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# Jaccard-based Random Distribution with Least and Most Significant Bit Hiding Methods for Highly Patients MRI Protected Privacy

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***Abstract*— In this study, the main goal is to improve patient care by making it easier for patient data and pictures to be sent between medical centers without problems. Still, one of the biggest problems with telemedicine is keeping patient information private and ensuring data is safe. This is especially important because even small changes to patient information could have serious consequences, such as wrong evaluations and lower-quality care. This study develops a new model that uses the unique Jaccard distribution of the least significant bit (LSB) and the most significant bit (MSB) to solve this complex problem. The goal of this model is to hide much information about a patient in the background of an MRI cover picture. The careful creation of this model is a crucial part of the current study, as it will ensure a solid way to hide information securely. A more advanced method is also suggested, which involves randomly putting private text in different places on the cover picture. This plan is meant to strengthen security steps and keep private patient information secret. The peak signal-to-noise ratio (PSNR), the structural similarity index measure (SSIM), and the mean square error (MSE) all improved significantly when this method was tested in the real world. With these convincing results, the study shows telemedicine is more effective than traditional methods for keeping patient data safe. This proves that the model and method shown have the potential to greatly improve patient privacy and data accuracy in telemedicine systems, which would improve the general quality of health care.**

***Keywords*—Jaccard; Random distribution; bit hiding method; MRI method.**

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## I. INTRODUCTION

Studies on text transfer in telemedicine highlight the complexities of managing image data due to advancements in digital technology [1]. Thus, high-security hiding information methods were introduced to protect digital data from cybercriminals [2]. A unique and robust algorithm is necessary to optimize the new equipment. A secret text represents a common language and tool among senders and receivers [4]. The transference of patients' diagnostic medical data is not a novel phenomenon in the healthcare sector following the rapid growth in telemedicine applications [5]. Technically, sensitive healthcare data should be protected with optimal security techniques to evade cyberattacks. This study discussed the issues underpinning unauthorized access to medical images to secure sensitive patient information. The Jaccard distribution depends on the worst clustering between the cover and key images. Lastly, both LSB and MSB physically hid the secret bits. An evaluation strategy was presented in this study to test the proposed system's effectiveness. Peak signal-to-noise ratio (PSNR), structural similarity index metric (SSIM), and reduced mean square error (MSE) served as quality metrics for evaluation and efficiency research. 25 MRI images and three MRI image sizes evaluated the proposed system achievement. The recommended model generated improved outcomes compared to other counterparts.

Authors in [6] have discussed the process of transferring medical data in a very confidential manner that has flourished between health institutions to maintain the confidentiality of information for patients and not to reveal the type of information. This article has proposed adopting the hiding data and patient medical information steganography method, one of the methods of steganography information in the cover of images and the process of extracting that data. It includes a combination of encryption and information steganography. Relying on measurements to discover the efficiency of the technology used (PSNR,

SSIM, MSE, UQI, and R) [7]. The proposed model has been evaluated based on using the Magnetic resonance imaging (MRI) dataset, the Peak Signal Noise Ratio (PSNR), the Structural Similarity Index (SSIM), the Mean Square Error (MSE), the Universal Quality Index (UQI) and the correlation coefficient (R) values. Original images from Amrita's Indian side face profile database have been used for evaluation. The dataset from Brain-Tumor-Progression) and the dataset utilized. The dataset contains a database of 20 individuals' patients with newly diagnosed who were treated with surgery and routine concurrent chemo-radiation therapy (CRT) followed by adjuvant chemotherapy. The best results for PSNR were between 51.28 dB and 67.79 dB, SSIM between 0.9876 and 0.9969, MSE between 1723.79 and 21001.25, UQI between 0.513 and 0.753, and R was 0.7992 and 0.9639. The proposed model has used few images, and this paper aims to hide the same size patient data medical image in the same size cover medical image; therefore, the model is weak [8].

Authors in [9] have discussed that because of the increase in population as a result of population inflation and the increasing demand for health care, the amount of data required to deal with the healthcare sector has increased, such as medical pictures, patient information, and various diagnoses of diseases. This article has proposed that reverse data masking technology was used depending on the inflation of health care. Reversible data hiding (RDH) is a modern technology used recently in the field of information security and medical image security within the cloud. RDH is based on compression without losing data, which creates a space to hide that data and uses the traditional Elias gamma coding process [10]. The proposed model has been evaluated based on PSNR and SSIM analysis—original images of natural images from the USC-SIPI image dataset [11].

The best-achieved results are PSNR about ∞ and SSIM about 1. The proposed model includes medical images, which is good compared to other natural images. In addition, the design is not strong enough to resist attacks [13]. The use of DICOM medical images has increased, particularly in transmitting medical images by telemedicine or e-health services. Furthermore, the confidentiality and security of patient information require additional attention and investigation. This article has proposed an improved algorithm for medical image steganography in which patients' information is hidden in cover medical images.

Furthermore, it has a higher level of features while keeping a higher level of medical image quality and a higher embedding capacity. The proposed model has been evaluated based on PSNR, MSE, RMSE, and SSIM [14]. The best result PSNR about 64.7999, MSE about 0.03519, RMSE about 0.16889, and SSIM about 0.9016. The proposed model has increased the hidden characters inside the images' steganography, leading to the emergence of distortions that may affect the quality of the images and may appear in the results of (PSNR, SSIM, and MSE), although they are not visually determined [15].

The apparent increase in the process of losing or leaking electronic information such as internal records and health information has been discussed, as well as what increases hackers' misuse of this information [16]. This article has an order to protect the information from unauthorized persons (hackers) [17]. This information process was hidden using the method Least Significant Bit (LSB). The method is to hide messages inside the pictures so that they are not visible from view to increase the security of data messages between the sender and the recipient [18]. The proposed model has been evaluated based on PSNR and MSE. Original images from Amrita's Indian side face profile database have been used for evaluation. The proposed model has used LSB data masking process alone, which is not sufficient for strong information masking, as additional methods are supposed to be used to strengthen the data masking within the images [19].

It has been discussed the process of transferring confidential information within systems that needs high-security systems. This research has proposed a process of concealing the confidential sharing of information using certain controlled sharing services that are established using a security system subject to the process of creating an automatic key. This research tests the hiding of Arabic texts within the text database. The proposed model is based on secret sharing with steganography. Databases have been used for original Arabic text steganography [20]. The proposed model has used steganography calculations that are very complex and require many simplifications; however, the use of masking Be of high database quality using different media such as text, images, and audio.

