers. Embedding is done from the lowest layers towards the highest ones. The BPCS scheme can defy statistical attacks in a enhanced way.

II.III Variable bit replacement (VBR)

In the variable bit replacement technique [9] the information is embedded within the host image at variable positions. The information's are embedded between LSB and MdSB [10]. At the time of extraction of secret information is extracted by reversing the embedding process

III. THE PROPOSED SCHEME

In the proposed scheme we are going to hide multiple QR Codes in different color component of a medical image. The total process is divided into 4 major steps: QR Code generation from the patient information, Session key generation process, Secret QR Code embedding process and secret QR Code extraction process.

III.I QR Code Generation Process

Three QR Codes (200 X 200) are generated consist of patient personal and sensitive information. Fig. 3 illustrated the QR Code generation process from patient personal information

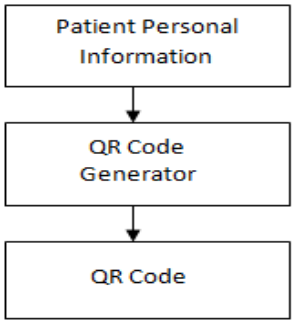


figure 3: QR Code generation Process.

III.II Session Key Generation Process:

Step I: A Session based password is taken from the user (say "SHore") for Red color component

Step II: 32 character key has been generated from the password using MD5 hash algorithm.("*Say* 2de46b5a62fad83f47d528e6f541d5f4")

Step III: 128 bit sequence has been generated from 32 characters key.

Step IV: Afterwards 64 digit (consisting of 0, 1,2and 3) key is generated from the 128 bit sequence by combining the adjacent value.

Step V: Steps I to IV are repeated for both Blue and Green component also.

Fig 4 illustrated the session based key generation process.

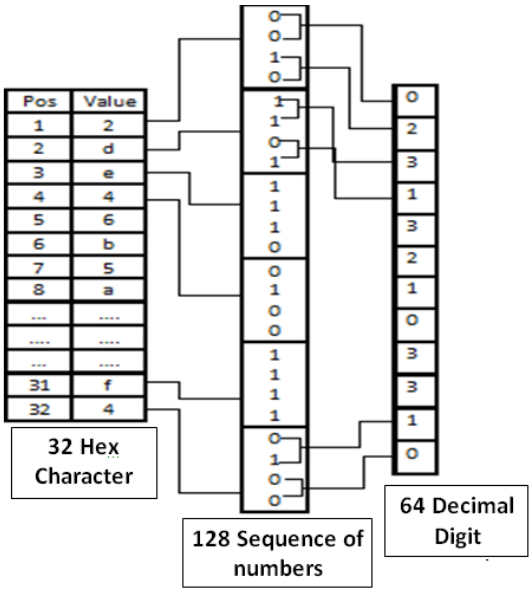


figure 4: Session Key Generation process

III.III Secret QR Code Embedding Process

The secret QR Code embedding process consists of following steps.

Step I: A color medical image (800 X 600) is taken.

Step II: Then the color medical image is sub divided into three color components, red, green and blue.

Step III. Three sessional passwords for three components (R, G and B) are taken from the user.

Step IV. QR Codes which are generated earlier in QR Code Generation process is now converted into binary numbers and finally reshape into 1D Vector.
Step V. Three 64 digit keys are generated from the passwords for three color components, as stated in the session key generation process. These Keys indicate the position of the color medical image where QR Codes are to be embedded. For a sequence of binary number ***00***, ***01***, ***10*** and ***11*** the decimal values are ***0 1, 2 and 3***. Here **0** indicates last bit, **1** indicates 2nd last bit, **2** indicates 3rd last bit and **3** indicates 4th last bit.
Step VI: QR Codes are then embedded within color components (R, G and B) of the medical image by the help of the 64 digit key in a cyclic manner.
Step VII: Each of the components are combined to form a final watermarked medical image

Fig 5 illustrated the watermarked medical image generation process.

