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Fusion of Image by Integrating ASAR using Hybrid Pan sharpening Technique

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ABSTRACT: The task of multi-sensor image fusion is to combining several images from the different sensors and fuses it into the single images. Here the ASAR images are first register and then it is fused into the single image, then the dynamic and stationary areas are divided from that fused images. The stationary area of the image is incorporated by the novel fusion scheme and then the panchromatic images are obtained. In conclusion the dynamic areas and the incorporated stationary areas of the images are combined into the single multispectral image by using the hybrid PAN sharpening method.

KEYWORDS: Listing, segmentation, transformation, hybrid PAN sharpening.

I. INTRODUCTION

The hasty expansion in the ground of sensing technologies, multisensor image system is majorly used in military and sensing technologies. Where the process of multisensor image fusion is to coordinate the several ASAR images into the single image to improve the concentration in the remote sensing images [2][3]. The main purpose of multisensor image fusion is to merge the flattering in sequence from the multi sensors images of the same sight into the single images to upgrade the quality of the images as more useful by falling the sketchiness and insecurity in the spatial property [3].Those images are more useful for the supplementary responsibilities like segmentation, image classification and the local revolutionize exposure [4][5][6]. This category of mixture is called as pixel level multisensor image fusion [4]. The multisensor image fusion is based on power intonation for incorporating the ASAR and PAN character into MS images [7], those characters slander on SAR surface extract by quotienting the de-spotted SAR image to its small overtake estimate with"à trous" wavelet disintegration. It can fine-tune the quantity of incorporation by means of a porch to stay away from occupied incorporation of ASAR character. The ensemble empirical mode decomposition(EMD)is used to mingle the estimate flat surface of the ASAR image with the MS image[8].In this proposed scheme the incorporation is based on coalesce the wavelet conversion and the elective fusion of ASAR in sequence generate the incorporated diagram. In common sky-scraping backscattering reaction occurs in artificial radar images due to the large dielectric material goods of manufacture such as metal and the statistical shape of numerous matters. The backscatter intensities of the majority heavily occupied metropolitan area in ASAR images therefore enclose diverse quality, excluding for a little areas where short mount structure with flat tops are secluded from adjacent structure. These diverse characters have negative outcome on the interpretability of this neighbourhood in the fused image.

II. PROPOSED ALGORITHM (FUSION PROCESS)

In the fusion process it consists of four steps. The first step is listing, which is the process of estimate and most favorable alteration to resolve the point to point association among the multisensor images of the comparable sight. The second process is the extraction of the dynamic and stationary image using the quad tree data structure. The subsequently process is the incorporation of ASAR and PAN images through novel feature selection rule. After all the hybrid PAN sharpening method is implemented, is to fuse the PS and MS images.

A. *Co-Listing of Multisensor Images:*

The fundamental of multisensor image fusion is to co-listing the images into the numerous images attain from the dissimilar sensors. In the ASAR images, the typical blast is known as speckle. A solitary pixel in the ASAR image

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encloses several flings which fabricate speckle. Those speckles causes' echoes that will corrupt the in sequence restricted in the images and not only that it will also openly change the precision of the images and reduce the excellence of the fused images. Due to this the various cut back algorithm is second-hand to diminish the speckles in this paper the Lee filter [10] is use to diminish the speckles. Behind that cutback mutual in sequence is used to decode the x and y direction. The coarsest pyramid images of every one sensor created by the Gaussian Pyramid scheme to uncover the preliminary conversion difference of the x, y direction. The MI computation functional to the pyramid image helps to pull out the total optimization values. After the initial value dissimilarities are determined the sensed images were altered and the line attribute are taken out by the canny edge operator.

