PES UNIVERSITY
Electronic City Campus, 1 KM before Electronic City, Hosur Road,
Bangalore-100

PROJECT REPORT
on

“WAVELET BASED IMAGE FUSION”

Submitted in partial fulfilment of the requirements for the IV Semester
Digital Image Processing using MATLAB (UE18CS257E)

Bachelor of Engineering
IN
COMPUTER SCIENCE AND ENGINEERING

For the Academic year
2019-2020

BY

SAIPRAKASH L SHETTY	**PES2201800730**
AKASH YADAV	**PES2201800415**

Under the Guidance of
Dr. Sabeeha Sultana
Assistant Professor

Department of Computer Science and Engineering
PES UNIVERSITY EC CAMPUS
Hosur Road, Bengaluru -560100

PES UNIVERSITY EC CAMPUS

Hosur Road, Bangalore -560100

Department of Computer Science and Engineering

<u>CERTIFICATE</u>

Certified that the project work entitled **“WAVELET BASED IMAGE FUSION”** is a bona fide work carried out by **SAIPRAKASH L SHETTY** bearing USN: **PES2201800730** and **AKASH YADAV** bearing USN: **PES2201800415**, students of **PES University EC CAMPUS in** partial fulfilment for the award of **Bachelor of Engineering** in **Computer Science and Engineering** of the **PES University**, **Bangalore** during the year 2019-2020.

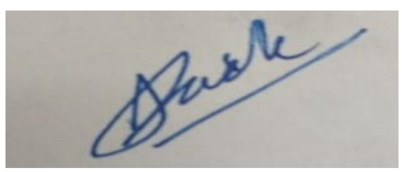
<u>Signatures:</u>

Project Guide: **Dr Sabeeha Sultana** **Assistant Professor, Dept. of CSE, PES UNIVERSITY EC CAMPUS, Bengaluru**	**Dr Sandesh B J** **Head, Dept of CSE** **PES UNIVERSITY EC CAMPUS, Bengaluru**

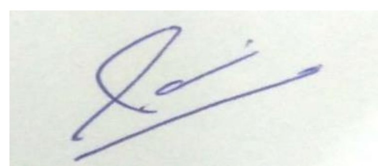
Declaration

We hereby declare that the project entitled **"WAVELET BASED IMAGE FUSION"** submitted for Bachelor of Engineering in Computer Science and Engineering of PES University, Bangalore is my original work and the project has not formed the basis of the awards of any degree, associate ship, fellowship or any other similar titles.

Signature of the Student:



AKASH YADAV
PES2201800415



SAIPRAKASH L SHETTY
PES2201800730

Place: Bengaluru

Date: 04 – 06 – 2020

INDEX

INTRODUCTION

The objective of image fusion is to combine information from multiple images of the same scene. The result of image fusion is a new image which is more suitable for human and machine perception or further image-processing tasks such as segmentation, feature extraction and object recognition. Over the past decade, a significant amount of research has been conducted concerning the application of wavelet transforms in image fusion.

In this project we are demonstrating image fusion using wavelet transform with maximum and average rules. Since the input images are CT (computed tomography) and MRI (magnetic resonance imaging) scans of the brain containing a tumor, we are also showing the tumor. In the arena of biomedical imaging, two widely used modalities, namely the MRI and the CT scan do not reveal identically every detail of brain structure. While CT scan is especially suitable for imaging bone structure and hard tissues, the MR images are much superior in depicting the soft tissues in the brain that play very important roles in detecting diseases affecting the skull base. When finally fused together can conclude many things in the medical field.

PROJECT DESCRIPTION

When the two source images are loaded, initially they are whether they are of the same size, if not they resize to be made to be equal. Next they are converted to 2D by using rgb2gray. Later Discrete Wavelet transform is applied on them separately. They are compared pixel by pixel by using the Average rule and the Maximum rule. The fused image shall contain the pixel which has higher frequency among the two images (CT and MRI) at each of its new pixel position. This procedure is done horizontally, vertically and diagonally each separately and later fused by using Inverse Discrete Wavelet Transform. Later it is checked where the tumor is present in the fused image. The main objective of this project is to understand how the image fusion takes place rather the brain tumor extraction.

