International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8, Issue-1, May 2019

An Implementation of Futuristic Deep Learning Neural Network in Satellite Images for Hybrid Image Fusion

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Abstract: ***Image fusion is the process of registering two different images of same scene to combine the individual image quality details to single image. This work is going to reduce the complexities while implementing image fusion by applying the Deep Neural Network (DNN) to analyse the input images to get the resultant output image. At first, the DNN checks whether the input images are in same size by checking the dimensions of the input images. Then, the DNN checks the resolution of the input images and it resize the low resolution image corresponds to the high resolution image for better image quality output, if the input images are in different sizes. Then it performs image rectification using the left side and right side images. After rectification, the DNN executes the image registration by matching the coordinates of the input images. Finally, the image fusion is performed with the input images and the resultant image is enhanced to improve the quality of an image and it can be evaluated by Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Correlation Coefficient (CC), Maximum Squared Error (MAXERR), Structured Similarity Index Measurement (SSIM) and Ratio of Squared Norms (L2RAT).***

Index Terms: Deep Neural Network (DNN), Hybrid Image Fusion, Image Enhancement, Image Rectification.

I. INTRODUCTION

Deep learning neural network [4] plays a major role in recent technologies, which makes its own decision by considering the some input parameters. The algorithm designed manually and it strictly follows the algorithm constructed by the designer. It checks the possibilities and providing problem solving to implement the task. Here, the same DNN [2], [7] helps to perform image fusion process for satellite images. The acquired images may have different sizes and different resolutions. The trained DNN checks the resolution of the input images and classifies the high resolution image and low resolution image. Then, it adjusts the size of the low resolution image to match the size of the high resolution image. The major problem in the satellite images are misaligned frame due to left focus and right focus image. It can be reduced by image rectification. The trained DNN makes auto correction of this alignment and also provides parallax correction for both the input images [8], [10]. Later, image registration is performed by trained DNN to match the individual coefficients of an image. After this pre-processing, the images become ready for image fusion. The trained DNN performs pixel averaging for low resolution image prior to the image fusion for better performance. The image fusion can be done by any conventional method and the resultant image is enhanced by decorrelation method to make the output image as a better quality image.

Revised Manuscript Received on 30 May 2019.
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II. RELATED WORK

The spatial resolution can be classified into fine spatial resolution and coarse spatial resolution. The both techniques are used by Palsson et al. (2018) to design the residual architecture to improve the convergence between the images [2]. They use sentinel-2 real datasets for processing. Yu liu et al. (2018) proposed the method, which assigns weightage to each pixel based on the activity of the pixel [3]. Athanasios et al. (2018) reviewed the different machine learning concepts like convolutional neural network, Deep machines by Boltzmann and auto encoders used for denoising an image to conclude the suitable techniques for the corresponding data by comparing the merits and demerits of those methodologies [4]. Huihui song et al. (2018) proposed a spatiotemporal image fusion especially designed for low spatial resolution images from MODIS and LANDSAT satellites. The Convolutional Neural Network is used to map the pixel between the two images, and also the weighting techniques are used to improve the details of every pixel [7].

III. PROPOSED METHODOLOGY

The first step of image processing is the image acquisition. Here, it can be done by the satellites and the DNN performs the pre processing of the image. The evaluation of size of an image, resolution of an image and alignment of an image are the major pre processing steps. The pixel averaging, image resizing and image rectification and image registration are the further steps done in pre processing. The images are ready to perform image fusion after the pre processing steps. Then, image fusion is performed by any suitable method like wavelet image fusion or Principal Component Analysis. Based on our application and analysis, the spatial image fusion or spectral image fusion is chosen by DNN. The DNN always prefer the hybrid image fusion for better quality image output. The only post processing technique is enhancing the obtained image by decorrelation method. The figure 1 shows the fundamental steps of the proposed methodology

