

# Information Hiding Using Least Significant Bit Steganography and Cryptography

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Abstract-Steganalysis is the art of detecting the message's existence and blockading the covert communication. Various steganography techniques have been proposed in literature. The Least Significant Bit (LSB) steganography is one such technique in which least significant bit of the image is replaced with data bit. As this method is vulnerable to steganalysis so as to make it more secure we encrypt the raw data before embedding it in the image. Though the encryption process increases the time complexity, but at the same time provides higher security also. This paper uses two popular techniques Rivest, Shamir, Adleman (RSA) algorithm and Diffie Hellman algorithm to encrypt the data. The result shows that the use of encryption in Steganalysis does not affect the time complexity if Diffie Hellman algorithm is used in stead of RSA algorithm.

*Index Terms*—Cryptography, Image hiding, Least-significant bit (LSB) method, Steganography

# I. INTRODUCTION

With the recent advances in computing technology and its intrusion in our day to day life, the need for private and personal communication has increased. Privacy in digital communication is desired when confidential information is being shared between two entities using computer communication. To provide secrecy in communication we use various techniques. One such technique is Steganography [1-2] that is the art of hiding the fact that communication is taking place, by hiding information in other information. Classification of stenography techniques based on the cover modifications applied in the embedding process is as follows:

# A. Least significant bit (LSB) method

This approach [3-8] is very simple. In this method the least significant bits of some or all of the bytes inside an image is replaced with a bits of the secret message.

# B. Transform domain techniques

This approach [9-10] embeds secret information in the frequency domain of the signal. Transform domain

methods hide messages in significant areas of the cover image which makes them more robust to attacks such as: compression, cropping, and some image processing, compared to LSB approach.

# C. Statistical methods

This approach [11] encodes information by changing several statistical properties of a cover and uses a hypothesis testing in the extraction process. The above process is achieved by modifying the cover in such a way that some statistical characteristics change significantly i.e. if "1" is transmitted then cover is changed otherwise it is left as such.

# D. Distortion techniques

In this technique [12-15] the knowledge of original cover in the decoding process is essential at the receiver side. Receiver measures the differences with the original cover in order to reconstruct the sequence of modification applied by sender.

This paper tries to overcome the disadvantage of the LSB method [16-20] by appending encrypted data in image in place of plain textual data. To encrypt the data RSA [21] and Diffie Hellman [21] algorithms were used. To check the efficacy of the proposal, we calculated the number of instructions executed at sender and receiver site since the number of instructions executed is a measure of time complexity of the process.

The paper has been organized as follows: Section 2 provides the proposal, Section 3 provides the simulation and results, Section 4 provides the inference of the results, Section 5 provides the conclusion followed by references.

## II. THE PROPOSED SCHEME

# A. Sender Side

The proposed scheme uses RSA or Diffie Hellman algorithm to encrypt secret information. To provide higher security the secret information is encrypted first and encrypted ASCII value is converted in binary form. The image pixels at the same time are also converted into binary form. The image is now used as a cover to embed the encrypted information. This process is done by LSB encoder which replaces the least significant bit of pixel values with the encrypted information bits. The modified picture is now termed as Stego image. The whole process is explained in Fig. 1.



Figure 1. Proposed steganography mechanism for sender

## A. Receiver Side

Upon reception of Stego image the receiver firstly converts the pixels into their corresponding binary values. The LSB decoder then detaches the encrypted data from image pixel values. The encrypted data is decrypted using decryption algorithms. This is how, the plain text is recovered from image. Fig. 2 shows the whole process at the receiver side.



Figure 2. Proposed steganography mechanism for receiver

## **III. SIMULATION AND RESULTS**

We simulate the process as shown in Fig. 1 and Fig. 2 using MATLAB-7.01. Since the number of instructions executed is a measure of time complexity of the algorithm therefore we calculated the number of instructions executed both at sender and receiver side to compare the performance of pure steganography and our proposed scheme.

