IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁒ Peer-reviewed & Refereed journal ⁒ Vol. 13, Issue 2, February 2024

DOI: 10.17148/IJARCCE.2024.13221

THE PERFORMANCE OF DEVELOPED INTENSITY HUE SATURATION FUSION OF MULTISPECTRAL AND PANCHROMATIC IMAGES USING PELICAN OPTIMIZATION ALGORITHM

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Abstract:

Background: In medical applications, image fusion has become a popular approach for improving image interpretation quality. It comprises combining data from two or more object pictures to create a single, more informative image that is suitable for computer analysis or visual perception.

Material and methods: The datasets of two thousand eight hundred, which consist of images and postures of randomly selected students of Department of Computer Science, Ladoke Akintola University of Technology, were acquired using a SAMSUNG 315 digital camera and normalized to a uniform size of 300 x 300 pixels. Sixty percent of the images were used for the training while the remaining forty percent were used for testing purposes.

Results: The results showed that at optimum threshold value of 0.85, the Enhanced Intensity Saturation (EIHS) gave 98.44%, 98.22%, 97.78%, 96.90, 107.75s and 14.81% for recognition accuracy, Sensitivity, Specificity, Precision, Computational Speed and False Positive Rate respectively. The standard Intensity Hue Saturation (IHS) produced 96.44%, 96.00%, 95.78%, 95.56%, 120.0s and 8.89% for recognition accuracy, Sensitivity, Specificity, Precision, computational speed and False Positive Rate respectively

Conclusion: It was concluded that the performance of the developed model of Enhanced Intensity Hue Saturation (EIHS) based model could be very useful and reduce crime and fraudulent cases.

Keywords: Image fusion, Enhanced Intensity Hue Saturation (EIHS), multispectral, panchromatic images, pelican optimization algorithm

I. INTRODUCTION

Image fusion has become a widely used tool for increasing the interpretation quality of images in medical applications. It entails integrating information from two or more images of an object into a single image that is more informative and appropriate for visual perception or computer analysis. The purpose of image fusion is to decrease ambiguity and minimize redundancy in the final image while maximizing the relative information specific to an application (Goshtasby and Nikolov 2015).

Prospective algorithms for image fusion are generally classified into three categories viz: Substitution methods (such as Intensity-Hue-Saturation (IHS) and principal component analysis), arithmetic combination (such as Brovey, synthetic variable ratio and ratio enhancement and multi-resolution fusion methods (such as Retina-Inspired Model (RIM), wavelets, and Gaussian laplacian pyramid techniques).

Multi-resolution fusion techniques have been widely discussed in literature because of their advantages over the other fusion techniques (Tu and Huang 2007).

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The model was initiated based on the biological computational processes of the human retina. Vision in human is made possible by the combination of the three different cone cells of the retina which are sensitive to the short, medium, and long wavelengths of the visible spectrum (Ross *et al*. 2000). The outputs from these photoreceptors are within the various bands of the retina through spatial component processes at its bipolar cells.

How well a retina could combine and further enhance the outputs of its photoreceptors will determine how easily a human could identify object; especially colored objects. This insight into how the human visual system contrasts and combines information from different spectral bands provides the basis for the formulation of the multi-spectral Retinal Inspired Model. Though it has been widely employed in several fusion systems since the resultant image are characterized with high spectral intensities however the spatial details in the retina-inspired-fusion images are often low which introduces spatial distortion into the fused images (Ghassemian 2001).

In contrast, IHS transform converts a multispectral image with red, green and blue channels (RGB) to intensity, hue and saturation independent components. The intensity displays the brightness in a spectrum; the hue is the property of the spectral wavelength while the saturation is the purity of the spectrum. Transforming these spectra components independently preserves the spatial information therefore yielding a high quality spectral image with high spatial resolutions.

Several works have been proposed to change the attributes of Intensity Hue Saturation by introducing Optimization model such as Kernel Principal Component Analysis, Semi-supervised Discriminant Analysis (SDA), Multidimensional Scaling, Self-Organizing Map (SOM) and Active Shape Models for Intensity by removing insignificant connections between quantizing the weight, neurons and intermediate results of IHS.