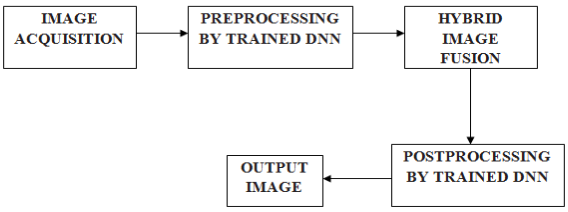

Fig. 1: Fundamental steps of the proposed methodology

IV. FUSION METHODOLOGY

A. Image Resizing

The first step of pre processing is matching the two input image to same size. The DNN considers image 1 with size M X N and image 2 with size P X Q. If M = P and N = Q means the images are in same size, otherwise the sizes of the images are not equal. Then, it adjusts the size of both the images by trained DNN. The image resizing process is shown in figure 2.

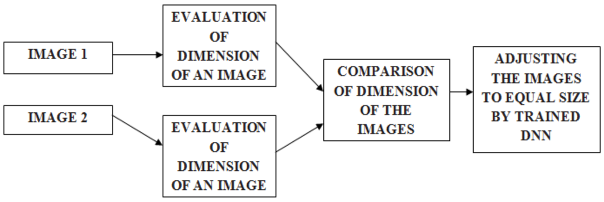

Fig. 2: The process of image resizing

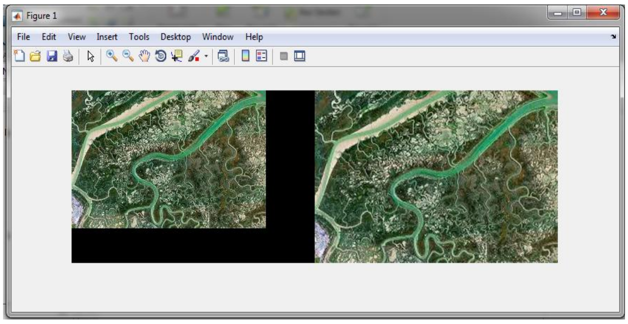

Fig. 3: The original and Resized Multispectral image

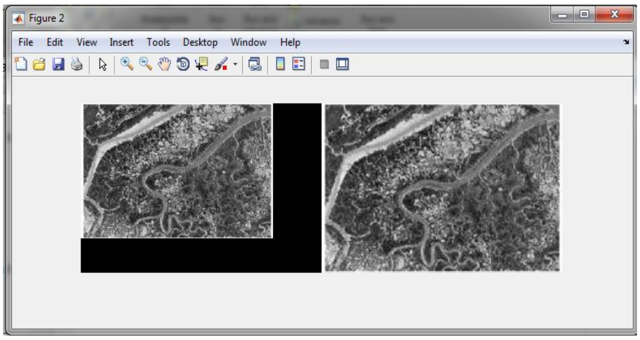

Fig. 4: The original and Resized Panchromatic image

The second step of the pre processing is checking the resolution of the input images [9]. The DNN performs pixel averaging to low resolution image for better processing. Usually, the hyper spectral image has low resolution when comparing to the panchromatic image. The trained DNN finds the hyper spectral image to perform pixel averaging to improve the image details. Figure 5 shows the process of finding resolution of an image.

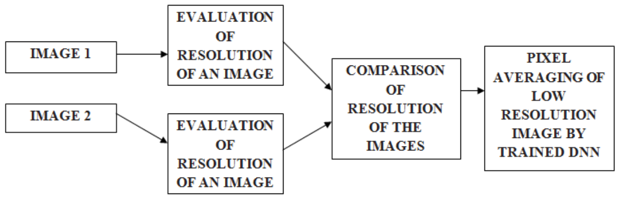

Fig. 5: The process of finding image resolution

The third step of pre processing is image rectification. The images' dimension from left side and right side appeared as an elevated image has some shape errors [9] and it can be rectified by the trained DNN. The process of image rectification is shown in figure 6 and the visualization of image rectification is shown in figure 7.

