

Image Processing and Analysis

Lecture 1、Introduction

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Course Overview

- Teaching Goals
- Text Books and References
- What We Learn from the Course
- Ways in Teaching
- Grade Evaluation
- Some Suggestions and Contact Information

Teaching goals



- As an **introductory course** for senior content of computer vision, extensive fundamental techniques of image processing and analysis are presented
- Besides introducing fundamental theories and approaches, an important **programming language Matlab** is also introduced, and more attention is paid to one of its toolbox-image processing toolbox (IPT).
- For a student learning the course, he will set up a **solid foundation**, for further learning computer vision in the next semester, and the programming skills using Matlab will make him **benefit more and more in the study of other courses and future thesis research**.

半学科研生语言, 开发速度快

mat文件:

2° 批处理文件

↑

实时脚本文件

2° 函数文件

↑

实时函数文件

Text Books

- "Digital Image Processing" (2nd Edition), R.C. Gonzalez, R.E. Woods, Prentice, 电子工业出版社
- "Digital Image Processing Using MATLAB", R.C. Gonzalez, R.E. Woods, S.L. Eddins, Prentice, Gatesmark Publishing



References

- 图像处理基础(2nd edition), Maria Petrou, Costas Petrou, 清华大学出版社
- 图像处理、分析与机器视觉, Milan Sonka, Vaclav Hlavac, Roger Boyle, 清华大学出版社
- "Computer vision: a Modern Approach", David A. Forsyth, Jean Ponce, Prentice, 电子工业出版社
- 数字图像处理, 王桥编著, 科学出版社
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What We Learn from the Course



- Introduction+Matlab tutorial 1.5 week
- Image enhancement 3 weeks
- Image restoration 2 weeks
- Color image processing 1.5 week
- Wavelets and Multiresolution Processing(algorithm) 3 weeks
- Image Compression 1 week
- Morphological Image Processing 0.75 week
- Image Segmentation 0.75 week
- Representation and description 0.5 week
- show time and review 0.5 week

What We Learn from the Course I

- Introduction+Matlab tutorial 1.5 week
read, write, show an image, basics of Matlab programming
- Image enhancement 3 weeks
intensity transform, histogram equalization and matching, spatial filters and convolution, smoothing linear filter, order-statistics filters, Laplacian operator
Fourier transform and some properties, spatial domain and frequency domain, low-pass and high-pass filter, homomorphic filter
- Image restoration 2 weeks
degradation model, noise model, noise reduction, linear position-invariant system, inverse filtering, Wiener filtering, Geometric transformations

What We Learn from the Course II

- Color image processing 1.5 week
color, color space, color image processing (smoothing and sharpening), segmentation
- Wavelets and Multiresolution Processing(algorithm) 3 weeks
image pyramids, subband coding, Haar transform, multiresolution analysis, scale and wavelet function, wavelet transform, fast wavelet transform, wavelet packet
- Image Compression 1 week
elements of information theory, DCT transform and other famous transforms
- Morphological Image Processing 0.75 week
dilation and erosion, opening and closing operator, Hit-or-missing transform, some basic morphological algorithms

What We Learn from the Course II

- Image Segmentation 0.75 week
edge detection, Hough transform, thresholding, region segmentation, watershed segmentation algorithm
- Representation and description 0.5 week
representation (chain codes,..., skeletons), descriptors(Fourier descriptor, statistics moments,...), texture, principal components,....
- show time and review 0.5 week

Ways in Teaching



- Deliver lectures in Chinese, while PPT in English, discuss some problems
- Homework
2-3 problems each week,
Complete electronically, and submit through course web
plagiarism will be punished
- Final exam
highly relevant to homeworks, so...