TEAM MEMBERS:

SAIPRAKASH L SHETTY - PES2201800730

AKASH YADAV - PES2201800415

LITERATURE SURVEY

1) *Image Fusion Using Wavelet Transform, By Zhu Shu-Long, Symposium on Geospatial Theory, Process and Applications, Ottawa 2002, Department of remote sensing information Engineering, Zhengzhou Institute of surveying and mapping, Zhengzhou, China*

In the paper, the image fusion algorithm based on wavelet transform is proposed to improve the geometric resolution of the images, in which two images to be processed are firstly decomposed into sub-images with different frequency, and then the information fusion is performed using these images under the certain criterion, and finally these sub images are reconstructed into the result image with useful information.

2) *International Journal of Engineering Research, Volume No.3, Issue No.7, pp : 442-445 ,Image Fusion Based On Wavelet Transform, Souparnika Jadhav Department of Electronics and Communication Engineering, VTU,MMEC, Belgaum, Karnataka, India*

This paper mainly spoke about complex Discrete wavelet Transform in image fusion, majorly focusing on Dual Tree DWT. Even though our project is based on this type of wavelet transform, we were able to gather lot information on Average rules, Maximum Rule and Inverse DWT and how they effect the fusion image using wavelet Transform.

ALGORITHM

The algorithm of image fusion using DWT (Discrete Wavelet Transform) described in the following steps

1. Size of inputs images:

Given a two dimensional images (example, image A, image B) it is necessary to convert it into the same size a power of two square forms.

2. Computation of two dimensions DWT:

In this step, the two dimensional Discrete Wavelet Transform should be applied to the resized two dimensional images.

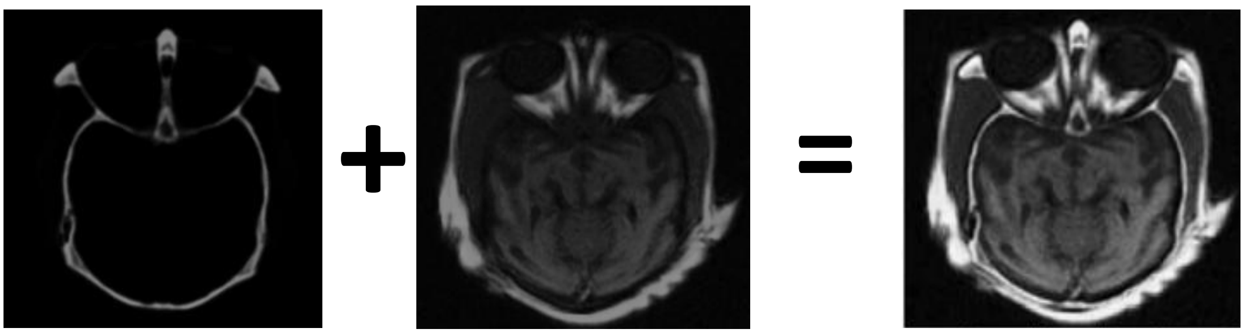
3. Fusion rule:

The most used of image fusion rule using wavelet transform is maximum selection, compare the two coefficients of DWT of the two images and select the maximum between. While the lowpass sub band is an approximation of the input image, the three detail sub bands convey information about the detail parts in horizontal, vertical and diagonal directions. Different merging procedures will be applied to approximation and detail sub bands. Lowpass sub band will be merged using simple averaging operations since they both contain approximations of the source images.