## II. Materials and Methods

This section highlights the recommended model, elaborating on the techniques used to embed and extract secret information.

### *A. Jaccard Measurements*

The Jaccard distance implies the common proximity measurement, which computes the similarity between two points. Jaccard similarity identifies the similarity between two asymmetric binary vectors or two sets [21]. It is deemed challenging to calculate the similarity measurement between two points in many applications. In this study, Jaccard distance identified the worst similitude to ensure the selection of random positions for the hidden bits. The maximum distance between the cover image corresponding to the block of pixels and a randomly generated image key block was computed to address this problem [22]. Technically, each block constitutes eight pixels. This calculation determined the block indices from the image key (i, j). The Jaccard distance formula is expressed in Equation 1:

$$J(A,B) = \frac{|_{A \cap B}|}{|_{A \cup B}|} \quad (1)$$

Notes: J denotes the Jaccard distance, and A∩B provides the number of members shared between shared and un-shared sets. Besides, A∪B provides the total number of members in both sets.

### *B. Jaccard Distribution*

A random secure distribution of secret text was developed following Jaccard similarity to safeguard patient privacy from unauthorized access. The image is categorized into RGB bands. The red band functions as a Jaccard map to identify the secret positions, while the blue band hides the

secret text [23]. The red band was checked for secret positions compared to blocks in the key image (i, j). Meanwhile, the critical image matrix was generated by pre-random distribution following a random generation model. This process resulted in the destination block [24]. Finally, indices were extracted and utilized to conceal the secret text in the blue band. Figure 1 illustrates using Jaccard similarity to hide content in a cover picture, while Figure 2 depicts extracting hidden text that represents patients' private data.

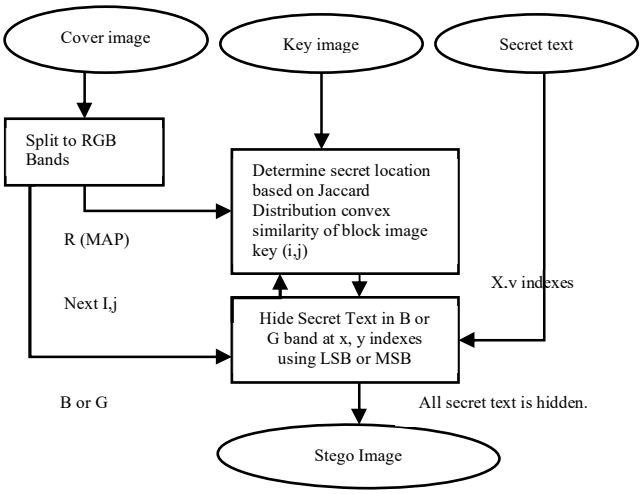


Fig. 1 Proposed operating system for hiding

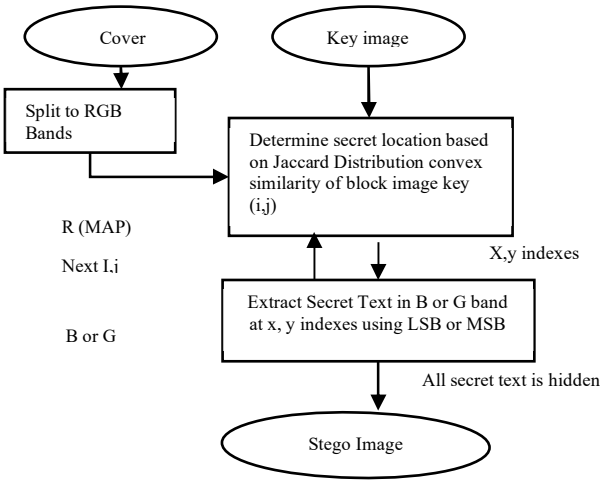


Fig. 2 Proposed operating system for extraction

## C. Key Image Generation

The key image was produced with the same size as the original cover image. Euclidean distance was computed for the cover image block in the key image to identify the secret location randomly. Notably, the key image was constructed for the sender and receiver on both sides in an unexpected manner. Secret seeds (seed1 and seed2) were defined on the sender and receiver sides with asymmetric encryption [25]. Concurrently, both senders and receivers have seed1 and seed2. Figure 3 illustrates the key image process for both parties.

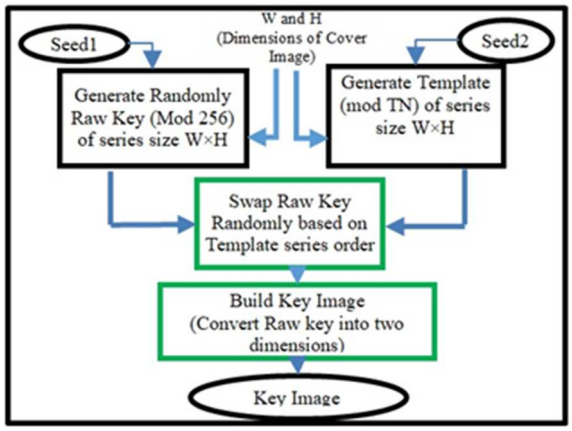


Fig. 3 The key image process for both the sender and receiver

## D. Least Significant Bit Steganography Technique LSB

As the first hiding technique developed for the suggested model, LSB sequentially embedded information bits into the cover image. Tampering LSB does not reflect a notable difference, as the change occurs on a small scale following its capacity [26]. The hackers would check secret bits from the cover least successively, a common flaw in steganography techniques. Binary masking extracted the LSB from cover bands to obtain the secret bits.

## E. Most Significant Bit Steganography Technique MSB

The MSB is a robust security method with low computing complexity and distortion of the gathering signal. This technique embedded patient information into specific places, known as special range numbers of MRI images. This approach must conceal a secret bit in the high significant bit, with the resulting distortion equivalent to LSB. The same technique hid and extracted secret information [27]. The MRI host was then shifted with the following formula:

$$S = Rmin + (M \bmod n) \tag{2}$$

Where,
S: The resulting shifted value.
Rmin: Start value of the target special range.
n: Length of the special range.
The current work used Rmin = 127, Rmax = 129, and n = 3.
Following Equation 3, the set S of shifted values served as a gathering to conceal the secret bit B:

$$M_n = \begin{cases} M_o + (R_{max} - S) \; if \; B = 1 \\ M_o - (S - R_{min}) \; if \; B = 0 \end{cases} \tag{3}$$

Where,
Mn: New resultant value of the host data.
Rmin: Minimum value of the selected special range.
Rmax: Maximum value of the selected special range.
Mo: Original host signal sample.
B: Secret bit.

