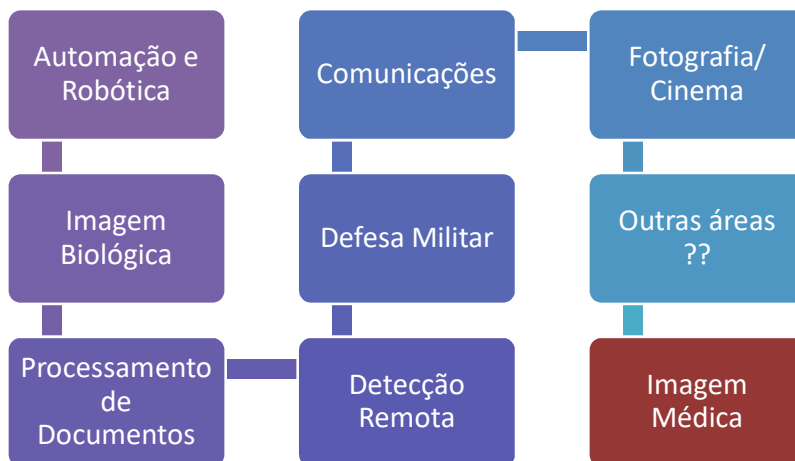




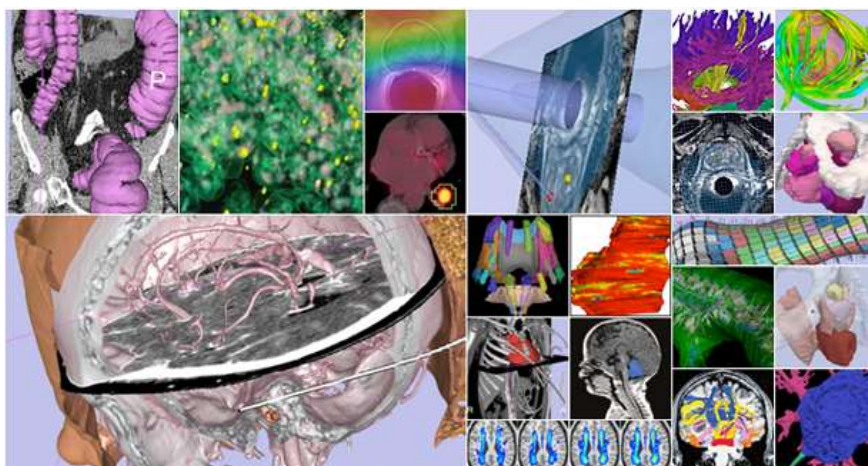
Aplicações do Processamento de Imagem



1



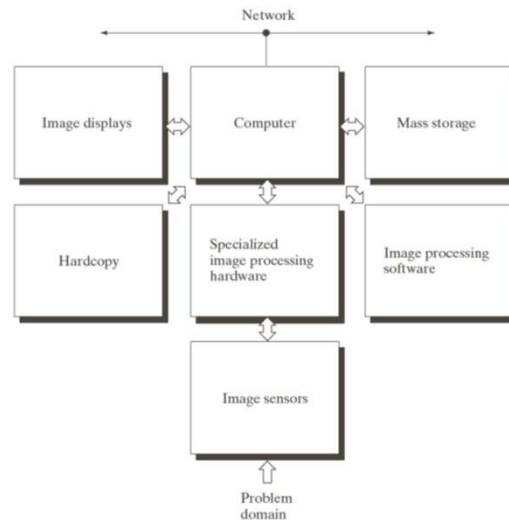
Imagem Médica



2



Componentes de um Sistema de Processamento de Imagem – Visão Global



(Imagens: Rafael C. Gonzalez and Richard E. Wood, Digital Image Processing, 3rd Edition.