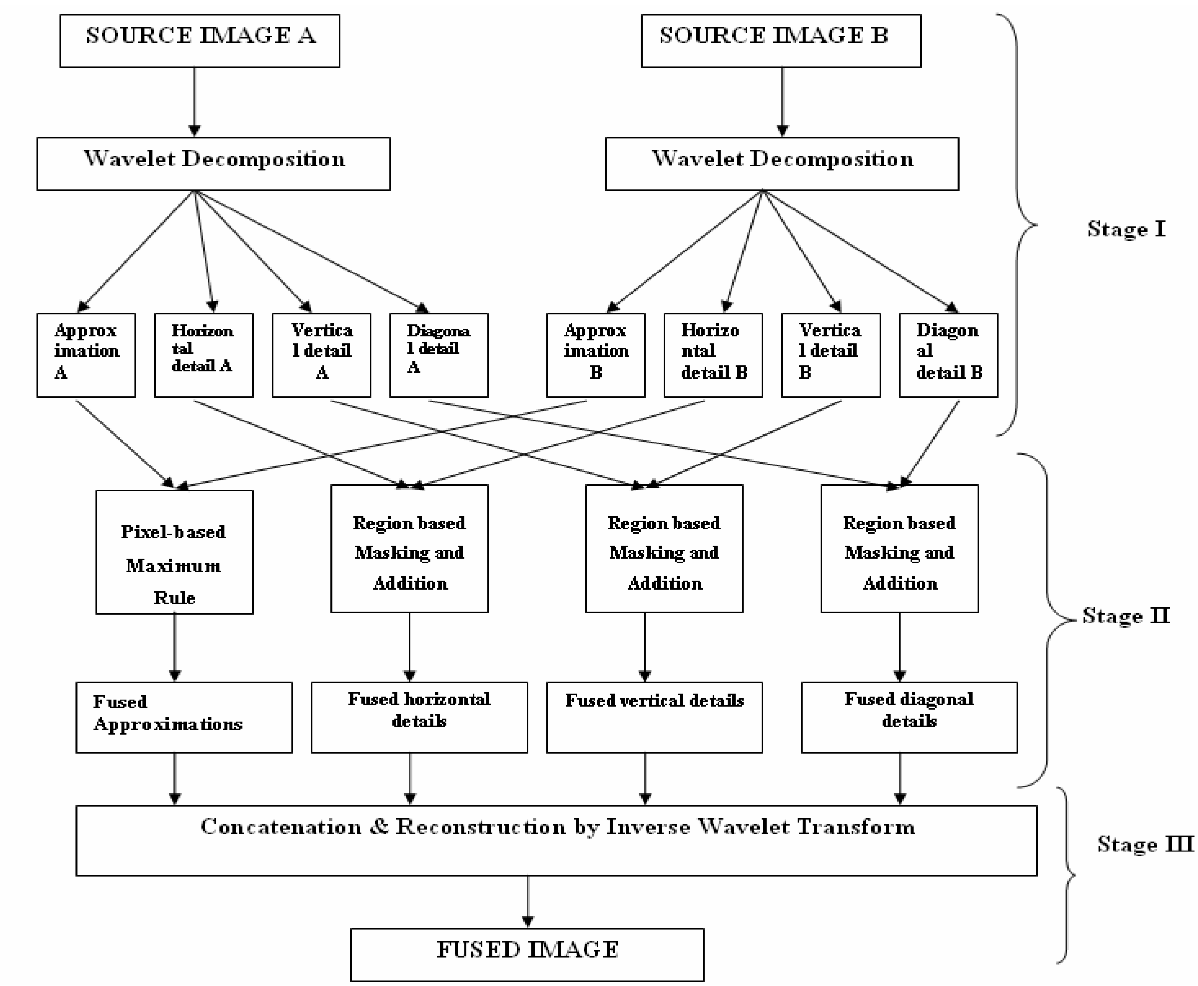
4. Inverse discrete wavelet transforms:

After selected the fused low frequency and high frequency bands, fused coefficient is reconstructed using the Inverse fast discrete wavelet transform to get the fused image which represent the new image.

WORKING



(Note: These images are used for demonstration, actual images are in output page)



PERFORMANCE EVALUATION

$$MSE = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}[S(i,j)-F(i,j)]^2}{MXN}$$

$$PSNR = 10\log_{10}\left(\frac{255^2}{MSE}\right)$$

MSE: Mean Square Error

PSNR: Peak Signal to noise ratio

S: Source Image

F: Fused image

The term **peak signal-to-noise ratio (PSNR)** is an expression for the ratio between the maximum possible value (power) of a signal and the power of distorting noise that affects the quality of its representation. Because many signals have a very wide **dynamic range**, (ratio between the largest and smallest possible values of a changeable quantity) the **PSNR** is usually expressed in terms of the logarithmic decibel scale.

HARDWARE REQUIREMENTS:

1)Hard disk(space) 1TB

2) Ram 2GB

3) Processor i3

SOFTWARE REQUIREMENTS:

1) Operating system Windows 10

2) Coding Language MATLAB

3) Tools MATLAB R2019B

4) Toolboxes:

    (i) Wavelet Toolbox

    (ii) Image Processing Toolbox

CODE

```
close all
clear
clc
%% Read Images
%% the size of images must be equal
a=imread("CT_Image2.jpg");
a=rgb2gray(a);
a=imresize(a,[276,276]);
b=imread("MRI_Image.jpg");
b=rgb2gray(b);
b=imresize(b,[276,276]);
%%   Wavelet Transform
[a1,b1,c1,d1]=dwt2(a,'db2’);
%a1 is approximate coefficient matrix
%b1,c1,d1 are detail horizontal,vertical and diagonal
%coefficient matrix respectively
[a2,b2,c2,d2]=dwt2(b,'bd2’);
%a2 is approximate coefficient matrix
%b2,c2,d2 are detail horizontal,vertical and diagonal
%coefficient matrix respectively
[k1,k2]=size(a1);
%% Fusion Rules
a3 = zeros([k1 k2]);%preallocating with zeros
%% Average Rule
for i=1:k1
    for j=1:k2
        a3(i,j)=(a1(i,j)+a2(i,j))/2;
   end
end
%% Max Rule
b3 = zeros([k1 k2]);%preallocating with zeros
c3 = zeros([k1 k2]);%preallocating with zeros
d3 = zeros([k1 k2]);%preallocating with zeros
for i=1:k1
    for j=1:k2
        b3(i,j)=max(b1(i,j),b2(i,j));
```

```
        c3(i,j)=max(c1(i,j),c2(i,j));
        d3(i,j)=max(d1(i,j),d2(i,j));
    end
end
%% Inverse Wavelet Transform
c=idwt2(a3,b3,c3,d3,'db2');
figure,imshow(a)
title('CT Scan of Brain')
figure,imshow(b)
title('MRI Scan of Brain')
figure,imshow(c,[])
title('Fused Image')
%% Showing the tumour part
imageRGB=imread('final.jpg');
brain_bw=im2bw(rgb2gray(imageRGB));
figure,imshow(brain_bw)
title('Fused Image in gray scale')
result=bwareafilt(brain_bw,1);
figure,imshow(result)
title('Tumor Segmented')
%% Performance Criteria
CR1=corr2(a,c);
CR2=corr2(b,c);
S1=snrr(double(a),double(c));
S2=snrr(double(b),double(c));
fprintf('Correlation between first image and fused
image =%f \n\n',CR1);
fprintf('Correlation between second image and fused
image =%f \n\n',CR2);
fprintf('Signal to Noise Ratio between first image and
fused image =%4.2f db\n\n',S1);
fprintf('Signal to Noise Ratio between second image and
fused image =%4.2f db \n\n',S2);
function r = snrr(in, est)
    error = in - est;
    r = 10 * log10((255^2)/ mean(error(:).^2));
end
```

OUTPUT

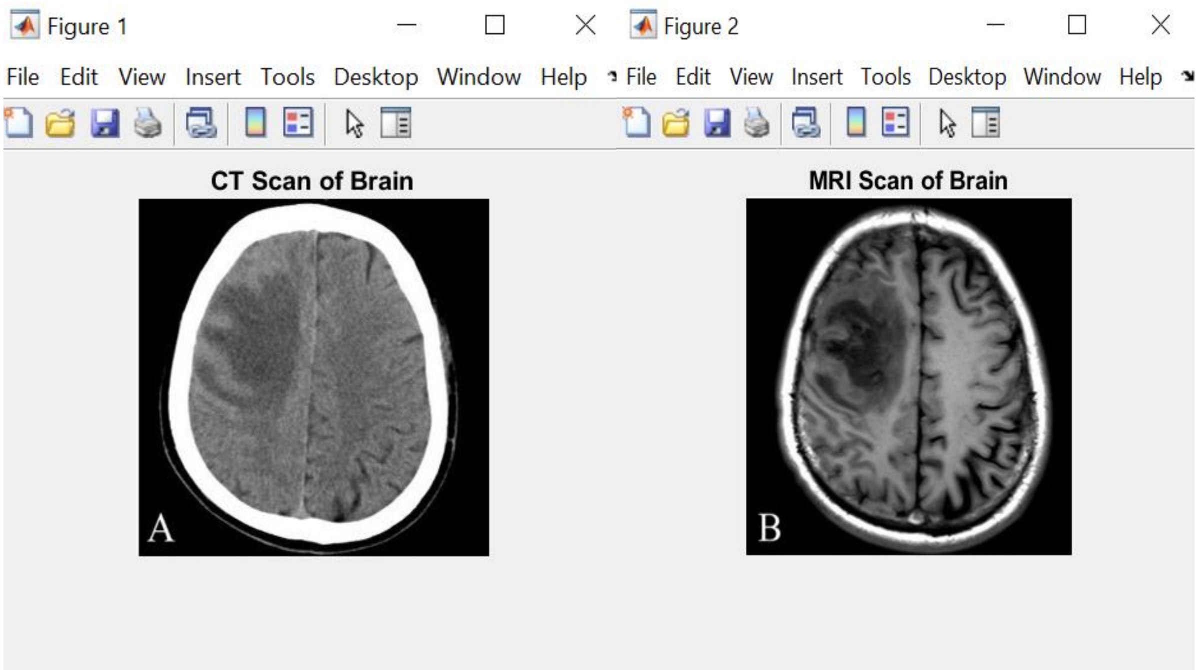


Figure 1
File Edit View Insert Tools Desktop Window Help
CT Scan of Brain
A
Figure 2
File Edit View Insert Tools Desktop Window Help
MRI Scan of Brain
B