B. *Removal of Dynamic and Stationary areas:*

In this sector the algorithm used for taken out the stationary areas from the ASAR images. The surface image is fashioned by gray level co-occurrence matrix (GLCM) and this image is detachment into situate a choice of sizes of block sections by the quad tree data structure. At last the areas in the segmented sections are taken out as stationary areas. After erecting the GLCM the entropy is deliberated. Entropy course the chance of the essentials of the co-occurrence matrix, here when the value is 0 then the essential are poles apart ,when it is maximum then the essentials are same. The entropy equation is :

$$Ent = -\sum_{x}^{D}\sum_{y}^{D} p_{xy}\log_2(\mathrm{p_{xy}}) \qquad \rightarrow (1)$$

Here $\mathrm{p_{xy}}$ represents the essentials of co-occurrence matrix. Formerly the surface is produced in the GLCM, Quad tree structured split and merge (QSM) segmentation is used, due to its plainness and working out effectiveness [11]. QSM is based on top-down approach which starts with the entire image and partition into four sub-sections based on homogeneity of the sections. Formerly spitting has been talented then the merging is performed. The merging process must check this homogeneity criterion:

$$H(S_x) = \frac{d(s_x)}{\sigma(I)} \qquad \rightarrow (2)$$

$$d(S_x) = \frac{1}{|s_x|}\sum_{(i,j)\in}(I(i,j) - \mu(s_x))^2 \quad \rightarrow (3)$$

$$\mu(s_x) = \frac{1}{|s_x|}\sum_{(i,j)\in}(I(i,j) \qquad \rightarrow (4)$$

Where the $H(S_x)$ represent the homogeneity compute of the region. If the $H(S_x)$ value is high then it is said to be homogenous sections, if it is low then it is said to be non homogeneous sections.

C. *Wavelet Conversion:*

For the phase space or time frequency investigation of signals the wavelet conversion is the very successful instrument with several balance of declaration. Along with the various relevance, multi-resolution breakdown of an image is appropriate for pixel level image fusion, while it will gives the creative images fine details. Normally the Mallet algorithm [12] is used but it produces the non-shift-invariant for the reason that it fundamental the down sampling development in DWT. This generates the artifacts in the merged image. Thus in this paper "à trous" wavelet transform (AWT) [13] is used, by this which attain the shift variant DWT for the images. The AWT is similar to that of the Laplacian Pyramid. The next equations explain how the complete images are attained:

$$a_{y=}a_{y-1*}k_y \qquad \rightarrow (5)$$

$$d_y = a_{y-1-}a_y \qquad \rightarrow (6)$$

Where $a_y and d_y$ are the approximation, Here the filter k is up-sampled by placing in$2^y - 1$ zeroes connecting its samples. The inverse convert to find the unique image isa_0.

$$a_{0=}a_{s+}d_{0+}d_{1+\cdots+}d_s \qquad \rightarrow (7)$$

D. *Integration Scheme for the Images:*

In our proposed system the central design is to execute the selective fusion instead of completely incorporating the ASAR images to get the PAN images. Because the ASAR quality of the stationary part have negative end product on the interpretability of these merged images. The AWT is to make the wavelet breakdown of the foundation image. Then

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the wavelet approximation image is joined with the quality selection rule. As a final point the PAN and ASAR in sequence are created. The complete method is as follows:

1. Relate the histogram matching [14] to match the histogram of PAN and ASAR images to correct the backscatter intensities stand on gray scale values
2. Using the AWT two level breakdowns both the PAN and ASAR images are decayed.
3. An inverse AWT is performed to get a fused image.

Histogram matching can be second-hand to stabilize two images that can gain at the similar position but by the diverse sensors. Histogram matching is performed in the ASAR image is:

$$S_H = \frac{\sigma_{PAN}}{\sigma_{SAR}} * \left(SAR_{(P)-}\square_{SAR}\right) + \square_{PAN} \quad \rightarrow(8)$$

The scheme to produce the original approximation image can be articulated as

$$a_N(PO) = \begin{cases} a_N(P) if M(p) = true \\ a_N(P)Xw_1 + a_N(O)Xw_2 otherwise \end{cases} \quad \rightarrow(9)$$