#### TABLE I. SIMULATION SETUP PARAMETERS

Image Pixels (NXN)	N = 64, 128, 192, 256
Number of bits changed	K = 1, 2, 3 and 4
Image Type	Tif
Encryption	32 bit
Encryption Algorithm	RSA, Diffie Hellman
Simulation Tool	MATLAB 7.01

The plain text, encrypted text using RSA and Diffie Hellman algorithms are shown in Fig. 3.

Plaintext	Encrypted text using RSA					Encrypted text using Diffie	
Test paper-1 1. There are 150 weights. Some are 1 kg weights and some are 2 kg weights. The sum of the weights is 260. What is the number of 1kg weights?	ÁS E/S¶pEÓ apS¶SSaS ES!-akaÁpi	E] E000 E/EuEÓ apE] EEúÁ apE] EEEE 2gEUEEçEú apE] E <sup>*</sup> Á 2f ÁEúEEapi	-0/Á/999 ap3193Á 1936° 3 19269919 19269919 5ÁÁg95 20 ú0203	55 (1995, f° 50- 55x°5, f959 5Áx°Ó (193 Á2115 - 9	- Бú- БgБ¶рВÓ 13 -SfBD/¶р0 Б0fаe	Bú- BÓ XÓ BB∋Á	Vguv rcrgt/3 30 Vjgtg ctg 372 ygkijvu O Uqog ctg 3 mi ygkijvu cpf uqog ctg 4 mi ygkijvu O Vjg uw o qh vjg ygkijvu ku 4820 Vjcv ku vjg pwodgt qh 3mi ygkijvu A
2. A is driving on a highway when the police fines him for over speading and exceeding the limit by 10 km/hr. At the same time B is fined for over speeding by twice the amount by which A exceeded the limit. If he was driving at 35 km/hr what is the speed limit for the road? what is the speed limit for the road????	80 85Á2054 8	5 a*a1500 1915 1957-5f( 1:4p5005 50*fx4150 1: 1915 500 5-fú!"Á5	-/ !aÁpSúÁ(5 is)/uS(*'B- SEÚ* -SEO ¶Óae ÓÓSÓSaeS DáSÓSaeS B a*a¶SE aÁpSú¶SE	5 èe 5 èe 5 6 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	B>Daddda èe \$10add1 f-010 500	!aÁp©¶⊡ Á	40 C ku tikxkipi qp c jikijv(j vjgp vjg ranke hkogu jiko hat avgt urgsfkpi cpf gregsfkpi vjg nkokv d(32 moljt0 Cv vjg ucog vkog D ku hkogh hat avgt urgsfkpi d(vykeg vjg coawpv d(yike) (zgregsfr vjg nkokv) Kh jg ycu tikxkpi cv 57 moljt vjcv ku vjg urgsf nkokv hat vjg tatfÅ vjcv ku vjg urgsf nkokv hat vjg tadfAAA
Test paper-1 1. There are 150 weights. Some are 1 kg weights and some are 2 kg weights. The sum of the weights is 260. What is the number of 1kg weights?	¶p⊇Ó ⊡	12 a°a¶23/ -5/Á/555 E/Eu3Ó ap2¶ 55úÁ ap2¶ 5555 ap2¶ 5565 5Áx°Ó ap2¶ 5°Á	f-2¶3 ap3¶ 53…/ 153f° 3 3g5u83ç5ú -5f53/¶p3 ÁÁg534	0-fú!"""" - - Dú- 02x*0f00 90-0090 90 20 20 20	ÁÁD Dú- Dý- DgD ID ÁpDfÁDúCD	E¶E0ú0 E/E¶pEÓ EÓ apEÓúÓEÓ	Vguv rcrgt/3 30 Vjgtg ctg 372 ygkijvu O Uqog ctg 3 mi ygkijvu cpf uqog ctg 4 mi ygkijvu Oʻlgu vvo qh vjg ygkijvu ku 4820 Yjcv ku vjg pwodgt qh 3mi ygkijvuA
