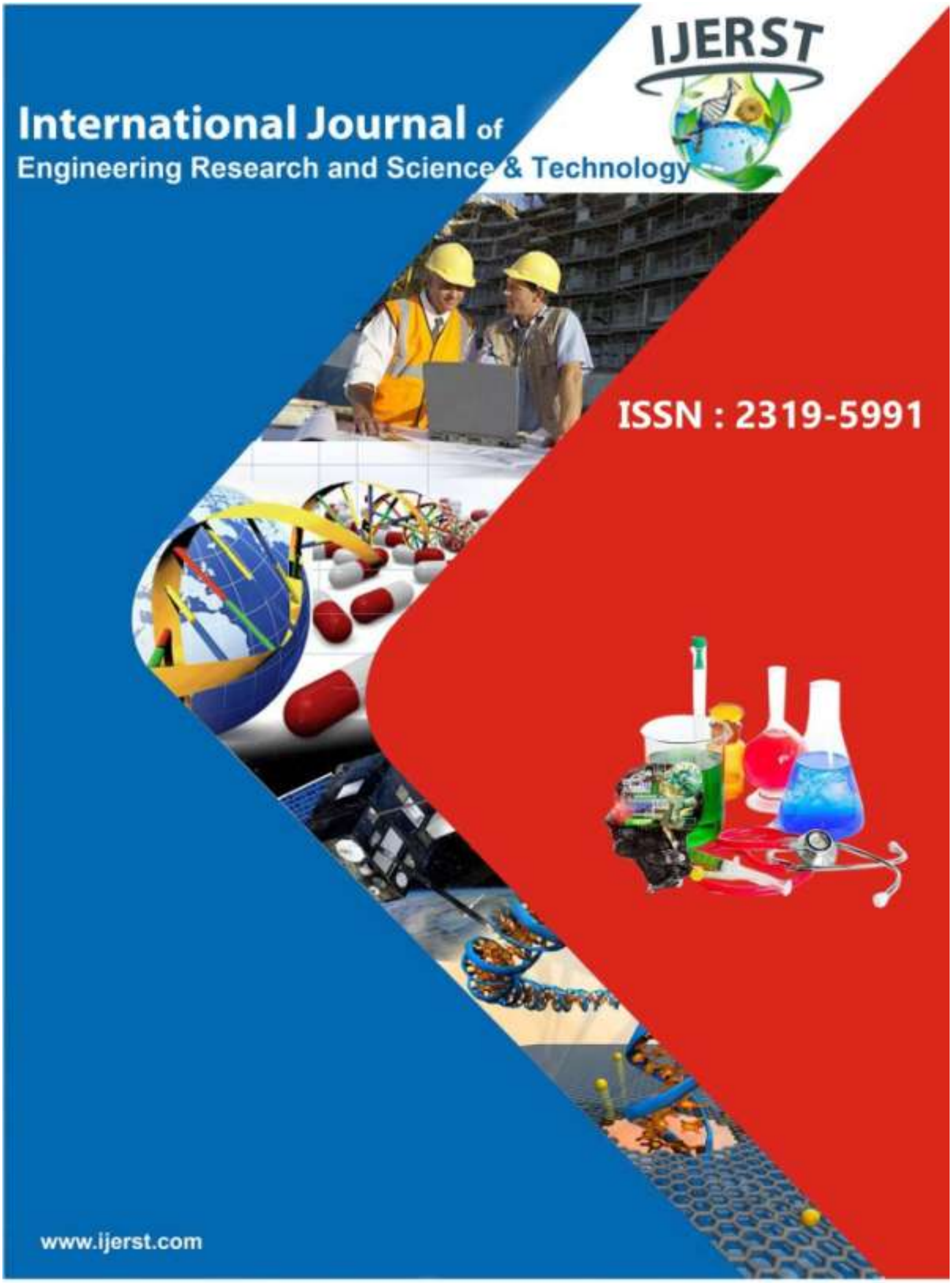

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Multimodal Medical Image Fusion Using DC Coefficient Scaling and MWGF in DWT Domain