E. *Hybrid PAN sharpening Algorithm:*

The variety of applications based on high spatial declaration satellite imagery is to increase the spatial resolution of MS images with PAN images. The hybrid PAN sharpening algorithm is to advance the spatial superiority of a PAN sharpened image while continuing the unique MS images spectral quality. The overall procedure is expressed as:

$$F_n^h = MS_n^l + \lambda_n.[\mu_n.H_n + v_n.Lap(H_n)] \quad \rightarrow(10)$$

Let F_n^h be the merged image on the band by means of high spatial resolution. Then the edge pixels are removed by the selective median and mean filter behind extorting edges via Laplacian of a Gaussian filter. In order to judge the quantity of spatial in sequence in the integrated records and to optimize the addition of spatial in sequence the equation is expressed

$$\lambda_{n(i,j)} = \frac{S_n}{W_l} * \sqrt{\frac{\sigma(MS_{n}{}^{l}{}_{(i,j)})}{\sigma(I_{n(i,j)}^l}} s_{n(i,j)} \quad \rightarrow(11)$$

III. Performance Measures

The image quality valuation methodologies created on determining the dissimilarities between both the fused and original images, it has been classified into

- Pixel Difference Measures:

  This measure is used for compute the pixel wise differences between two images. It includes:
  1. Mean Square Error (MSE) is used for measure the Mean squared error between both the images.
  2. Peak Signal to Noise Ratio (PSNR) is used for measure the maximum possible pixel difference between both the images. The above two MSE and PSNR are the Error metrics for compare image compression Quality.
  3. Signal to Noise Ratio (SNR) is used for measure the ratio of useful information to false or irrelevant data in a conversation or exchange.
  4. Structural Content (SC) is used for identify the structural (blocking) artifact difference between both the images.
  5. Maximum Difference (MD) is used for measuring the maximum of the error signal difference (color difference) between both the Images.
  6. Average Difference (AD) is used for measuring the average color difference.
  7. Normalized Absolute Error (NAE) is used for measuring the Normalized color difference between both the Images.
  8. R-Averaged Maximum Difference (RAMD) is used for find the r-highest pixel difference between both the images.
  9. Laplacian Mean Square Error (LMSE) is used for measure the mean square error in L-shaped domain.

- Correlation Based Measures:

  The image quality metric is used for find the angle statistics difference between two images. It includes:
  1. Normalized Cross Correlation is used for checking whether the input image is subset of another image in database or not.

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2. Mean Angle Similarity (MAS) which is used for find the scaled difference between two images. For example, both of the image having the same shape. But, the shape is scaled differently. This difference is identified while performing Mean Angle Similarity.
3. Mean Angle Magnitude Similarity (MAMS) is used for identified the difference for size of the object between two images.

- Edge Based Measures:
  Edges and corners are most informative part of an image which is play important role in the human visual system. It includes:
  1. Total Edge Difference (TED) is used for find out the edge difference between two images. Total Edge Difference is performed by using Sobel operator.
  2. Total Corner Difference (TCD) is used for find out the corner difference between two images. Total Corner Difference is performed by using Harris Corner Detector.
- Spectral Based Difference: The image quality metric considers the Spectral related features. It includes: Spectral Magnitude Error (SME) and Spectral Phase Error (SPE). To perform these measures, apply Fourier Transform to the input image. Fourier transform is Traditional image processing tool for applied to the Field of image quality assessment.
- Gradient Based Measures: The image quality metric consider the Gradient related features. It includes: Gradient Magnitude Error (GME) and Gradient Phase Error (GPE).Gradient conveys important role for visual Information used for quality assessment. If the Distortions may affect an image, then there is Change in its gradient. This metric is used for identify the structural and contrast difference between both the images.
- Structural Similarity Measures: This image quality measure considers the non-structural distortions. It includes: Structural Similarity Index Measure (SSIM) is used for brightness changes between two images and this non-structural should be treated differ from the structural ones. This SSIM considers only the image resolution. Mean Structural Similarity Index Measure (MSSIM) is better indication of image quality than Structural Similarity Index Measure. Weighted Structural Similarity Index Measure (WSSIM) provides efficient result than Structural Similarity Index Measure.
- Information Theoretic Measures: This image quality measure is used for identify the mutual information between two images. It Include: Visual Information Fidelity (VIF) is the quality fidelity as the ratio between the total information in the original image and the total information in the distorted image. Reduced Reference Entropy Difference (RRED) does not require the entire image information. It measures the amount of local difference between the original image and the distorted image.
- No Reference: No Reference Image Quality Measures estimate the quality of an image according to some pre-trained statistical models. It classified into the following types:
  1. Distortion Specific Approaches: This approach provides the quality score for specific distortion (JPEG, blur, noise, and block). It includes: JPEG Quality Index (JQI) used for identify the input image affected by blackness or not. High Low Frequency Index (HLFI) is used for detect noise and blur in an input image.
  2. Training Based Approaches: This metric provide the general quality score not related to specific distortion. It includes: Blind Image Quality Index (BIQI) having two stages. First stage is classification stage and it checks the probability of each distortion in the image. Second stage evaluates the quality of the image along with each of the distortions. There are some distortions available and they are as follows: JPEG, JPEG 2000 (JP2K), White Noise (WN), Gaussian Blur and Fast Fading (FF). These distortions are found out from the image and final quality score obtained.
  3. Natural Scene Statistics: This metric use a priori knowledge taken from the natural scene distortion free images for train this NSS model. It extracts the pixel values by using a priori knowledge. The pixel values are compared with the pixels which of the image stored in the database.