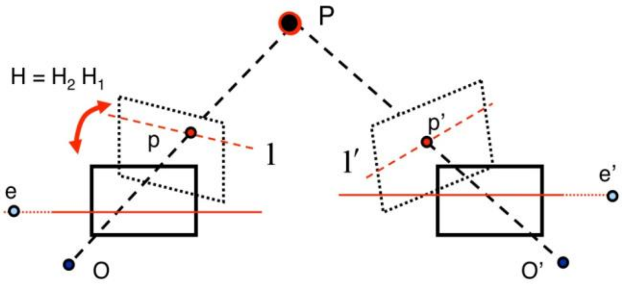

Fig. 6: The process of image rectification

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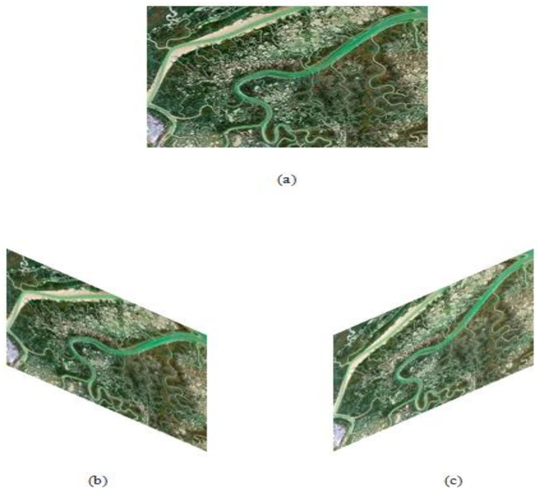

Fig. 7: (a) Rectified Image (b) Left focussed image (c) Right focussed image

The DNN also checks the alignment of an image by matching the coordinates of the input images. The DNN considers the x and y coordinates and matching those for both the images to perform better image fusion is called image registration.

V. RESULTS AND DISCUSSIONS

The hybrid image fusion technique is applied to the registered image. The hybrid image fusion helps to improve the both spatial and spectral details of an image to increase the quality of the output image. The decorrelation method of image enhancement is performed after image fusion to visualize the image details. The Vision of input and output images are shown in figure 8. The table 1 shows the obtained PSNR and MSE values [8], [10].

Table I. Evaluated MSE, CC and PSNR of both input and STAGE 1 output images

	MEAN SQUARE ERROR (MSE)	PEAK SIGNAL TO NOISE RATIO (PSNR)	CORRELATION COEFFICIENT (CC)
PAN IMAGE	63.85	64.69	0.9087
HYPERSPECTRAL IMAGE	64.09	30.11	0.9592
ENHANCED IMAGE AFTER IMAGE FUSION	30.06	30.11	0.9335

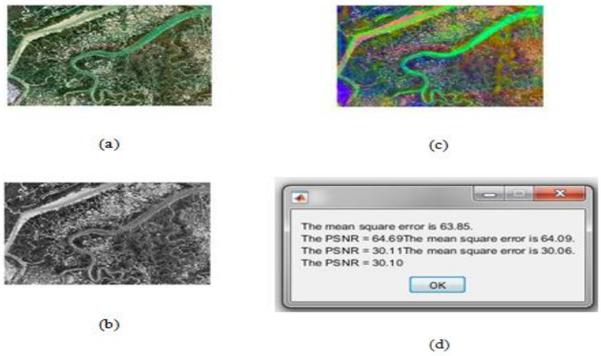

Fig. 8: (a) Hyper spectral Image (b) PAN image (c) Enhanced image after fusion
(d) Message box displaying MSE and PSNR

The stage 2 output is obtained from trained DNN which reduces the value of MSE, PSNR, and CC and improved the quality of an image. The image quality results are listed in table 2.

