

A Proposed Algorithm for Hiding a Text in an Image Using QR Code

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Abstract— In this paper, an algorithm to hide information in an image using QR code technology is presented. QR Code “QUICK RESPONSE CODE” is a two-dimensional array that can include different types of data and was first developed in 1993 for the Japanese Toyota Corporation for the purpose of tracking products through production and marketing. The researchers paid great attention to QR code technology especially in the field of information security. The proposed algorithm in this paper hides the secret text in the image in a random way by generating random positions and using the LSB “Least Significant Bit” method. After that, the random positions are saved in the QR code file, and this is the hiding stage. In the extraction stage, the QR code file is read first to extract the positions where the secret text has been hidden. After that, the secret text is read according to the LSB method. The algorithm was implemented using the C-Sharp programming language and Microsoft Visual Studio 2019 development environment. After conducting experiments on a number of images and extracting results based on the PSNR “Peak signal-to-noise ratio” test method, the results were good and the algorithm is very strong against a brute force attack. This algorithm can be used in building authentication systems.

Index Terms— Information Security, Text Hiding, QR Code, LSB Steganography, Random Position LSB.

I. INTRODUCTION

The great development in information technology, whether in storing it on storage media or sending it over networks, has become very necessary to secure this data from unauthorized access, especially sensitive data. Many algorithms have been developed in order to secure data, including encryption and data concealment [1]. All the types and classes of cryptosystems have a variety of factors that are contract among them like the real-time and computation complexity of the implementation. In recent year, hiding information is considered as a promising way for sending and receiving secret data [2]. Hide information includes a wide range of applications that are an integral part of messages to the media of confidential part for different purposes [3,4]. In data hiding technology, many algorithms have been developed to hide information in digital media such as image, sound, and video files and each of these algorithms has its advantages and disadvantages [5,6]. The issue of information security is extremely important, and it directly affects the lives of those dealing with electronic media, and is reflected in their interests and the means of carrying out their work. Therefore, research and development activity in the field of information security is growing increasingly [7,8].

This paper tried to use the QR Code technology in order to hide information in an image. QR Code technology has been used by many researchers in recent years, and each researcher has his own method. In the following paragraphs, will explain the proposed algorithm in detail using QR code technology. The paper is organized as follows: in section (II), related work a brief survey of some researchers' work in the field of hiding information in image using QR code, section (III) Definition of QR code technology, its advantages and capabilities, in section (IV) Brief explanation and definition of “Least Significant Bit” LSB method, section (V) A detailed explanation of the proposed algorithm with a

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general diagram and the steps of the algorithm with the flowchart of the process of hiding and extraction, section (VI) Explanation of the algorithm steps programmatically, section (VII) Conducting experiments and drawing the results and conclude the paper.

II. RELATED WORK

In (2017), Warang .A et al. present a method to hide information using DWT “Discrete Wavelet transform “ with additional layer of protection encryption using AES “Advanced Encryption standard”, the secret text is first encrypted using AES and then included with a QR code file, after that by using a cover image and applies Haar DWT transformations, where the QR code file is hidden within cover image.

The method was tested using (PSNR) and the researchers concluded that the index value is high when the QR code file is of a large capacity [9].

In (2017), Lin .P.Y et al. Proposed a way to hide the information using QR technology, and his method is summarized in two stages:

The concealment stage and the data extraction stage.

In the concealment stage, the QR tag file is processed depending on the error handling feature, and it should be noted that error detection and correction in the QR file depends on the QR version that is being worked on, as there are different levels for error detection and treatment, and each level has its own recovery capacity, noting that there are four Levels of error detection and handling are: L, M, Q, H and each one has different recovery capacity.

The proposed system embeds the secret text in the code words for detection and error correction while keeping the remaining unmodified area.

And the recipient can extract the secret text through the secret key [10].

In (2017), Kakade .R et al. Proposed a way to keep criminal data safe, and uses the QR code to save all criminal records.

Sensitive information is hidden in an image file that is first encrypted using the AES algorithm.

The original image is undergoes DWT (Discrete Wavelet Transformation) applied to it and the data is hidden in the HH band.

The researcher concludes that this system can be useful in preserving criminal information from unauthorized access as well as from tampering with it [11].

