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Performance Comparison of Steganography Techniques

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***Abstract*—**Confidentiality calls for substantial research and development in network security and data communication. Several techniques have been proposed for the past decades to ensure secure and confidential transmission of data. Steganography is a significant method of hiding data in another media, such that it is physically and virtually invisible. It is used primarily to ensure secure communication in an indiscernible fashion so that the hidden information is not discovered at any stage. The goal is to hide the presence of secret information rather than the contents of information to avoid breaching of data confidentiality. This paper is an effort to bring about a comparison of some of the recent techniques used for steganography on the basis of embedding capacity and Peak signal to noise ratio (PSNR), Universal image quality index (UIQI), Number of pixel change rate (NPCR) and correlation. The performance metrics undertaken are robustness, security analysis and perceptual quality. The techniques were implemented in MATLAB 2013a v 8.1.0.604.

***Index Terms*—**Steganography, BPCS, PSNR, Entropy.

I. Introduction

Good quality network security is an integral part of data communication infrastructure. With the growth in intelligent transmission and communication networks, a breech in security is a matter of concern [1, 2, 3]. The ITRC report gives the number of data breaches which demonstrates that the numbers have taken a great hike over the years. This is shown as in the figure 1:

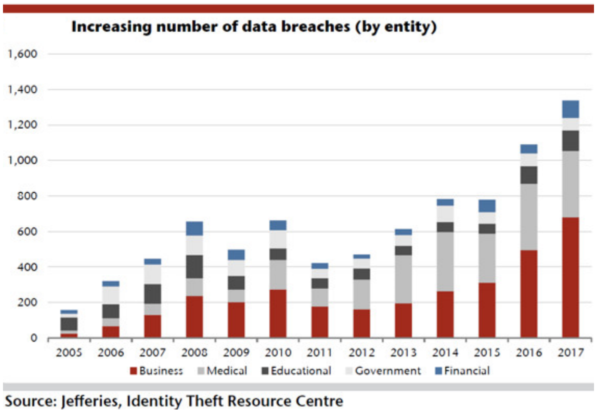


Fig.1. ITRC Report for Number of Data Breaches in years 2005-2017

One primary clause that ensures secure data communication is data confidentially. Steganography produces an efficient mechanism for secure transmission of sensitive data [3, 4, 5]. The data is embedded in a cover media in a fashion such that its existence is not detected by an intruder. The most basic steganography technique uses an image to hide the secretive information .This is demonstrated as in figure 2.

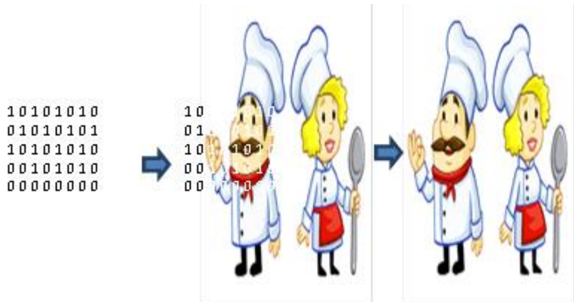


Fig.2. The Basic Scheme of Steganography

This paper compares most of the popular steganography techniques which have good embedding capacity and robustness. The rest of the paper is organized as follows: Section II explains the techniques implemented. Section III gives simulation set-up parameters. Section IV gives the snapshots. Section V provides the performance metrics on the basis of which results and conclusion are formulated in section VI and VII respectively.

II. Techniques Implemented

The implemented steganography techniques are described in this section.

A. Implementation using BPCS

BPCS stands for Bit Plane Complexity segmentation [14]. The last plane of the cover image is a complex noisy plane which is used for embedding. The First step in BPCS is to segment the cover image into 8 planes. Blocks of 8x8 are formulated of each plane. After block segmentation, canonical gray code conversion is applied on pure binary codes present in each block.

The next step is to divide the data into 8x8 blocks. Complexity is calculated for each data that is to be embedded. The complexity (α) is given by

$$\propto = \frac{K}{M} \tag{1}$$

Where, α should be lie from 0 to 1.

M is the total number of blocks and k is total no. transition changing from white to black or vice versa.

Threshold value is computed by:

$$th = \propto * \, Cmax \tag{2}$$

Where, Cmax is maximum complexity of Block. This threshold value acts as cut-off for block selection i.e. the blocks having complexity value greater than the threshold value are opted for embedding. Also complexity for data blocks is calculated to check whether it should be embedded without modifications or some needs to be done. If the complexity of the data block is greater than the threshold it is embedded into the image blocks directly. Otherwise, the conjugate of the block is taken to be embedded into the image block as shown in figure 3.

