



## Short Term Course on Wavelet *via* Matrices and its Applications in signal and image processing

Discipline of Mathematics, IIT Indore  
November 16-21, 2020



Coordinators: Dr. Niraj K. Shukla, Dr. Sk. Safique Ahmad

### Report of the course

The workshop entitled “Wavelet via Matrices and its Applications in signals and image processing ” was conducted by the Discipline of Mathematics of IIT Indore during 16-21 November 2020 under QIP approved by AICTE. In this workshop, lectures were given by various experts both from Indian and abroad. Every day their 6 hrs lectures were conducted, including a discussion among participants and subject experts. Every day we have conducted talks on wavelet and matrix theory, including both research and basics of the subjects. In this workshop, the experts cover the programming language like Julia and Matlab. The main topics were covered are as follows: wavelets including Haar and Daubechies, sheralets, DFT, FFT, lowpass, and high pass filter, multi-resolutions techniques for both theoretical and computational aspects on continuous and discrete cases. Also, the recent development of wavelets & shearlets for detection of singularity was discussed.

The 2nd part of this workshop was on matrix theory: Items were covered on the matrix theory are as follows: the Sensitivity analysis of LU decompositions, QR decompositions, SVD, least squares problem, and their various applications in image, signal processing, and data sciences. Hadamard matrices, and its applications in cryptography, Bi partitioning of graph, Fiedler vector, partitioning of a bipartite graph, were covered. The following resource persons were involved as experts in this workshop.

1. **Dr. Bhupendra Singh, Scientist, CAIR-DRDO, Bangalore**
2. **Prof. Bin Han, University of Alberta, Canada**
3. **Dr. Gajendra Kumar Vishwakarma, IIT Dhanbad**
4. **Prof. Hans Georg Feichtinger, University of Vienna, Austria**
5. **Prof. Ivan Slapnicar, University of Split, Croatia**
6. **Dr. Mani Mehera, IIT Delhi**
7. **Dr. Niraj Kumar Shukla, IIT Indore**
8. **Dr. Rajesh Kumar Pandey, IIT Bhu**
9. **Prof. Ram Bilas Pachori, IIT Indore**
10. **Dr. Sk. Safique Ahmad, IIT Indore**
11. **Dr. Swaraj Paul, IIT Delhi**

We have received very good response from the participants who had joined from various parts of country and were motivated towards the subjects covered during this workshop.



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Meeting details

People (33) Chat

Let everyone send messages

Roops K 11:58 AM  
yes sir

SER-ICE PSG CT 11:58 AM  
yes sir. It is visible.

RISHABH YADAV 12:13 PM  
Voice is getting stuck.

Pooja Singh 12:23 PM  
what is the significance of exponential functions for ON basis

RISHABH YADAV 12:28 PM  
Yes

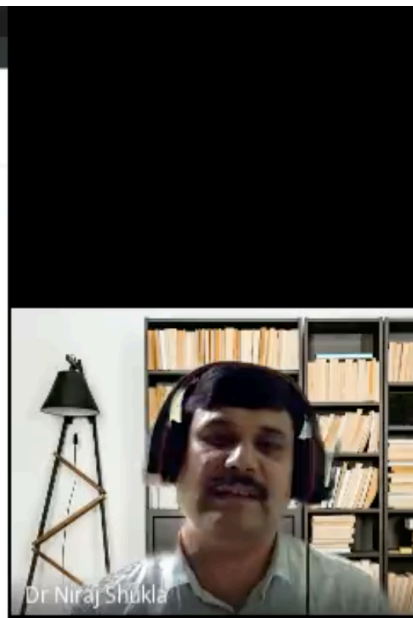
Pramod Kachare 12:58 PM  
Sahil IIT, our mic is unmute. Could you please mute it.

Safique Ahmad 12:58 PM  
Please mute your audio

SER-ICE PSG CT 1:02 PM  
What is the significance of complex exponential?

SER-ICE PSG CT 1:03 PM  
What is Hilbert space?

Send a message to everyone



REC You are presenting

Anupam Gumber and 31 more

43 Presentation (You)

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123.pdf

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Arithmetic and seri...Answers