In (2018), Dsouza .D. J et al. Designed an algorithm to encrypt the secret text using AES “Advanced Encryption standard” and then hide the cipher text in the image using LSB “Least Significant Bit “, the encryption keys are included with the QR code file, the researchers suggest that this method can be used in the authentication process, text encryption and hiding in an image gives high security for this algorithm [12].

In (2018), Zhoua .Y et al. Present a method for conceal multiple images in a “Quick Response Code” QR Code file based on “Compressed Sensing” (CS) and “Orthogonal Modulation”.

The (CS) reduces the processed data to a smaller size and thus reduces the potential errors that may occur, and this leads to the extraction of data without problems.

The researcher used “Orthogonal” basis matrices to modify the sequence density detected by the CS system.

The advantages of this technique has been tested through experiment, whereby a video projector is used to integrate random measurement arrays into the system [13].

In (2018), Mendhe .A et al. Proposed a hybrid method of combining encryption and steganography and this is done at sequential levels and in each stage there is a level of security.

In the main level, the secret message is encrypted using the RSA system, and in second level the text that has been encrypted is included with the QR barcode file and the last level the QR barcode

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file is hidden within the cover image.

In this research, this relies on the combination of encryption and steganography to increase the level of security for important information [14].

In (2020), Iswaryah.G et al. Proposed an idea for sharing sensitive information through a QR code. It first encrypts sensitive information using the Advanced Encryption Standard (AES), then the encrypted file is hidden or encrypted again with a QR code, and then it is sent to the user who will scan and download the file. First, the user will test the “QR code” and encrypted file will be transferred which can be decrypted using the reverse operation of the advanced encryption standard algorithm.

The researcher concludes that this method can be used in ATMs, government sectors to transfer confidential data and those that are mainly focus on audit sectors, because in the audit the data is still stored in the hard disk. We can implement this in the cloud so that data audit files can be stored and transferred using cloud technology, which is reducing many things including resources [15].

In (2020), Mustafa .R .A et al. Presented a scheme for encoding iris image based on the QR code. The main idea of the researcher is behind the QR code through the entered text. After that, some characteristics are extracted from the QR code file using convolution. These characteristics are a will used to generate the encryption key. After encrypting the iris image using the encryption key, there is another stage of encoding to result image using a 2D logistic map.

Encryption keys tested by NIST and image efficiency test using (PSNR) and (UACI, NPCR) histogram [16].

In (2020), Alajmi .M et al. Proposed a data hiding scheme based on shading the enemies. By placing a text, and adding a payload.

To do this goal, they used QR codes. A QR codes file is created through the proposed system. The QR codes file carries the text. Anyone can read the message, but he cannot obtain the payload except through a key. There is no relationship between the text and the payload, as it can be used any text that misleading information to the adversary.

The researchers worked on testing the proposed method, and the results were acceptable. The QR codes files were created through the proposed system and they were acceptable for steganalysis attacks [17].

III. QR CODE

The QR code is a technology developed from the barcode. The barcode is a one-dimensional array that can include information in the form of numbers or Latin letters, but in a limited way. As for the QR code, it can include more information in terms of quantity as well as a variety of data types that can be saved. The QR code is in the form of a two-dimensional array and saves data from numbers, Latin letters, or other symbols [18]. QR Code technology was developed for the first time in 1994 and was initially used for marketing, advertising and documentation of industrial products, and because of its advantages, it was widely used for other purposes, including the field of information security [19]. QR code files can include an amount of information up to 7089 if it is only numbers, but if the type of information is letters, it can save 4296 characters [20].

IV. LEAST SIGNIFICANT BIT

Steganography is covering information with a cover. There is data and a cover that may be an image file, an audio file, a video file, etc., and a embedding algorithm to hide it [21]. One of these ways to hide is LSB The “Least Significant Bit” is a method using the least-valued bit in the binary system, where the last bit in the string of bits has the least effect on the value of the variable, so when replacing the value of this bit with

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another value, the effect on the pixel value in the image will be little or invisible. For example, the binary number (1000110), which is equivalent to the decimal number 70, the last bit with a value of 0 represents the LSB-bit. When you change the value of this bit to 1 and become (1000111), the value of the decimal number is 71. We note that the effect in terms of value is very slight [22].