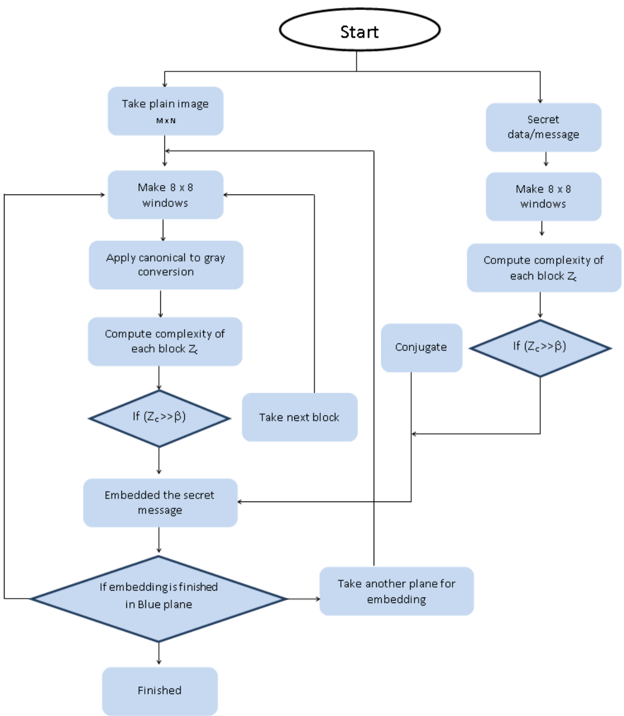


Fig.3. BPCS Steganography

Algorithm: Embedding Block

Input: secret message
Output: Embedding block

Step 1: Take secret message.
Step 2: Make 8x8 window of secret message.
Step 4: Calculate complexity of each Block.
Step 5: Select threshold values on the Base of complexity value
Step 6: Take direct data for embedding whose complexity value greater then to threshold value else take conjugate.

Algorithm: Stego Image

Input: Plain image Im_{MXN} where M, N are height and width of the image, secret message (embedding block).
Output: Stego Image

Step 1: Take plain image (m x n) where M, N are the height and width.
Step 2: Make 8x8 window of entire image.
Step 3: Apply canonical to gray conversion of all windows.
Step 4: Calculate complexity of each Block.
Step 5: Select threshold values on the Base of complexity value
Step 6: Select that block whose complexity value is grater then threshold value.
Step 7: Embed the secret message into blue plane.
Step 8: Take another plane if embedding in blue plain is finished.

B. Implementation using Status Bit

The first step in Status bit Steganography involves the extraction of the R, G and B planes from the cover media. The most significant bits of each plane are taken and their decimal equivalent is computed [10, 11, 12,13, 14, 15] then, the binary values of the pixels in the blue plane are computed. Embedding Decision would be taken on the basis of darker and lighter pixels.

If the MSB bits contains at least two “1” bits, then the pixel is called as lighter pixel. If the MSB bits contains at least two “0” bits, then the pixel is called as lighter pixel. The decimal equivalent (Zn) of the three MSB bits of each RGB pixels is used to decide the position of embedding in blue plane.

Embedding in lighter pixels: - If the bit position ‘Zn’ and message bit is same, then change the LSB bit of the pixels of blue plane into 1 otherwise make it 0.

Embedding in darker pixels: - If the bit position ‘Zn’ and message bit is same, then change the LSB bit of the pixels of blue plane into 1, otherwise make it 0. Here, there is one more condition that if all the MSB bits of pixels are 0, then directly inserts the message in blue plane

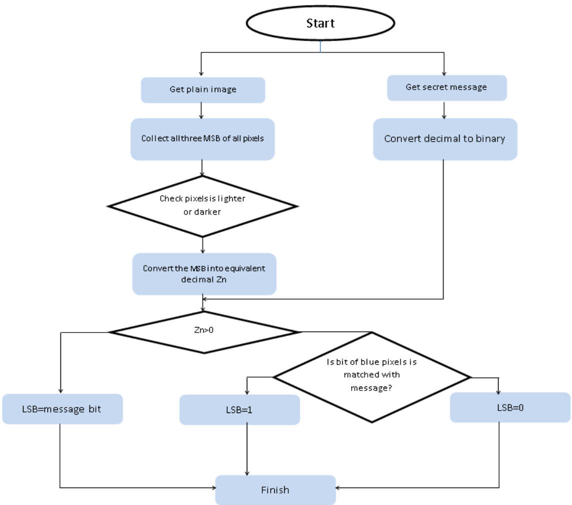


Fig.4. LSB Status Steganography

Algorithm: compute the lighter and darker pixels

Input: Plain image Im_{MXN} where M, N are height and width of the image, data.
Output: Stego image

Step 1: Take plain image
Step 2: Make 3x3 windows of plain image.
Step 3: Collect the MSB bits from a pixel {R, G, B} color space.
Step 4: For darker pixels- if the MSB bits contain at least two bit 1, then the pixels is used for data hiding.
Step 5: For lighter pixels- if the MSB bits contain at least two bit 0, then the pixels is used for data hiding.

Algorithm: Embedding data in darker pixels

Input: Darker pixels of Blue planes
Output: Stego image

Step1: The decimal representation Z_n of three MSB bits of RGB pixels are used for determining the position in blue plane. Now if bit position Zn and message bit is same then change the LSB bits of the pixels of blue plane into1 otherwise 0.