To attain a smooth combination of spectral and spatial features of an image, the proposed technique attempted to first enhance the fused image output of Retinal Inspired Model into a high quality RGB image by employing histogram equalization. Afterwards, the enhanced RGB image was further decomposed into its intensity, hue and saturation independent components. Spatial features extracted from these components were fused using wavelet transform then IHS inverse also employed to convert the new intensity and the old hue and saturation components back into RGB space.

Thus, this research formulated Pelican Optimization Algorithm based Intensity Hue Saturation model to address the problem of low resolution and low visual perception for Multispectral and Panchromatic Image fusion to select high resolution from initial randomized weight parameters.

II. MATERIAL AND METHODS

Research Approach

In developing an enhanced Intensity Hue Saturation fusion of multispectral and panchromatic images using Pelican Optimization Algorithm for image fusion system, the following steps were involved;

i. The first stage is to acquire data. This was obtained from faces of captured images and postures of randomly selected students of Department of Computer Science, Ladoke Akintola university of Technology, Ogbomoso.
ii. The next stage is to preprocess the acquired data images. Image normalization, thining, image augumentation and image segmentation were pre-processing techniques used on both the training dataset and the test dataset.

Data Acquisition

Images of 2800 Students were acquired from randomly selected students of Department Computer Science, Ladoke Akintola University of technology, Ogbomoso. The data samples were divided into 60% training and 40% testing dataset using Random sampling cross-validation method for each of the data sample groups.

Conversion of grayscale

An image is an array, or a matrix of square pixel (picture elements) arranged in colomns and rows. In an (8-bit) gray scale image each picture element has an assigned intensity that ranges from 0 to 255.

Formulation of Enhanced Intensity Hue Saturation

The pre-trained IHS architectures have several limitations. The noted limitations are that most of the hyper-parameters of any such pre-trained IHS cannot be modified and has some of the hyper-parameters which require adjustment namely, the mini-batch size and also the unit numbers in every false potivite rate and accuracy. In this work, the EIHS algorithm was employed in the IHS architecture models classifier section to optimize the mini-batch size and false positive rate.

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In the learning phase, the IHS architecture models were used to classify the captured and postures images. Hence, the feature extraction and the fine-tuning were employed to adjust the network model to the current database used for this work.

The objective function is then is then used in the multispectral and panchromatic images by calculating the new rank of RGB using dimension as shown in table 1

Table 1: A pelican IHS fusion

Start POA.
Step 1. Input the RGB color space information.
Step 2. Regulate the POA size of population (N) and the number of repetitions (T).
Step 3. Initialization of the position of pelicans and calculate the objective function.
Step 4. For t = 1:T
Step 5: Generate the position of the prey at random.
Step 6. For I = 1:N
Step 7. Phase 1: Moving towards prey (exploration phase).
Step 8. For j = 1:m
Step 9. Calculate new rank of RGB by inverse transform of the jth dimension using

$$\begin{pmatrix} R \\ G \\ B \end{pmatrix} = \begin{bmatrix} \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{3}} \\ \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{3}} \\ \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{3}} \end{bmatrix} \begin{pmatrix} I \\ Ssin(H) \\ S\cos(H) \end{pmatrix}$$

Where $H = \tan^{-1}\frac{v1}{v2}$,

S= $\sqrt{v1^1 + v2^2}$ where $v1$ and $v2$ are the transitional values

$$I = \frac{R+G+B}{3}$$

$$I,H,S_{i,j}^{P_1} = \begin{cases} I,H,S_{i,j} + rand.\left(p_j - I.(I,H,S_{i,j})\right), & F_p < F_i \\ I,H,S_{i,j} + rand.\left(I,H,S_{i,j} - p_j\right), & else, \end{cases}$$

where $I,H,S_{i,j}^{P_1}$ is the new triangular spectral model of the ith pelican in the jth dimension based on phase 1, I is a random number which is equal to one or two, p_j is the location of prey in the jth dimension, and F_p is its objective function value, F is the objective function vector and F_i is the objective function value of the ith color solution.