Sumit Narayan Jarholiya 1, Dr. Shachi Awasthi 2

Abstract: Multimodal pictures, as the term implies, are medical images that were obtained with the use of numerous camera modules. A difficult challenge awaits us in extracting these photos' characteristics. As a result, both photos have a vastly different amount of information and low contrast when compared to each other. These photos have a poor contrast because of a lack of doctor's competence and practical hands. There are two major contributions to this study. This approach uses two layers of DWT, and then a modified DC coefficient scaling method in compressed DCT domain to improve multimodal pictures with low contrast. L component DC coefficient is adjusted to improve entropy and brightness in translated CIE-Lab colour space. It is then utilised to merge the two improved pictures by using a Modified Weighted Gradient Fusion (MWGF). For the final reconstruction, the inverse DWT is applied to the fused picture. Images from a variety of environments are used to evaluate the approaches.

Keywords: CT, MRI, Discrete Cosine Transform (DCT), CIE-Lab, and Modified Weighted Gradient Fusion are some of the imaging techniques used today (MWGF)

1. Introduction

Human bodily components may be identified and studied using medical pictures. Many different modalities of imaging, such as Positron Emission Tomography (PET) [1], Computed Tomography (CT) [2], and Magnetic Resonance Imaging (MRI) [3], are used to gather accurate information for medical diagnosis and treatment. Typically, these techniques are utilised to get information about the inside body components that are damaged or compromised. An image fusion approach is critical to extracting additional relevant information from scanned pictures. Various fusion approaches Viz. [1, 3, and 4] have been developed by researchers to improve the qualities of these medical pictures. It is suggested in this study that the contrast be improved prior to the pictures being fused. As a result, medical photographs now have better feature quality [5]. The photos' information content is improved by fusing contrast-enhanced versions. Image fusion is a technique that combines the best elements of two separate pictures (often medical) into a single composite image. The fusion procedure gets lengthy and entropy analysis becomes necessary since it is imperative that no information be lost during the fusion process. Medical image fusion is a popular method for

1Research Scholar, Jayoti Vidyapeeth Women's University, Jaipur, India
2Faculty of Engineering and Technology, Jayoti Vidyapeeth Women's University, Jaipur, India
1 sum_it_1976@yahoo.com, 2 shachiawasthi0803@gmail.com

researchers because it allows them to combine information from several sensors and imaging modalities.

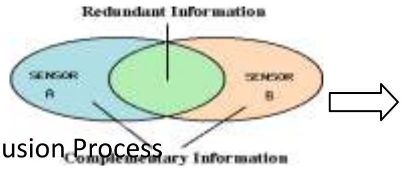


Figure 1 Basic Fusion Process

2. This research focuses on extracting the most important medical information from various multi-modal pictures. Pictures from two separate modalities, as well as images from the same modality, have been analysed for their performance.

3.

4. Using DCT-based DC coefficient scaling in CIE-Lab colour space, this work suggests enhancing colour pictures first before fusing. However, the method's efficacy varies depending on the kind of photos being analysed. To retain the entropy, the pixel-based fusion approach is employed to increase the contrast [7] of the pictures at the front end in the present enhancement method. Fusion of improved multimodal pictures is done using the modified weighted gradient fusion (MWGF)Next, Section II examines numerous extant studies in the medical image fusion sector specifically multimodal pictures, which follow the introduction. Section III explains and discusses the most common approach of enhancing a website. The technique for compressing DC coefficients in LAB space is explained. IV explains the fundamental Gradient-based fusion techniques. Described in detail in Section V is a potential hybrid fusion process. VI compares the predicted experimental findings of different strategies. Section VII concludes with a summary of the findings and recommendations for the future. Section

9. Literature Review

There are several ways to combine medical pictures, including feature-based and data-based fusions, as shown in the schematic displayed in Figure 2. There are three types of feature-based fusion: Wavelet, morphological operation, and gradient. In order to improve significant characteristics, this section examines medical image fusion approaches.

