Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X
IMPACT FACTOR: 7.056

IJCSMC, Vol. 9, Issue. 6, June 2020, pg.106 – 113

A Survey of RGB Color Image Encryption Methods

Dr. Jihad Nader[1]; Dr. Mohammad S. Khrisat[2]; Prof. Ziad Alqadi[3]
Albalqa Applied University[1, 2, 3], Faculty of engineering technology, Jordan, Amman

Abstract: The digital RGB color image is one of the most important types of data circulated through the Internet and through various social media, it can contain secret and personal information, so protecting it is an important issue. In this paper research we will analyse some efficient methods used to encrypt-decrypt color images, these methods include XORING, blocking and reordering and selective random signal methods. For each method we will experimentally find the parameters MSE, PSNR , encryption time and throughput. A comparison of the methods results will be done in order to select the best method of color image encryption-decryption.
Keywords: RGB color image, Noise, YIQ image, MSE, PSNR, PK, encryption time, decryption time, encryption quality.

1- Introduction

The digital RGB color image is one of the most important types of data circulated through the Internet [1], [2], [3], [4] and through various social media. The importance of the digital image lays in the following things [5], [6], [7]:

- ✓ The large number of applications that use digital photos.
- ✓ The possibility of the image being very confidential.
- ✓ The possibility that the image be of a personal nature.
- ✓ The possibility that the image be a carrier of confidential data.

And for the reasons mentioned above [23[, [24], [25], the image and its intrusion process must be protected by unauthorized persons or entities, as well as the process of protecting the image from penetration by third parties, which leads us to the need to encode the image and destroy it so that it becomes distorted and incomprehensible to any one is trying to snoop on it [8], [9], [10].

RGB digitalcolor images[1], [2], [3], [4]are considered the most important types of digital data circulating in the Internet and through most of the available social media [5], [6], [7]. The importance of the digital image lies in the following reasons:

- Possibility of the digital image being confidential
- The possibility of the image to be of a personal nature
- The possibility of the image carrying very important data

RGB digital color images are usually represented by a three 2 dimensional matrices, the first matrix indicates red color; the second indicates green color, while the third matrix indicates blue color [11], [12], [13], and here we can deal with each color separately, or it can even be reconfigured into an array and as we see fit for the treatment process [14], [15]. Figure 1 shows an RGB color image with its colors histograms [16], [17].

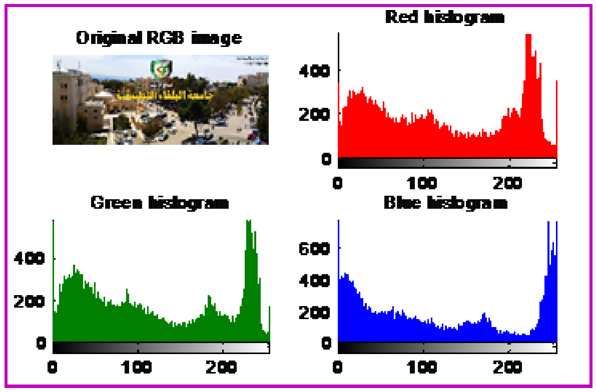

Figure 1: RGB color image and colors histogram

Many methods are used to encrypt the digital image [21], and the efficiency [28], [29] of the method used depends on a set of characteristics that must be provided by the specific encryption method, including [25], [26], [27]:

- maximizing the percentage of deformation or destruction of the original image so that it becomes incomprehensible to any third party, and this is achieved through[22], [30], [31], [32]:

1) Minimizing the value of Peak-to-Signal-Noise-Ratio (PSNR) between the original and the encrypted images [38], [39].
2) Maximizing Mean Square Error (MSE) between the original and the encrypted images [31], [32], [33], [35], [41], [34].

- Minimizing the encryption time and maximizing the encryption throughput (encrypted bytes per second) [30], [37], [39].
- Maximizing the security and protection level [36] by making the hacking process impossible [40].

2- Encryption Methods

Many methods were proposed to encrypt-decrypt color images [24], [27], [32], and here we will discuss and analyse 3 different efficient methods of data encryption-decryption.