Frames as subspaces

oor frames on lly c...ed topics

GIAN

You're presenting to everyone

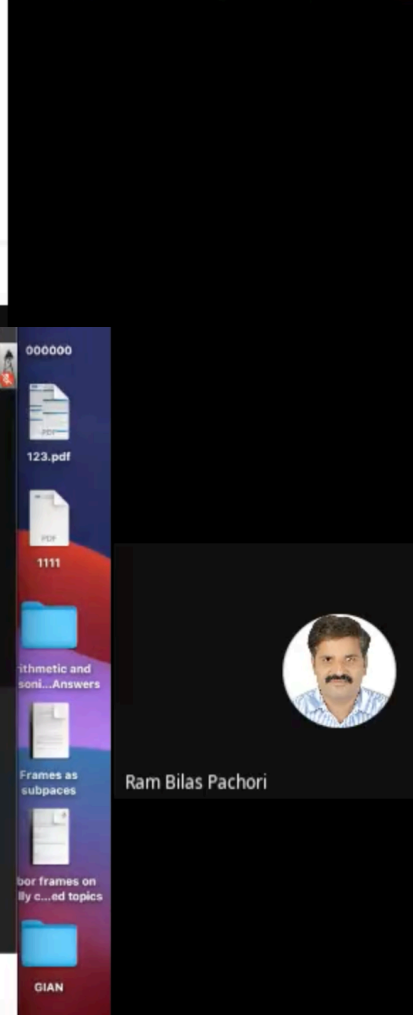
Stop presenting

R S Y Q A

Roopa K Sharath Shettigar Yuvraj Singh QIP Coordinator Ashok Singh

Meeting details

Turn on captions You are presenting

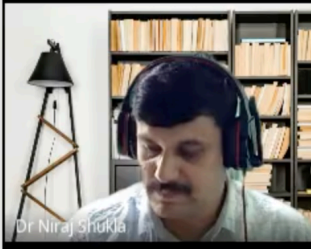


QIP Course on Wavelets via Matrices:

Monday, 19 November 2020 11:41 AM

Books:-

1. E. Hernandez and G. Weiss, A first Course on Wavelets, CRC Press, 1996.
2. M.W. Frasier, An introduction to wavelets through linear algebra, Springer-Verlag, 1999.
3. D.F. Walnut, An introduction to wavelet Analysis, Birkhauser Basel



Workshop

- ① Fundamentals of Matrix Computation  
Third Edition (David S. Watkins)  
Wiley
- ② Applied Numerical Analysis  
James W. Dammel  
Scam
- ③ Linear Algebra Done Right  
2nd Edition  
Sheldon-Axel (Springer)



```

begin
    alpha=0.7 # 0.1
    W2=exp.(-pairwise(SqEuclidean(),X)/alpha^2)-I
    L2=Diagonal(vec(sum(W2,dims=2)))-W2
    E2=eigs(L2,nev=2,which=:SM,v0=ones(m))
    C2=ones(Int64,m)
    C2[findall(E2,[2],[2],>0)].=:2
    plotKpartresult(C2,X)
end
  
```



Recursive bipartitioning

# Fractional Filters For Image Processing Applications

Rajesh K. Pandey

Associate Professor  
Department of Mathematical Sciences  
Indian Institute of Technology (BHU), Varanasi-221005  
Email id: rkpandey.mat@iitbhu.ac.in



# Introduction to Wavelet Theory

Bin Han

Department of Mathematical and Statistical Sciences  
University of Alberta, Edmonton, Canada

Present at Indian Institute of Technology Indore

on Wavelet via Matrices and its Applications in Signals and Image Processing

November 16–20, 2020



A screenshot of a Zoom meeting grid. At the top, there are two video feeds of participants in a library setting. Below them are several circular icons representing other participants: a purple circle with 'R', a blue circle with 'A', a green circle with 'V', a purple circle with 'D', and a blue circle with 'A'. At the bottom right, there is a larger video feed of a man in a light blue shirt, with the name 'Ivan Slapnicar' below it.





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Time Frequency Analysis: Numerical Realization of Gabor Analysis and Function Spaces HGFei

PDF Reader interface showing a slide from the Numerical Harmonic Analysis Group (NuHAG). The slide title is "Time Frequency Analysis: Numerical Realization of Gabor Analysis and Corresponding Function Spaces" by Hans G. Feichtinger, Univ. Vienna. Contact information includes hans.feichtinger@univie.ac.at and www.nuhag.eu. A video feed of the speaker is visible in the top right corner.

Hans G. Feichtinger, Univ. Vienna hans.feichtinger@univie.

**Eigenanalysis and**  
**Singular Value Decomposition**



Gajendra K. Vishwakarma

**Gajendra K. Vishwakarma** | Ph.D. (Statistics)  
 Department of Mathematics & Computing  
 Indian Institute of Technology (ISM) Dhanbad, India  
 Email: vishwagk@iitism.ac.in  
<https://www.iitism.ac.in/facultydetail.php?id=OTg3>

# Applications of Matrices: In Cryptography and Quantum Computing<sup>I</sup>

Bhupendra Singh  
bhupendra@cair.drdo.in

CAIR, DRDO, Bangalore



Bhupendra Singh

## Extension of wavelets to topologically complicated domains

Mani Mehra

Department of Mathematics  
Indian Institute of Technology Delhi (IITD)



References  
○○○

## Introduction to shearlets and detection of directional singularity

Swaraj Paul  
Post-Doctoral Fellow  
Department of Mathematics  
Indian Institute of Technology Delhi



Workshop: Wavelet via Matrices and its Applications in  
signals and image processing



Swaraj Paul