V. PROPOSED ALGORITHM

The proposed algorithm, shown in Fig. 1, hides the secret bits in the image randomly. Each bit of the secret text is concealed in a pixel of the cover image which its location generated randomly. The generated random numbers which are representing the locations where the secret text bits are saved in a QR code file.

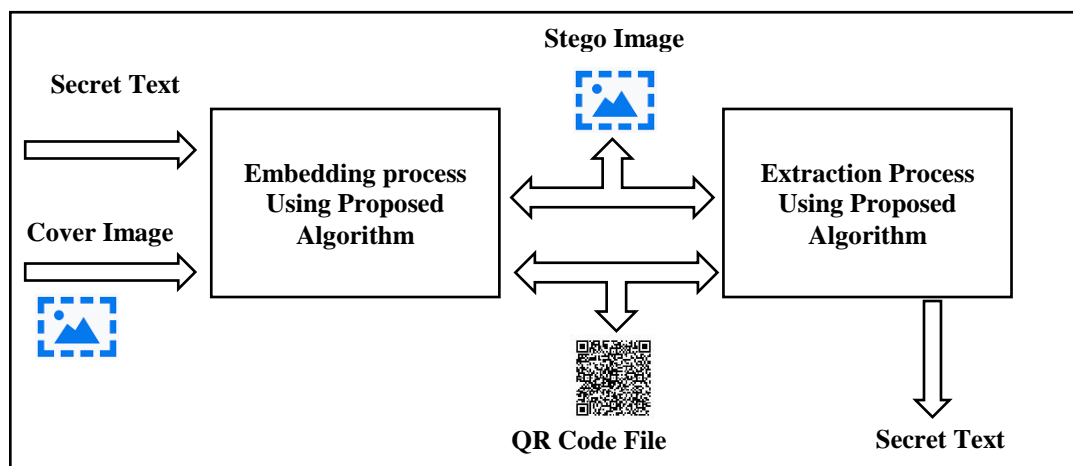


FIG. 1. GENERAL DIAGRAM FOR PROPOSED ALGORITHM.

The algorithm described as follow:

Algorithm1 RPLSB Embedding process:

Step1: input the cover image and the secret text.

Step2: convert the secret text to binary and put it in an array Bits[]

Step3: calculate the width (w) and height (h) of cover image.

Step4: calculate the total number of image pixels $Total=w*h$,

Step4: define array called Position[]=[]

Step5: Looping Through an array Bits[]

Step6: generate random number R between 1 and Total

Step7: check if R already exist in array Position [] if yes go to step6

Step8: use LSB method to hide the bit in the pixel with position R and save R in array positions

Step9: is the last element in array Bits[] if no go to step 6

Step10: create Qr code image with array position[]

Step11: save the stego image

End

Algorithm2 RPLSP Extraction process:

Step1: input the stego image and Qr code

Step2: scan Qr code and extract the content and save it in array called position[]

Step3: get the first element of position[]

Step4: go to the pixel of stego image which have the address equal the element of position[]

Step5: extract the LSB bit and save it in variable text

Step6: go to the next element of position[]