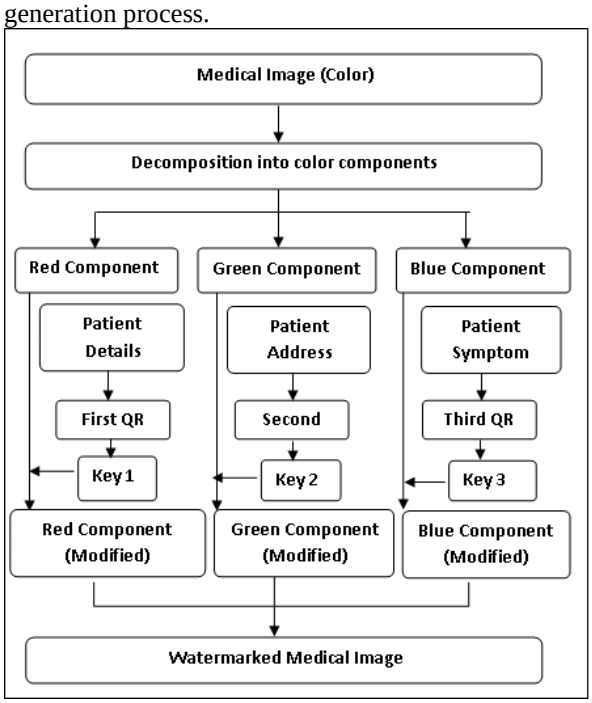


figure 5**:** Generation of watermarked medical image

III.IV Secret QR Code Extraction Process

The secret QR Code extraction process consists of following steps.

. Step I: The watermarked medical image (800 X 600) is taken.
Step II: Then the watermarked color medical image is sub divided into three color components, red, green and blue.
. Step III: Three session based passwords for three components (R, G and B) are taken from the receiver.
Step IV: QR Codes are extracted from watermarked image by reversing the embedding process
Step V: Personal information of patient is retrieved through QR Codes reader.

Fig 6 illustrated the QR Codes extraction process

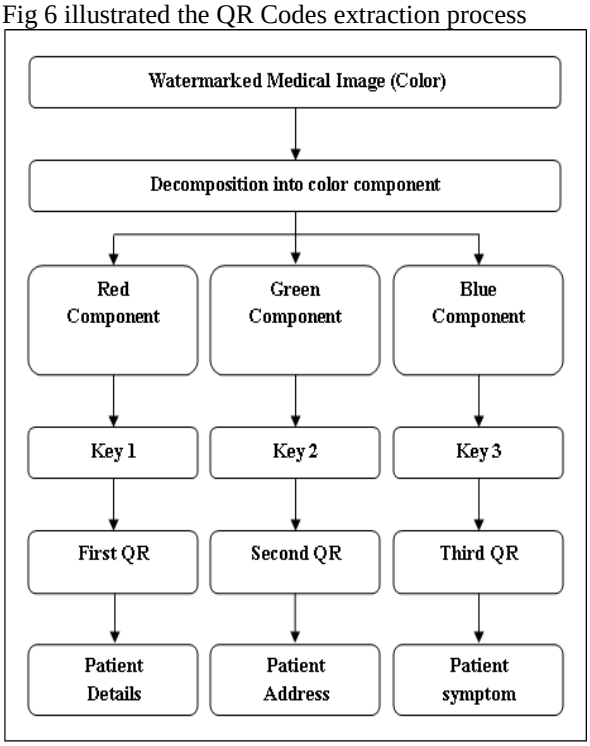


figure 6: Secret QR code extraction process

IV. RESULTS AND DISCUSSION

The proposed approach has been implemented in MATLAB 7.5.0. Fig 7&8 shows color medical image and corresponding watermarked medical image. TABLE 1 shows patient information(Patient Details, Patient Address, Patient Symptom),TABLE 2 depicts QR Code against respective patient information, TABLE 3 shows retrieved QR Code from watermarked medical image, TABLE 4 illustrated PSNR value for imperceptibility, TABLE 5 illustrated robustness against various attacks(Salt& Pepper, Cropping and Compression by converting watermarked medical image in '.PNG' and '.TIFF' format) QR Codes containing patient information are generated from http://www.the-qrcode-generator.com.