3



Introdução

O espectro electromagnético...

$$E = hf$$

$$\lambda \text{ (comp onda)} = c / f$$

c- velocidade da luz ($2,9 \times 10^8$ m/s)
h- const Plank ($6,6 \times 10^{-34}$ Js)

**O olho humano
 é receptivo a uma
 gama de
 frequências muito
 pequena**

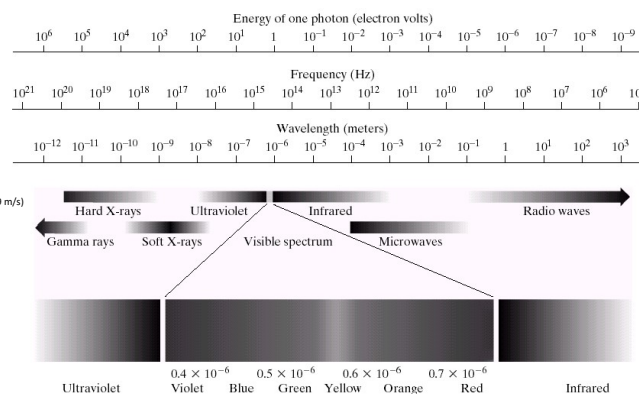


FIGURE 2.10 The electromagnetic spectrum. The visible spectrum is shown zoomed to facilitate explanation, but note that the visible spectrum is a rather narrow portion of the EM spectrum.

(Imagens: Rafael C. Gonzalez and Richard E. Wood, Digital Image Processing, 3rd Edition.

4

Introdução



Energy of one photon (electron volts)

Gamma rays X-rays Ultraviolet Visible Infrared Microwaves Radio waves

Medicina nuclear

a) São injectados no paciente isótopos radioactivos no paciente, que emitem raios gama. A imagem é formada em detectores de raios gama.

b) **PET** (Positron Emission Tomography) - O paciente é injectado com isótopos radioactivos que emitem positrões.

Astronomia

c) Constelação que explodiu à 15 000 anos.

d) Radiação gama de uma válvula de um reactor nuclear.

c, d) Imagem adquirida usando a radiação natural dos objectos.

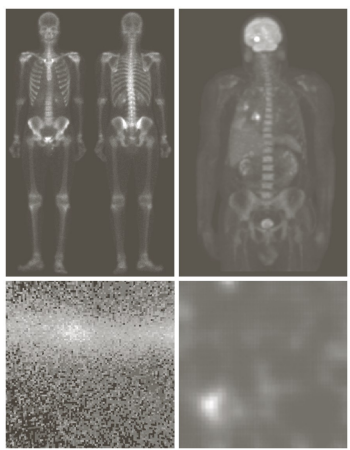
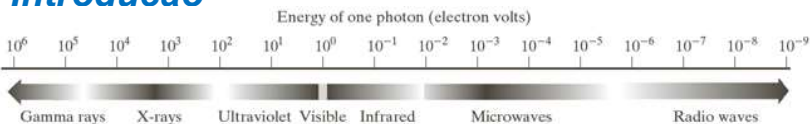


FIGURE 1.6 Examples of gamma-ray imaging. (a) Bone scan. (b) PET image. (c) Cygnus Loop. (d) Gamma radiation (bright spot) from a reactor valve. (Images courtesy of (a) G.E. Medical Systems, (b) Dr. Michael E. Casey, CTI PET Systems, (c) NASA, (d) Professors Zhong He and David K. Wehe, University of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

5

(Imagens: Rafael C. Gonzalez and Richard E. Wood, Digital Image Processing, 3rd Edition.)

Introdução



Energy of one photon (electron volts)

Gamma rays X-rays Ultraviolet Visible Infrared Microwaves Radio waves

**Medicina ;
Inspeção Industrial;
Astronomia**

a) Radiografia.
b) Angiografia
c) TC
d) Indústria
e) Constelação Cygnus

Modo mais antigo utilizar o EE para obter imagens.