The parameter I is a number that can be randomly equal to 1 or 2.

Step 10. End.

Step 11. Update the ith population member using

$$I,H,S_i = \begin{cases} I,H,S_i^{P_1}, & F_i^{P_1} < F_i \\ I,H,S_i, & else, \end{cases}$$

where $I,H,S_i^{P_1}$ is the new triangular spectral model of the ith pelican and $F_i^{P_1}$ is its objective function

value based on phase 1.

Step 12. Phase 2: Winging on the water surface (exploitation phase).

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Step 13. For j = 1:m.

Step 14. Calculate new inverse transform of the jth dimension using

$$IHS_{i,j}^{P_2} = IHS_{i,j} + R.\left(1 - \frac{t}{T}\right).(2.rand - 1).IHS_{i,j}$$

where $IHS_{i,j}^{P_2}$ is the new status of the ith pelican in the jth dimension based on phase 2, R is a constant, which is equal to 0.2, $R.\left(1 - \frac{t}{T}\right)$ is the neighborhood radius of $IHS_{i,j}$ while, t is the iteration counter, and T is the maximum number of iterations.

Step 15. End.

Step 16. Update the ith population member using

$$IHS_i = \begin{cases} IHS_i^{P_2}, & IHS_i^{P_2} < F_i \\ IHS_i, & else, \end{cases}$$

where $IHS_i^{P_2}$ is the new status of the ith pelican and $F_i^{P_2}$ is its objective function value based on phase 2.

Step 17. End.

Step 18. Update best candidate solution.

Step 19. End.

Step 20: Output best fused and enhanced spectral image IHS.

End

Table 1 expressed the pelican IHS fused technique.

The Algorithm explained the Pelican Optimization Algorithm processes, where it starts by input the Red, Green and Blue color space information, regulates the Pelican Optimization Algorithm size of the population size and the number of repetitions which concluded the initialization of the position of Pelican and also calculate the objectives of the function.

III. RESULT

The results of the evaluation of the developed Enhanced Intensity Hue Saturation fusion of Multispectral and Panchromatic Images using Pelican Optimization Algorithm were presented in this chapter. The Pre-processed and enhanced images used for the study were grouped into Original Images, Processed and Final images are presented in Table 4.1.

The results obtained from the developed technique are also presented in this chapter. In terms of computation time for training the dataset shown in Table 4.1, the time spent increases as the number of datasets increases, which implies that the time consumed depends on the features in the training set for both Intensity Hue Saturation (IHS) and the Enhanced Intensity Hue Saturation (EIHS) techniques.

All performance metrics were analyzed using a square dimension pixel resolution at different average threshold of 0.25, 0.4, 0.6 and 0.85 from a range of 0-0.20, 0.21-0.35, 0.36-0.50 and 0.51-1.00 respectively. Each threshold values range generated the different accuracy values for HIS of 95.56, 95.78, 96.00 and 96.44 respectively as defined in Figure 1.

Figure 2 showed the choice threshold value used in this research. Seventy percent (70%) of the total images were used for training and Thirty percent (30%) were used for testing random sampling cross-validation method.