1) Encryption-decryption based on XORING operation

This method of encryption can be implemented applying the following steps [28], [29], [31]:

- Initialization:
  In this step we have to generate a huge integer 3D matrix, which can cover any RGB color image, this matrix can be used later as a private key (PK), it must be saved and known only by the authorized persons.
- Encryption
  In this step we have to follow the following tasks:
  a) Get the original color image.
  b) Load PK.
  c) Adopt PK to suit the image size by extracting a 3D matrix from PK with size equal image size.
  d) Apply XORING between the image and the extracted key to get the encrypted image.

Figure 2 shows a sample RGB color image, while figure 3 shows the encrypted image using XORING method:

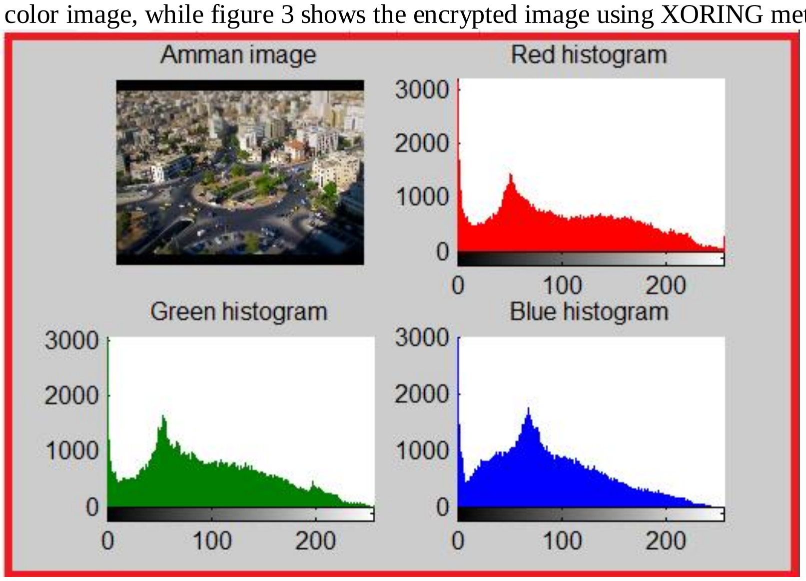

Figure 2: Original image used in XORING encryption

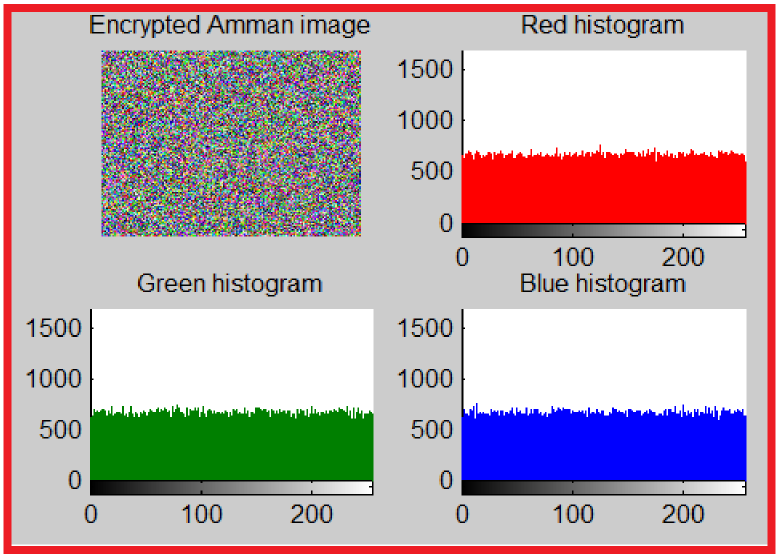

Figure 3: Encrypted image used in XORING encryption

In the decryption phase we have to follow the following tasks:

a) Get the encrypted color image.
b) Load PK.
c) Adopt PK to suit the image size by extracting a 3D matrix from PK with size equal image size.
d) Apply XORING between the encrypted image and the extracted key to get the decrypted original image.

2) Encryption-decryption using blocking and reordering

This method of encryption –decryption [42], [43] can be implemented applying the following steps:
For encryption we have to follow the following:

- Get the original image.
- Reshape the image into one row matrix.
- Select the number of blocks (nb)(this number will be a part of PK).
- Find the block size by taking the floor of dividing matrix size by nb.
- Calculate the nb+1 block size.
- Assign the reordering table (which is also a part of PK).
- Do the reordering process of the image matrix.
- Reshape back the row matrix to 3D matrix to get the encrypted image.