Medical image**:** **800** X 600 (color)
Patient Personal Information
QR Codes: Three Monochromes (each 200 X 200)

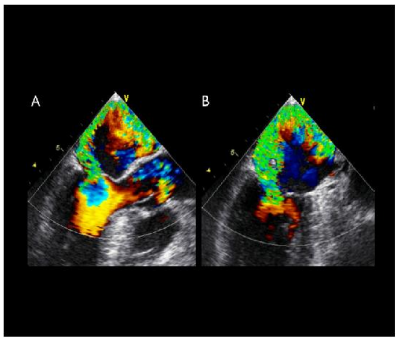


figure 7: Color Doppler Cardio Image(800 X 600)

Table 1: Patient Information

Patient Details	Patient Address	Patient Symptom
Sirshendu Hore Age:30 Sex:Male Blood Group: A+	Address: Hooghly, West Bengal, India	Symptoms: High BP Chest Pain

Table 2: QR Code of Patient information

First QR	Second QR	Third QR

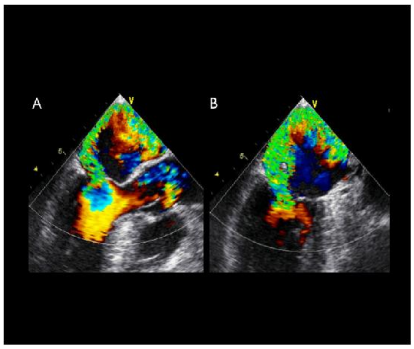


figure 8: Watermarked Medical Image(800 X 600)

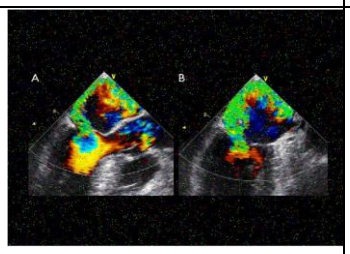
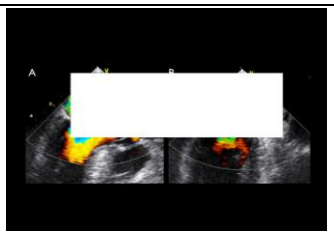
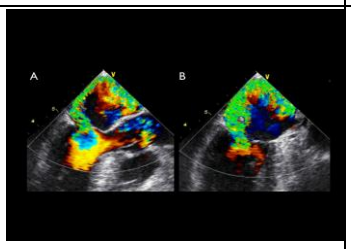
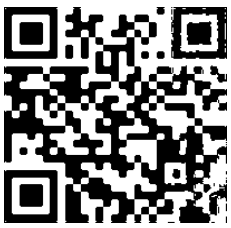
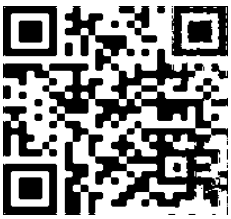
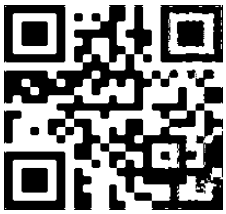
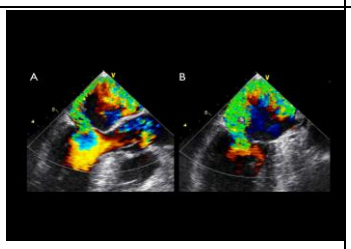
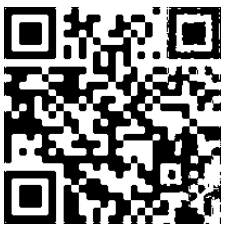
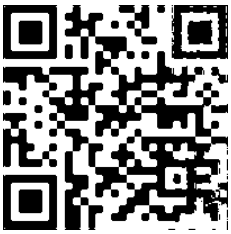
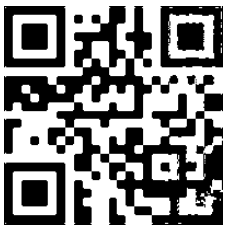
Table 3: Retrieved QR Code from watermarked medical image

Retrieved First QR	Retrieved Second QR	Retrieved Third QR

Table 4: PSNR value

Original image and Watermarked image	PSNR
	40.23

Table 5: Sustainability against various attacks

Attack	Attacked watermarked image	Recovered First QR	Recovered Second QR	Recovered Third QR
Noise (Salt & Pepper, 20%)				
Cropping (25%)				
Compression (Converted to .PNG format)				
Compression (Converted to .TIF format)				

V. CONCLUSION

The work successfully authenticate legitimate user by preserving the useful information within the QR Codes against different attacks. In this work a QR code is made of textual information and watermarked is performed in spatial domain. The work can be further extended by using an image instead of textual data which is larger than the specified percentage of error correction and watermark can be performed either in the spatial domain or in the frequency domain.

VI. ACKNOWLEDGEMENTS

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