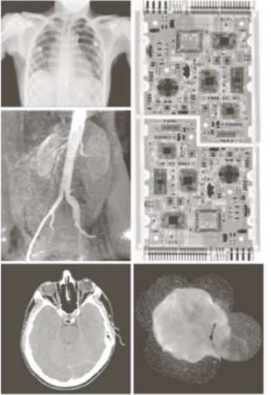
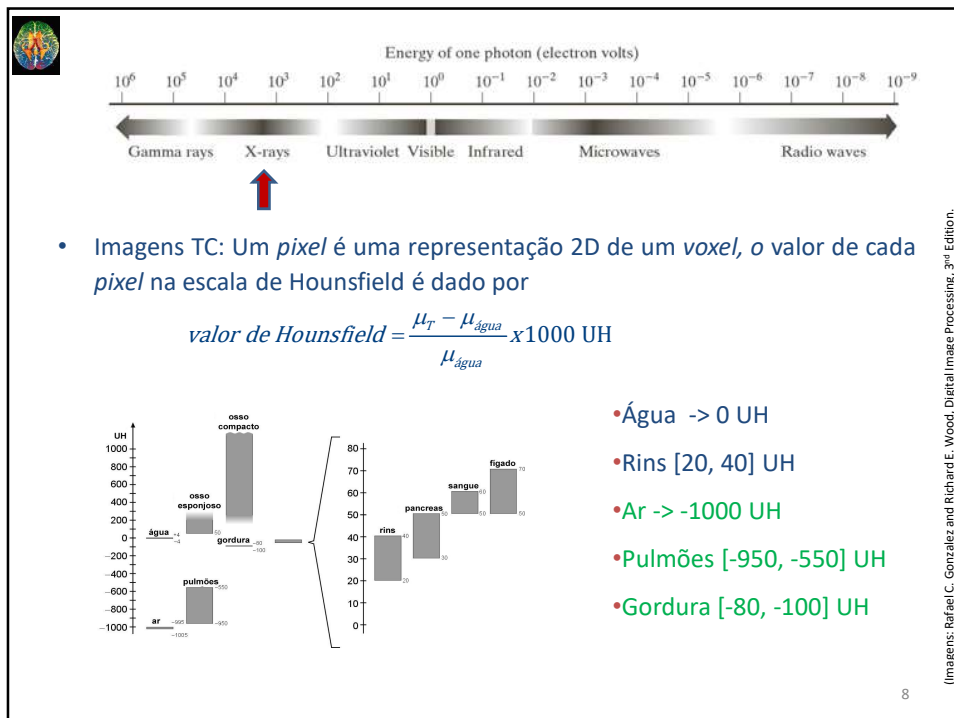


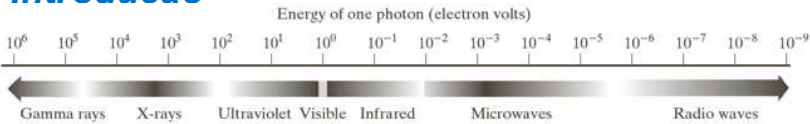
FIGURE 1.7 Examples of X-ray imaging. (a) Chest X-ray. (b) Aortic angiogram. (c) Head CT. (d) Circuit boards. (e) Cygnus Loop. (Images courtesy of (a) and (c) Dr. David R. Pickens, Dept. of Radiology & Radiological Sciences, Vanderbilt University Medical Center; (b) Dr. Thomas R. Gest, Division of Anatomical Sciences, University of Michigan Medical School; (d) Mr. Joseph E. Pascente, Lxi, Inc.; and (e) NASA.)

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(Imagens: Rafael C. Gonzalez and Richard E. Wood, Digital Image Processing, 3rd Edition.)



Introdução



Energy of one photon (electron volts)

10⁶ 10⁵ 10⁴ 10³ 10² 10¹ 10⁰ 10⁻¹ 10⁻² 10⁻³ 10⁻⁴ 10⁻⁵ 10⁻⁶ 10⁻⁷ 10⁻⁸ 10⁻⁹

Gamma rays X-rays Ultraviolet Visible Infrared Microwaves Radio waves

UV- excelente para estudar substâncias que são ou se podem tornar-se fluorescentes, absorvem a energia da [luz ultravioleta](#) e emitem depois radiação dentro do espectro de [luz visível](#). Um dos equipamentos que permite a observação da [fluorescência](#) denomina-se [microscópio de fluorescência](#).