A sample image was divided into 8 blocks and reordered as shown in the reordering table 1:

Table 1: Reordering table example

Block number	Size(byte)	Order
1	18856	**4**
2	18856	**7**
3	18856	**9**
4	18856	**1**
5	18856	**3**
6	18856	**2**
7	18856	**5**
8	18856	**6**
9	1	**8**

Figure 4 shows a sample RGB color image, while figure 5 shows the encrypted image using blocking and reordering method:

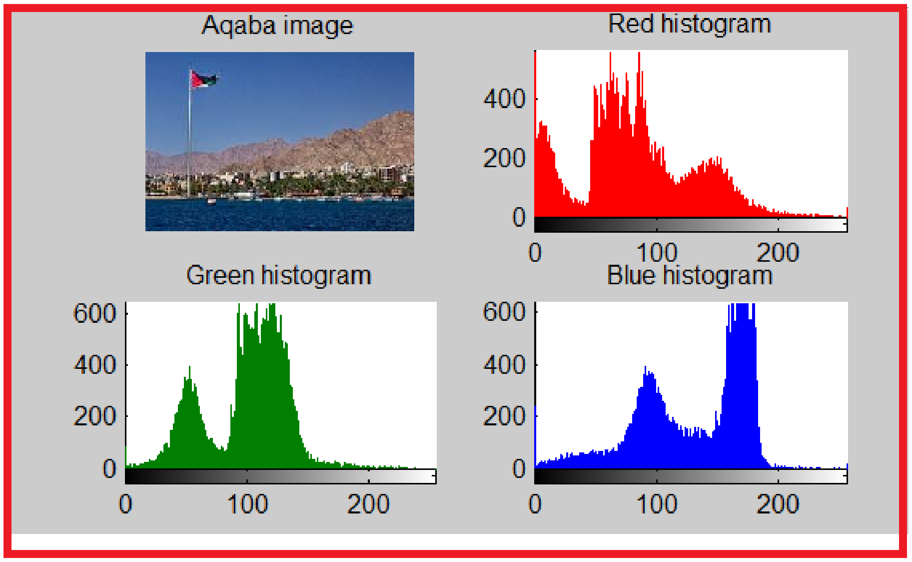

Figure 4: Sample RGB image for blocking and reordering method

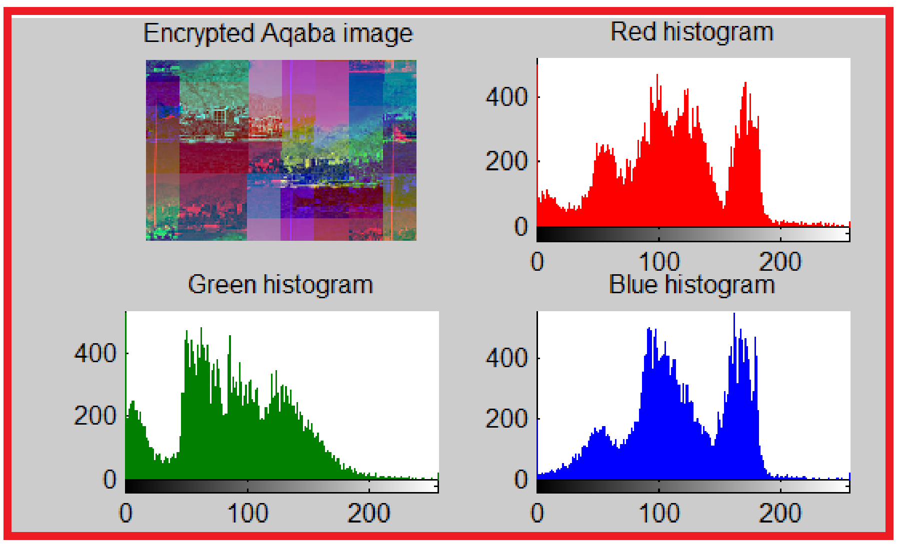

Figure 5: Encrypted image using blocking and reordering method

For decryption phase we have to follow the following steps:

- Get the encrypted image, and find the image size.
- Reshape the image into one row matrix.
- Get the private key, for the image used previously as a sample image the PK will be as shown in table 2:

Table 2: PK example

Order
4
7
9
1
3
2
5
6
8

From table 2 we can see that the blocking factor is 8, thus we can find the size of each block, and use the order value to reorder the image and reshape the matrix back to 3D matrix to get the decrypted original image.

