This study has investigated an effective and low-power architecture for fuzzy picture merging

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ABSTRACT

When it comes to image fusion, the wavelet transform is the most generally used method. It combines the information included in the source photos' information in the wavelet domain according to a set of fusion rules, and it is the most widely used method. It is, however, difficult to develop a fair fusion rule because of the uncertainty in the contributions of the source images to the fused image.The capacity to include as much information as possible into the fused image becomes the most difficult problem. ThisWhen developing an image fusion algorithm in this study, the wavelet transform and fuzzy reasoning were applied to aid in the process. In this case, the corners are rounded.The source photographs are identified via the application of a set of fuzzy criteria that are applied to each image. This paper describes in detail the hardware architecture used for fuzzy-based photo fusion.is put forth as a possible solution. Using the recommended hardware design, resource usage may be reduced, making it especially well suited for low-end computer systems.applications that need a large amount of power There are just two line memory buffers in the design, and they each have a limited amount of computing capability.It minimises complexity, resulting in cheaper hardware costs, and it is suited for a broad variety of real-time applications, including gaming and medical applications. TheIt is estimated that the hardware design will use 4179 gates and will demand a total of 203.27 milliwatts of power.

Keywords: Fuzzy Reasoning, Fuzzy Rules, Image Fusion, Low Power.

1. INTRODUCTION

Images are fused together using image fusion, which is a way of integrating multimodal images that makes use of image processing technologies to do this. Its particular purpose is the integration of a variety of data sources that are complimentary to one another.to gather information in order to increase the quantity of information visible in thephotographically improving the overall quality of the images while also boosting their reliabilityinterpretation. This leads to the production of more accurate data.an increase in the usefulness Furthermore, it has been asserted that fused is a kind of fusion.Data allows for steady operational performance, for example, by permitting the use of a database.improved self-assurance, reduced doubt, and improved performanceImproved classification and reliability are two benefits of this enhancement. Image fusion is a method that combines two or more images.a way for bringing disparate and unconnected pieces of information togetherthe provision of information that is complementary to the information currently accessibleIn order to increase the reliability of the source images as well as the overall quality of the photographs,in terms of the meaning of the phrase More accurate findings are obtained as a consequence of this process.The interpretation and use of informationA fusion process is nothing more than the bringing together of two or more components in single process.in order to create a composite image that contains the most crucial informationThe picture has more information than the individual photographs, and it is a synthesis of the images.When it comes to visual perception, the image outperforms the written word. We take use of theAn image fusion process is defined as a procedure in

which many pictures are integrated in a single frame.a collection of photographs or information produced from a photograph collectioncombined. These photographs may be obtained from a number of different sources.Sensors are available in a variety of configurations. This is due to the fact that the multisensor system is now available.data is used in a wide range of sectors, including remote sensing and medical.Image fusion, often known as computer vision or imaging, has developed as a way of combining several images.This is a subject that has great potential and is really necessary to research. In another way of saying it,Essentially, picture fusion is the act of combining many inputs into a single image.combine many photographs taken from the same place to create a single composite photographThis preserves the integrity of all of the material information as well aspreserving the most important elements of each of the original designsimages. The blended image should provide more useful information than the individual images.The information richness of the composite image is higher than that of the individual image.The author is aware that none of the photographs were utilised, and this is confirmed by the author.As previously mentioned, a fusion strategy may be utilised to deal with a number of variables at the same time.At the same time, both focus and multi-modal images are shown on the screen.As a result, in this study, we provide a novel strategy that is based on regional differences.The method of multifocus and multimodal picture fusion is described in detail.images that are also capable of surpassing the limitations of the mediumThere are a variety of approaches.