Inspecção Industrial; microscopia, Lasers; Imagiologia biológica; astronomia.

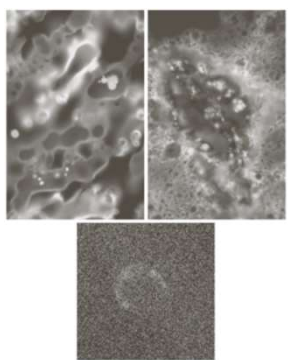


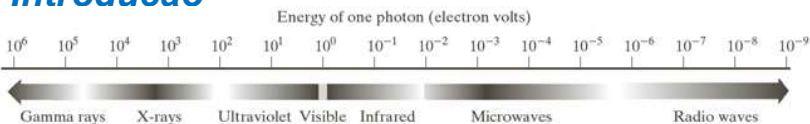
FIGURE 1.8
Examples of ultraviolet imaging.
(a) Normal corn.
(b) Smut corn.
(c) Cygnus Loop.
(Images courtesy of (a) and (b) Dr. Michael W. Davidson, Florida State University, (c) NASA.)

a) b) Imagens obtidas através do microscópio fluorescente de milho saudável e com doença. c) Constelação Cygnus

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(Imagens: Rafael C. Gonzalez and Richard E. Wood, Digital Image Processing, 3rd Edition.)

Introdução



Energy of one photon (electron volts)

10⁶ 10⁵ 10⁴ 10³ 10² 10¹ 10⁰ 10⁻¹ 10⁻² 10⁻³ 10⁻⁴ 10⁻⁵ 10⁻⁶ 10⁻⁷ 10⁻⁸ 10⁻⁹

Gamma rays X-rays Ultraviolet Visible Infrared Microwaves Radio waves

Meteorologia – observação e previsão

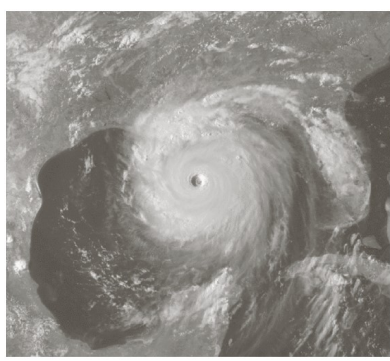


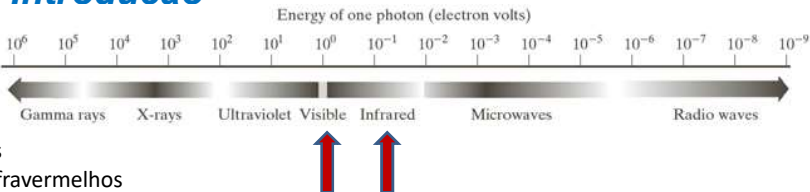
FIGURE 1.11
Satellite image of Hurricane Katrina taken on August 29, 2005. (Courtesy of NOAA.)

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(Imagens: Rafael C. Gonzalez and Richard E. Wood, Digital Image Processing, 3rd Edition.)



Introdução



Energy of one photon (electron volts)

10⁶ 10⁵ 10⁴ 10³ 10² 10¹ 10⁰ 10⁻¹ 10⁻² 10⁻³ 10⁻⁴ 10⁻⁵ 10⁻⁶ 10⁻⁷ 10⁻⁸ 10⁻⁹

Gamma rays X-rays Ultraviolet Visible Infrared Microwaves Radio waves

Os infravermelhos são usados muita vez em conjugação da banda visível.

Imagens obtidas através de sensores remotos. Recorrem a diversas bandas na gama visível e infravermelho.