3) Encryption-Decryption using Selective Random Noise Signal

This method was proposed in [44], [45], [46], [47], and the encryption process is to be done by adding a selective random noise (which is used as a PK) to the image, while the decryption process is to be done by subtracting the noise from the encrypted image.

Figure 6 shows a sample RGB color image, while figure 7 shows the encrypted image using this method:

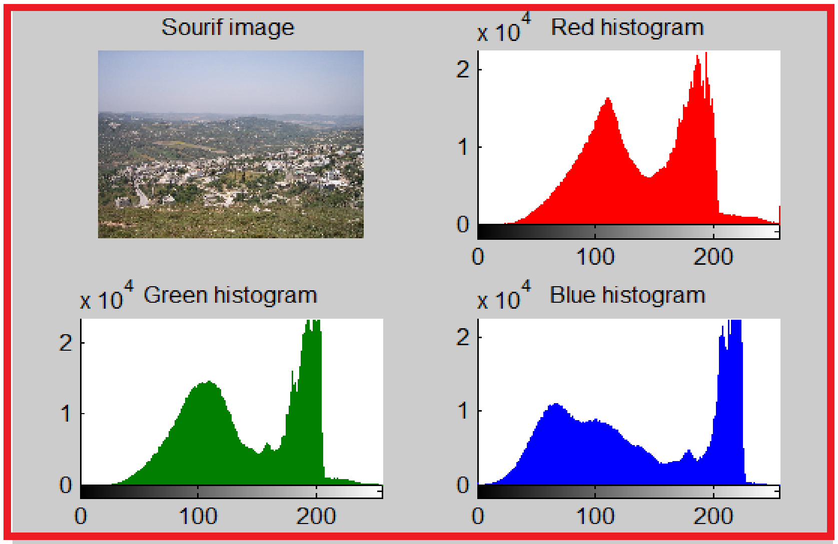

Figure 6: Sample RGB image for selective noise method

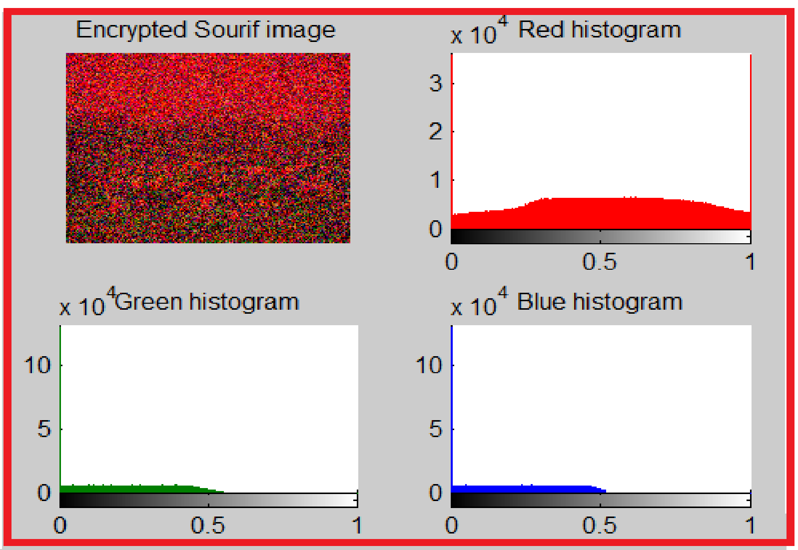

Figure 7: Encrypted image using selective noise method

3- Implementation and Experimental Results

Several images were selected and treated using XORING encryption method; table 3 shows the results of implementation

Table 3: XORING method results

Image number	Size(byte)	MSE	PSNR	ET(second)	Throughput(byte/second)
1	150849	12761	16.2836	0.001	150850000
2	518400	10990	17.7778	0.001	518400000
3	4326210	9553.8	19.1783	0.0070	618030000
4	122265	1209.0	16.8238	0.001	518400000

5	**518400**	**12090**	**16.8238**	**0.001**	**518400000**
6	**150975**	**11202**	**17.5870**	**0.001**	**150980000**
7	**150975**	**9454.2**	**19.2831**	**0.001**	**150980000**
8	**5035536**	**9454.2**	**19.2831**	**0.001**	**150980000**
9	**151875**	**8464.8**	**20.3885**	**0.0080**	**629440000**
10	**1890000**	**11479**	**17.3428**	**0.0030**	**630000000**
11	**6119256**	**7089.9**	**22.1611**	**0.0120**	**509940000**
12	**150876**	**10215**	**18.5092**	**0.001**	**150880000**
Average	**1607100**	**9496.9**	**18.4535**	**0.0032**	**391440000**