## F. Embedding Model

Steganography used both LSB and MSB with Jaccard distribution. First, the seed1 and seed2 values were pre-defined to the embedding system. Second, the suggested model split RGB bands into an R map to determine secret locations following the Jaccard distribution convex similarity of block image key (i, j) and B or G to hide secret

text in B or G band at x, y indices using LSB or MSB. Equation 2 shifted the cover byte first, while Equation 3 concealed the secret bit [28].

### *G. H. Information Extraction*

The recipient must first possess the values for seed1 and seed2 to extract hidden bits from the cover image. Subsequently, the key image was created using the same approach on the transmitter and receiver sides. Hidden texts were extracted by reversing the hiding technique and determining secret locations following the Jaccard similarity of block image key (i, j) [29]. Lastly, secret texts were extracted from B or G bands at x, y indices with LSB or MSB.

## III. Results and Discussion

A dataset was derived from Sudad Najim Abed for accurate evaluation. Technically, the new model was tested and evaluated on multiple sample images of MRI with LSB- and MSB-infused Jaccard models.

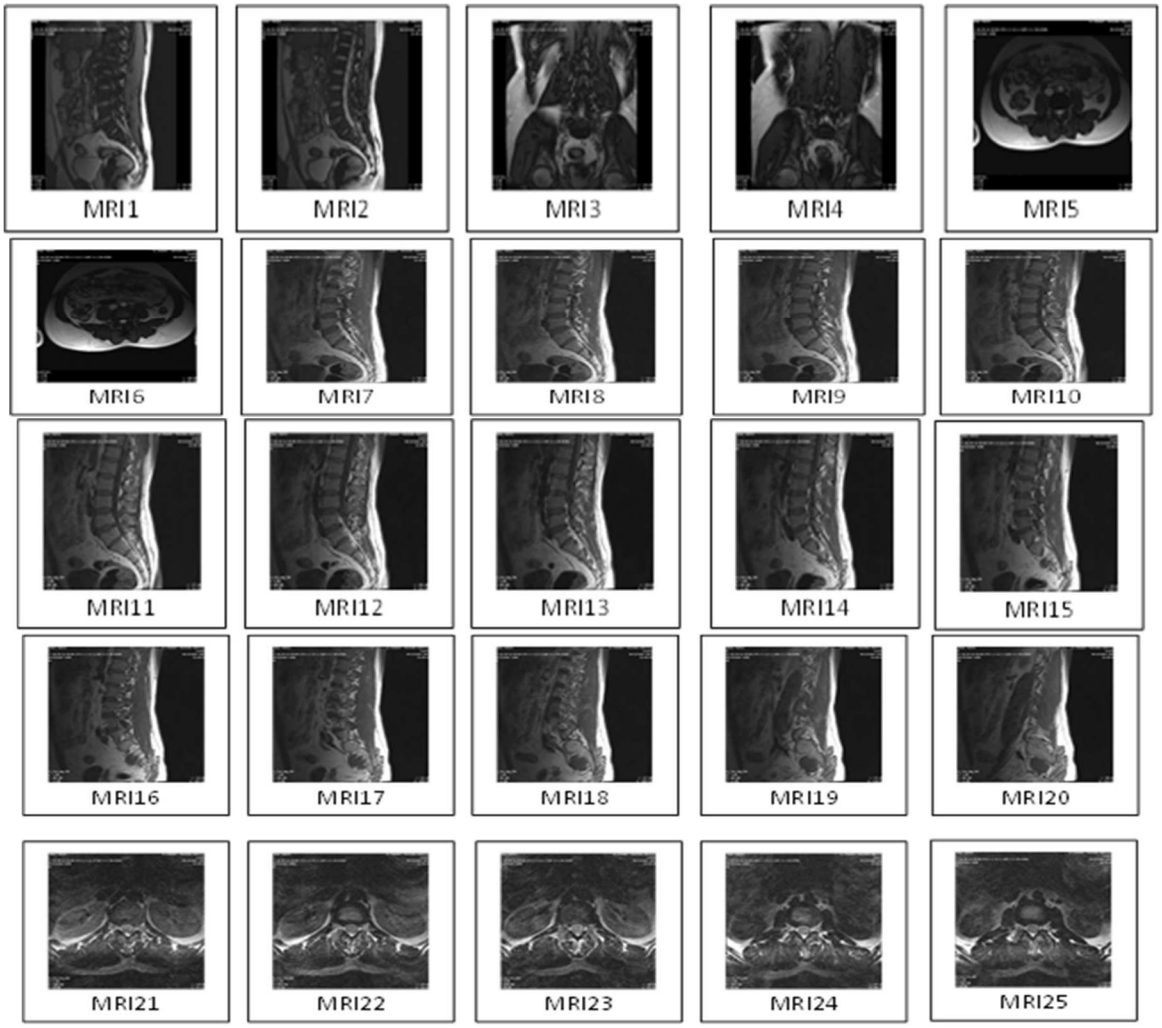


Fig. 4 Original Samples Images MRI

### *A. Evaluation metrics*

Several evaluation metrics were used to evaluate the proposed system's efficiency [30]. The quality metric was determined by calculating PSNR, SSIM, and MSE. The evaluation outcomes include comparisons between the new model and other techniques of MRI images upon hiding the information:

*1) PSNR*: Calculates the imperceptibility of the stego image. A higher PSNR value implies a higher quality of the stego image or imperceptibility of the hidden message. It is also known as the peak square value of the pixels divided by MSE and computed as follows:

$$\text{PSNR} = 10.\log_{10}\left(\frac{Max^2}{MSE}\right) \quad (4)$$

*2) MSE*: Calculates the volume of the average error between the embedded and the original MRI image. The error decreases with a high MSE value [31] based on Equation 5:

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}[I\,(i,j)\, - I`\,(i,j)\,] \quad (5)$$

Where,
M, N: The number of values MRI image sample (rows and columns of MRI image sample);
I: The original MRI image sample.
I`: The MRI image sample post-steganography;

(I−I`) : Difference between MRI image sample pre- and post-steganography.