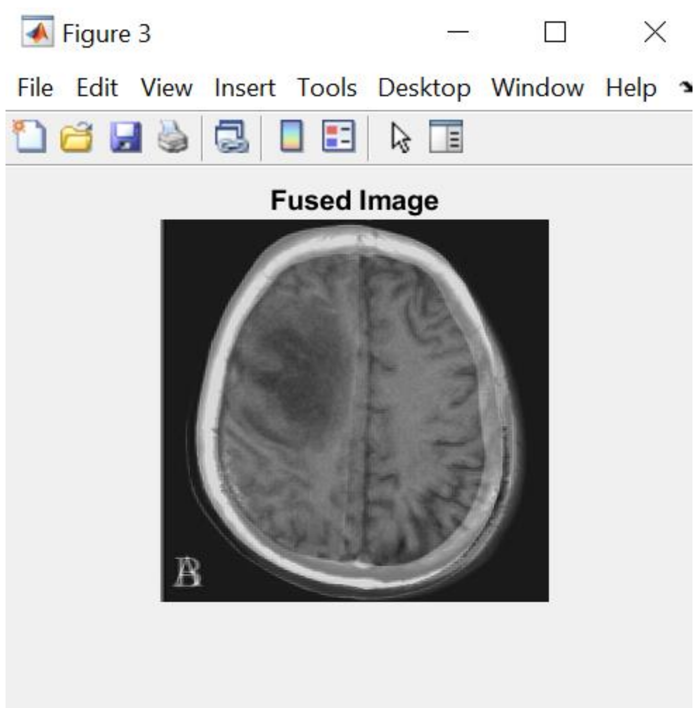
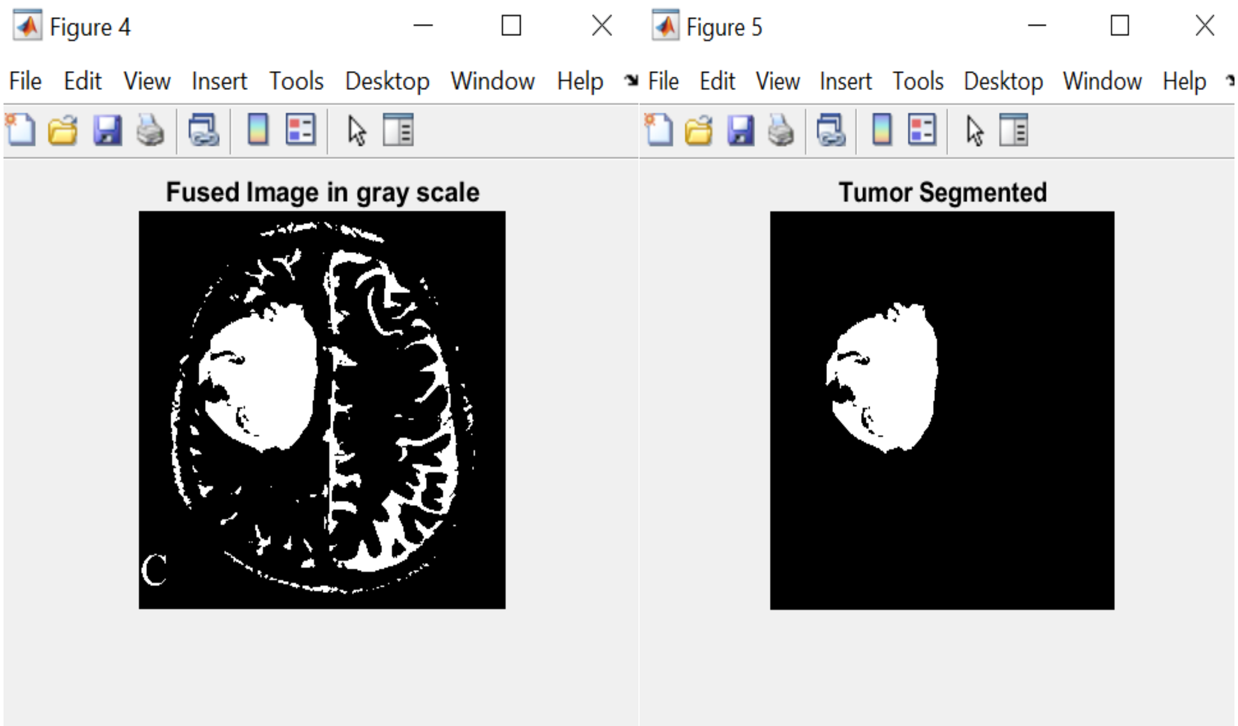
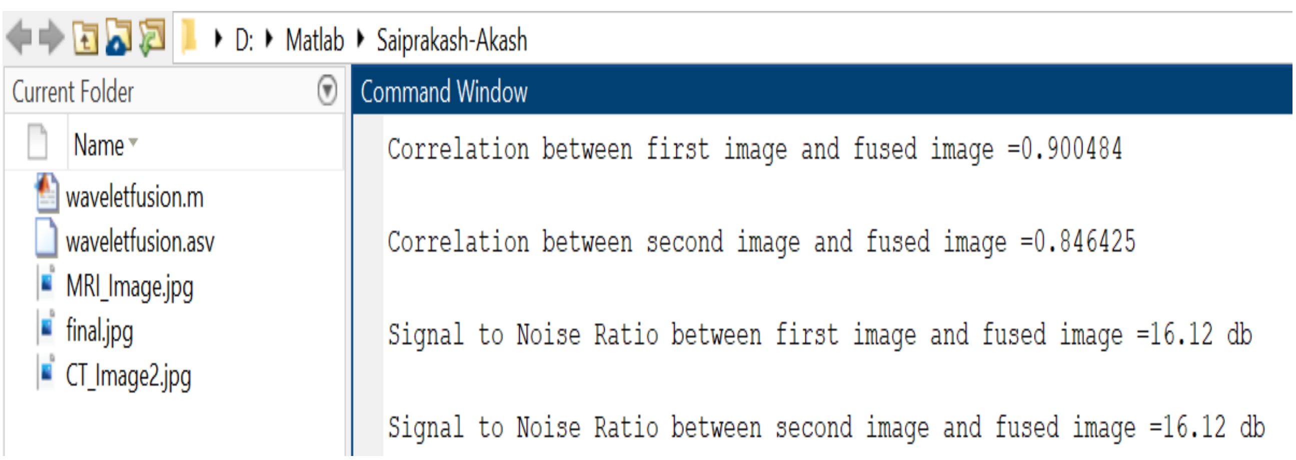