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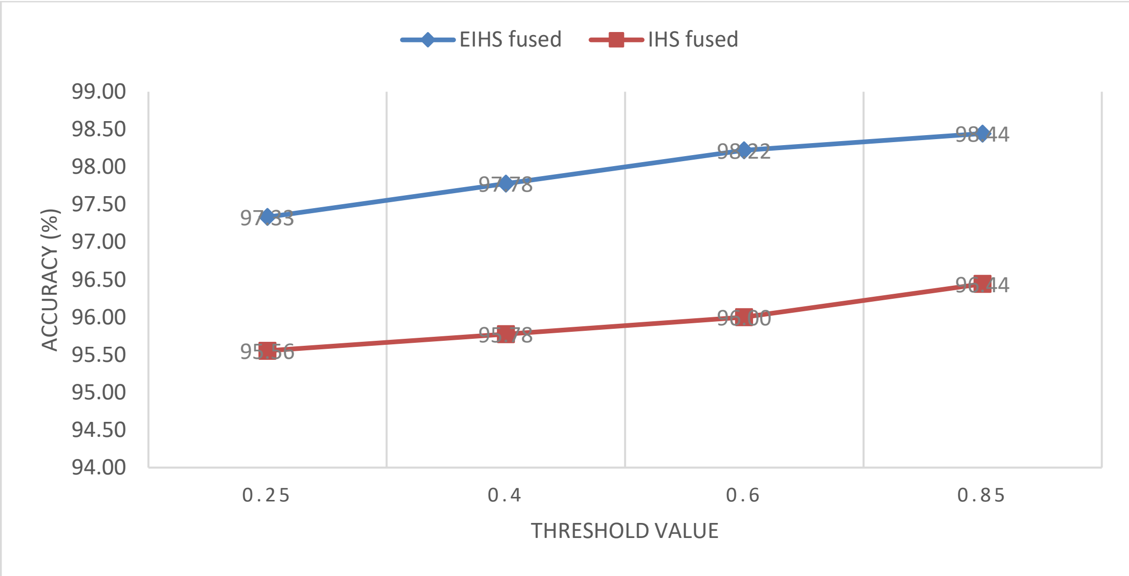

Figure 1: Graphical representation showing Accuracy against Threshold value for EIHS fused Panchromatic and Multispectral images

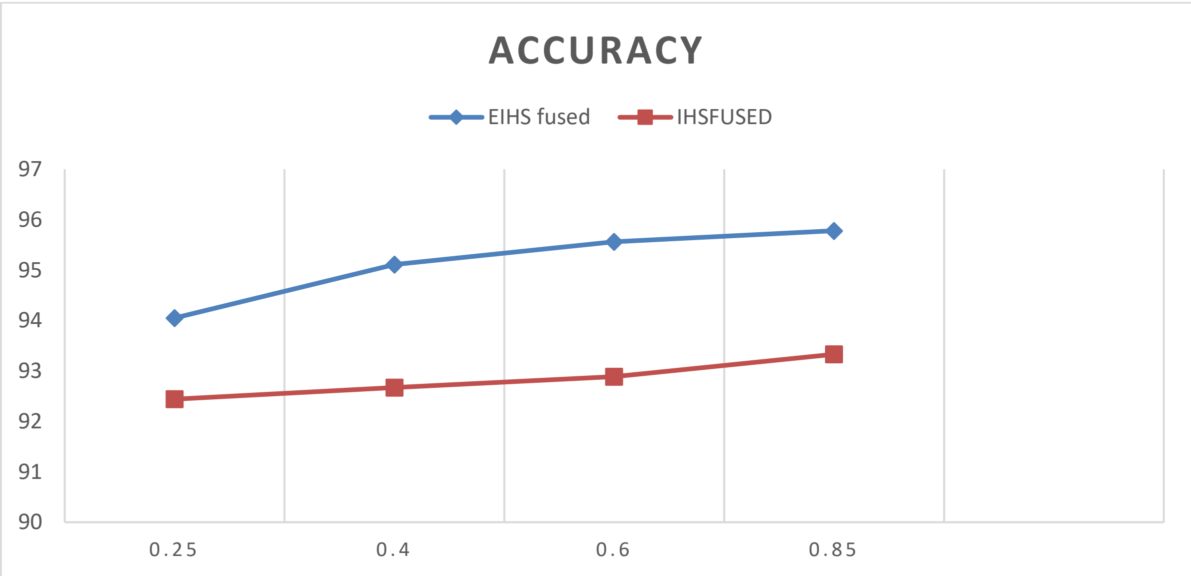

Figure 2: Graphical representation showing Accuracy against Threshold value for EIHS and IHS Panchromatic image.

Table 2 and 3 showed that Optimization IHS and EIHS on Pelican Optimization Algorithm at 40 iterations with different number of processed images, the numbers of filters to extract the feature map (the convolution filter number), the filter size or filter dimension used in each convolutional and the size number; this value represent the number images that are entered into POA in each training block. Recognition rate was used as the objective functions.

