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Selected Topics in Image Processing, Graphics and Computer Vision

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Course 5107212

Selected Topics in Image Processing, Graphics and Computer Vision Synopsis

1. Imaging transforms (2 hours).

- Direct imaging and Convolution transform. Point spread function and resolving power of imaging systems
- Transform imaging. Kirchhoff integral; Fresnel integral transform; Fourier integral transform; Radon transform.

2. Imaging transforms in digital computers (6 hours).

- Convolution integral and digital filters. Overall point spread function and frequency response of digital filtering. Continuous PSF and FrR of digital filtering.
- Discrete Fourier Transforms: canonical DFT, Shifted DFT and its derivatives, DCT, Scaled DFT, Affine DFT, Rotated DFT. Point spread function and resolving power of discrete Fourier analysis. Boundary effect free convolution in DCT domain.
- Discrete Fresnel Transform. Convolutional Discrete Fresnel Transform
- Numerical methods for image reconstruction from projections

3. FFT methods for image resampling (6 hours)

- Perfect resampling filter
- Signal interpolation by means of zero padding of its transform coefficients
- FFT/FDCT based algorithms for fractional signal shift and their applications for image fractional shift, magnification, rotation, Fast Radon Transform
- Signal re-scaling using Scaled DFT
- Signal re-scaling and rotation using RotDFT
- Local adaptive methods for image re-sampling
- Signal integration and differentiation
- Discrete sinc-interpolation methods for image reconstruction from projections

4. Image data fusion (4 hours)

- Mathematical models of multi-component imaging systems
- MSE – optimal linear filtering methods for image data fusion
- Correlational accumulation for image denoising, deblurring and “super-resolution”
- Spatial-temporal image data fusion using local adaptive filters
- Image data fusion methods for perfecting video sequencies
- Multi-modality imaging and inter-channel data fusion

5. 3-D imaging and vision (2 hours)

- Mechanisms of 3-D human vision. Stereoscopic vision and redundancy of stereoscopic images
- 3-D displays; stereoscopic displays; anaglyphs and methods for generating color anaglyphs

6. Digital holographic imaging (6 hours)

- Principles of holography.
- Principles of digital holographic imaging,
- Digital recording and numerical reconstruction of holograms
- Computer generated holograms: principles
- Speckle phenomena in coherent imaging systems
- Statistical properties of speckle noise: linear model
- Speckle phenomena in digital holographic imaging

7. Efficient computational algorithms for digital image processing (2 hours)

- Principles of Fast Transforms
- Parallel, sequential and recursive digital filtering methods
- Recursive algorithms for DFT/DCT transforms in sliding window
- Recursive algorithms for sliding window statistical signal analysis

Recommended reading:

1. L. Yaroslavsky, Digital Holography and Digital Image Processing, Kluwer Academic Publishers, Boston, 2004
2. L. Yaroslavsky, M. Eden, Fundamentals of Digital Optics, Birkhauser, Boston, 1996
3. R. C. Gonzalez, R. E. Woods, Digital Image Processing, Prentice Hall, 2002
4. R. N. Bracewell, Two-dimensional imaging, Prentice Hall International, 1995