Algorithm: Embedding data in lighter pixels

Input: lighter pixels of Blue planes
Output: stego image

Step 1: The decimal representation Z_n of three MSB bits of RGB pixels is used for determining the position in blue planes. If the bit position Zn and message bit is same then change the LSB bits of the pixels of blue plane into 1 otherwise 0.
Step 2: If all three MSB bits of pixels are 0 then in this situation directly insert the message bit in blue plain.

C. Implementation using LSB Steganography

In the first step of this technique, the binary value of the pixels in the image and that of the message is computed. The LSB of pixel is then compared with the corresponding bit of the message [4, 5, 6, 7, 8, 9]. If the message bit and LSB of pixel are found to be same, no change in the pixels ensues. If they are found to be different, an increment or a decrement in the LSB of corresponding pixel is undertaken for embedding the data.

The whole message length is traversed for comparison with corresponding pixels' LSB till the end of the message is reached. The rest of the pixels in the image are unchanged. The process is shown in figure 5.

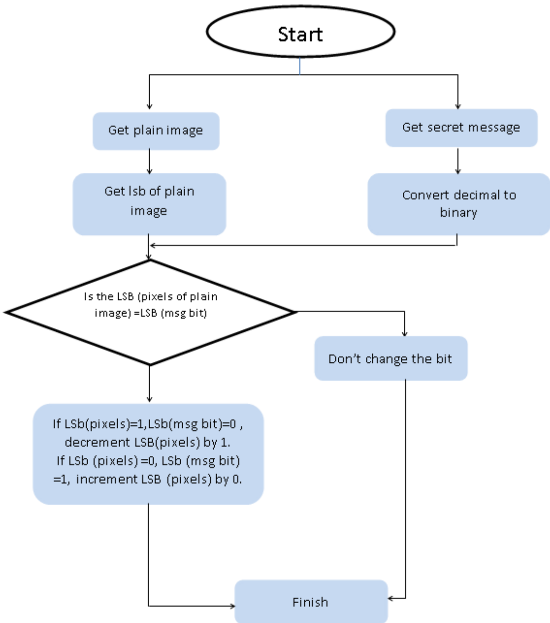


Fig.5. LSB using Steganography

Algorithm: Stego Image

Input: Plain image Im_{MXN} where M, N are height and width of the image, data.
Output: Stego image

Step 1: Take plain image
Step 2: Take the LSBs of all pixels of Plain Image
Step 3: Convert the data, decimal to binary
Step 4: If the LSB of image pixels not equal to msg bit then don't change the LSB of image pixels.
Step 5: a) If LSB(pixels of plain image)=1,LSB(msg bit)=0 , then decrement LSB(pixels) by 1.
b) If LSB (pixels of plain image) =0, LSB (msg bit) =1, then increment LSB (pixels) by 0.
Step 6: Transmit the stego Image.

D. Implementation using LSB based Image Steganography using Secret Key

To hide the secret information, the cover image is divided into three planes (Red, Green and Blue). After dividing each plane, the secret key is chosen on the basis of user. The secret key is converted into one-dimension array of bit stream [16, 17,18, 19, 20].

Secret key and red plane are used only for decision making to hide the information into either Green plane or Blue plane. Each bit of secret key is ex-ored with the LSB of red plane. The obtained ex-or results decide that the information will be embedded in either Green plane or Blue plane.

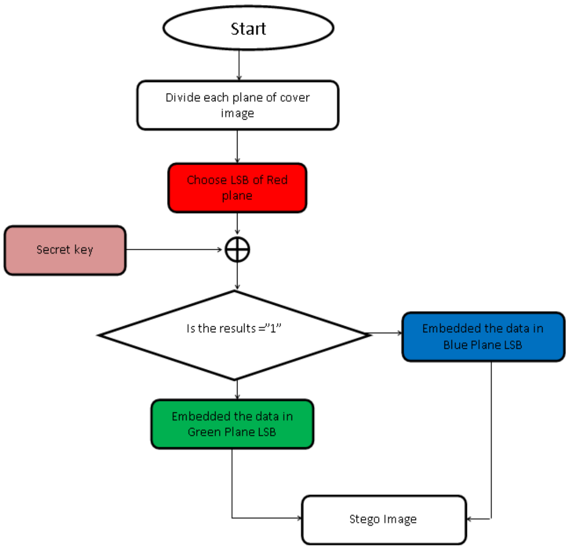


Fig.6. LSB based Image Steganography using Secret Key

Algorithm: Stego Image

Input: Plain image Im_{MXN} where M, N are height and width of the image, secret key data.
Output: Stego image

Step 1: Take plain image
Step 2: Divide image into three planes (R, G, and B).
Step 3: Convert the secret key into binary, if it is then keep it as such.
Step 4: Convert the secret key into one dimension array.
Step 5: Ex-or each bit of secret key with LSB of Red plane.
Step 6: Change the LSB of Green plane pixel if Ex-or result is 1 else, embed the data in LSB of Blue plane pixel.
Step.7: Transmit the stego image.