The best recognition rate was achieved by IHS-POA and EIHS-POA at a value of 98.22% and 98.44% respectively as defined in Table 2 and Table 3. Based on the results, the optimal POA architecture attained by application of PIHS and EPIHS were as follows:

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Table 2: Result of IHS fused panchromatic and multispectral image

TP	FN	FP	TN	FPR(%)	SEN(%)	SPEC(%)	PREC(%)	ACC(%)	Time(sec)	Threshold
307	8	12	123	8.89	97.46	91.11	96.24	95.56	120	0.25
306	9	10	125	7.41	97.14	92.59	96.84	95.78	120	0.4
305	10	8	127	5.93	96.83	94.07	97.44	96.00	115	0.6
304	11	5	130	3.70	96.51	96.30	98.38	96.44	122	0.85

Table 3: Result of IHS with panchromatic image

TP	FN	FP	TN	FPR(%)	SEN(%)	SPEC(%)	PREC(%)	ACC(%)	Time(sec)	Threshold
300	15	19	116	14.07	95.24	85.93	94.04	92.44	70.2	0.25
299	16	17	118	12.59	94.92	87.41	94.62	92.67	66.1	0.4
298	17	15	120	11.11	94.60	88.89	95.21	92.89	68.9	0.6
297	18	12	123	8.89	94.29	91.11	96.12	93.33	67.2	0.85

Result of Table 2 using IHS fused Panchromatic and Multispectral Image for two hundred (200) with 0.25 threshold, FPR, Sensitivity, Specificity, Precision, Accuracy and computational time value recorded were 8.89%, 97.46%, 91.11%, 96.24%, 95.56%, and 120 seconds respectively. At 0.40 threshold, FPR, Sensitivity, Specificity, Precision and Accuracy and computational time value recorded were 7.4%, 97.14%, 92.59%, 96.84%, 95.78 and 120seconds respectively.

At 0.60 thresholds, FPR, Sensitivity, Specificity, Precision, Accuracy and computational time value recorded were 5.93%, 96.83%, 94.07%, 97.44%, 96.00 and 115seconds, respectively. However, at 0.85 thresholds, the system recorded FPR, Sensitivity, Specificity, Precision, Accuracy and computational time value of 3.70%, 96.51%, 96.30%, 98.38%, 96.44% and 122seconds, respectively. Looking at the result shown in Table 4.1, it would be deduced that IHS with 304 datasets performs best at 0.85 threshold value.

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Table 3 shows the result of EIHS for three hundred (300) transactions. At 0.25 thresholds, FPR, Sensitivity, Specificity, Precision, Accuracy and computational time value recorded were 7.41%, 99.37%, 92.59%, 96.90%, 97.33% and 100.56seconds respectively. At 0.40 thresholds, FPR, Sensitivity, Specificity, Precision, Accuracy and computational time value recorded were 5.19%, 99.05%, 94.81%, 97.81%%, 97.78 and 27.69sec, respectively. At 0.60 thresholds, FPR, Sensitivity, Specificity, Precision, Accuracy and computational time value recorded were 2.96%%, 98.73%, 97.04%, 98.73%, 98.22 and 107.75seconds, respectively. However, at 0.85 thresholds, the system recorded, FPR, Sensitivity, Specificity, Precision, Accuracy and computational time value of 1.48%, 98.41%, 98.52%, 99.36%, 98.44 and 106.97seconds, respectively for EIHS. When compare the two results of IHS fusion using POA and EIHS fusion using POA for two hundred datasets images, it is recorded that at each of the threshold value, EIHS performs better in terms of sensitivity, specificity, precision, false positive rate, Accuracy with low computational time with low False Positive Rate. EIHS is highly sensitive to correctly identify person with genuine pattern and also has the ability to correctly identified person without genuine image. The EIHS has low false positive rate because it has the ability to classify each image correctly.

IV. CONCLUSION

This research focused on optimizing the numbers of filter size used in each convolutional layer, the number of convolution filters using Pelican Optimization Algorithm. Also this research presented EIHS method to optimize standard IHS and further applied to image fusion. It was concluded that the performance of the developed model of Enhanced Intensity Hue Saturation (EIHS) based model could be very useful and reduce crime and fraudulent cases.

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