*B. Analysis and Comparisons*

Based on the findings from Tables 1 to 6, the new model performed optimally compared to Sudad Najim Abed and Hussein Kadhem Bander [15]. These outcomes were compared against PSNR, MSE, and SSIM measurements for the proposed model and the ones above. The evaluation was performed on both LSB and MSB with Jaccard distribution. The proposed model and two other counterparts tested the sample MRI images for dimensions 125×125, 250×250, and 512×512. The proposed model outperformed its past counterparts with an average PSNR and MSE of 71.476061 and 0.009760533, respectively. The elicited outcomes in Tables 1 to 3 are illustrated in a band chart (see Figures 5 and 6), which represents the comparison of the proposed model's PSNR and MSE average against those of Sudad Najim Abed and Hussein Kadhem Bander for LSB Jaccard distribution. Meanwhile, the findings in Tables 4 to 6 are illustrated in a band chart (see Figures 7 and 8) that demonstrates comparisons of the proposed model's PSNR and MSE average against those of Sudad Najim Abed and Hussein Kadhem Bander for MSB Jaccard distribution.

TABLE I
COMPARATIVE PERFORMANCE FOR PROPOSED METHOD LSB JACCARD , SUDAD NAJIM ABED AND HUSSEIN KADHEM BANDER METHODS OF STEGANOGRAPHY IMAGES WHEN IMAGES HAVE 125×125 DIMENSION

| **samples** | **Sudad method** | | **Hussein method** | | **The proposed method LSB Jaccard** | | |
|---|---|---|---|---|---|---|---|
| **file name** | **MSE** | **PSNR** | **MSE** | **PSNR** | **MSE** | **PSNR** | **SSIM** |
| MRI1 | 1.809728 | 45.55467 | 0.0496037 | 61.17566 | 0.008917 | 68.62846 | 0.000507 |
| MRI2 | 1.71712 | 45.7828 | 0.04926247 | 61.20564 | 0.009564 | 68.32421 | 0.000516 |
| MRI3 | 1.7504 | 45.69943 | 0.04554437 | 61.54646 | 0.009202 | 68.49209 | 0.000616 |
| MRI4 | 1.773376 | 45.6428 | 0.05315119 | 60.87567 | 0.008953 | 68.61118 | 0.000579 |
| MRI5 | 1.812928 | 45.547 | 0.05213461 | 60.95954 | 0.006087 | 70.28667 | 0.00052 |
| MRI6 | 1.5344 | 46.27142 | 0.05302335 | 60.88613 | 0.006187 | 70.21621 | 0.000522 |
| MRI7 | 1.712512 | 45.79447 | 0.05214886 | 60.95835 | 0.010389 | 67.96488 | 0.000482 |
| MRI8 | 1.817792 | 45.53536 | 0.04972468 | 61.16508 | 0.010205 | 68.04287 | 0.000479 |
| MRI9 | 1.739776 | 45.72587 | 0.04903502 | 61.22574 | 0.009963 | 68.14701 | 0.000465 |
| MRI10 | 1.762048 | 45.67063 | 0.04971751 | 61.16571 | 0.010453 | 67.93822 | 0.000477 |
| MRI11 | 1.71872 | 45.77875 | --- | --- | 0.010397 | 67.96193 | 0.000451 |
| MRI12 | 1.734976 | 45.73787 | --- | --- | 0.010169 | 68.05805 | 0.000434 |
| MRI13 | 1.74624 | 45.70976 | --- | --- | 0.010197 | 68.04593 | 0.000435 |
| MRI14 | 1.723712 | 45.76616 | --- | --- | 0.010091 | 68.09159 | 0.00045 |
| MRI15 | 1.777472 | 45.63278 | --- | --- | 0.010084 | 68.09464 | 0.000452 |
| MRI16 | 1.803136 | 45.57052 | --- | --- | 0.010283 | 68.00972 | 0.000471 |
| MRI17 | 1.786496 | 45.61078 | --- | --- | 0.010333 | 67.98875 | 0.000484 |
| MRI18 | 1.69504 | 45.839 | --- | --- | 0.010212 | 68.03985 | 0.000487 |
| MRI19 | 1.805568 | 45.56467 | --- | --- | 0.010482 | 67.92641 | 0.000472 |
| MRI20 | 1.787392 | 45.60861 | --- | --- | 0.010354 | 67.97977 | 0.000445 |
| MRI21 | 1.722432 | 45.76938 | --- | --- | 0.010283 | 68.00977 | 0.000813 |
| MRI22 | 1.75424 | 45.68991 | --- | --- | 0.01029 | 68.00678 | 0.000909 |
| MRI23 | 1.724928 | 45.76309 | --- | --- | 0.01046 | 67.93533 | 0.000895 |
| MRI24 | 1.735168 | 45.73739 | --- | --- | 0.010027 | 68.11927 | 0.000914 |
| MRI25 | 1.733696 | 45.74107 | --- | --- | 0.010325 | 67.9918 | 0.000924 |
| Avg | 1.74717184 | 45.7097676 | 0.050335 | 61.1164 | 0.009756 | 68.27646 | 0.000568 |

TABLE II
COMPARATIVE PERFORMANCE FOR PROPOSED METHOD LSB JACCARD , SUDAD NAJIM ABED AND HUSSEIN KADHEM BANDER METHODS OF STEGANOGRAPHY IMAGES WHEN IMAGES HAVE 250×250 DIMENSION