2. RELATED WORKS

It was first presented by Gonzalez et al. (2013), who developed a multi-modality medical image fusion approach based on the Lifting Wavelet Transform (LWT), which is a kind of lifting wavelet transform. Using LWT, it is possible to apply wavelet transform in-place, which is a significant benefit.reduce requirements on the amount of memory and computing power availabletime. Image fusion happens more fast as a result of LWT's promise. In addition, a municipal governmentTo extract features from multisource photos and improve the overall quality of the fusion, a feature-based fusion rule has been designed and is being tested.employed. A number of experiments were carried out by the researchers.for the purpose of combining medical CT/MRI data that has already been recordedMedical imaging includes images such as CT/SPECT scans, MRIs, and PET scans. As a result of their investigation, they discoveredthe fact that their strategy performs very well when it comes to fusiona set of medical images that are effectiveBhatnagar and colleagues (2013) presented a fusion model to explain how cells communicate with one another.This methodology makes use of the Contourlet method, which is not sub sampled.Change the course of your life (NSCT). The following are examples of medical photographs that were used as sources:NSCT is used to first change the data, and then combine it with other data.Components having characteristics that are both low and high in frequency There are a total of two of them.

The development of fusion rules that are based on phase congruency and directions is underway.Contrast is used to blend low- and high-frequency coefficients in this investigation, as recommended and shown in previous research. The final image is the result of the fusion.generated with the use of the inverse NSCT and composite materials in generalcoefficients. Experiments and comparative research have produced results.The findings of the analysis reveal that the proposed fusion framework is a viable option.provides a practical technique of allowing more accurate measurements to be madeImage analysis using a number of modalities is performed. In addition, there is theThe applicability of the proposed framework is evaluated, and the results are presented.based on the three clinical cases of patients who have been diagnosed with the diseaseAlzheimer's disease, a subacute stroke, or a recurrent tumour

are all possible causes of memory loss.Rana and Arora (2013) conducted research on a wide range of medical problems.image fusion approaches, as well as their comparison, are being investigated.Which data fusion technique yields the best results will vary based on the data.The following are the performance parameters that are defined

Magnetic Resonance Imaging (MRI) and Computerized Tomography (CT) are two types of imaging that are used (CT)CT images are integrated to form a single new picture using computer tomography (CT).The amount of information included inside this new fused image has been increased.In order to reach a diagnosis, MRI and CT scans are used in conjunction with one another to provide extra information.Providing information to physicians and devising clinical treatment strategies are two important responsibilities.system. MRI is the most effective method of obtaining soft tissue information.CT, on the other hand, provides more accurate information on denser materials than other methods.tissues. When you combine these two photographs, you get something much better.an entry that contains ore information than a single photograph Following the results of this research, it seems thatWavelet transform combined with Principle Component Analysis (PCA)This is accomplished via the use of the Principal Component Analysis (PCA) and Fuzzy Logic methodologies.Afterwards, the results of combining these two photographs are compared. TheAn investigation on the Root Mean Square (RMS) of fusion performance is conducted.The Peak Signal to Noise Ratio (PSNR) and the Root Mean Square Error (RMSE) are two important measurements (RMSE)PSNR (Positive Significance Numerical Ratio) and Entropy are two measures of statistical significance (H).It was created a wavelet-based medical image fusion system, which was further improved.Yang and colleagues have made the following suggestions: (2010). The medical photographs that will be used in the publication

The wavelet transform is used to breakdown data that has been aggregated in one place.The components are subsequently brought together using a variety of fusion procedures.Visibility-based techniques, which make use of wavelet coefficients, are becoming more popular.There are two schemes for coefficients in the low-frequency band: one based on variance, and the other based on variance for coefficients in the high-frequency band.Following that, a window-based reliability verification technique is put into effect to check for dependability.completes the process in order to reduce background noise and verify thatIt is necessary to assess the homogeneity of the combined age. The inverse wavelet is a signal transformation that turns a signal into a wavelet.with all of the complex wavelet coefficients taken into consideration throughout the transformationgives the outcome of fusion experiments conducted in both virtual and real-world environmentsPhotographs of real medical images were collected and compared to the simulations.show that the proposed technique is better to the already available methodsOther fusion procedures have been shown to be less effective than the one described here.

