

✓ FRACTAL ANALYSIS AND IMAGE PROCESSING

Introduction to fractals: Fractals and self-similarity, The von Koch snowflake curve, self-similarity and dimension, Fractals in nature; Mathematical background- Fractional Brownian motion, statistical self-similarity, self-affinity, Hausdorff Measure and Dimension, Box Counting Dimensions, Properties and problems of box counting dimension, Modified box-counting dimensions, Lacunarity; Dimension calculation techniques- Basic methods, Subsets of finite measure, Potential theoretic methods, Fourier transform methods, Calculating Fractal Dimension of Images – Box counting method, Sarkar method, Variation method.

Random Fractals, Deterministic fractals and chaotic dynamical systems: Random Fractals - A random Cantor set, Fractal Percolation, Fractional Brownian Surfaces; Deterministic Fractals- The Mandelbrot set, Level sets, Newton's method, Sullivan classification, polynomials; Dynamical systems -The chaotic set, Complex maps, The Julia set, Exploding Julia sets.

Iterated functions system: Iterated Functions systems - Introduction, The Collage Theorem, What the Collage Theorem says; Computation of images from IFS code: What an IFS code is, The underlying model associated with an IFS code, How images are defined from underlying model, The algorithm for computing rendered images

Fractals and Wavelets: Wavelet transform: Continuous wavelet transform , Discrete wavelet transform; Scale invariance - Fractional Brownian motion-paradigm of scale invariance, self-similarity; Multifractal functions - Wavelets and pointwise regularity, Multifractal functions, Multifractal measures, Coarse multifractal analysis, Fine multifractal analysis

Applications to image processing: Medical Image Analysis (Brain Imaging, Mammography, bone imaging etc.), Texture Analysis, Image compression, Segmentation, Remote sensing images

References:

1. Kenneth Falconer, "Fractal Geometry: Mathematical Foundations and Applications", 2nd Ed., Wiley, 2003.
2. M.F. Barnsley, R.L. Devaney, B.B. Mandelbrot, H.O. Peitgen, D. Saupe, R.F. Voss, "The Science of Fractal Images" Springer-Verlag, 1988
3. Chaos, Fractals & Dynamic Systems, NPTEL Course by Prof. S. Banerjee, Electrical Engineering, IIT Kharagpur "<http://nptel.ac.in/courses/108105054/>"
4. Stephen T. Welstead, "Fractal and Wavelet Image Compression Techniques" SPIE Press, 1999.
5. Benoit B. Mandelbrot, "Fractals and Chaos: The Mandelbrot Set and Beyond", 1st Ed., Springer, 2004.