| **samples** | **Sudad method** | | **Hussein method** | | **The proposed method LSB Jaccard** | | |
|---|---|---|---|---|---|---|---|
| **file name** | **MSE** | **PSNR** | **MSE** | **PSNR** | **MSE** | **PSNR** | **SSIM** |
| MRI1 | 1.97736 | 45.16994616 | 0.0466255 | 61.44457 | 0.002314667 | 74.48592 | 0.000483086 |
| MRI2 | 1.887008 | 45.3730662 | 0.04665039 | 61.44225 | 0.002307551 | 74.49929 | 0.000489902 |
| MRI3 | 1.926112 | 45.28398824 | 0.04567461 | 61.53405 | 0.002247123 | 74.61453 | 0.000586822 |
| MRI4 | 1.896288 | 45.35176064 | 0.05345755 | 60.85071 | 0.002346669 | 74.42628 | 0.000553004 |
| MRI5 | 2.02944 | 45.05704145 | 0.05319807 | 60.87185 | 0.000357332 | 82.60008 | 0.000496877 |
| MRI6 | 1.699856 | 45.82668228 | 0.05363532 | 60.8363 | 0.000357332 | 82.60008 | 0.000499058 |
| MRI7 | 1.870224 | 45.41186735 | 0.05375794 | 60.82638 | 0.002581351 | 74.01233 | 0.000458564 |
| MRI8 | 1.94848 | 45.23384408 | 0.04636779 | 61.46864 | 0.002704015 | 73.81071 | 0.000455312 |
| MRI9 | 1.918208 | 45.30184663 | 0.04617405 | 61.48682 | 0.002590235 | 73.99741 | 0.000442444 |
| MRI10 | 1.942992 | 45.24609348 | 0.04643177 | 61.46265 | 0.00261157 | 73.96178 | 0.000453834 |
| MRI11 | 1.845664 | 45.4692772 | --- | --- | 0.0025369 | 74.08777 | 0.000429464 |
| MRI12 | 1.932288 | 45.27008504 | --- | --- | 0.002609781 | 73.96477 | 0.000414447 |
| MRI13 | 1.903264 | 45.33581328 | --- | --- | 0.002540448 | 74.0817 | 0.000415275 |
| MRI14 | 1.914032 | 45.31131167 | --- | --- | 0.002552896 | 74.06047 | 0.000429322 |
| MRI15 | 1.964704 | 45.19783232 | --- | --- | 0.002552896 | 74.06047 | 0.000430797 |
| MRI16 | 1.96752 | 45.19161205 | --- | --- | 0.002419565 | 74.29343 | 0.000448806 |

| samples | Sudad method | | Hussein method | | The proposed method LSB Jaccard | | |
|---|---|---|---|---|---|---|---|
| file name | MSE | PSNR | MSE | PSNR | MSE | PSNR | SSIM |
| MRI17 | 1.97448 | 45.17627622 | --- | --- | 0.002640011 | 73.91475 | 0.000461443 |
| MRI18 | 1.868048 | 45.4169233 | --- | --- | 0.002549346 | 74.06651 | 0.000464157 |
| MRI19 | 1.95848 | 45.2116122 | --- | --- | 0.002487137 | 74.17381 | 0.000451356 |
| MRI20 | 1.957088 | 45.21470007 | --- | --- | 0.002490694 | 74.1676 | 0.000426838 |
| MRI21 | 1.9124 | 45.31501626 | --- | --- | 0.002497772 | 74.15527 | 0.000741253 |
| MRI22 | 1.907536 | 45.32607618 | --- | --- | 0.002543986 | 74.07565 | 0.00081221 |
| MRI23 | 1.90424 | 45.33358677 | --- | --- | 0.002584877 | 74.00641 | 0.000797851 |
| MRI24 | 1.903584 | 45.33508315 | --- | --- | 0.002503096 | 74.14603 | 0.000808852 |
| MRI25 | 1.915632 | 45.30768278 | --- | --- | 0.002591982 | 73.99448 | 0.000819047 |
| Avg | 1.91699712 | 45.306761 | 0.049197 | 61.22242 | 0.002340769 | 74.8103012 | 0.000530801 |

TABLE III

COMPARATIVE PERFORMANCE FOR PROPOSED METHOD LSB JACCARD, SUDAD NAJIM ABED AND HUSSEIN KADHEM BANDER METHODS OF STEGANOGRAPHY IMAGES WHEN IMAGES HAVE 512×512 DIMENSION

| samples | Sudad method | | Hussein method | | The proposed method LSB Jaccard | | |
|---|---|---|---|---|---|---|---|
| file name | MSE | PSNR | MSE | PSNR | MSE | PSNR | SSIM |
| MRI1 | 2.036514282 | 45.04192901 | 0.1730302 | 55.74958 | 0.000517 | 80.99857 | 0.000445 |
| MRI2 | 1.877239227 | 45.3956074 | 0.1682519 | 55.8712 | 0.000509 | 81.0668 | 0.00045 |
| MRI3 | 1.924274445 | 45.28813349 | 0.1527259 | 56.29168 | 0.000562 | 80.63642 | 0.000532 |
| MRI4 | 1.911251068 | 45.3176262 | 0.1807513 | 55.55999 | 0.00051 | 81.05595 | 0.000505 |
| MRI5 | 1.943630219 | 45.24466718 | 0.1868587 | 55.41567 | 5.68E-05 | 90.58759 | 0.000455 |
| MRI6 | 1.737731934 | 45.73097579 | 0.1791579 | 55.59845 | 5.68E-05 | 90.58759 | 0.000457 |
| MRI7 | 1.914749146 | 45.30968476 | 0.1778001 | 55.63148 | 0.000637 | 80.09191 | 0.000427 |
| MRI8 | 1.941310883 | 45.24985272 | 0.1729732 | 55.75101 | 0.000608 | 80.29314 | 0.000424 |
| MRI9 | 1.932186127 | 45.27031401 | 0.1700507 | 55.82502 | 0.000589 | 80.43161 | 0.000412 |
| MRI10 | 1.937366486 | 45.25868578 | 0.1679534 | 55.87892 | 0.000593 | 80.40045 | 0.000423 |
| MRI11 | 1.913192749 | 45.31321635 | --- | --- | 0.000627 | 80.15601 | 0.000401 |
| MRI12 | 1.936374664 | 45.26090969 | --- | --- | 0.00061 | 80.28103 | 0.000388 |
| MRI13 | 1.896503448 | 45.35126724 | --- | --- | 0.000634 | 80.10929 | 0.000388 |
| MRI14 | 1.939590454 | 45.25370323 | --- | --- | 0.000608 | 80.29312 | 0.0004 |
| MRI15 | 1.939495087 | 45.25391677 | --- | --- | 0.000632 | 80.12675 | 0.000402 |
| MRI16 | 1.905849457 | 45.32991768 | --- | --- | 0.000632 | 80.12675 | 0.000417 |
| MRI17 | 1.909034729 | 45.32266532 | --- | --- | 0.000629 | 80.14135 | 0.000429 |
| MRI18 | 1.902450562 | 45.33766981 | --- | --- | 0.000613 | 80.25693 | 0.000432 |
| MRI19 | 1.916313171 | 45.30613876 | --- | --- | 0.000621 | 80.19726 | 0.000421 |
| MRI20 | 1.945339203 | 45.24085022 | --- | --- | 0.000625 | 80.17362 | 0.000399 |
| MRI21 | 1.928749084 | 45.27804628 | --- | --- | 0.000637 | 80.09191 | 0.000656 |
| MRI22 | 1.894256592 | 45.35641554 | --- | --- | 0.000621 | 80.20322 | 0.000708 |
| MRI23 | 1.894332886 | 45.35624062 | --- | --- | 0.000596 | 80.38187 | 0.000697 |
| MRI24 | 1.894226074 | 45.3564855 | --- | --- | 0.000638 | 80.0804 | 0.00071 |
| MRI25 | 1.894226074 | 45.3564855 | --- | --- | 0.000635 | 80.10064 | 0.000718 |
| Avg | 1.914647522 | 45.31125619 | 0.172955 | 55.7573 | 0.00056 | 81.15481 | 0.000484 |