2. A is driving on a highway when the police fines him for over speeding and exceeding the limit by 10 km/hr. At the same time B is fined for over speeding by twice the amount by which A exceeded the limit. If he was driving at 35 km/hr what is the speed limit for the road? what is the speed limit for the road????	a°a¶eóóe ee'eee ¶e	ÁS¶S -580 èe >>5855555 9>5855555 9>5855555 9>585555 9>5400 9 5000 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	00f ae Á305<%0 Á MÓae 20203ae31 1913 aÁp2ú%1936 192050%1936 192050%1936 192050%1936	00aÁ !aÁp0jÁl0 !aÁp010 10 !00f-0f( 015 2<0 0 a'a100 01'02-000 f-0 0-f ú!************************************	555a 1957- 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	5f( 5¶a* 550	40 C ku tikokpi ap c jikijyć yjg vjg rankeg hkpgu jko hat avgt urggfkpi cpf greegfkpi vjg nkokv d{32 maljto C v ig ucag vkog D ku hkpgf hat avgt urgffkpi d{ vykeg vjg cogwpv d{ vjikej C greegff vjg nkokv0 Kh jg vc tikokpi cv 57 maljt vjcv ku vjg urgf nkokv hat vjg tafA vjcv ku vjg urgf nkokv hat vjg tafAAA
Test paper-1 1. There are 150 weights. Some are 1 kg weights and some are2 kg weights. The sum of the weights is 260. What is the number of 1kg weights?	6 6 6 7 8 7 ÁÁ	70 5ú- 5g31 p2Ó 2Ó -3f35/1p3 Ág35<5a35 80f ae -350 IaÁp3113	E   EUCO E / EUSÓ E / E1 PEÓ a pE1 EESE a pE1 EESE a pE1 EESE X E a a A PEÁ E a a A PEÁ E a a A PEÁ	-цА/222 ар5¶5504 ар5¶5504 Бар5¶ (5005ар50 (505ар50 (5540 1055а°55- !аА́р504/15	20 (1995, 1954° 1952° 1953919 úÓSÓS 84 14 15 15 15 15 15 15 15 15 15 15 15 15 15	- ⊡ú- ⊡Áx°Ó Á⊠¶⊡	Vguvrcrg√3 30 Vjgtg ctg 372 ygkijvuO Uqog ctg 3 mi ygkijvu cpf uqog ctg 4 mi ygkijvuO Vjg uwo qh vjg ygkijvu ku 4820 Yjcv ku vjg pwodgt qh 3mi ygkijvuA
2. A is driving on a highway when the police fines him for over speading and exceeding the limit by 10 km/hr. At the same time B is fined for over speeding by twice the amount by which A exceeded the limit. If he was driving at 35 km/hr what is the spead limit for the road? what is the speed limit for the road???? Test paper-1	6¶ *8-30 ! !5 a*a¶ 60; 60	4505<919 1927-27 20 <sup>1</sup> 7x <sup>4</sup> 92 1995 20 <sup>1</sup> 021-20 20 2-701 <sup>2</sup> Å 2910 2-2/Å 2010 2Å	- 530 - 530 !aÁp2Ó Ó3 Ó Ó3Ó Sae31 B a°a¶ 55. aÁp3ú ¶35. 355 Ó Sú ¶36. 355 Ó Sú ¶36. 356 Ó Sú ¶36. 356 J °		8>5a555a 5¶5 èe f-5¶5 550 5¶500 5¶500 50 5 5 5 5 5 5 5 5 5	Á B/Eu	40 C ku tikxkipi qp c jikijv( yjgp vjg ranke hkogu jiko hat avgt urgsfkpi cpf grægsfkpi vig nkokv d 32 maljt0 Cv vig ucag vkag D ku hkpgf hat avgt urgsfkpi d( vykeg vig cogwpv d( yikej C grægsfsf vig nkokv0 Kh jg vc uftikkipi cv 57 maljt vjov ku vig urgsf nkokv hat vig tacfA yjor ku vig urgsf nkokv hat vig tadfAAAA

Figure 3. Encrypted plain textual data using RSA and Diffie Hellman algorithms

## A. Simulation Setup

The various simulation parameters are given in Table 1.