The same images were treated using blocking and reordering method, table 4 4 shows the obtained experimental results:

Table 4: Blocking and reordering method results

Image number	Size(byte)	MSE	PSNR	ET(second)	Throughput(byte/second)
1	**150849**	**12414**	**16.5595**	**0.001**	**150850000**
2	**518400**	**3737.7**	**28.5630**	**0.0020**	**259200000**
3	**4326210**	**8068.5**	**20.8681**	**0.0200**	**216310000**
4	**122265**	**4437.4**	**26.8469**	**0.001**	**122270000**
5	**518400**	**3176.4**	**30.1902**	**0.0020**	**259200000**
6	**150975**	**1118.9**	**17.5984**	**0.001**	**150980000**
7	**150975**	**6662.8**	**22.7823**	**0.001**	**150980000**
8	**5035536**	**1869.7**	**35.4898**	**0.0280**	**179840000**
9	**151875**	**7252.4**	**21.9345**	**0.001**	**151880000**
10	**1890000**	**11035**	**17.7372**	**0.0090**	**210000000**
11	**6119256**	**2744.6**	**31.6515**	**0.0310**	**197400000**
12	**150876**	**8674.7**	**20.1436**	**0.001**	**150880000**

The same images were treated using selective random noise method; table 5 shows the obtained experimental results:

Table 5: Selective random noise method results

Image number	Size(byte)	MSE	PSNR	ET(second)	Throughput(byte/second)
1	**150849**	**21601**	**11.0202**	**0.0340**	**4436700**
2	**518400**	**11294**	**17.5046**	**0.0380**	**13642000**
3	**4326210**	**20321**	**11.6313**	**0.2370**	**18254000**
4	**122265**	**13274**	**15.8900**	**0.0180**	**6792500**
5	**518400**	**11387**	**17.4230**	**0.0360**	**14400000**
6	**150975**	**21969**	**10.8514**	**0.0200**	**7548800**
7	**150975**	**15864**	**14.1072**	**0.0200**	**7548800**
8	**5035536**	**22379**	**10.6664**	**0.2280**	**22086000**
9	**151875**	**30322**	**7.6290**	**0.0200**	**7593800**
10	**1890000**	**24509**	**9.7572**	**0.0950**	**19895000**
11	**6119256**	**20034**	**11.7735**	**0.2730**	**22415000**
12	**150876**	**24330**	**9.8304**	**0.0200**	**7543800**
Average	**1607100**	**19774**	**12.3404**	**0.0866**	**12679700**

From the obtained experimental results shown in tables 3, 4 and 5 we can see the following:

- The three studied methods of encryption-decryption have a high quality by providing small values for PSNR (high MSE) after the encryption and infinite PSNR (zero MSE) after the decryption.
- All methods needed significant small time for encryption or decryption, thus the proposed methods have a significant high throughput.
- Selective random noise method provides the best results for PSNR and MSE (as shown in table 6).
- XORING method provides a best results for encryption-decryption times (see table 6).
- All the studied methods provide a high security level by using PK which is difficult to hack.

Table 6: Results summery

Method	MSE	PSNR	ET(second)	Throughput(byte/second)
Noise	19774	12.3404 (1)	0.0866 (3)	12679700
Reordering	5932.7	24.1971 (3)	0.0082 (2)	183320000
XORING	9496.9	18.4535 (2)	0.0032 (1)	391440000

Conclusion

A survey analysis of some color image encryption-decryption was made. The studied methods were effective and they gave good values for the parameters MSE, PSNR and throughput, it was shown that these methods are highly secure. The best method regarding the PSNR values was selective random noise method, but regarding the throughput the best method was XORING method.

References

[1]. Majed O Al-Dwairi, Ziad A Alqadi, Amjad A Abujazar, Rushdi Abu Zneit, Optimized true-color image processing, World Applied Sciences Journal, vol. 8, issue 10, pp. 1175-1182, 2010.

[2]. Jamil Al Azzeh, Hussein Alhatamleh, Ziad A Alqadi, Mohammad Khalil Abuzalata, Creating a Color Map to be used to Convert a Gray Image to Color Image, International Journal of Computer Applications, vol. 153, issue 2, pp. 31-34, 2016.