TABLE IV

COMPARATIVE PERFORMANCE FOR PROPOSED METHOD MSB JACCARD, SUDAD NAJIM ABED AND HUSSEIN KADHEM BANDER METHODS OF STEGANOGRAPHY IMAGES WHEN IMAGES HAVE 125×125 DIMENSION

| samples | Sudad method | | Hussein method | | The proposed method MSB Jaccard | | |
|---|---|---|---|---|---|---|---|
| file name | MSE | PSNR | MSE | PSNR | MSE | PSNR | SSIM |
| MRI1 | 1.21856 | 47.27233443 | 0.04478258 | 61.61971 | 0.032299 | 63.03892 | 0.000507 |
| MRI2 | 1.20576 | 47.31819488 | 0.04467173 | 61.63047 | 0.03104 | 63.21154 | 0.000516 |
| MRI3 | 1.213568 | 47.29016245 | 0.04405297 | 61.69105 | 0.032171 | 63.05616 | 0.000616 |
| MRI4 | 1.220288 | 47.2661802 | 0.05481656 | 60.74169 | 0.03146 | 63.15323 | 0.000579 |
| MRI5 | 1.1504 | 47.52231488 | 0.0545953 | 60.75925 | 0.021156 | 64.87653 | 0.00052 |
| MRI6 | 1.13728 | 47.57212959 | 0.05402113 | 60.80517 | 0.021433 | 64.81997 | 0.000522 |
| MRI7 | 1.2416 | 47.19098657 | 0.05485563 | 60.73859 | 0.035058 | 62.68295 | 0.000482 |
| MRI8 | 1.249024 | 47.16509577 | 0.04404915 | 61.69143 | 0.03382 | 62.839 | 0.000479 |
| MRI9 | 1.241344 | 47.19188211 | 0.04410266 | 61.68616 | 0.033998 | 62.81624 | 0.000465 |
| MRI10 | 1.239232 | 47.19927741 | 0.04418293 | 61.67826 | 0.034432 | 62.76118 | 0.000477 |
| MRI11 | 1.244416 | 47.18114774 | --- | --- | 0.035549 | 62.62259 | 0.000451 |
| MRI12 | 1.231424 | 47.22672747 | --- | --- | 0.035165 | 62.66973 | 0.000434 |
| MRI13 | 1.2576 | 47.13537832 | --- | --- | 0.034461 | 62.75756 | 0.000435 |
| MRI14 | 1.238848 | 47.20062337 | --- | --- | 0.034013 | 62.81439 | 0.00045 |
| MRI15 | 1.233024 | 47.22108831 | --- | --- | 0.035207 | 62.66447 | 0.000452 |
| MRI16 | 1.268544 | 47.09774825 | --- | --- | 0.034283 | 62.78004 | 0.000471 |
| MRI17 | 1.2576 | 47.13537832 | --- | --- | 0.034354 | 62.77104 | 0.000484 |
| MRI18 | 1.199424 | 47.34107626 | --- | --- | 0.034176 | 62.79358 | 0.000487 |

| samples | Sudad method | | Hussein method | | The proposed method MSB Jaccard | | |
|---|---|---|---|---|---|---|---|
| file name | MSE | PSNR | MSE | PSNR | MSE | PSNR | SSIM |
| MRI19 | 1.265088 | 47.10959625 | --- | --- | 0.035676 | 62.60698 | 0.000472 |
| MRI20 | 1.265088 | 47.10959625 | --- | --- | 0.033949 | 62.82259 | 0.000445 |
| MRI21 | 1.213184 | 47.29153687 | --- | --- | 0.034916 | 62.70056 | 0.000813 |
| MRI22 | 1.23008 | 47.23147004 | --- | --- | 0.034632 | 62.73609 | 0.000909 |
| MRI23 | 1.215872 | 47.28192504 | --- | --- | 0.033856 | 62.8344 | 0.000895 |
| MRI24 | 1.225216 | 47.24867701 | --- | --- | 0.033942 | 62.82347 | 0.000914 |
| MRI25 | 1.228352 | 47.23757524 | --- | --- | 0.034759 | 62.72007 | 0.000924 |
| Avg | 1.22763264 | 47.24152412 | 0.048413 | 61.30418 | 0.033032 | 62.97493 | 0.000568 |

TABLE V

COMPARATIVE PERFORMANCE FOR PROPOSED METHOD MSB JACCARD, SUDAD NAJIM ABED AND HUSSEIN KADHEM BANDER METHODS OF STEGANOGRAPHY IMAGES WHEN IMAGES HAVE 250×250 DIMENSION