NOTE: Decryption process of each technique is just reverse as like encryption.

III. SIMULATION SETUP PARAMETERS

Hardware and software requirement for simulation and implementation of intended steganography techniques are given in table 1.

Table 1. Simulation Setup Parameters

Parameter	Values
Data size	16X16 (color image)
Image size	256 x 256 512 x 512 1024 x 1024
Image category	Color image (.bmp format)
Programing language tool	MATLB 2013a v 8.1.064
Simulation implemented	64 bit MATLAB
Processor	1.4 Ghz dual core Intel i5
Memory size	4 GB/1TB of1600 Mhz LPDDR3

IV. SNAPSHOTS

Relationship of original image and stego image obtained by implementation of steganography techniques is described in table 2.

Table 2. Comparison of stego Image

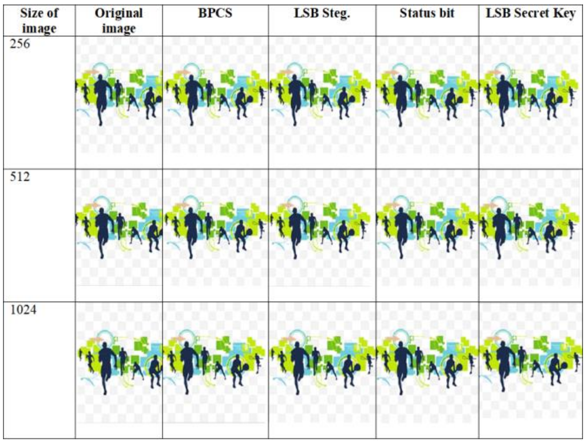
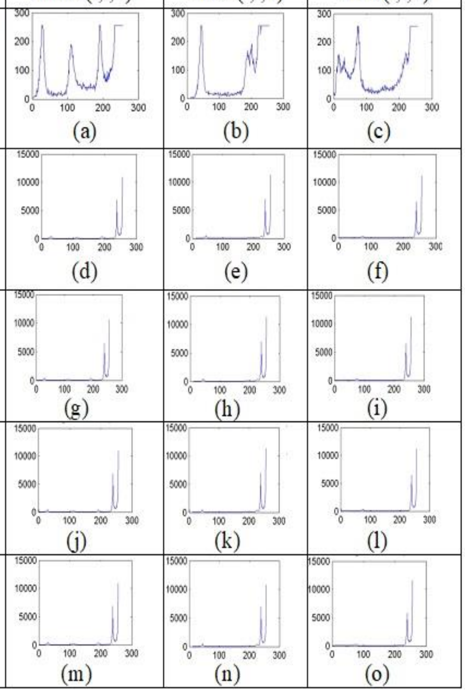


Table 3. Comparison of Histogram for 256 x 256 Images

Technique	Red Plane(:,:,1)	Green Plane(:,:,2)	Blue Plain(:,:,3)
Original Image	(a)	(b)	(c)
BPCS	(d)	(e)	(f)
LSB Steg.	(g)	(h)	(i)
Status bit	(j)	(k)	(l)
LSB Secret Key	(m)	(n)	(o)

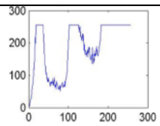
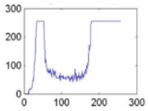
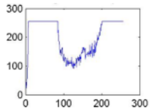
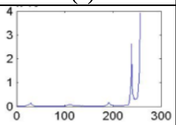
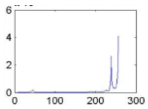
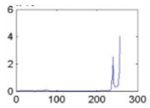
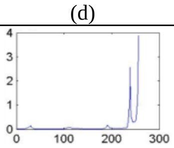
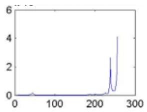
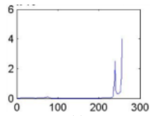
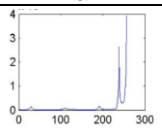
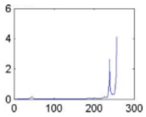
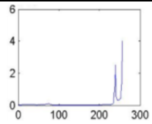


A. Histogram Analysis for 256 x 256 Image

Relationship of original image and stego image histogram analysis found by implementation of steganography techniques is described in table 3.

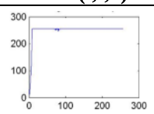
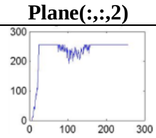
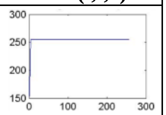
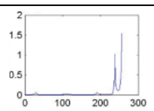
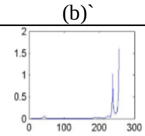
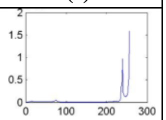
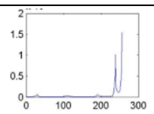
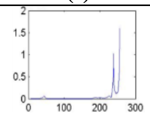
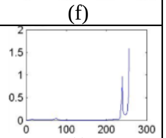
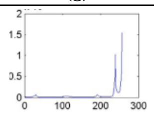
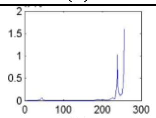
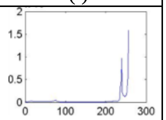
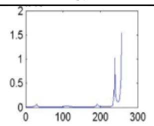
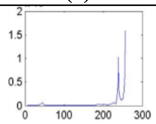
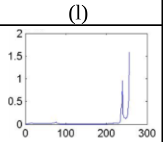
B. Histogram Analysis for 512 x 512 Image