[3]. AlQaisi Aws, AlTarawneh Mokhled, A Alqadi Ziad, A Sharadqah Ahmad, Analysis of Color Image Features Extraction using Texture Methods, TELKOMNIKA, vol. 17, issue 3, 2018.

[4]. Mohammed Ashraf Al Zudool, Saleh Khawatreh, Ziad A. Alqadi, Efficient Methods used to Extract Color Image Features, IJCSMC, vol. 6, issue 12, pp. 7-14, 2017.

[5]. Akram A. Moustafa and Ziad A. Alqadi, Reconstructed Color Image Segmentation, Proceedings of the World Congress on Engineering and Computer Science, WCECS 2009, vol. II, 2009.

[6]. JAMIL AL-AZZEH, BILAL ZAHRAN, ZIAD ALQADI, BELAL AYYOUB AND MAZEN ABU-ZAHER, A NOVEL ZERO-ERROR METHOD TO CREATE A SECRET TAG FOR AN IMAGE, Journal of Theoretical and Applied Information Technology, vol. 96, issue 13, pp. 4081-4091, 2018.

[7]. Saleh Khawatreh, Belal Ayyoub, Ashraf Abu-Ein, Ziad Alqadi, A Novel Methodology to Extract Voice Signal Features, International Journal of Computer Applications, vol. 975, pp. 8887, 2018.

[8]. Dr Rushdi S Abu Zneit, Dr Ziad AlQadi, Dr Mohammad Abu Zalata, A Methodology to Create a Fingerprint for RGB Color Image, IJCSMC, vol. 6, issue 1, pp. 205-212. 2017.

[9]. RA Zneit, Ziad Alqadi, Dr Mohammad Abu Zalata, Procedural analysis of RGB color image objects, IJCSMC, vol. 6, issue 1, pp. 197-204, 2017.

[10]. Amjad Y Hindi, Majed O Dwairi, Ziad A AlQadi, A Novel Technique for Data Steganography, Engineering, Technology & Applied Science Research, vol. 9, issue 6, pp. 4942-4945, 2019.

[11]. Mutaz Rasmi Abu Sara Rashad J. Rasras, Ziad A. AlQadi, A Methodology Based on Steganography and Cryptography to Protect Highly Secure Messages, Engineering, Technology & Applied Science Research, vol. 9, issue 1, pp. 3681-3684, 2019.

[12]. Dr. Amjad Hindi, Dr. Ghazi M. Qaryouti, Prof. Yousif Eltous, Prof. Mohammad Abuzalata, Prof. Ziad Alqadi, Color Image Compression using Linear Prediction Coding, International Journal of Computer Science and Mobile Computing, vol. 9, issue 2, pp. 13 – 20, 2020.

[13]. Ziad Alqadi, Mohammad Abuzalata, Yousf Eltous, Ghazi M Qaryouti, Analysis of fingerprint minutiae to form fingerprint identifier, International Journal on Informatics Visualization, vol. 4, issue 1, pp. 10-15, 2020.

[14]. Prof. Ziad Alqadi, Dr. Mohammad S. Khrisat, Dr. Amjad Hindi, Dr. Majed Omar Dwairi, USING SPEECH SIGNAL HISTOGRAM TO CREATE SIGNAL FEATURES, International Journal of Engineering Technology Research & Management, vol. 4, issue 3, pp. 144-153, 2020.

[15]. Prof. Ziad Alqadi, Dr. Amjad Hindi, Dr. Majed Omar Dwairi, Dr. Mohammad S. Khrisat, Features Analysis of RGB Color Image based on Wavelet Packet Information, IJCSMC, vol. 9, issue 3, pp. 149 – 156, 2020.

[16]. Ziad Alqadi Dr. Mohammad S. Khrisat, Dr. Amjad Hindi, Dr. Majed Omar Dwairi, VALUABLE WAVELET PACKET INFORMATION TO ANALYZE COLOR IMAGES FEATURES, International Journal of Current Advanced Research, vol. 9, issue 2, pp. 2319-6505, 2020.

[17]. Amjad Hindi, Majed Omar Dwairi, Ziad Alqadi, Analysis of Digital Signals using Wavelet Packet Tree, IJCSMC, vol. 9, issue 2, pp. 96-103, 2020.