Because it incorporates both wavelet and gradient fusion, our approach is classified as a hybrid feature-based approach. Channels for brightness and chrominance are used in this Fusion. In the gradient domain, the luminance channel is fused.The weighted sum of the chrominance channels of the input pictures is used to fuse the chrominance channels. For both multi-focus and multi-exposure photos, this method generated excellent results. This method is superior than eight exemplary fusion techniques in terms of multi-focus picture fusion.

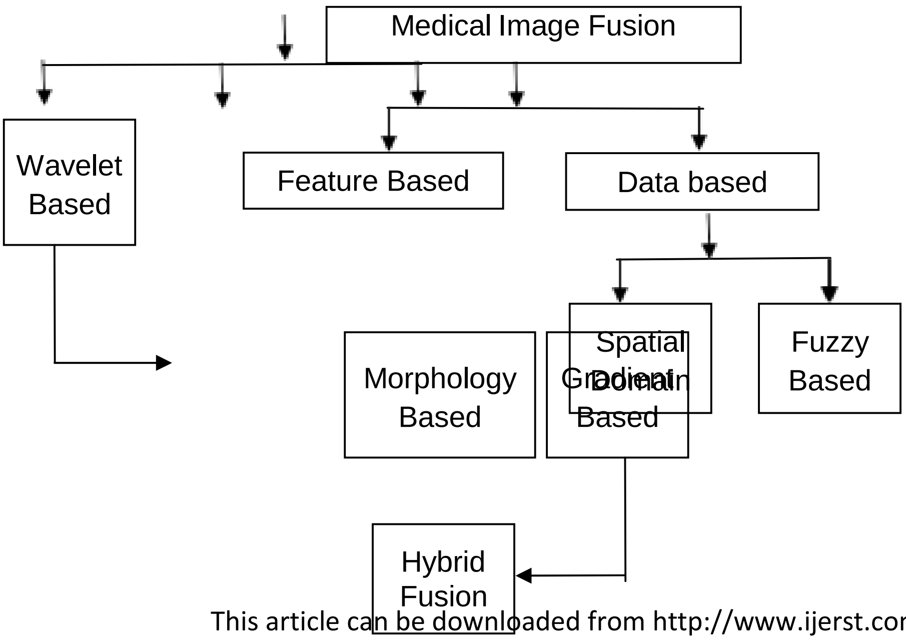


Figure 2 A Broad Classifications of Image Fusion Methodologies.

Table 1 Comparison of Existing Methods

Author/ Reference	Method Used	Kind of Images (Application Areas)	Used Colour Spaces
Jayanta M.[8]	Compressed DCT	True Colour Images with Low Contrast	Scaling the DC Coefficient in Y-Cb-Cr Space
Sujoy Paul [1]	Image Fusion	Multi Focused Images	Gradient Based Fusion Map
Xiangzhi Bai, [6]	Fusion by Boundary Adjustment	Multi Focused Images	Adjusting Weighted Kernel Based on Image Gradient and Morphological Operations
Deron et al. [4]	Multimodal Fusion	Multimodal Medical Image Database	Various Image Fusion in Wavelet Domain using Pixels
Our Proposed Work	Multimodal Fusion	Different Colour Multimodal Medical Images with Low Contrast	DC Coefficient Scaling in LAB Space with Weighted Gradient Based Fusion in Wavelet Domain

An image retrieval approach for multimodal images has been developed by Yu Cao et al. [5]. The novel gradient-based image fusion technique, developed by Sujoy Paul [1] and colleagues, is employed in this literature for picture fusion.

There are several ways to alter the boundaries between focus and defocus areas, and a weighted kernel based on image gradient is presented to quantify focus portions of the picture.