| samples | Sudad method | | Hussein method | | The proposed method MSB Jaccard | | |
|---|---|---|---|---|---|---|---|
| file name | MSE | PSNR | MSE | PSNR | MSE | PSNR | SSIM |
| MRI1 | 1.326784 | 46.9028 | 0.1632809 | 56.00145 | 0.008133 | 69.02808 | 0.000483 |
| MRI2 | 1.31504 | 46.94141 | 0.1595647 | 56.10143 | 0.007828 | 69.1945 | 0.00049 |
| MRI3 | 1.320816 | 46.92238 | 0.1532035 | 56.27811 | 0.007554 | 69.34914 | 0.000587 |
| MRI4 | 1.320208 | 46.92438 | 0.1859117 | 55.43774 | 0.007284 | 69.50734 | 0.000553 |
| MRI5 | 1.246896 | 47.1725 | 0.1842818 | 55.47598 | 0.001458 | 76.4939 | 0.000497 |
| MRI6 | 1.24768 | 47.16977 | 0.1789682 | 55.60305 | 0.001458 | 76.4939 | 0.000499 |
| MRI7 | 1.37992 | 46.73226 | 0.1791608 | 55.59837 | 0.008411 | 68.88248 | 0.000459 |
| MRI8 | 1.357824 | 46.80237 | 0.1634848 | 55.99603 | 0.009001 | 68.58794 | 0.000455 |
| MRI9 | 1.373456 | 46.75266 | 0.1590756 | 56.11477 | 0.008724 | 68.72384 | 0.000442 |
| MRI10 | 1.370688 | 46.76142 | 0.1603907 | 56.07901 | 0.008805 | 68.68333 | 0.000454 |
| MRI11 | 1.355392 | 46.81015 | --- | --- | 0.008727 | 68.72208 | 0.000429 |
| MRI12 | 1.366736 | 46.77396 | --- | --- | 0.008637 | 68.76741 | 0.000414 |
| MRI13 | 1.368528 | 46.76827 | --- | --- | 0.008309 | 68.93511 | 0.000415 |
| MRI14 | 1.351408 | 46.82294 | --- | --- | 0.008562 | 68.80513 | 0.000429 |
| MRI15 | 1.384176 | 46.71889 | --- | --- | 0.008873 | 68.65012 | 0.000431 |
| MRI16 | 1.380256 | 46.73121 | --- | --- | 0.008923 | 68.62583 | 0.000449 |
| MRI17 | 1.379664 | 46.73307 | --- | --- | 0.008756 | 68.70794 | 0.000461 |
| MRI18 | 1.369408 | 46.76548 | --- | --- | 0.008469 | 68.85229 | 0.000464 |
| MRI19 | 1.39896 | 46.67275 | --- | --- | 0.008699 | 68.73627 | 0.000451 |
| MRI20 | 1.414512 | 46.62474 | --- | --- | 0.008757 | 68.70708 | 0.000427 |
| MRI21 | 1.338048 | 46.86609 | --- | --- | 0.008661 | 68.75491 | 0.000741 |
| MRI22 | 1.331008 | 46.889 | --- | --- | 0.008651 | 68.76026 | 0.000812 |
| MRI23 | 1.337536 | 46.86775 | --- | --- | 0.008718 | 68.72649 | 0.000798 |
| MRI24 | 1.327408 | 46.90076 | --- | --- | 0.008953 | 68.61114 | 0.000809 |
| MRI25 | 1.339472 | 46.86147 | --- | --- | 0.008651 | 68.76027 | 0.000819 |
| Avg | 1.34807296 | 46.8355392 | 0.168732 | 55.86859 | 0.00796 | 69.44267 | 0.000531 |

TABLE VI

COMPARATIVE PERFORMANCE FOR PROPOSED METHOD MSB JACCARD, SUDAD NAJIM ABED AND HUSSEIN KADHEM BANDER METHODS OF STEGANOGRAPHY IMAGES WHEN IMAGES HAVE 512×512 DIMENSION

| samples | Sudad method | | Hussein method | | The proposed method MSB Jaccard | | |
|---|---|---|---|---|---|---|---|
| file name | MSE | PSNR | MSE | PSNR | MSE | PSNR | SSIM |
| MRI1 | 1.3358383 | 46.87326 | 0.1552551 | 56.22034 | 0.001993 | 75.13576 | 0.000445 |
| MRI2 | 1.3401718 | 46.8592 | 0.1534092 | 56.27229 | 0.001622 | 76.02998 | 0.00045 |
| MRI3 | 1.3202171 | 46.92435 | 0.1469943 | 56.4578 | 0.001643 | 75.97362 | 0.000532 |
| MRI4 | 1.3250885 | 46.90835 | 0.1901397 | 55.34008 | 0.001598 | 76.09515 | 0.000505 |
| MRI5 | 1.2719269 | 47.08618 | 0.1901526 | 55.33978 | 0.000227 | 84.56699 | 0.000455 |
| MRI6 | 1.3478355 | 46.83443 | 0.183803 | 55.48728 | 0.000227 | 84.56699 | 0.000457 |
| MRI7 | 1.3976898 | 46.6767 | 0.181969 | 55.53083 | 0.002309 | 74.49622 | 0.000427 |
| MRI8 | 1.3824539 | 46.7243 | 0.1523289 | 56.30298 | 0.002153 | 74.80081 | 0.000424 |
| MRI9 | 1.3937263 | 46.68903 | 0.1522143 | 56.30625 | 0.002182 | 74.74135 | 0.000412 |
| MRI10 | 1.3832588 | 46.72177 | 0.1529645 | 56.2849 | 0.002155 | 74.79567 | 0.000423 |
| MRI11 | 1.395195 | 46.68445 | --- | --- | 0.002294 | 74.525 | 0.000401 |
| MRI12 | 1.39077 | 46.69825 | --- | --- | 0.002265 | 74.58073 | 0.000388 |
| MRI13 | 1.3732567 | 46.75329 | --- | --- | 0.001977 | 75.17101 | 0.000388 |
| MRI14 | 1.3898888 | 46.701 | --- | --- | 0.002302 | 74.51058 | 0.0004 |
| MRI15 | 1.3923035 | 46.69346 | --- | --- | 0.002187 | 74.73209 | 0.000402 |
| MRI16 | 1.3894615 | 46.70234 | --- | --- | 0.002138 | 74.82998 | 0.000417 |
| MRI17 | 1.3910599 | 46.69735 | --- | --- | 0.002226 | 74.65533 | 0.000429 |
| MRI18 | 1.3993111 | 46.67166 | --- | --- | 0.002319 | 74.47871 | 0.000432 |
| MRI19 | 1.3970375 | 46.67872 | --- | --- | 0.002196 | 74.71446 | 0.000421 |
| MRI20 | 1.4143867 | 46.62512 | --- | --- | 0.002186 | 74.73378 | 0.000399 |

| samples | Sudad method | | Hussein method | | The proposed method MSB Jaccard | | |
|---|---|---|---|---|---|---|---|
| file name | MSE | PSNR | MSE | PSNR | MSE | PSNR | SSIM |
| MRI21 | 1.3439407 | 46.847 | --- | --- | 0.002131 | 74.8455 | 0.000656 |
| MRI22 | 1.3442459 | 46.84602 | --- | --- | 0.002058 | 74.99667 | 0.000708 |
| MRI23 | 1.3408165 | 46.85711 | --- | --- | 0.002206 | 74.69521 | 0.000697 |
| MRI24 | 1.3495331 | 46.82897 | --- | --- | 0.002165 | 74.77608 | 0.00071 |
| MRI25 | 1.3442078 | 46.84614 | --- | --- | 0.002133 | 74.84118 | 0.000718 |
| Avg | 1.366144864 | 46.777138 | 0.165923 | 55.95425 | 0.001956 | 75.69155 | 0.000484 |