[18]. Amjad Y. Hindi, Majed O. Dwairi, Ziad A. AlQadi, Creating Human Speech Identifier using WPT, International Journal of Computer Science and Mobile Computing, vol. 9, issue 2, pp. 117 – 123, 2020.

[19]. Dr. Amjad Hindi, Dr. Majed Omar Dwairi, Prof. Ziad Alqadi, Efficiency analysis of color image features extraction methods, International Journal of Software & Hardware Research in Engineering, vol. 8, issue 2, pp. 58-65, 2020.

[20]. Ziad A. AlQadi Amjad Y. Hindi, Majed O. Dwairi, PROCEDURES FOR SPEECH RECOGNITION USING LPC AND ANN, International Journal of Engineering Technology Research & Management, vol. 4, issue 2, pp. 48-55, 2020.

[21]. Dr. Amjad Hindi, Dr. Majed Omar Dwairi, Prof. Ziad Alqadi, Analysis of Procedures used to build an Optimal Fingerprint Recognition System, International Journal of Computer Science and Mobile Computing, vol. 9, issue 2, pp. 21 – 37, 2020.

[22]. Ziad alqadi, Analysis of stream cipher security algorithm, Journal of Information and Computing Science, vol. 2, issue 4, pp. 288-298, 2007.

[23]. Ziad Alqad, Prof. Yousf Eltous Dr. Ghazi M. Qaryouti, Prof. Mohammad Abuzalata, Analysis of Digital Signal Features Extraction Based on LBP Operator, International Journal of Advanced Research in Computer and Communication Engineering, vol. 9, issue 1, pp. 1-7, 2020.

[24]. Ziad A. AlQadi, A Highly Secure and Accurate Method for RGB Image Encryption, IJCSMC, vol. 9, issue 2, pp. 12-21, 2020.

[25]. Belal Zahran Rashad J. Rasras, Ziad Alqadi, Mutaz Rasmi Abu Sara, Developing new Multilevel security algorithm for data encryption-decryption (MLS_ED), International Journal of Advanced Trends in Computer Science and Engineering, vol. 8, issue 6, pp. 3228-3235, 2020.

[26]. Ziad Alqad, Majid Oraiqat, Hisham Almujafet, Salah Al-Saleh, Hind Al Husban, Soubhi Al-Rimawi, A New Approach for Data Cryptography, International Journal of Computer Science and Mobile Computing, vol. 8, issue 9, pp. 30-48, 2019.

[27]. Majed O Al-Dwairi, A Hendi, Z AlQadi, An efficient and highly secure technique to encrypt-decrypt color images, Engineering, Technology & Applied Science Research, vol. 9, issue 3, pp. 4165-4168, 2019.

[28]. Amjad Y Hendi, Majed O Dwairi, Ziad A Al-Qadi, Mohamed S Soliman, A novel simple and highly secure method for data encryption-decryption, International Journal of Communication Networks and Information Security, vol. 11, issue 1, pp. 232-238, 2019.

[29]. Ziad Alqadi, Ahmad Sharadqh, Naseem Asad, Ismail Shayeb, Jamil Al-Azzeh, Belal Ayyoub, A highly secure method of secret message encoding, International Journal of Research in Advanced Engineering and Technology, vol. 5, issue 3, pp. 82-87, 2019.

[30]. Rushdi Abu Zneit, Jamil Al-Azzeh, Ziad Alqadi, Belal Ayyoub, Ahmad Sharadqh, Using Color Image as a Stego-Media to Hide Short Secret Messages, IJCSMC, Vol. 8, Issue 6, pp. 106 –123, 2019.

[31]. Qazem Jaber Rashad J. Rasras, Mohammed Abuzalata, Ziad Alqadi, Jamil Al-Azzeh, Comparative Analysis of Color Image Encryption-Decryption Methods Based on Matrix Manipulation, IJCSMC, vol. 8, issue 3, pp. 14-26, 2019.

[32]. Jamil Al-Azzeh, Bilal Zahran, Ziad Alqadi, Belal Ayyoub, Muhammed Mesleh, A Novel Based On Image Blocking Method To Encrypt-Decrypt Color, International Journal on Informatics Visualization, vol. 3, issue 1, pp. 86-93, 2019.