It's important to note that the fusion and registration processes of a picture are very important, and this is explained in detail in the paper by Fatma Ahmed El-Gamal et al [11]. In this article, we presented the concept of medical picture registration and surveyed several medical image fusion studies. The registration of medical pictures and/or the fusion procedure are the most often discussed difficulties in this literature.We employ the energy of Laplacian and a guided image filter for a novel fusion approach and this technique presented in this literature to extract the local and sharp changes in intensity of pictures. There are positives to the state-of-the-art fusion techniques over the multi-focus image fusion system, and it prevents information without distortion.This discrete cosine transform was employed for six distinct forms of picture fusion, and the quality of the fused images was assessed using performance assessment measures. [13] Using methods with block sizes less than 8x8 and equal to the picture size has a negative impact on Fusion's performance, according to this research. Image fusion methods based on DCT and DCT max provide excellent real-time performance. Wavelet-based image fusion rules have been employed by Paresh et al [21] with pixel-based fusions.However, there is a serious issue with the photos' colour shifting and brightness changing. To switch from one colour to another, colour shifting is used. For the identification of the optical disc in retinal pictures, Irene et al [8] employed the CIE-Lab colour space.

Recently, Jayanta et al. [9] has been widely employed. SNR and mean square error are used to compare three approaches in this research. Table 1 compares the many ways of enhancing colour images to show the relative merits of each. It is evident that the picture enhancement approach described here substitutes the Y-Cb-Cr colour system with the CIE Lab colour space.

Contrast enhancement strategies for low light pictures have been evaluated by Narasimhan and others [10]. When discussing how to improve contrast in a variety of lighting conditions, Method said that DCT transform techniques may be employed as well as other performance metrics that were created.

10. Pre Image Enhancement using Modified DC Coefficient Scaling

In this study a compressed domain approach is suggested for contrast enhancement in the discrete cosine transform (DCT) [7, 12] domain. The approach is utilized for enhancing the aesthetic looks of true colour medical photographs. DCT based techniques changes the picture from R-G-B to Y-Cb-Cr colour space. In this study, RGB is transformed to LAB first and the compressed DCT domain approach by scaling of DC coefficients is utilized to improve the L component of colour medical pictures. Although approach works as well with gray photos.

Method determines the DCT coefficients of the L components using DCT block size of 8X8. Then modify local background lighting using DC coefficient of every DCT block.

1. The average brightness of the block is defined as the DC value. Brightness levels to the value in the required range are mapped by the adjustment value. This brightness mapping function must be monotonic within the supplied range. Find the maximum brightness value of input picture I as provided in eq 1),

max(I) = ImaS (1) (1)

2. Map the DC coefficient using monotonic Twicing function [7] specified as the mapping function.

DC = $(x) * Ima$S (2.a) (2.a)

3. Where technically Twicing function (x) is defined as stated in eq 2(b);

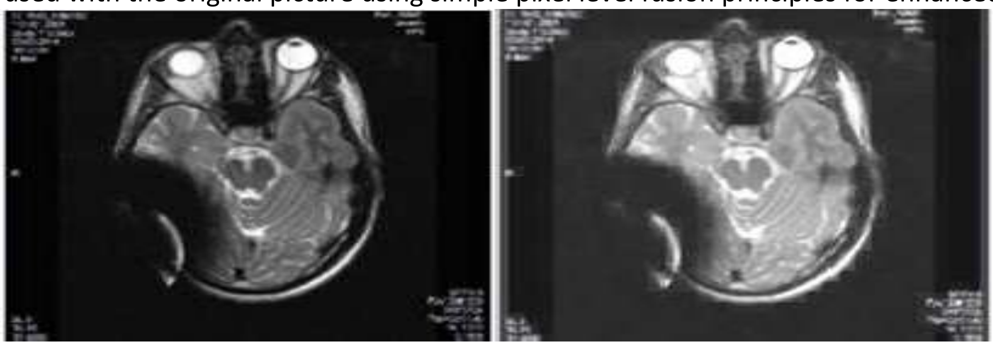
$(x) = x * (2 - x)$ (2.b) (2.b)