IV. EXPERIMENTAL OUTCOME

In this paper, the two images from different dataset are taken, in order to fuse them into single image so the further process can be held very easily in which those images are combined into single image as MS image. The similar spatial resolution of PAN image and ASAR image was obtained from the MS image which was re-sampled. This increases the qualitative and quantitative analyses by using hybrid pan sharpening method. The integration of both the images are

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based the magnitude ratio. The pan sharpened image of MS, PAN and ASAR was applied to estimate the quality of the fused images. On comparing the unique outcome with our integration result, the expected difference was indicated. This was because of the insertion of extra information from ASAR image. Hence this multisensor fusion is able to protect most of the spectral information in fused image. Thus the outcome from the MBT-CW scheme does not reproduce the authority of speckles in ASAR images. As a result, we terminate that the proposed technique is being capable of sharpening the MS images. Multisensor image fusion, which is defined as the process of combining relevant information from two or more images into a single image, has been receiving increasing attention in the remote sensing research community due to the increasing availability of space borne imaging sensors. The objective of multisensor image fusion is to combine complementary information from multisensor images of the same scene into a single image to obtain data that is more useful than the data from any of the individual source images by reducing imprecision and uncertainty in the spatial properties and maintaining completeness of the spectral information. Thus input from two data set was got for fusion process which shown in Fig 1 and Fig. 2.

Fig .1 Input 1

Fig .2 Input 2

The images present in that data set may contain speckles. It is removed with the help of Lee filter. After that, Mutual Information (MI) was used to estimate the initial differences in translation of the x and y directions between images. The mutual information had been calculated using the entropy of two separate images with the joint entropy level of those two images. It is shown in Fig .3.

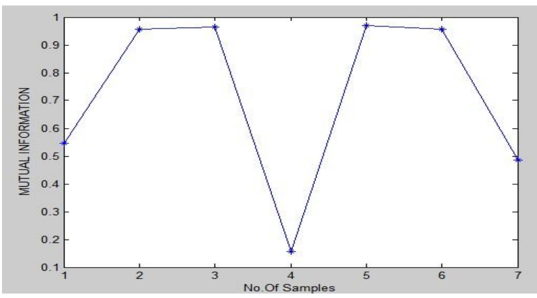

Fig .3.Mutual Information

After the pre-processing steps got completed those two images were fused. Since that fusion does not able to produce the enhancement of the image we are going to perform the further process. It will enhance the image and will produce the good spatial resolution. The fused image is shown in Fig.4.

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Fig .4 Initial fusion

Edge detection is the one form of segmentation technique. It is used to make the edges of the picture to visible accurately. So that it may be easy to get the inactive part exactly from one image to other image. It shows the entire information of the areas. The fusion of this area does not substantially affect the fusion quality of the ASAR image because the intensity variations between two images in this area are relatively small and consistent.

The edge detected images are contoured and the contoured output is fused into the single images for the extraction of the high quality images which is represented in Fig.5 & Fig.6.