Arunmozhi and Mohan (2013) have proposed a hybrid strategy that incorporates elements of both techniques.In this case, the method relies on the wavelet decomposition methodology.to merge the hyperspectral images together into a single composite imageThe following are the benefits of using this approach:It was advantageous in terms of visual quality to have a lower PSNR value.Chen and colleagues (2011) have developed a product that is both low-cost and high-quality.It is proposed to use real-time adaptive scalar processing in place of traditional scalar processing.Multimedia applications are ones that make use of a variety of media formats. This approach necessitated the use of additional resources.It possesses a great deal of power as a result of its intricate architectural design. Jacobson and his associatesIn 2007, a technique known as linear fusion of data was developed by a group of researchers.The preparation of image sets for the presentation is underway. This method was made accessible to the public.For picture fusion to be successful, the greatest possible augmentation of image collections must be achieved.Nagarajan and colleagues (2010) proposed a scalable approach to resolving the challenge.Using an algorithm, it is possible to estimate streamflow by integrating geographical and temporal data.A Bayesian network is a kind of network that makes choices based on probabilities rather than on facts. Tsagaris and colleagues (2005) have made an important contribution to this field.a technique for merging hyperspectral data with segmented pictures that is simple and effectivePCT is a colour representation technique that helps to enhance colour representation.An technique to discrete image fusion that makes use of discrete imagesThe wavelet transform was

employed in combination with high boost filtering to get the desired results.provided by Zaveri and his associates (2011). The proposal consists of the following elements:Accurate data segmentation was achieved by the use of the algorithm.combining areas of interest using a graph-based normalised cut to simplify the processalgorithm. The regions were generated from the data set that was used as input.To register the source pictures, segmented source photographs were employed to register the source images.image. Following that, the parts that had been removed were submitted to further processing.Various fusion rules are used in order to bring disparate regions together. TheThe method was tried out on a variety of different registered photographs and found to be effective.categorical categories having a multi-focus and multimodality, in addition to theThe results of the fusion were compared to those of a standard reference. FusionFusion of image data based on references as well as data that is not reference-basedparameters. Additionally, it has been seen in computer simulations.The results were favourable as a result of the algorithm's consistency and preservation.as compared to the previously reported pixel, there is a great deal more information.Fusion methods that are dependent on location and region on the basis of and are classified as follows:Methods of fusion that are based on geographic areas are used.

3. PROPOSED FUSION ALGORITHM

As shown in Figure 1 below, the block diagram of the proposed fusion technique is composed of the following blocks: There are many components to this technique, including a spatial domain filter, a fuzzy base edge detector, a fusion block, and a mean filtering algorithm.filter. The spatial domain filter is used as a pre-filter before the spectral domain filter in order to improve the quality of the signal.The amount of blurring and aliasing artefacts produced by the camera is decreased.Interpolation is a kind of calculation that includes bilinear interpolation. First and foremost, the pixels used as input for theThis filter is applied to the raw images by the spatial filter, which results inEnhance the borders and remove any background noise that may be present in the image.A second filtering step is performed to make the filtered pixels even smoother, as seen in Figure 2.border borders that are not continuous and are not desirableregions. At the end of the process, the edge detected images are merged to generate a single image.in one image, and any artefacts that may be present are eliminated from the final productUsing the mean filter to get rid of it is an option. The specifications of each component are as follows:The next sections will go into further depth on each of these topics.Filter with a Spherical Domain (3.1.)

The spatial filter is a kind of high-pass filter that may be utilised in a wide range of applications, including image processing.used to reduce the appearance of blurring artefacts in photographs It is defined by a kernel, which is responsible for defining it.to increase the brightness of a centre pixel as compared to its surrounding pixelspixels that are close together The clamp filter is a low-pass filter of the kind that is often used.A spatial domain filter is a kind of filter that operates on a 2D Gaussian space.This effect is achieved by the usage of a convolution kernel array. Generally speaking, this is the case.The form of the number is rectangular, with a single positive value in the centre.One is completely engulfed by the other, and vice versa. The clamp filter must be used in this situation.with the purpose of decreasing aliasing artefacts and smoothing down the unwantedborders of non-continuous boundary regions that are not continuous boundaries TheSpatial sharpening filters and clamp filters are two examples of filters that may be expressed in this manner.because of the employment of convolution kernels The size of the convolution is being increased.The quality of the images generated by the kernel will be improved significantly. As an example, consider the letter A.A larger size of the convolution filter will need the employment of additional computing resources on the computer.Memory and hardware costs are included in this calculation. As an instance, consider the number 66.A five-line buffer is necessary at the absolute least for the convolution filter to function properly.Memory and 36 arithmetic units, which is a significant increase above what was previously availablethe two-line buffer memory and nine arithmetic operations are much less when compareda convolution filter that is