Table 4. Comparison of Histogram for 512 x 512 Images

Technique	Red Plane(:,:,1)	Green Plane(:,:,2)	Blue Plain(:,:,3)
Original Image	 (a)	 (b)	 (C)
BPCS	 (d)	 (e)	 (f)
LSB Steg.	 (g)	 (h)	 (i)
Status bit	 (j)	 (k)	 (l)

C. Histogram Analysis for 1024 x 1024 Image

Table 5. Comparison of Histogram for 1024 x 1024 Images

Technique	**Red Plane(:,:,1)**	**Green Plane(:,:,2)**	**Blue Plain(:,:,3)**
Original Image	 (a)	 (b)`	 (c)
BPCS	 (d)	 (e)	 (f)
LSB Steg.	 (g)	 (h)	 (i)
Status bit	 (j)	 (k)	 (l)
LSB Secret Key	 (m)	 (n)	 (o)

(a) Shows the histograms of Red plane of original image (b) Shows the histograms of Green plane of original image (c) Shows the histograms of Blue plane of original image (d) Shows the histograms of Red plane using BPCS Technique (e) Shows the histograms of Green plane using BPCS Technique (f) Shows the histograms of Blue plane using BPCS Technique (g) Shows the histograms of Red plane using LSB Steganography Technique (h) Shows the histograms of Green plane using LSB Steganography Technique (i) Shows the histograms of Blue plane using LSB Steganography Technique (j) Shows the histograms of Red plane using status bit Steganography Technique (k) Shows the histograms of Green plane using status bit Steganography Technique (l)Shows the histograms of Blue plane using status bit Steganography Technique (m) Shows the histograms of Red plane using LSB Secret key Steganography Technique (n) Shows the histograms of Green plane using LSB Secret key Steganography Technique (o) Shows the histograms of Blue plane using LSB Secret key Steganography Technique.

V. PERFORMANCE METRICS

For thorough exploration of the techniques, three analyses were performed that are explained in the subsequent section.

A. Security Analysis

For security analysis, histograms of original image and encrypted-image are matched. A technique is said to be secure when the difference in the histograms is negligible which means the parameter values lie close to its ideal values. The parameters which are used for security analysis are listed below:

- *Jaccard Index:*

The Jaccard index, also known as the Jaccard similarity coefficient is used for comparing similarity between the original image and the encrypted-image. The jaccard index is mathematically given by the formula

$$J(X,Y) = \frac{X \cap Y}{X \cup Y}$$

Where, X is the original image and Y is the encrypted-image

$J(X,Y)$ is the jaccard index between image matrices X and Y
$X \cap Y$ is the intersection of matrices X and Y
$X \cup Y$ is the union of matrices X and Y

The value of Jaccard index lies between 0 and 1. 1 signifies perfect matching and 0 signifies total mismatch.

- *Correlation Coefficient:*

The correlation coefficient is a measure of the linear correlation (dependence) between two images *X* and *Y*, giving a value between +1 and −1 inclusive, where 1 signifies perfect match and −1 signifies total mismatch. The correlation coefficient is given by the formula

$$\rho(X,Y) = \frac{cov(X,Y)}{\sigma_X \sigma_Y}$$

Where, X is the original image and Y is the stego-image

$\rho(X,Y)$ is the correlation coefficient between image matrices X and Y
$cov(X,Y)$ is the covariance between matrices X and Y
σ_X is the standard deviation of X
σ_Y is the standard deviation of Y

- *Intersection Coefficient:*

Intersection coefficient of histograms counts the common number of pixels of same value between two histograms (histograms of cover image and stego-image). The intersection coefficient is given by the formula:

$$I(X,Y) = \sum_{i=1}^{N} \min(X(i), Y(i))$$

Where, X is the original image and Y is the stego-image

$I(X,Y)$ is the intersection coefficient between image matrices X and Y
X and Y are the probability distributions of images A and B respectively

If value of intersection coefficient is 1 it signifies perfect match and if the value is 0 it signifies total mismatch.

- *Bhattacharyya Coefficient:*

The Bhattacharyya coefficient measures the similarity between two images by using their probability distributions. The formula for Bhattacharyya coefficient is given by:

$$BC(X,Y) = \sum_{i=1}^{N} \sqrt{X(i)Y(i)}$$

Where, A is the original image and B is the stego-image

BC (A, B) is the Bhattacharyya coefficient between image matrices A and B
X and Y are the probability distributions of images A and B respectively

If value of Bhattacharyya coefficient is 1 it signifies perfect match and if the value is 0 it signifies total mismatch.