[33]. Jamil Al-Azzeh, Ziad Alqadi, Qazem Jaber, A Simple, Accurate and Highly Secure Method to Encrypt-Decrypt Digital Images, INTERNATIONAL JOURNAL ON INFORMATICS VISUALIZATION, VOL 3 (2019) NO 3, pp. 262-265.

[34]. S. Wang, Y. Zheng, Z. Gao, "A New Image Scrambling Method through Folding Transform", IEEE International Conference on Computer Application and System Modeling, Taiyuan, China, October 22-24, 2010.

[35]. J. N. Abdel-Jalil, "Performance analysis of color image encryption\decryption techniques", International Journal of Advanced Computer Technology, Vol. 5, No. 4, pp. 13-17, 2016.

[36]. G. Ye, "An Efficient Image Encryption Scheme based on Logistic maps", International Journal of Pure and Applied Mathematics, Vol. 55, No. 1, pp. 37-47, 2009.

[37]. T. Sivakumar, R. Venkatesan, "A Novel Image Encryption Approach using Matrix Reordering", WSEAS Transactions on Computers, Vol. 12, No. 11, pp. 407-418, 2013.

[38]. H. Gao, Y. Zhang, S. Liang, D. Li, "A New Logistic maps for Image Encryption", Chaos- Solitons & Fractals, Vol. 29, No. 2, pp. 393- 399, 2006.

[39]. G. Chen, Y. Mao, C. K. Chui, "A Symmetric Image Encryption Scheme based on 3D Chaotic Cat Maps", Chaos, Solitons & Fractals, Vol. 21, No. 3, pp. 749–761, 2004.

[40]. K. Loukhaoukha, J. Y. Chouinard, A. Berdai, "A Secure Image Encryption Algorithm Based on Rubik's Cube Principle", Journal of Electrical and Computer Engineering, Vol. 2012, Article ID 173931, pp. pp. 1-13, 2012.

[41]. X. Wang, J. Zhang, "An Image Scrambling Encryption using Chaos-controlled Poker Shuffle Operation", IEEE International Symposium on Biometrics and Security Technologies, Islamabad, Pakistan, April 23-24, 2008.

[42]. Prof. Ziad Alqad i Prof. Yousif Eltous, Dr. Majed Omar Dwairi, Dr. Mohammad S. Khrisat, Dr. Saleh A. Khawatreh, Secure Secret Message Steganography (SSMS), International Journal of Computer Science and Mobile Computing, vol. 9, issue 6, pp. 1-9, 2020.

[43]. Dr. Saleh A. Khawatreh Dr. Majed Omar Dwairi, Prof. Ziad Alqadi, Dr. Mohammad S. Khrisat, Dr. Amjad Hindi, Digital color image encryption-decryption using segmentation and reordering, International Journal of Latest Research in Engineering and Technology (IJLRET), vol. 6, issue 5, pp. 6-12, 2020.

[44]. Prof. Ziad Alqadi Prof. Yousif Eltous, Dr. Akram Moustafa Hamarchi, Dr. Mohammad S. Khrisat, Dr. Saleh A. Khawatreh, Color Image Encryption-Decryption using RANDOM Noise and PMT, International Journal of Advanced Research in Computer and Communication Engineering, vol. 9, issue 5, pp. 1-7, 2020.

[45]. Prof. Ziad Alqadi Prof. Yousif Eltous, Dr. Akram Moustafa Hamarchi, Dr. Mohammad S. Khrisat, Dr. Saleh A. Khawatreh, SPEECH SIGNAL ENCRYPTION-DECRYPTION USING NOISE SIGNAL AND PMT, International Journal of Engineering Technology Research & Management, vol. 4, issue 5, pp. 49-59, 2020.

[46]. Prof. Ziad Alqadi Dr. Saleh A. Khawatreh, Dr. Mohammad S. Khrisat, Dr. Amjad Hindi, Dr. Majed Omar Dwairi, A Novel Method to Encrypt-Decrypt Digital Speech Signal (EDDSS), International Journal of Advanced Research in Computer and Communication Engineering, vol. 9, issue 4, pp. 117-123, 2020.

[47]. Prof. Ziad Alqadi Dr. Mohammad S. Khrisat, Dr. Saleh A. Khawatreh, Dr. Majed Omar Dwairi, Dr. Amjad Hindi, Prof. Yousif Eltous, Analysis of Color Image Noising Process, International Journal of Computer Science and Mobile Computing, vol. 9, issue 6, pp. 65 – 72, 2020.