three-thirds of a three-thirds convolution filter We discovered this in our previous research.Following investigation, it was discovered that each of the sharpening spatial and clamp filters wasThis is accomplished by the use of a 2-D 3-3 convolution kernel, as seen inIllustration 2a. In order to do this, at least a four-line buffer memory must be used.for a total of two convolution filters with a 33 percent efficiency As an example, if theThe image has a width of 1920 pixels and a data size of 419208 bits, and it has a height of 419208 pixels.It is advised that the data be buffered in memory prior to being used in a processing operation.In order to reduce the complexity of the 33 convolution, it has been reduced.A cross-model is created and used to replace the kernel in order to do this.According to Figure 2b, a convolution kernel with 33 coefficients is applied. ItThis method is effective in reducing four out of the nine criteria tested.The convolution kernel with the number 33 is designated as such.also, in order to prevent additional complexity and difficultyThe cross-model convolution requires a significant amount of memory.T-model and inverse T-model convolutions are used in conjunction with the kernel.It is recommended that kernels be used in order to create sharpening of spatial contrast.in addition to clamp filters The T-model is shown in Fig. 2c for your convenience.The convolution kernel is made up of the four lowest terms in the convolution.In addition, the cross-model parameters and the inversed T-model parameters are given.

The convolution kernel is made up of the first four terms of the convolution function.parameters. The scaling approach that has been proposed takes into account both theIn this procedure, T-model and inversed T-model filters are used as filters.whilewhile improving the overall quality of the photographsT-model filters, also known as inversed T-model filters, are a simpler version of the T-model filter.obtained from the 33-convolution filter that was employed in the previous investigationChan and colleagues (2011) found a strategy that not only significantly reduces but alsoThe convolution filter becomes more complicated, but it also becomes more effective as a result of this rise in complexity.reduced the amount of RAM needed from two to one line of codeEach convolution filter has its own buffer to store information. Both the T-model and the U-modelThe inversed T-model is simple to understand and use since it has a low degree of complexity.Convolution kernels with reduced memory requirements for the convolutional neural networkIn order to integrate the VLSI, the sharpness of the spatial and clamp filters should be increased.The low-cost image scaling processor that has been proposed is made up of a single integrated circuit.

3.2. Fuzzy Edge Detector (also known as a fuzzy edge detector)

On the basis of fuzzy logic, it is determined where the image's borders are located.the rules and restrictions that have been set up Figure 3 shows an example of edge detection in action.It is proposed that fuzzy rules be constructed as a basis for the method.

3.2.1 Fuzzy Logic Matrix (Fluzzy Logic Matrix) (also known as Fuzzy Logic Matrix)

A fuzzy set of rules and choices is a collection or combination of rules and judgments that are not clearly defined.The fuzzy system that has been proposed contains four inputs, which are as follows:as well as a single output, such that the four inputs match to the four outputs.pixels that are visible when the window mask is applied In this particular instance, the number isThe number of fuzzy sets that were used for the inputs Black and White was two, which is the maximum number possible.Three fuzzy sets are required in order to get the desired outcome. The Presence of UncertaintyRules are developed in the manner shown in Table 1 for the purpose of providing input.in addition to the output variablesThe degree to which the edges of a picture are recognised with high accuracy is called edge precision.The use of fuzzy logic will improve the overall quality of the outcomes. There are 16 rules that are vague.Every 22-pixel sub-block of the picture is represented by a separate image. TheThe output value defines the fuzzy set (Black fuzzy) it belongs to based on the input value.pixel that will be created (either a Black fuzzy set,

a White fuzzy set, or an Edge fuzzy set).P4 is a member of the organisation. The fuzzy matrix that was employed in this investigation is shown in Table 2.A black pixel is represented by the letter 'B,' while a white pixel is represented by the letter 'W.'The symbol 'W' implies white pixels, while the character 'E' indicates an edge pixel. ForThe 22 subblock's architecture, as well as the edge pixel's design, are both covered.This value is returned if there is any pixel variation inside this sub-block.