Grade Evaluation



- Homeworks 5%
- Paper Reading 20%
 - 3 papers related to image processing
 - Submit the copy of 3 papers, the PPT presentation (PPT more than 8 pages) for each paper and a summary report written in Chinese.
- Final exam 75%

Additional Requirements for Paper Reading Assignment

- The 3 papers should belong to the same research topic within the digital image processing domain
- All 3 papers should have been published within the last 10 years (i.e., since 2013)
- Submit a Chinese version of the Word report (more than 4000 Chinese characters) and a PPT presentation (≥ 24 pages totally).
- Grading Levels:
 - ◆ Excellent: 17-20
 - ◆ Good: 14-16
 - ◆ Average: 10-13
 - ◆ Poor: 0-9

Some suggestions and contact Information

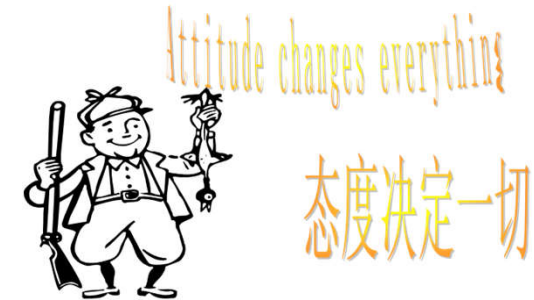


Suggestions

- Accomplish various assignments Independently, carefully, actively.
- Practice what you have learned from the lectures actively using matlab.

Contact information

- Email : wqwang@ucas.ac.cn



What is the digital image processing

Basic Conceptions

图像范围很广，电磁波/声波成像
其他图像概念

- Image**
 - Two-dimensional function $f(x, y)$
 - x, y : (Spatial coordinates)
 - Amplitude of f at (x, y) : intensity, gray level
- Digital Image**
 - x, y and $f(x, y)$ are all finite and discrete quantities
- Pixels** are the basic elements of a digital image

$\Rightarrow f(y, x)$
矩阵，先行后列
对称 对称

What is the digital image processing

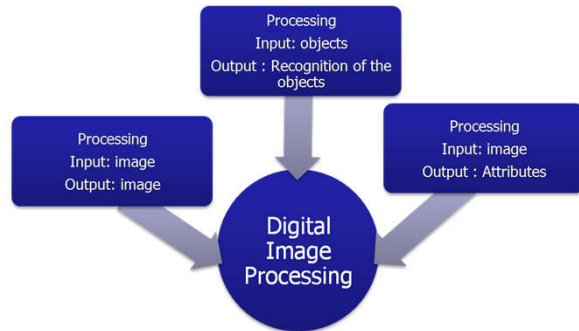
Digital Image Processing (DIP)

- Digital image processing is to process digital images using digital computer.
- Digital images cover almost the entire electromagnetic spectrum, i.e., DIP can operate on images generated by various sources including ultrasound, electron microscopy, and computer-generated images
- Big picture

ultrasound, 超声
electron microscopy
电子显微镜

Digital Image Processing (DIP)(Cont.)

♥ Digital Image Processing in this course



The Origin of Digital Image Processing



FIGURE 1.1 A digital picture produced in 1921 from a coded tape by a telegraph printer with special type faces.

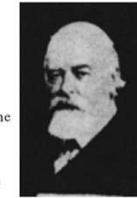


FIGURE 1.2 A digital picture made in 1922 from a tape after the signals had crossed the Atlantic twice. Some errors are visible.

FIGURE 1.3 Unretouched cable picture of Generals Pershing and Foch, transmitted in 1929 from London to New York by 15-tone equipment.



The Origin of Digital Image Processing (cont.)

- 1 1960s, improving images from a space probe
- 2 Late 1960s to early 1970s, medical imaging, remote earth resources observations, and astronomy

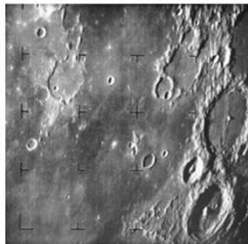


FIGURE 1.4 The first picture of the moon by a U.S. spacecraft. *Ranger 7* took this image on July 31, 1964 at 9:09 A.M. EDT, about 17 minutes before impacting the lunar surface.

Applications I: Gamma-Ray Imaging

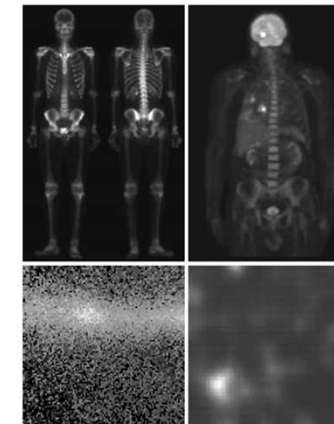
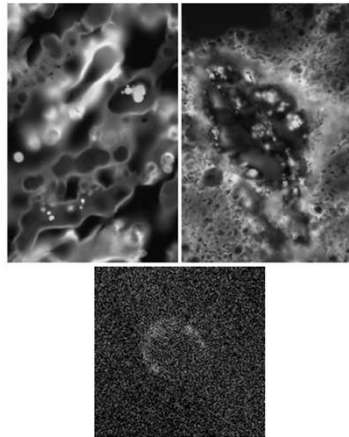