4. Calculate the DC 2coefficients and scale the DC coefficients as stated in the eq. 3);

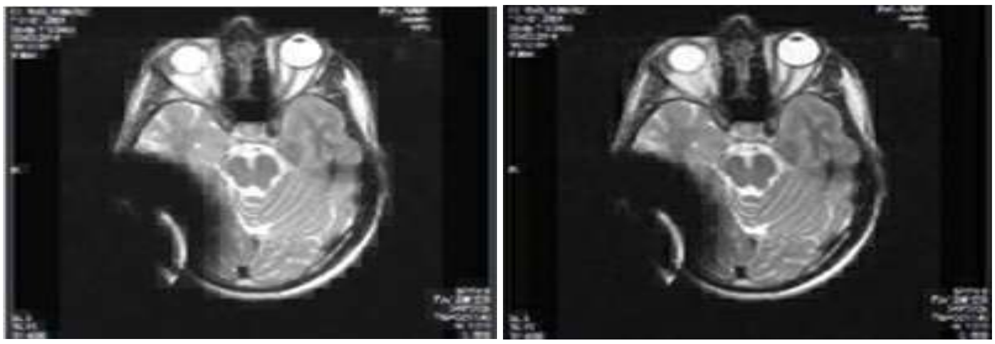
$Scal$e = K = (f (Y(0,0)))/(Y(0,0)) (3) (3)

N$Imax$ N$Imax$

Where Y(0,0) the DC coefficient to be improved and K is is the scaling factor. Scaled DC coefficient is fused with the original picture using simple pixel level fusion principles for enhanced entropy output.



a) MRI image b) enhanced using standard DC coefficient scaling by Jayanta,et al.



improved by pixel-based fusion of a) and c) in LAB colour space using our modified DC coefficient scaling

Original MRI patient picture enhancements are shown in Figure 3. 1 the traditional DC coefficient scaling by Jayanta,et al.[1], our modified DC coefficient scaling in LAB colour space, and the pixel-based fusion of these two methods [2–4] were used to improve this picture.

In this step, we'll find a scaling factor, multiply it by the block's DC component, and the outcome will be an improved picture.

In other words, k - origikal DC (4)To reassemble the original picture, perform IDCT on each block and then combine the results.

Recalibrate the LAB picture so that it may be used to recreate the original RGB image.

The algorithm is complete.In the DCT domain, Paper modifies the DC coefficient of the image's 'L' component. This is because the DC coefficient supplied by (Y(0,0)) contains the vast bulk of the available information. On the right, you can see an example of the enhancement step in action, as well as how it compares to the normal DCT approach.

Using gradient-based image fusion, images are combined based on the magnitudes of their gradients. Let IL = L1, L2 be the luminance component of two pictures.

Image f's gradient in the x and y directions is referred as as

f x fðfðyI'm not sure what you're saying, but (5)

It is a feature set of an image since it monitors pixel intensity changes and represents all of the picture's pixel values.

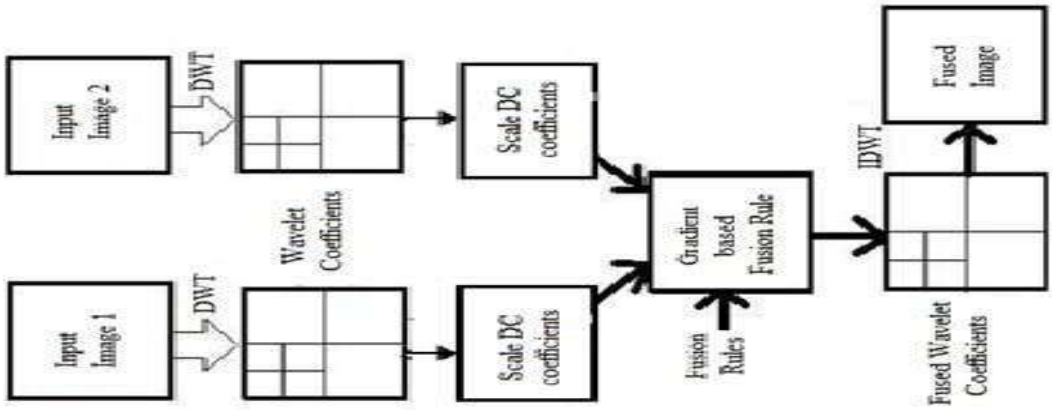
characteristically frequent occurrences. Mathematically, the gradient's magnitude may be determined as follows:

For example, M(S,y) = (LS2, Ly2) (6)

The most gradient pixels in both photos should be replaced. We use numerical parameters or coefficients to determine the gradients of the eigen coefficients in order to obtain the weighted gradients.