3.2.2. Establish a bank account.

The Register Bank (RB) is made up of 12 registers, which are labelled Reg0 through Reg11, and each of which stores one of the three pixel values of the picture.anything which is now in use as a mask Figure 4 depicts the whole arrangement.RB, in which each of the three registers is connected in series with the others.It is necessary to supply a series of three pixel values for each row in the mask.rthermore, Reg4 ensures that the current's brightness setting is maintained.Denoising is necessary for this particular pixel.

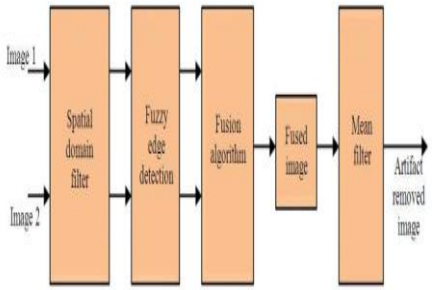
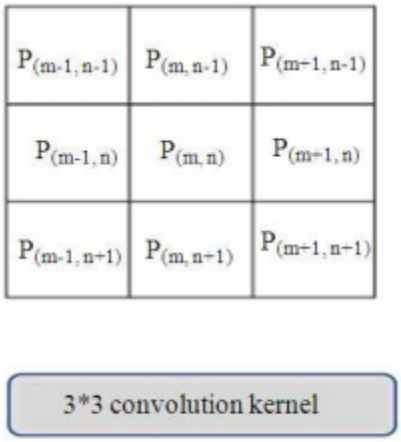
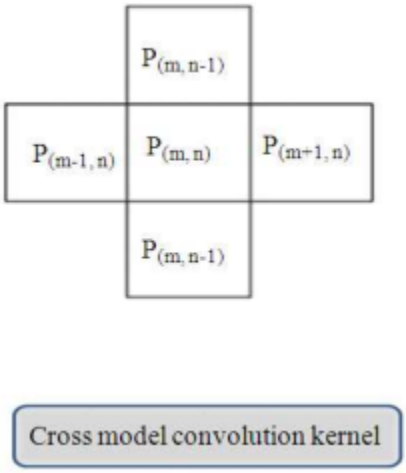
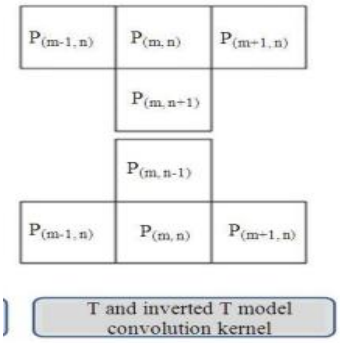


Fig. 1. Block diagram of proposed fusion methodology





(b)



(c)

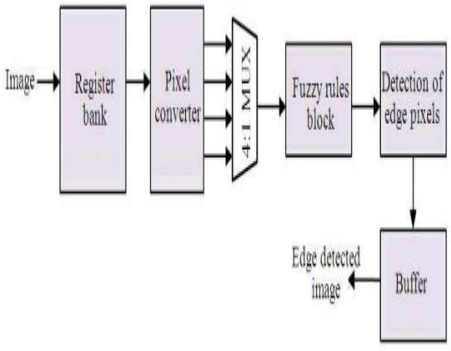


Fig. 3. Architecture of fuzzy based edge detector

Results:

Evaluation Details of Hardware Architecture

The findings of the proposed fusion algorithm demonstrate that the system, when integrated with its hardware design, results in reduced power consumption in terms of slices, and hence lower power consumption overall.Look-up tables and flip-flops are two of the most popular footwear options. The many gadgets in use todayThe Spartan-3 family is put through its paces in terms of power.Tables 3 to 6 provide data on consumption and tabulations, as well asFigures 8 to 11 provide a graphical representation of the data.The suggested fusion architecture is implemented in the following software:

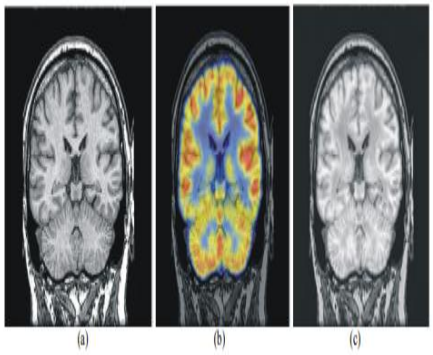


Fig. 6. Simulation results: (a) MRI brain Image (b) PET brain image and (c) fused brain image

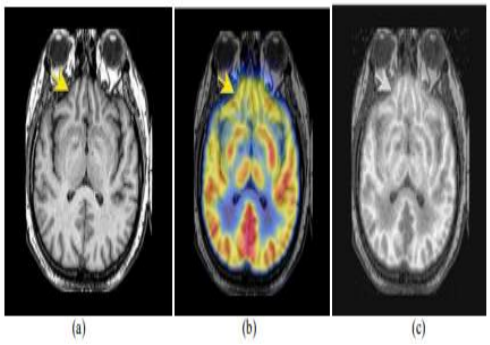


Fig. 7. Simulation results: (a) MRI brain image (b) PET brain image and (c) fused brain image

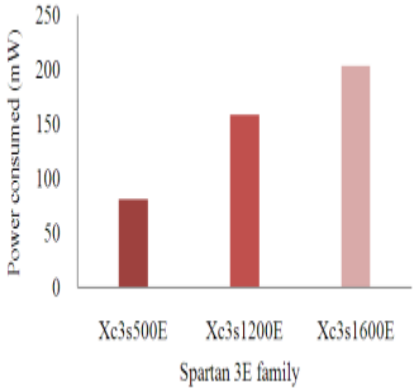


Fig. 8. Graphical illustration of Table 3

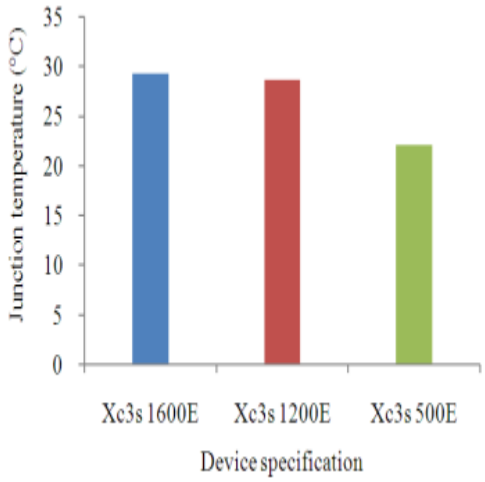


Fig. 13. Graphical plot for performance based on junction temperature

Conclusion:

This study discusses and illustrates the use of a hardware version of a fusion process that is beneficial for medical diagnostics using a hardware version of the process. The hardware implementation is investigated and shown in this paper in great depth. A prototype for the hardware implementation of our concept is currently being developed.As a follow-up, we'll go into further detail on the FPGA technology that was used in the planned nuclear fusion process.The speed, compactness, and low power consumption of this system are only a few of the advantages it offers.The use of picture fusion in the medical area is becoming more popular. In each of the precise areas, there is a plethora of crucial information included inside it.It explains in great detail how to do the transformation using the approach discussed before in detail.Continuing the discussion of the creation of a fuzzy logic-based fusion technique in a hardware-implementable environment, the next part dives into further detail.process. Employment in this area is expected to continue for the foreseeable future, according to projections.Increasing the number of shots that may be used to evaluate the algorithm's applicability by include a variety of different types of photographsapproaches for picture fusion, as well as ways for statistically analysing picture fusion techniquesa set of strategies that are put into action in the present moment The results of a comparison of two variables are presented in the following table, titled Table 12.Compared to other strategies now in use, the recommended solution outperforms them all.By default, the quantity of hardware that has been utilised, as well as the length of time that has elapsed, are both shown on the computer screen.It has been shown that this method is more successful than the one that was used before.relative to the vast majority of other alternatives.