Step7: if element \neq null go to step 4

Step8: convert the bits in array position to letters to obtain the secret text

Step9: print the text

End

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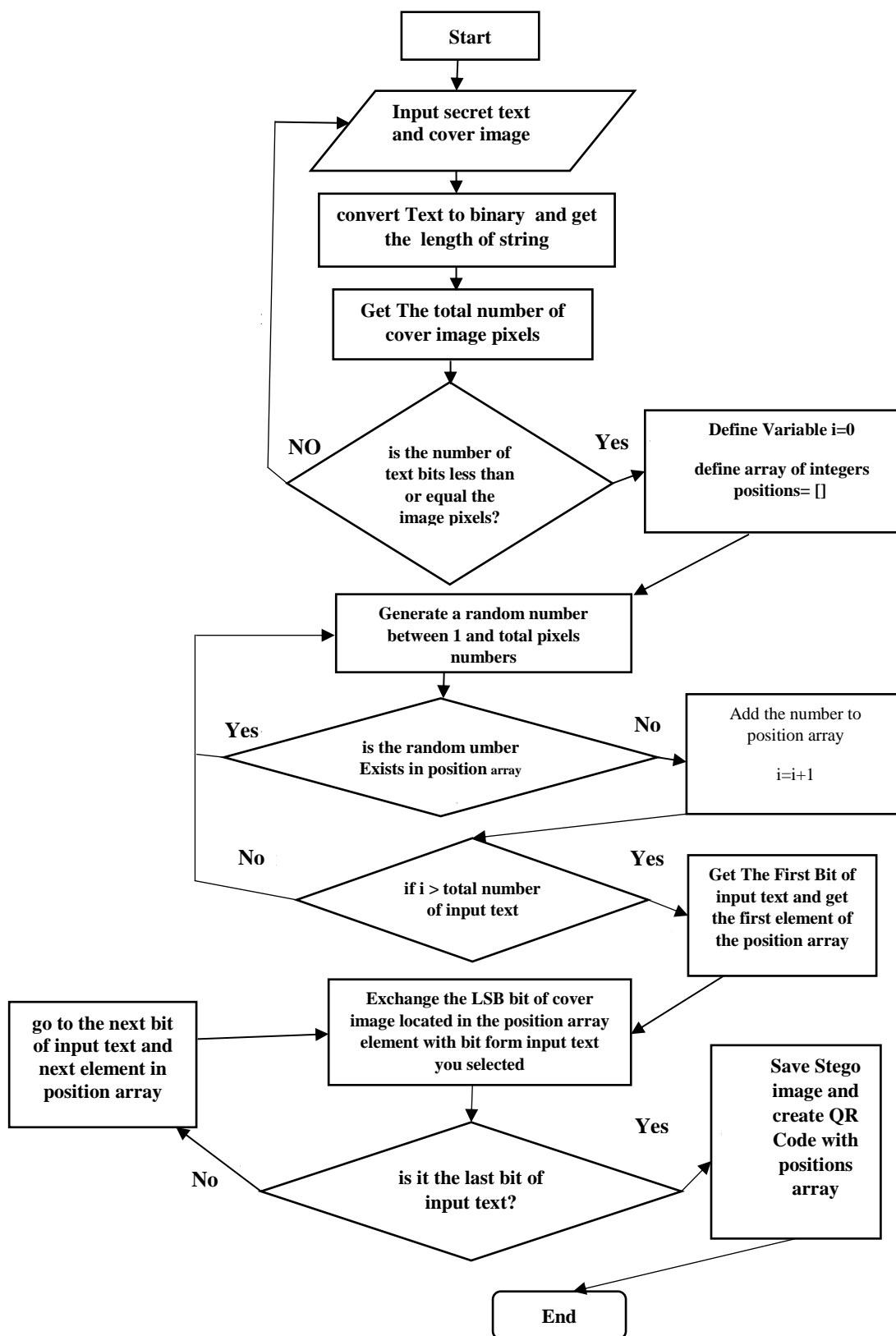


FIG. 2. EMMBEDDING PROCESS FOR PROPOSED ALGORITHM.