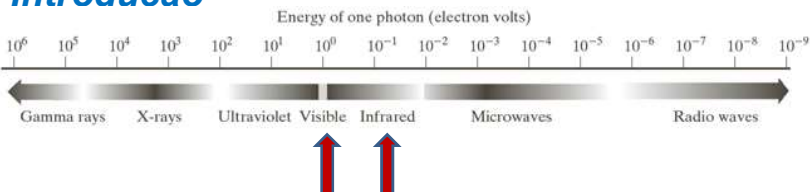
Band No.	Name	Wavelength (μm)	Characteristics and Uses
1	Visible blue	0.45–0.52	Maximum water penetration
2	Visible green	0.52–0.60	Good for measuring plant vigor
3	Visible red	0.63–0.69	Vegetation discrimination
4	Near infrared	0.76–0.90	Biomass and shoreline mapping
5	Middle infrared	1.55–1.75	Moisture content of soil and vegetation
6	Thermal infrared	10.4–12.5	Soil moisture; thermal mapping
7	Middle infrared	2.08–2.35	Mineral mapping

TABLE 1.1
Thematic bands in NASA's LANDSAT satellite.

(Imagens: Rafael C. Gonzalez and Richard E. Wood, Digital Image Processing, 3rd Edition.)

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Introdução



Energy of one photon (electron volts)

10⁶ 10⁵ 10⁴ 10³ 10² 10¹ 10⁰ 10⁻¹ 10⁻² 10⁻³ 10⁻⁴ 10⁻⁵ 10⁻⁶ 10⁻⁷ 10⁻⁸ 10⁻⁹

Gamma rays X-rays Ultraviolet Visible Infrared Microwaves Radio waves

Imagens obtidas de Washington D.C. recorrendo a diversas bandas na gama visível e infravermelho.

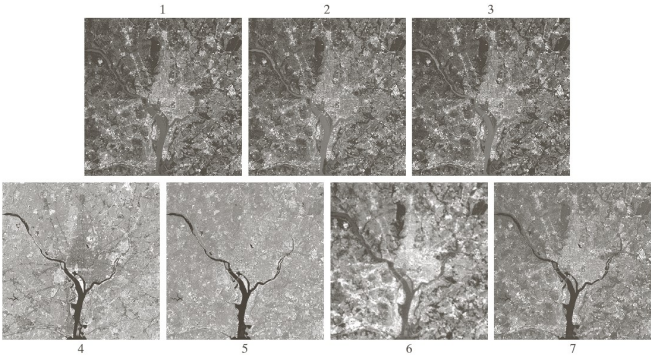


FIGURE 1.10 LANDSAT satellite images of the Washington, D.C. area. The numbers refer to the thematic bands in Table 1.1. (Images courtesy of NASA.)

(Imagens: Rafael C. Gonzalez and Richard E. Wood, Digital Image Processing, 3rd Edition.)

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Introdução



Energy of one photon (electron volts)

Gamma rays X-rays Ultraviolet Visible Infrared Microwaves Radio waves

Radar
Independente das condições climáticas ou luz ambiente.

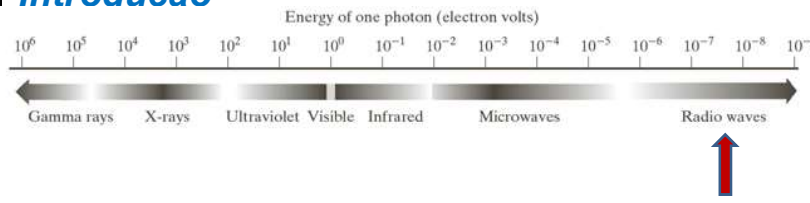
Radar é muitas vezes a única forma de aceder a certas zonas da superfície da terra



(Imagens: Rafael C. Gonzalez and Richard E. Wood, Digital Image Processing, 3rd Edition.