FIGURE 1.6 Examples of gamma-ray imaging. (a) Bone scan. (b) PET image. (c) Cygnus Loop. (d) Gamma radiation (bright spot) from a reactor valve. (Images courtesy of (a) G.E. Medical Systems, (b) Dr. Michael E. Casey, CTI PET Systems, (c) NASA, (d) Professors Zhong He and David K. Wehe, University of Michigan.)

Applications II: Imaging in the Ultraviolet Band

a b c

FIGURE 1.8
Examples of ultraviolet imaging.
(a) Normal corn.
(b) Smut corn.
(c) Cygnus Loop.
(Images courtesy of (a) and (b) Dr. Michael W. Davidson, Florida State University, (c) NASA.)



Applications III: Imaging in the Visible and Infrared Bands(1)

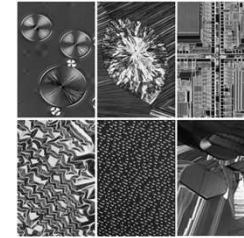


FIGURE 1.9 Examples of light microscopy images. (a) Taxol (anticancer agent), magnified 250 \times . (b) Cholesterol—40 \times . (c) Microprocessor—60 \times . (d) Nickel oxide thin film—600 \times . (e) Surface of audio CD—1750 \times . (f) Organic superconductor—40 \times . (Images courtesy of Dr. Michael W. Davidson, Florida State University.)

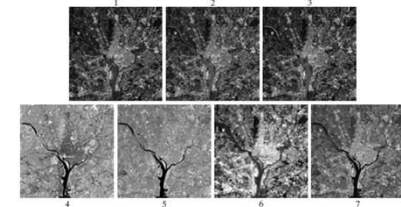


FIGURE 1.10 LANDSAT satellite images of the Washington, D.C. area. The numbers refer to the thematic bands in Table 1.1. (Images courtesy of NASA.)

Applications III: Imaging in the Visible and Infrared Bands(2)

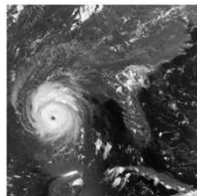


FIGURE 1.11
Multispectral image of Hurricane Andrew taken by NOAA GEOS (Geostationary Environmental Satellite) sensors. (Courtesy of NOAA.)



FIGURE 1.12
Infrared satellite images of the Americas. The small gray map is provided for reference. (Courtesy of NOAA.)

Applications III: Imaging in the Visible and Infrared Bands(3)

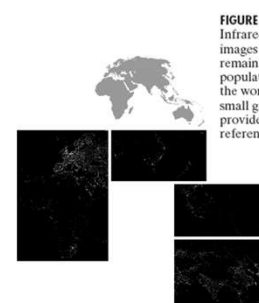


FIGURE 1.13
Infrared satellite images of the remaining populated part of the world. The small gray map is provided for reference.

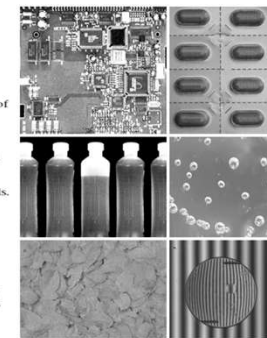


FIGURE 1.14
Some examples of manufactured goods often checked using digital image processing. (a) A circuit board controller. (b) Packaged pills. (c) Bottles. (d) Bubbles in clear-plastic product. (e) Cereal. (f) Image of intraocular implant. (Fig. (f) courtesy of Mr. Pete Sites, Perceptics Corporation.)

Applications III: Imaging in the Visible and Infrared Bands(4)



FIGURE 1.15
Some additional examples of imaging in the visible spectrum. (a) Thumb print. (b) Paper currency. (c) and (d), Automated license plate reading. (Figure (a) courtesy of the National Institute of Standards and Technology. Figures (c) and (d) courtesy of Dr. Juan Herrera, Perceptics Corporation.)