Figure 3
File Edit View Insert Tools Desktop Window Help
Fused Image



PERFORMANCE EVALUATION RESULTS



CONCLUSION

Discrete wavelet transform is any wavelet transform for which the wavelets are discretely sampled. As with other wavelet transforms, a key advantage it has over Fourier transforms is temporal resolution: it captures both frequency and location information.

We can conclude that when the two or more images are fused together, the resultant allows us to detect a plentiful of new information. When the two source images are loaded, they are compared pixel by pixel after applying DWT on them. The fused image shall contain the pixel which has higher frequency among the two images (CT and MRI). This procedure is done horizontally, vertically and diagonally each separately and later fused by using inverse DWT.

The discrete wavelet transform has a huge number of applications in science, engineering, mathematics and computer science. Most notably, it is used for signal coding, to represent a discrete signal in a more redundant form, often as a preconditioning for data compression. Practical applications can also be found in signal processing of accelerations for gait analysis, image processing, in digital communications and many others. It is shown that discrete wavelet transform (discrete in scale and shift, and continuous in time) is successfully implemented as analog filter bank in biomedical signal processing for design of low-power pacemakers and also in ultra-wideband (UWB) wireless communications.

BIBLIOGRAPHY

1) Pattern Recognition, Volume 37 Issue 9, September 2004, Pages 1855-1872

Authors: G Parajes, JM De La Cruz

2) M. Sasikala and N. Kumaravel, “A comparative analysis of feature based image fusion methods,” Information Technology Journal,6(8):1224- 1230, 2007.

3) P. Hill, M.E. Al-Mualla, D. Bull, Perceptual image fusion using wavelets IEEE Trans. Image Process., 26 (2017), pp. 1076-1088