- *Universal Image Quality Index(UIQI):*

UIQI is used to measure the changes in stego-image with respect to the cover-image. In this measure the comparison of the images is broken down into three comparisons: luminance (L), contrast (C) and structural comparison (S).

$$L(X,Y) = \frac{2\,\mu_X \mu_Y}{{\mu_X}^2 + {\mu_Y}^2}$$

$$C(X,Y) = \frac{2\sigma_X \sigma_Y}{{\sigma_X}^2 + {\sigma_Y}^2}$$

$$S(X,Y) = \frac{2\sigma_{XY}}{\sigma_X + \sigma_Y}$$

$$UIQI(X,Y) = L(X,Y) * C(X,Y) * S(X,Y)$$

Where, X is the original image and Y is the stego-image

μ_X is the mean of matrix X
μ_Y is the mean of matrix Y
σ_X is the standard deviation of matrix X
σ_Y is the standard deviation of matrix Y
σ_{XY} is the covariance between matrices X and Y

B. Robustness Analysis

Robustness analysis is performed to measure the quality of image after implementation of particular technique. The parameters used for analysis of robustness are given below:

- *Mean Square Error (MSE):*

This parameter is a quantitative representation of the error that occurs in the final stego-image with respect to the original image. For a colour image MSE is given by:

$$MSE = \frac{1}{M \times N \times 3} \sum_{c=1}^{3} \sum_{y=1}^{N} \sum_{x=1}^{M} [F^c(X,Y) - F^{c\sim}(X,Y)]^\wedge 2$$

Where, M x N is the size of image (height and width respectively)

C=1 to 3 denotes the Red, Green and Blue colour plane respectively
F^c(X, Y)=value of pixel at position (X, Y) in c colour plane of cover image
$F^{c\sim}$(X, Y)=value of pixel at position (X, Y) in c colour plane of stego-image

- *Mean Absolute Error (MAE):*

MAE is the average of absolute errors between the cover image and the stego-image. For a colour image the formula for MSE is given by:

$$MAE = \frac{1}{M \times N \times 3} \sum_{c=1}^{3} \sum_{y=1}^{N} \sum_{x=1}^{M} Abs\left[F^c(X,Y) - F^{c\sim}(X,Y)\right]^2$$

Where, M x N is the size of image (height and width respectively)

C=1 to 3 denotes the Red, Green and Blue colour plane respectively
F^c(X, Y)=value of pixel at position (X, Y) in c colour plane of cover image
$F^{c\sim}$(X, Y)=value of pixel at position (X, Y) in c colour plane of stego-image

- *Peak Signal to Noise Ratio (PSNR):*

PSNR is the most commonly used parameter to measure the quality of image after embedding. Higher the PSNR value, higher the robustness of the stego-image. PSNR value is most commonly defined in terms of MSE. The formula for PSNR is given as:

$$\text{PSNR} = 10\log_{10}(\frac{MAX^2}{MSE})$$

Where MAX is the maximum value of a pixel in the image. It is 255 for colour image of 8 bits.

VI. RESULTS

A. *Robustness*

Robustness of a steganography technique can be measured by calculating the PSNR, MSE and entropy of stego image with respect to original image.

- *PSNR*

Peak signal to noise ratio shows the changes of original message with respect to the stego Image. As per result observation the best results shows by LSB and LSB Secret Key Steganography Techniques. This is shown in figure 7.

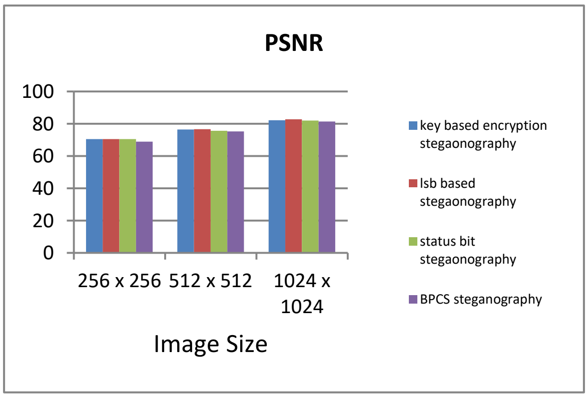


Fig.7. Comparison of PSNR

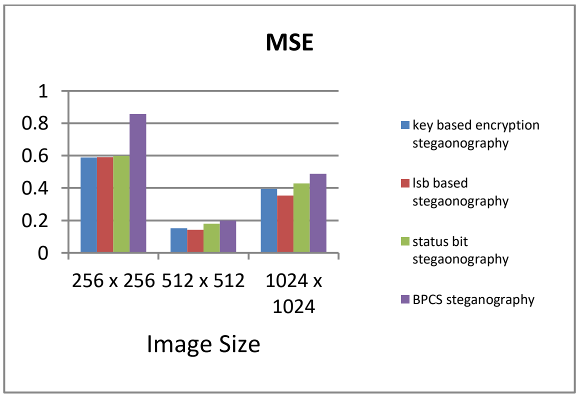


Fig.8. Comparison of MSE

- *MSE*

MSE shows the quantitative representation of the error that occurs in the final stego-image with respect to the original image. This is shown in figure 8.