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Introdução



Energy of one photon (electron volts)

Gamma rays X-rays Ultraviolet Visible Infrared Microwaves Radio waves

Medicina (MRI), astronomia

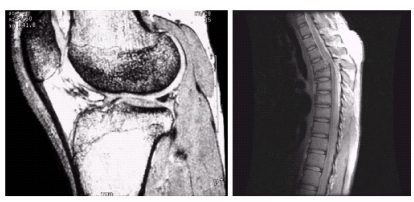


FIGURE 1.17 MRI images of a human (a) knee, and (b) spine. (Image (a) courtesy of Dr. Thomas R. Gest, Division of Anatomical Sciences, University of Michigan Medical School, and (b) Dr. David R. Pickens, Department of Radiology and Radiological Sciences, Vanderbilt University Medical Center.)

(Imagens: Rafael C. Gonzalez and Richard E. Wood, Digital Image Processing, 3rd Edition.

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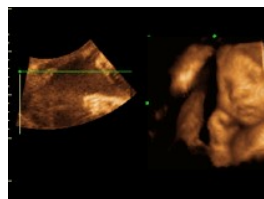
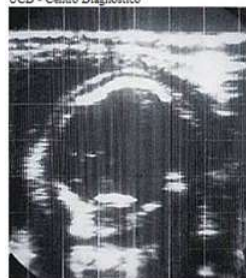




Para além da Radiação Electromagnética

Ultrasonografia
Grande aplicação
na obstetrícia.

UCD - Centro Diagnóstico



À esquerda, imagem de um bebé realizada em 1979 com ultrassom em 16 tons de cinza. À direita, um exame moderno em 4D que permite visualizar o feto e a sua anatomia interna, em tempo real.

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Imagens Sintetizadas

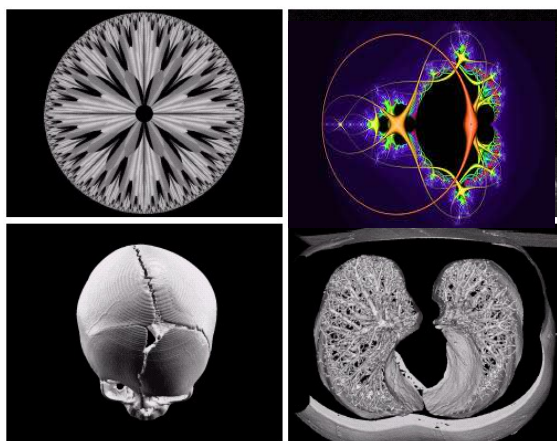


FIGURE 1.22
(a) and (b) Fractal images. (c) and (d) Images generated from 3-D computer models of the objects shown. (Figures (a) and (b) courtesy of Ms. Melissa D. Binde, Swarthmore College, (c) and (d) courtesy of NASA.)

A realidade “construída”.

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(Imagens: Rafael C. Gonzalez and Richard E. Wood, Digital Image Processing, 3rd Edition.



Realidade Virtual em Medicina: Novas Oportunidades para Diagnóstico e Planeamento Cirúrgico



<https://www.youtube.com/watch?v=AttXbcLUyR0&t=50s>

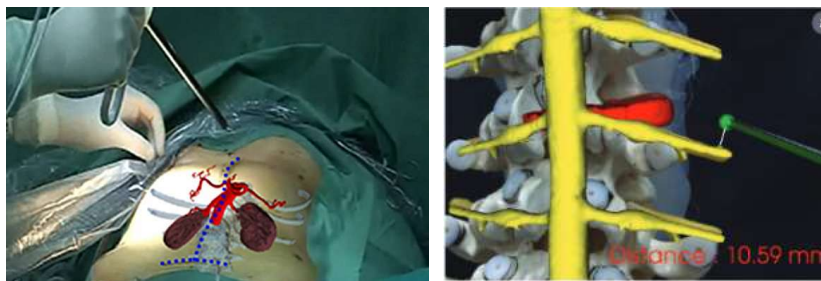
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Realidade Aumentada

Combina elementos virtuais com o ambiente real; através da sobreposição de informação virtual sobre o mundo real, informação que acompanha o campo de visão do utilizador.

É interactiva e tem processamento em tempo real



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