Fig .5 Edge Detection

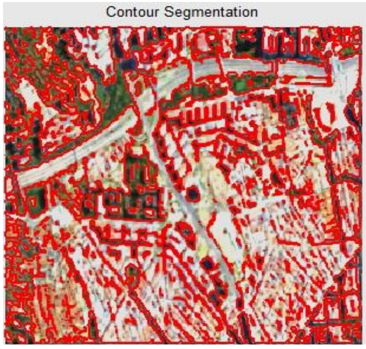

Fig.6 Contour

The colour image from the fused output which has RBG in it is converted to grey scale image. The grey image of the initial fusion is shown in Fig 4.6. It is used to separate the active and inactive areas from binary conversion.

Fig.7.Gray image

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The process of extracting the inactive area from the SAR image, which is based on texture segmentation with a quadtree data structure. For quadtree data structure, it is necessary to create a binary decision map(mask image) that is used to apply a different fusion rule within the detected inactive areas in a subsequent image fusion process. The texture image is first produced using the grey level co-occurrence matrix (GLCM), and this image is then partitioned into a set of block regions with various sizes through the process of texture segmentation, based on the quadtree data structure. Finally, all pixels included within the smallest region in the segmented regions are extracted as inactive areas.Thus by using the GLCM and the quadtree data structure the active and inactive areas were separated as shown in Fig.8 and Fig.9.In order to improve the PAN images of the spatial quality, the hybrid pan sharpening algorithm was developed.

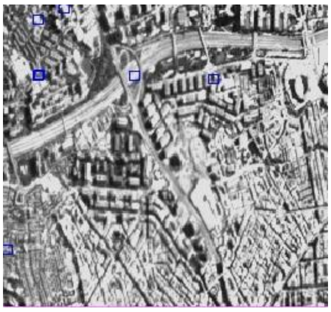

Fig 8.Active regions

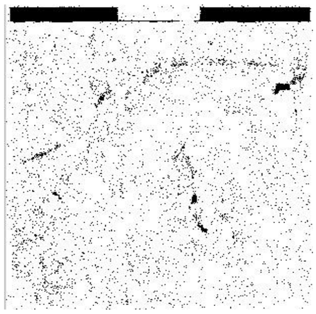

Fig 9. Inactive regions

By means of hybrid pan sharpening algorithm we combined the original MS, PAN and ASAR images. By the integration information for PAN and ASAR images, PAN image is substituted in the company of a PS image which is determined in the hybrid pan sharpening algorithm. Thus the enhancement of the image is developed.

Fig 10. Hybrid PAN sharpening fusion

Table 1 shows that performance of proposed method provides better fusion technology and improves the concentration of the remote sensing images. In this paper, we compared the Fig. 4 (initial fused image) with the Fig.10 (PAN sharpening fusion image) based on the parameters such asMSE, SNR, PSNR, SC, MD, AD, NAE, NK, RMAD, LMSE, MAS, MAMS, TED, TCD, SMV,SPE,GME, GPE, HLFI, SSIM, VIF, RRED, BIQI, JQI and NIQE.In proposed method, each parameter has been obtaining the better simulation results compared with existing.The formulas and values for the parameters are explained in the below table.

TABLE 1: FORMULAE AND VALUES FOR THE PARAMETERS

S.No	Parameters		Formulae	Values Obtained
1.	Mean Square Error	MSE	MSE=$\frac{1}{M*N}\sum_{I=1}^{M}\sum_{J=1}^{N}(y_{i,j}-s_{i,j})^2$	5006e+03
2.	Signal to Noise Ratio	SNR	SNR= $10log_{10}\frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(y_{i,j})^2}{M*N*MSE(y,s)}$	88.3903
3.	Peak Signal to Noise Ratio	PSNR	PSNR = $10log\frac{\max(y)^2}{MSE(y,s)}$	16.3681