#### B. Impact of single Bit Steganography on Images

Fig 4 shows the impact when one LSB of the image is replaced with data. The embedded data can be in encrypted or plain textual form. The following points may be noted:

- There is no visible change in the picture quality for pure as well as Diffie Hellman and RSA steganographic techniques.
- The complexity of Diffie Hellman steganography is nearly same as that of pure steganography.
- As the number of pixels in image increases, the number of instruction (complexity) at the sender and receiver side increases as can be shown in the graphs of Fig. 5 and Fig. 6.
- C. Impact of Two Bit Steganography on Images

Fig. 7 shows the impact of changing two bits of image



Original image



Image Quality using Diffie Hellman and pure Steganography

with data. The data can be in encrypted or plain textual form. The following points may be noted:

- There is a slight change in the picture quality as is evident from the picture.
- As the number of pixels in image increases, the complexity at the sender and receiver increases as shown in Fig. 8 and Fig. 9.
- There is an increase of 10% to 66% in the number of instruction execution in comparison to one bit steganography for pure steganography combined with RSA algorithm.
- There is a marginal increase (up to 3%) in the number of instruction in comparison to one bit steganography for pure steganography combined with Diffie Hellman algorithm.
- The complexity of steganography combined with RSA algorithm has higher complexity in comparison to pure and steganography combined with Diffie Hellman algorithm.



Image Quality using pure Steganography



Image Quality using RSA and pure Steganography

Figure 4. Impact of One bit steganography



Figure 5. Complexity vs Image size at sender side

## D. Impact of Three Bit Steganography on Images

Fig. 10 shows the impact of changing three bits of image with data. The data can be in encrypted or plain textual form. The following points may be noted:

• Distortion is much more prominent in comparison to one and two bit steganographic schemes.

The complexity of pure steganography combined with RSA algorithm (three bits)



Original image



Image Quality using Diffie Hellman and pure Steganography



Figure 6. Complexity vs Image size at receiver side

increases by 15 to 40% in comparison to two bit pure steganography combined with RSA.

- As the image size increases the complexity at both the sender and receiver side increases as shown in Fig. 11 and Fig. 12.
- The complexity of Pure Steganography and steganography combined with Diffie Hellman algorithm is nearly same.



Image Quality using pure steganography



Image Quality using RSA and pure steganography

Figure 7. Impact of Two bit steganography



Figure 8. Complexity vs Image size at sender side



Figure 9. Complexity vs Image size at receiver side



Original image



Image Quality using pure Steganography



Image Quality using Diffie Hellman and pure Steganography



Image Quality using RSA and pure Steganography



Figure 11. Complexity vs Image size at sender side

## E. Impact of Four Bit Steganography on Images

Fig.13 shows the impact of changing four bits of image with data. The data can be in encrypted or plain textual form. The following may be noted:

- The picture quality deteriorates significantly as is evident from the Fig.13
- The complexity increases for every scheme as is evident from the graphs as shown in Fig.14 and Fig.15.

#### **IV.** INFERENCE

The following inference can be drawn:



Figure 12. Complexity vs Image size at receiver side to provide higher security level in communication.

- As the size of the image increases the complexity at sender and receiver side increases.
- The RSA algorithm is more secured than Diffie Hellman algorithm when combined with pure steganography but at the same time has highest time complexity.
- Both Diffie Hellman RSA algorithms can be used in combination with pure steganography
- The time complexity increases with the number of embedded bits in image.





Image Quality using Diffie Hellman and pure Steganography



Image Quality using RSA and pure Steganography

Figure 13. Impact of Four bit steganography



Figure 14. Complexity vs Image size at sender side

#### V. CONCLUSION

The LSB modification technique provides an easy way to embed information in images, but the data can be easily decoded. The proposed scheme used in this paper encrypts the secret information before embedding it in the image. Certainly the time complexity of the overall process increases but at the same time the security achieved at this cost is well worth it. This cryptographic scheme can be used for other steganographic techniques also.

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Figure 15. Complexity vs Image size at receiver side

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