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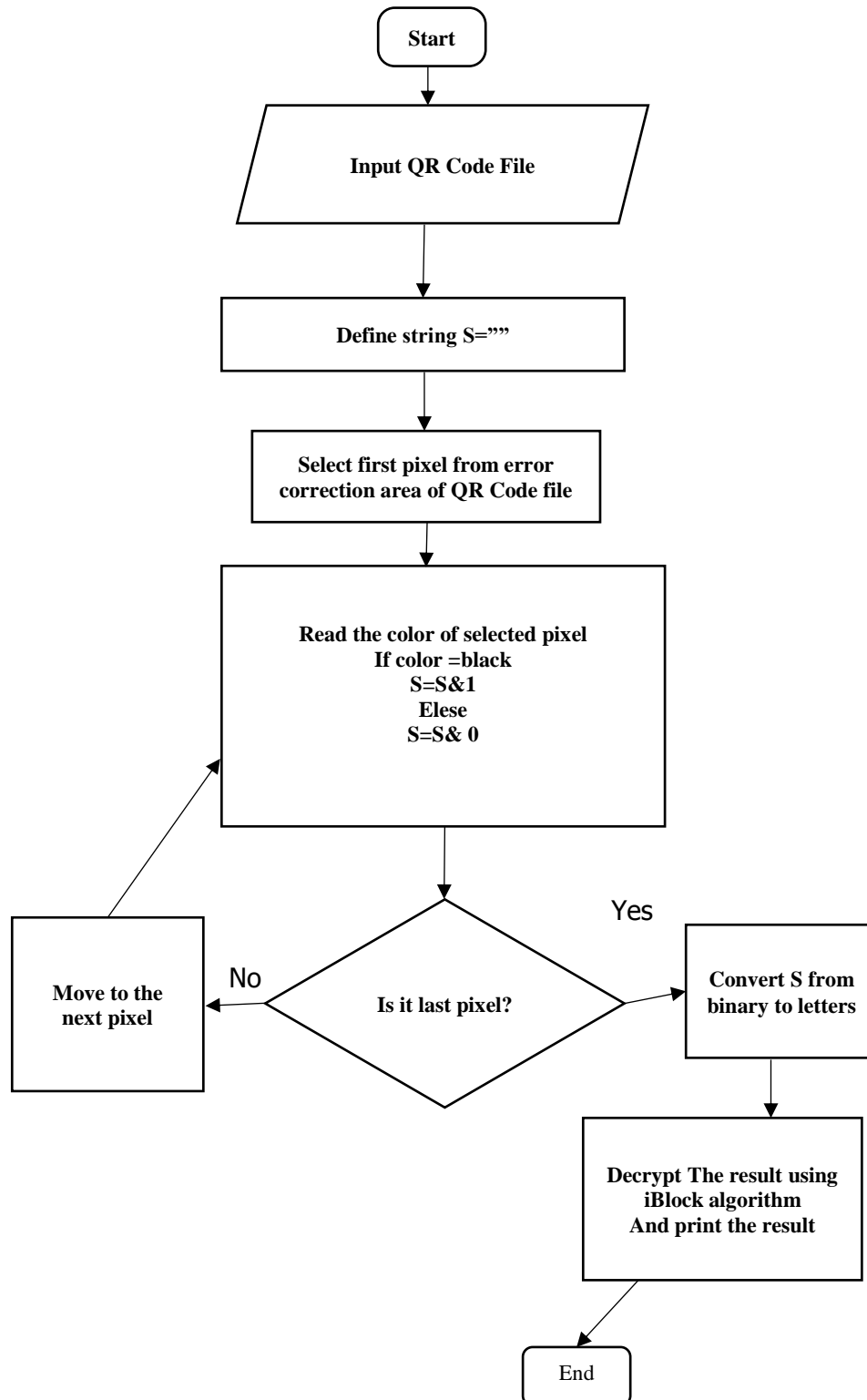


FIG. 3. EXTRACTION PROCESS FOR PROPOSED ALGORITHM.

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In Fig. 2, the embedding process begins with entering the secret text and selecting a cover image. It is checked if the number of bits of the secret text is greater than the number of pixels in the image, then another image is re-entered, then random locations are generated and saved in an array, and make sure there are no duplicate values. After that, the bits are read from the secret text and hidden in the image using LSB in the addresses which are generated and saved in the array. After that, the stego image is output and the array of random locations is saved in a QR code file.

In Fig. 3 the extraction process, the stego image and the QR code file are entered. The process of reading random locations from the QR code file begins, from which the pixels of the stego image will be read to extract the hidden bits, and the output is the secret text.

VI. IMPLEMENTATION

According to the steps of the proposed algorithm, a program was developed using C Sharp programming language with the development environment of Microsoft Visual Studio 2019 Fig. 4 and 5 illustrates both the hiding process and the extraction process.