4. Modified Weighted Gradient Fusion (MWGF) Method

Finally, fuse the weighted coefficients as provided by the conventional MWGF fusion approach using



morphological operators and the level set procedure. In Figure 4, you can see a block schematic of the system.

Figure 4 Block Diagram of the Proposed Fusion Method

5. Proposed Fusion Methodology

The suggested hybrid flow diagram for multi modal fusion is illustrated in the Figure 4. Initially 2D wavelet decomposition is done on both photos. Then for pre boosting the pictures DC coefficients are scaled in the compressed DCT domain by mapping the Twicing function.Wavelet Fusion: At this step to adopts the entropy of the augmented picture wavelet based pixel level averaging fusion is then applied on scaled and input images The suggested approach is exclusively applied on the luminance L component and chrominance components are maintained unmodified accordingly. Increasing L while leaving A and B fixed keeps the hue of the picture.

In order to obtain more exact edge features the weighted gradient image fusion is utilized on the LL wavelet coefficient as seen in the Figure 4. The inverse DWT is take on the fused multimodal picture. to reconstruct

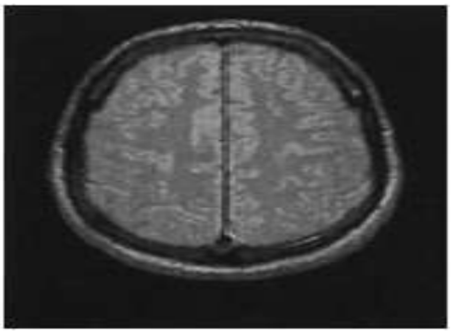
the actual colour fused picture characteristics. The method offers the unique feature set after fusing and may provide more specific details. But occasionally it may have likelihood to lose crucial material.

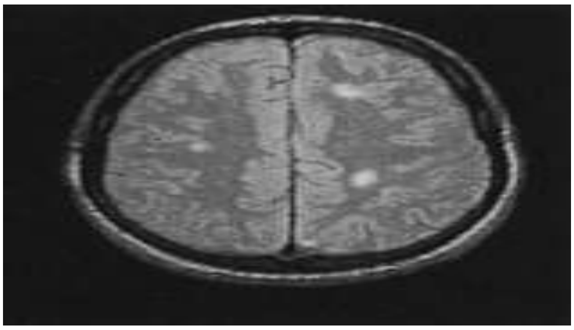
6. **Results and Discussions**

In this part, we'll go through a couple of our more interesting findings. The weighted gradient fusion and the DC coefficients scaling of DCT coefficients in LAB colour space are combined in the suggested technique to enhance DCT coefficients scaling. In the compressed DWT domain, the method is implemented. Our suggested method's sequential results are shown in Figures 5 and 6 for two different combinations of multi-modal MRI pictures, such as the Axial Brain MRI image and the brain tumour MRI image pair.

The input pictures are first decomposed into wavelet coefficients, as seen in Figures 5 and 6. Then, in LAB space, we use our DC coefficient scaling approach to improve the LL wavelet coefficient. Multi gradient weighted image fusion approach is utilised to combine the improved LL pictures. The last step in creating the merged pictures is to employ the inverse wavelet transformations.