- *Entropy*

Entropy is important factor in terms of robustness. It shows that the probability of occurrence of pixels in encrypted image should be equal to the original plain image. So the maximum value of entropy is provided by the Status bit. This is shown in figure 9.

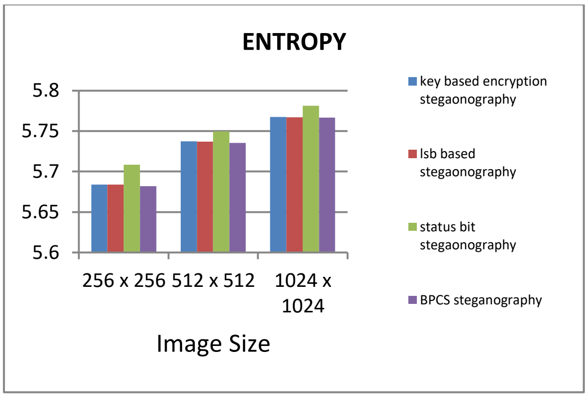


Fig.9. Comparison of Entropy

- *Correlation Coefficient*

This parameter is used to find the linear correlation between two images. Its value must lie between (-1, 1). In this scheme the best results are shown by the LSB and Status bit Steganography technique. This is shown in figure 10.

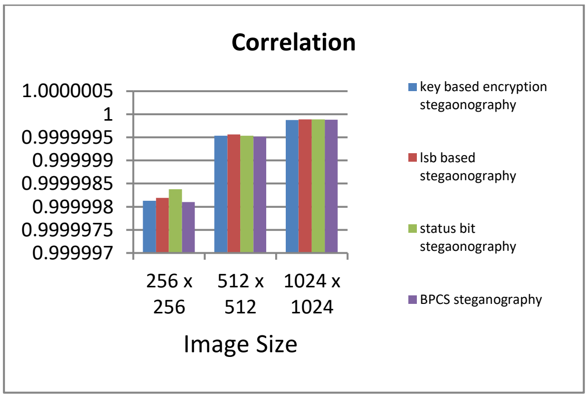


Fig.10. Comparison of Correlation Coefficient

- *Intersection Coefficient*

Intersection coefficient of histogram of original and stego image is used to calculate the common number of pixels of same value between two images. The best results are shown by the BPCS and Status bit Steganography techniques. This is shown in figure 11.

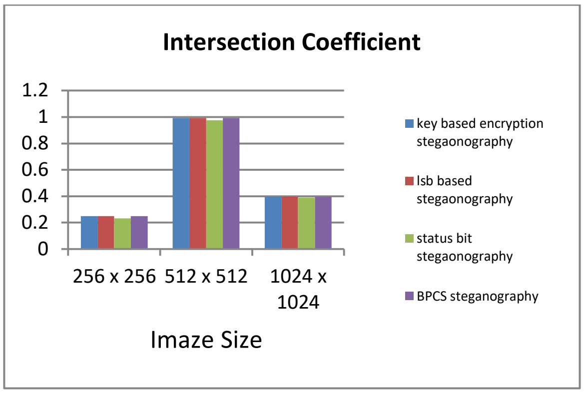


Fig.11. Comparison of Intersection Coefficient

- *Jaccard Index*

This factor is used to find the similarity between cover image and Stego Image. Its value also must lie in between (-1, 1). So the best results are provided by the LSB and BPCS Steganography techniques. This is shown in figure 12.

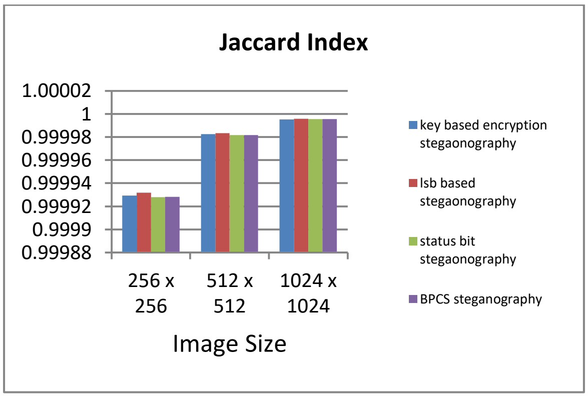


Fig.12. Comparison of Jaccard Index

- *UIQI*

This parameter is used to measure the modifications in stego image with respect to the cover image. The best results shown by the Bpcs steganography and status bit steganography as shown in below.

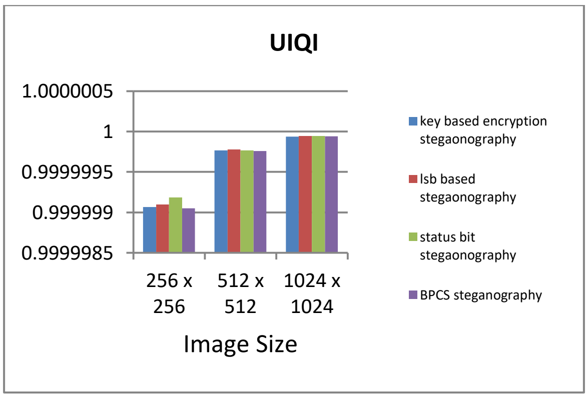


Fig.13. Comparison of UIQI

VII. Overall Comparison

A. *PSNR:-*

Table 6 shows the comparison of PSNR values of all techniques.