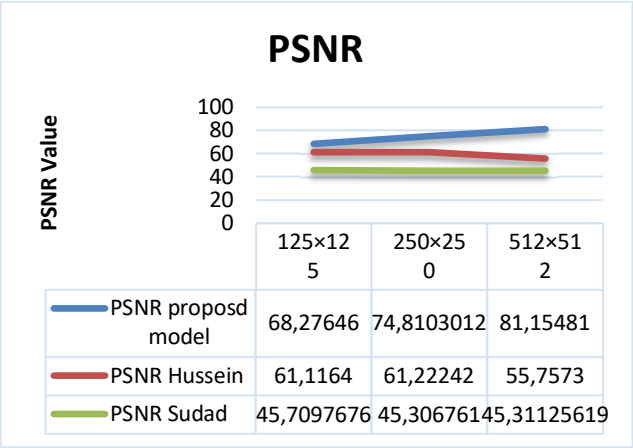


Fig. 5 Average for PSNR results for proposed model , Sudad Najim Abed and Hussein kadhem Bander methods for LSB Jaccard ,When size images 125 *125,250*250 and 512*512

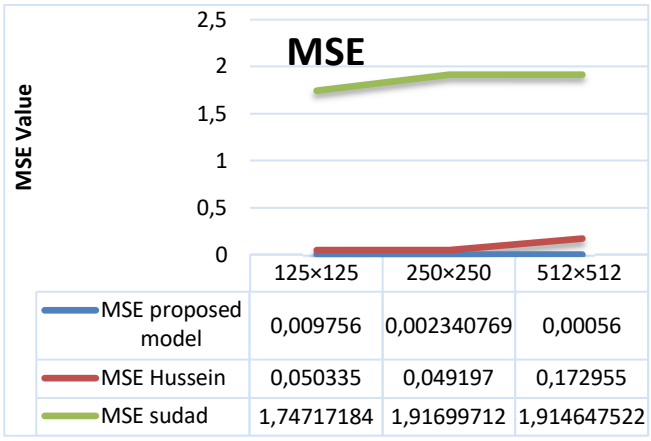


Fig. 6 Average for PSNR results for proposed model , Sudad Najim Abed and Hussein kadhem Bander for LSB Jaccard, When size images 125 *125,250*250 and 512*512 .

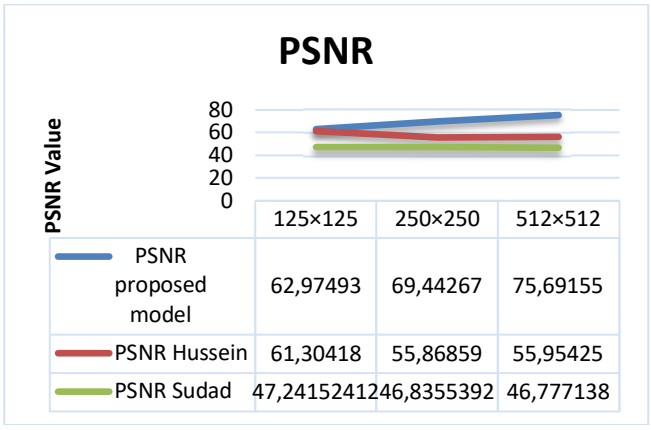


Fig. 7 Average for PSNR results for proposed model , Sudad Najim Abed and Hussein kadhem Bander or MSB Jaccard, When size images 125 *125,250*250 and 512*512

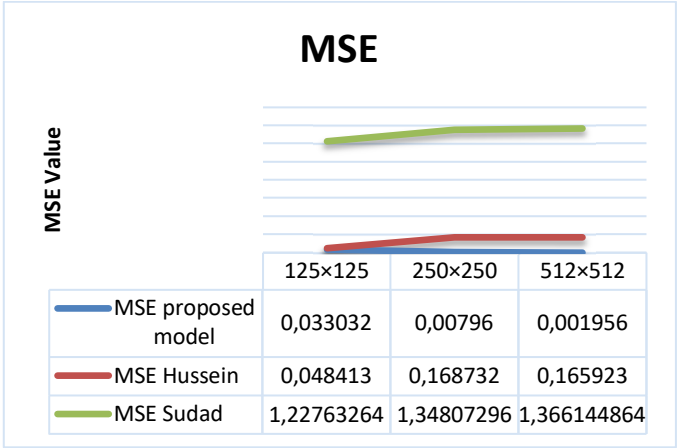


Fig. 8 Average for MSE results for proposed model , Sudad Najim Abed and Hussein kadhem Bander for MSB Jaccard, When size images 125 *125,250*250 and 512*512 .

## IV. Conclusion

In conclusion, the model that was provided is a testament to increased patient information security. Its sophisticated use of LSB and MSB Jaccard distribution was accomplished inside an encapsulating cover image. In other words, the model serves as a monument to enhanced patient information security. An exhaustive investigation was carried out by doing painstaking technical analyses and making in-depth comparisons of important parameters such as PSNR, MSE, and SSIM. The evaluation technique utilized a varied main dataset with 25 MRI samples and spanned the pixel dimensions of 125 × 125, 250 x 250, and 512 x 512, respectively.

Clearly, the recently presented model was head and shoulders above its competitors, whose achievements are best demonstrated by the work of Sudad Najim Abed and Hussein Kadhem Bander. Its performance demonstrated unmatched levels of both efficiency and safety at an unprecedented level. The research results, which are about to end, highlight the enormous leaps that have been accomplished in enhancing the security of patient data inside telemedicine frameworks. This approach can potentially transform the landscape of patient information security, creating a future with improved healthcare confidentiality and integrity. This promise has been confirmed by the combination of sophisticated concealing techniques and the substantial improvement of relevant metrics.

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