According to Figures 5 and 6, the two input photos include distinct but also comparable information..The goal of the study is to merge the characteristics of both input photos to obtain more accurate features. Our suggested technique provides two separate perspectives of the fused outputs.A comparison of this new method's performance with that of the previous approaches can be seen in Figure 7. There can be no doubt that the fusion approach we offer is superior and distinct. The method's performance is compared to the prior techniques' performance. The visual information provided by the suggested approach is superior to that provided by the current MWGF method. Figure 7 illustrates this point well. The Deron MRI picture 1 released by Deron et al [4] is used in the comparison. Derons'

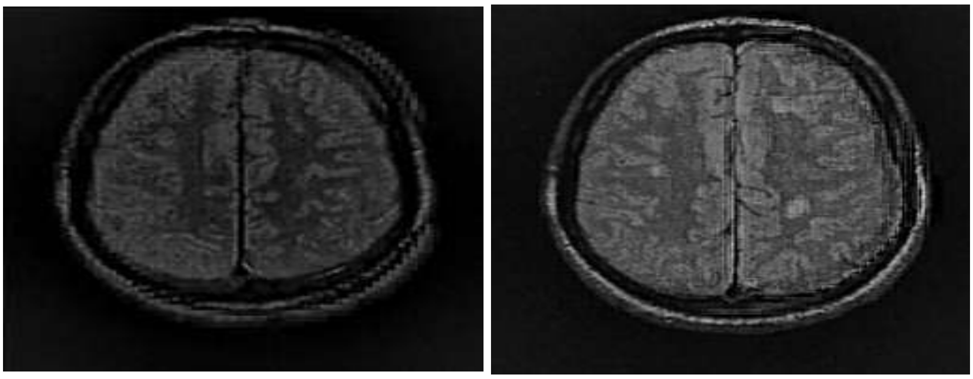




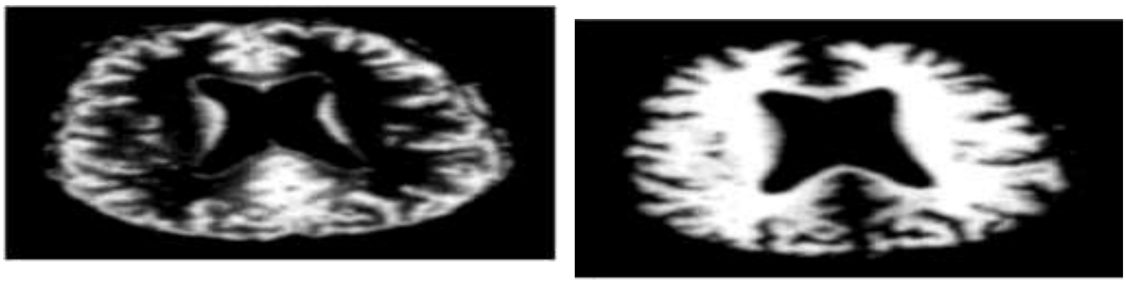
approach produces colour results, but the content in our suggested fusing method is superior to the outcomes of all the other methods we've tested.a) Axial Brain MRI 1. b) Axial Brain MRI 2.

c)Two Level DWT Image 1 d)Two Level DWT Image 2.

e) Enhanced LL Image 1, f) Enhanced LL Image 2



g)Gradient Fused Image 1, h) Gradient Fused Image 2
Figure 5 Sequential Results for Multimodal Image Fusion for Axial Brain MRI Images



b) Brain Tumer MRI 1. b) Brain Tumer MRI 2.

c)Two Level DWT Image 1.d)Two Level DWT Image 2.

7. **Conclusions**

Multimodal picture fusion is suggested in this work. Wavelet and weighted gradient fusions are combined in a new method. The photos need, however, be improved prior to being merged. In order to improve the medical pictures, a DCT-based DC coefficient scaling approach is applied. There is evidence that the suggested approach is capable of capturing the best characteristics, but the average brightness is lost. The amount of information or features available has been boosted as a result of the upgrade. Wavelet multi-resolution properties allow for additional information to be gleaned from the chrominance information. This is because the colours are more accurately represented by utilising the Lab colour space. Medical photos may be processed in a variety of ways using the suggested technology.

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