Applications IV: Imaging in the Microwave Band

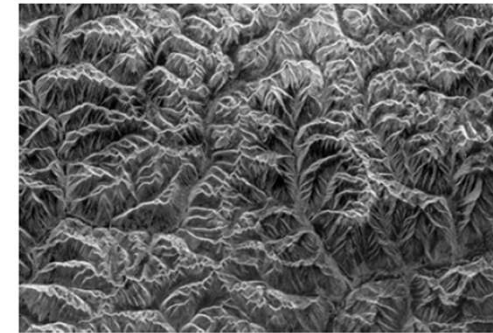


FIGURE 1.16
Spaceborne radar image of mountains in southeast Tibet. (Courtesy of NASA.)

Applications V: Imaging in the Radio Band

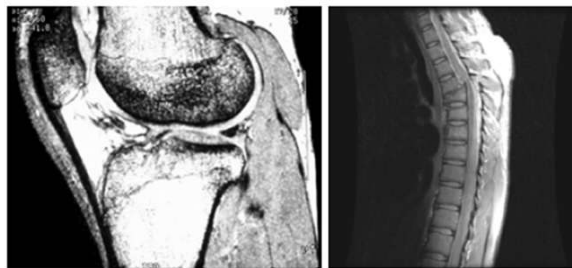


FIGURE 1.17 MRI images of a human (a) knee, and (b) spine. (Image (a) courtesy of Dr. Thomas R. Gest, Division of Anatomical Sciences, University of Michigan Medical School, and (b) Dr. David R. Pickens, Department of Radiology and Radiological Sciences, Vanderbilt University Medical Center.)

Applications VI: Other Imaging Modalities

FIGURE 1.19
Cross-sectional image of a seismic model. The arrow points to a hydrocarbon (oil and/or gas) trap. (Courtesy of Dr. Curtis Ober, Sandia National Laboratories.)

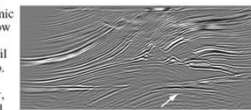


FIGURE 1.20
Examples of ultrasound imaging. (a) Baby. (2) Another view of baby. (c) Thyroids. (d) Muscle layers showing lesion. (Courtesy of Siemens Medical Systems, Inc., Ultrasound Group.)

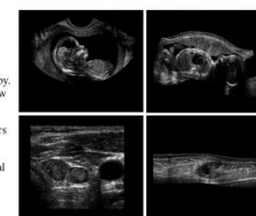


FIGURE 1.22
(a) and (b) Fractal images. (c) and (d) Images generated from 3-D computer models of the objects shown. (Figures (a) and (b) courtesy of Ms. Melissa D. Binde, Swarthmore College. (c) and (d) courtesy of NASA.)

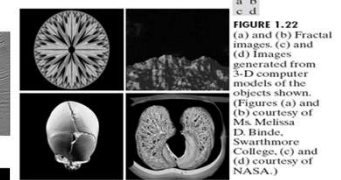
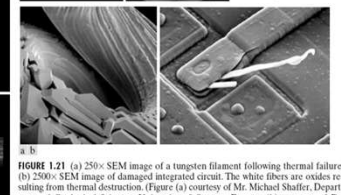
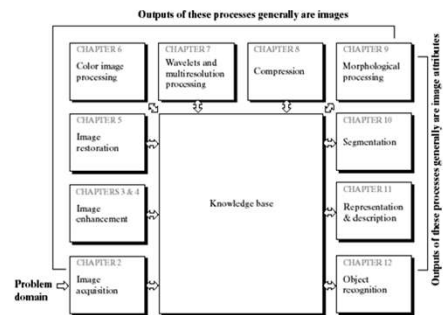


FIGURE 1.21 (a) 250 \times SEM image of a tungsten filament following thermal failure. (b) 2500 \times SEM image of damaged integrated circuit. The white fibers are oxides resulting from thermal destruction. (Figure (a) courtesy of Mr. Michael Shaffer, Department of Geological Sciences, University of Oregon. Figure (b) courtesy of Dr. J.M. Hudak, McMaster University, Hamilton, Ontario, Canada.)



Basic steps of digital image processing

FIGURE 1.23
Fundamental
steps in digital
image processing.



Components of an image processing system

- Image sensors
- Specialized image processing hardware
- Computer
- Image processing software
- Mass storage
- Image displays
- Hardcopy
- Laser printers, file cameras...
- Network