Table 6. Comparison of PSNR

Image size	BPCS Steganography	Status bit Steganography	LSB Steganography	LSB Secret Key Steganography
256 X 256	68.8033945 90476415	70.3607312 22298767	70.4184932 64726976	70.4297298 68198535
512 X 512	75.1284188 51299998	75.5753674 94174571	76.5797522 6306192	76.2956029 14916088
1024 X 1024	81.2582633 8168936	81.8087767 27900437	82.6508746 99263284	82.1633040 02255515

B. *MSE:-*

Table 7 shows the comparison of MSE values of all techniques.

Table 7. Comparison of MSE

Image size	BPCS Steganography	Status bit Steganography	LSB Steganography	LSB Secret Key Steganography
256 X 256	0.85652669 270833337	0.59842156 921659362	0.59051513 671875	0.58898925 78125
512 X 512	0.19963582 356770834	0.18011239 925675135	0.14292399 088541669	0.15258789 0625
1024 X 1024	0.48669179 280598956	0.42874857 347686596	0.35317738 850911456	0.39513905 843098956

C. *Entropy:-*

Table 8 shows the comparison of Entropy values of all techniques

Table 8. Comparison of Entropy

Image size	BPCS Steganography	Status bit Steganography	LSB Steganography	LSB Secret Key Steganography
256 X 256	5.6819561 067912518	5.70831778 47660442	5.684018599 9671187	5.6837178 965130013
512 X 512	5.7351863 467407274	5.74952317 40143229	5.736882404 4255113	5.7372235 001117264
1024 X 1024	5.7665946 878979781	5.78113672 38206337	5.767116194 0310984	5.7672020 404465014

D. Correlation Coefficient:-

Table 9 shows the comparison of Correlation Coefficient values of all techniques.

Table 9. Comparison of Correlation

Image size	BPCS Steganography	Status bit Steganography	LSB Steganography	LSB Secret Key Steganography
256 X 256	0.99999810 116155885	0.999998381 85416845	0.99999819 285453684	0.99999813 045791908
512 X 512	0.99999951 298750989	0.999999532 35229688	0.99999955 973976529	0.99999953 53833081
1024 X 1024	0.99999987 80502577	0.999999884 73720525	0.99999988 509118853	0.99999987 16463776

E. Intersection Coefficient:-

Table 10 shows the comparison of Intersection Coefficient values of all techniques.

Table 10. Comparison of Intersection Coefficient

Image size	BPCS Steganography	Status bit Steganography	LSB Steganography	LSB Secret Key Steganography
256 X 256	0.24835840 680893925	0.23154428 191046689	0.24835603 495373784	0.24835348 610465022
512 X 512	0.99388411 257678544	0.97536470 775934314	0.99388273 850978004	0.99388165 801008865
1024 X 1024	0.39675645 302009649	0.38939569 632666965	0.39675627 452248408	0.39675606 75920393

F. Jaccard Index

Table 11 shows the comparison of Jaccard Index values of all techniques.

Table 11. Comparison of Jaccard Index

Image size	BPCS Steganography	Status bit Steganography	LSB Steganography	LSB Secret Key Steganography
256 X 256	0.99992834 898345062	0.999927879 38723726	0.99993178 394441506	0.99992940 831655186
512 X 512	0.99998164 163912162	0.999981582 79648375	0.99998340 156047349	0.99998248 335717332
1024 X 1024	0.99999537 926377824	0.999995438 16509651	0.99999564 578961153	0.99999513 630288095

G. UIQI

Table 12 shows the comparison of UIQI values of all techniques.

Table 12. Comparison of UIQI

Image size	BPCS Steganography	Status bit Steganography	LSB Steganography	LSB Secret Key Steganography
256 X 256	0.99992834 898345062	0.999927879 38723726	0.99993178 394441506	0.99992940 831655186
512 X 512	0.99998164 163912162	0.999981582 79648375	0.99998340 156047349	0.99998248 335717332
1024 X 1024	0.99999537 926377824	0.999995438 16509651	0.99999564 578961153	0.99999513 630288095

VIII. Conclusions

In this paper various steganography techniques has been implemented for confidentiality and security purpose. The human perceptibility of blue plane is known to be very low as compared to any other plane. So, the data hidden in blue plane is considered to be much secure. Therefore, in BPCS technique all the data was embedded in complex noisy blue plane. The embedding capacity of BPCS techniques and LSB techniques is high. On comparison, it is found that the LSB steganography and LSB using secret key perform the best on the basis of PSNR. According to entropy and correlation point of view, the best results are shown by the status bit and BPCS steganography techniques.

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