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4.	Structural Content	SC	$SC=10log_{10}\frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(y_{i,j})^2}{\sum_{i=1}^{M}\sum_{j=1}^{N}(s_{i,j})^2}$	6.7072
5.	Maximum Difference	MD	$MD= \max\|y_{i,j}-s_{i,j}\|$	197
6.	Average Delay	AD	$AD=\frac{1}{M*N}\sum_{i=1}^{M}\sum_{j=1}^{N}(y_{i,j}-S_{i,j})$	-1.4529
7.	Normalized Absolute Error	NAE	$NAE=\frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(y_{i,j}-S_{i,j})}{\sum_{i=1}^{M}\sum_{j=1}^{N}\|y_{i,j}\|}$	0.3113
8.	Normalized Cross Correlation	NK	$NCC=\frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(y_{i,j}\,.\,S_{i,j})}{\sum_{i=1}^{M}\sum_{j=1}^{N}(y_{i,j})2}$	0.0431
9.	R-Averaged MD	RAMD	$RAMD=\frac{1}{R}\sum_{r=1}^{R}max_r\|y_{i,j}-S_{i,j}\|$	2267
10.	Laplacian MSE	LMSE	$LMSE=\frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(y_{i,j}-S_{i,j})^2}{\sum_{i}^{M}\sum_{j}^{N}(y_{i,j})2}$	41.0432
11.	Mean Angle Similarity	MAS	$MAS=1-\frac{1}{M*N}\sum_{i}^{M}\sum_{j}^{N}(y_{i,j})$	0.9956 - 0.2462i
12.	Mean Angle Magnitude Similarity	MAMS	$MAMS=\frac{1}{M*N}\sum_{i=1}^{M}\sum_{j=1}^{N}(1-[1-y_{i,j}][1-\frac{(y_{i,j}-S_{i,j})}{255}])$	-4.9011 + 0.0000i
13.	Total Edge Difference	TED	$TED=\frac{1}{M*N}\sum_{i}^{M}\sum_{j}^{N}(y_E-S_E)$	0.0077
14.	Total Corner Difference	TCD	$TCD=\frac{(yN_{cr}-SN_{cr})}{\max(yN_{cr},SN_{cr})}$	0.001
15.	Spectral Magnitude Error	SME	$SME=\frac{1}{M*N}\sum_{i}^{M}\sum_{j}^{N}(\|yF_{(i,j)}-SF_{(i,j)}\|)^2$	5.3935e+09
16.	Spectral Phase Error	SPE	$SPE=\frac{1}{M*N}\sum_{i=1}^{M}\sum_{j=1}^{N}(\|\arg(yF_{(i,j)})-\arg(SF_{(i,j)})\|)^2$	0.3054
17.	Gradient Magnitude Error	GME	$GME=\frac{1}{M*N}\sum_{i}^{M}\sum_{j}^{N}(\|yG_{(i,j)}-SG_{(i,j)}\|)^2$	1.0451e+03
18.	Gradient Phase Error	GPE	$GPE=\frac{1}{M*N}\sum_{i=1}^{M}\sum_{j=1}^{N}(\|\arg(yG_{(i,j)})-\arg(SG_{(i,j)})\|)^2$	1.8283e+03
19.	High Low Frequency Index		HLFI	0.0322 + 0.0008i
20.	Structural Similarity Index Measure		SSIM	0.9780
21.	Visual Information Fidelity		VIF	0.7683
22.	Reduced Reference Entropy Difference		RRED	0.1941
23.	Blind Image Quality Index		BIQI	64.2795
24.	JPEG Quality Index		JQI	80.0207
25.	Naturalness Image Quality Estimator		NIQE	6.3359

V. CONCLUSION

Thus the data set ASAR images are initially registered and then for the supplementary development it is filtered and for the expansion of wonderful images it is edge detected so that the edges of the image is acquire perfectly. Later than the edge detected images are binary contoured and the contoured images are fused into the single image as the first step. To get better quality of that fused image it is segmented as the dynamic and stationary regions.Afterwards segmentation was performed to get the active and inactive images. The segmented active areas were kept as it is and the inactive images were integrated to get better quality as it in the original image, finally the active MS image and the integrated inactive images are fused into the single image using the hybrid PAN sharpening technique.

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