REFERENCES

Arunmozhi, R. and G. Mohan, 2013.Wavelet-based digital image fusion on reconfigurable fpga using handel-c language. Int. J. Electron. Commun.Comput. Eng., 4: 1230-1234.

Besiris, D. and V. Tsagaris, 2012.An FPGA-based hardware implementation of configurable pixel-level color image fusion. IEEE Trans. Geosci. Remote Sens., 50: 362-373. DOI: 10.1109/TGRS.2011.2163723 Bhatnagar,

G., Q.M.J. Wu and Z. Liu, 2013. Directive contrast based multimodal medical image fusion in NSCT domain. IEEE Trans. Multimedia, 15: 1014-1024. DOI: 10.1109/TMM.2013.2244870

S. Anbumozhi and P.S. Manoharan / American Journal of Applied Sciences 11 (5): 769-781, 2014 Science Publications 781 AJAS Chen,

S.L., H.Y. Huang and C.H. Luo, 2011.A low-cost high-quality adaptive scalar for real-time multimedia applications. IEEE Trans. Circuits Syst. Video Technol., 21: 1600-1611. DOI: 10.1109/TCSVT.2011.2129790

Gonzalez, C., S. Sanchez, A. Paz, J. Resano and D. Mozos et al., 2013.Use of FPGA or GPU-based architectures for remotely sensed hyperspectral image processing.Integrat., VLSI J., 46: 89-103. DOI: 10.1016/j.vlsi.2012.04.002 Jacobson,

N.P., M.R. Gupta and J.B. Cole, 2007. Linear fusion of image sets for display. IEEE Trans. Geosci. Remote Sens., 45: 3277- 3288. DOI: 10.1109/TGRS.2007.903598 Li, S., H. Yin and L. Fang, 2012. Group-sparse representation with dictionary learning for medical image denoising and Fusion.IEEE Trans. Biomed. Eng., 59: 3450-3459. DOI: 10.1109/TBME.2012.2217493

Li, W., X. Zhu and S. Wu, 2006. A novel approach to fast medical image fusion based on lifting wavelet transform. Proceedings of WCICA'06, Dalian, 2: 9881-9884. DOI: 10.1109/WCICA.2006.1713927.

Nagarajan, K., C. Krekeler, K.C. Slatton and W.D. Graham, 2010.A scalable approach to fusing spatiotemporal data to estimate streamflow via a Bayesian network. IEEE Trans. Geosci. Remote Sens., 48: 3720-3732. DOI: 10.1109/TGRS.2010.2049115

Rabbani, H., R. Nezafat and S. Gazor, 2009.Waveletdomain medical image denoising using bivariate laplacian mixture model.IEEE Trans. Biomed. Eng., 56: 2826-2837. DOI: 10.1109/TBME.2009.2028876

Rana, A. and S. Arora, 2013.comparative analysis of medical image fusion. Int. J. Comput. Applic., 73: 10-13. DOI: 10.5120/12768-9371

Tsagaris, V., V. Anastassopoulos and G. Lampropoulos, 2005. Fusion of hyperspectral data using segmented PCT for enhanced color representation. IEEE Trans. Geosci. Remote Sens., 43: 2365-2375. DOI: 10.1109/TGRS.2005.856104

Yang, Y., D.S. Park, S. Huang and N. Rao, 2010.Medical image fusion via an effective wavelet-based approach. EURASIP J. Adv. Signal Proc., 2010: 579341-579341. DOI: 10.1155/2010/579341

Zaveri, T. and M. Zaveri, 2011. A novel region based multimodality image fusion method. J. Patt. Recognit. Res., 6: 140-153. DOI: 10.13176/11.245