Table II. Evaluated MSE, CC and PSNR of STAGE 2 DNN output images

	MEAN SQUARE ERROR (MSE)	PEAK SIGNAL TO NOISE RATIO (PSNR)	CORRELATION COEFFICIENT (CC)		
			DIAGONAL	VERTICAL	HORIZONTAL
DNN IMAGE OUTPUT	2519.6645	14.1174	0.616723	0.792997	0.705676

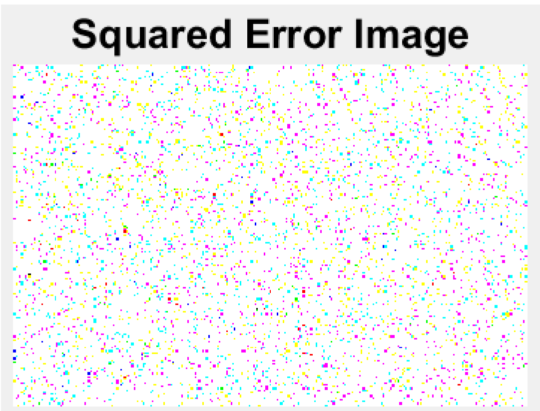

Fig. 9: The squared error image of input image

Table III. Evaluated MAXERR, L2RAT and SSIM of DNN output image

	MAXIMUM SQUARE ERROR (MAXERR)	Ratio of Squared Norms (L2RAT)	Structured Similarity Index Measurement (SSIM)
DNN IMAGE OUTPUT	99	0.7750	0.5664

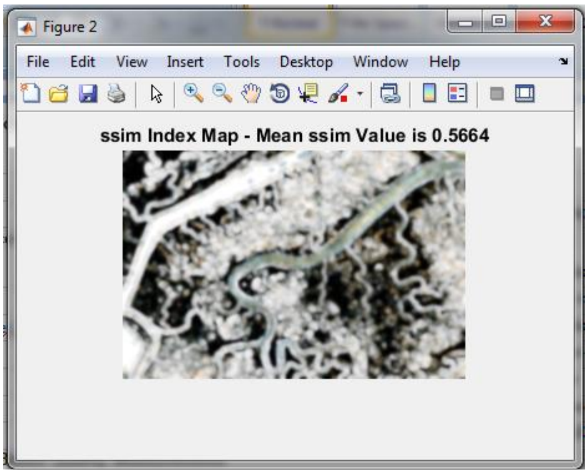

Fig. 10: The Visualisation of SSIM mapping

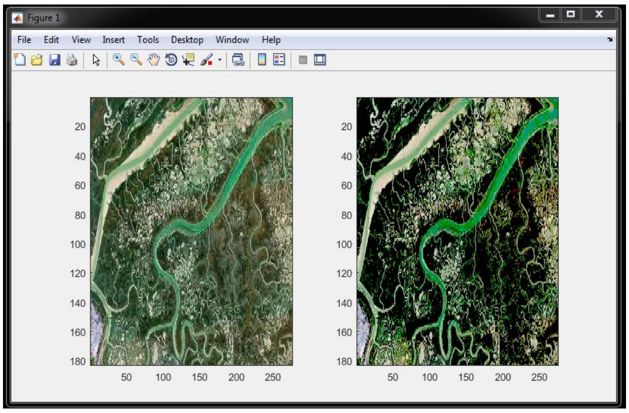

Fig. 11: The stage 1 fused image and stage 2 DNN image

VI. CONCLUSIONS

The trained DNN helps to pre process the input images and performs auto correction of images like image resizing, image rectification and image registration. The hybrid image fusion is performed and the fused image is enhanced by decorrelation method to achieve the better Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Correlation Coefficient (CC), Maximum Squared Error (MAXERR), Structured Similarity Index Measurement (SSIM) and Ratio of Squared Norms (L2RAT) [8], [10].

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Dr.Aswin Kumer S V graduated in Electronics and Communication Engineering from Pallavan College of Engineering, Kanchipuram in April 2008 and received his Masters degree in Embedded System Technology SRM University, Kanchipuram in May 2012. He received his doctoral degree for the implementation of image fusion using Artificial Neural Network from SCSVMV (Deemed to be University), Enathur in February 2019. He is working as an Assistant Professor in Department of Electronics and Communication Engineering at KLEF (Deemed to be University), Guntur. He has more than 10 years of teaching experience.He has presented part of his research findings in three international journals, three IEEE conference proceedings and one national conference proceedings. His areas of interest are Digital Communication and Digital Signal Processing.

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