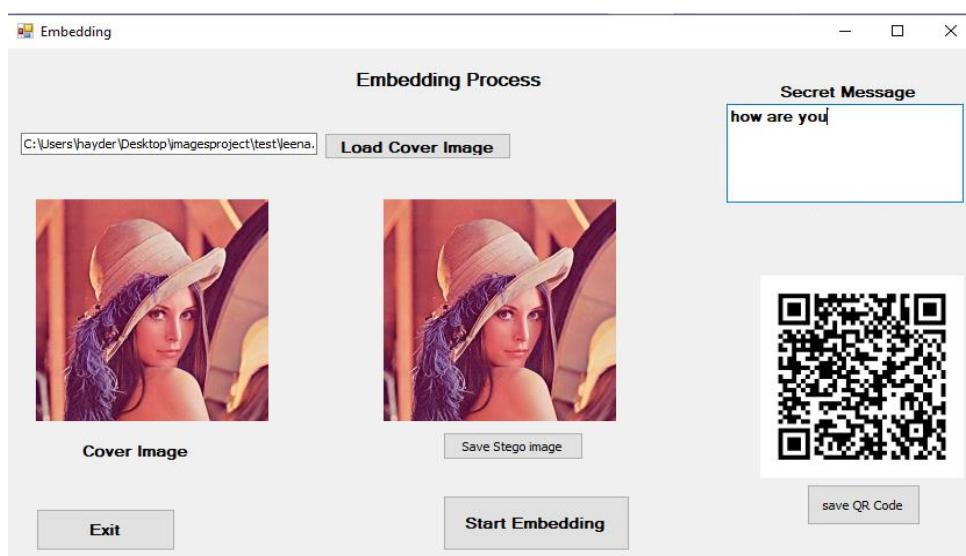


FIG. 4. EMBEDDING PROCESS WINDOW.

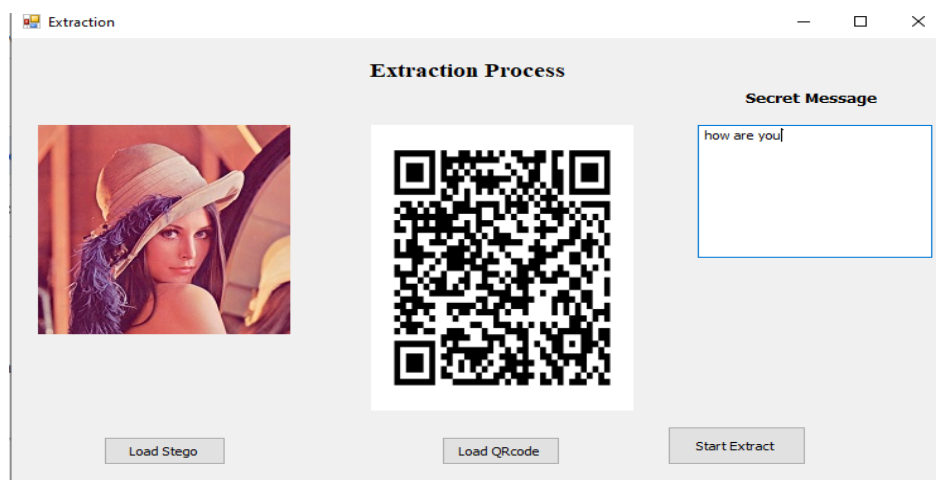


FIG. 5. EXTRACTION PROCESS WINDOW.






















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VII. EXPERIMENTAL RESULTS

In the experiments, a set of images were used as cover images, Table I shows the image files used in the experiments as a cover, and the resulting stego images, as well as QR code files and PSNR test result, the average of PSNR value tests is 53.7.

Distributing the secret text in random locations within the image gives a very high security, to restoring a hidden text without knowing the locations needs a number of attempts equal to 2^n , since n equal the number of pixels of the image, as example if the image dimensions 10x10 pixels the number of tries equal $2^{100} = 1,267,650,600,228,229,401,496,703,205,376$.

TABLE I. SET OF EXPERIMENTAL IMAGES WITH PSNR TESTS VALUE

| File Name | Cover image | Stego image | QR Code | PSNR |
|--------------|---|--|---|------|
| Leena.jpg |  |  |  | 48.7 |
| Elephant.jpg |  |  |  | 41.6 |
| fruit.jpg |  |  |  | 58.4 |
| lanscap.jpg |  |  |  | 44.1 |
| peaper.jpg |  |  |  | 57.5 |
| nature.jpg |  |  |  | 65.7 |
| city.jpg |  |  |  | 57.8 |

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VIII. CONCLUSIONS

The use of QR code technology helped in finding new ways in the process of hiding secret data from unauthorized people, and it also helped improve the work of some previously developed algorithms that had some disadvantages, so this research sheds light on this technique. It tries to find good and reliable hiding methods. The idea of the algorithm in hiding the secret text bits in randomly generated scattered locations and then saving these locations in a QR code file gives high information security as it is difficult to retrieve using a brute force attack and also reduces the effect that may occur to the image due to the spacing of bits that will be saved in the image. The algorithm described in this research can be used in authentication processes and it can also be employed in data recovery operations.

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