Introduction

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Methods for Image Processing

academic year 2018-2019

Image processing

Computer science concerns the

- representation,
- processing and
- transmission

of information.

Image processing considers in particular the information contained in (digital) images.

What is an image?

Some definitions:

- a percept that arises from the eyes; an image in the visual system [TheFreeDictionary];
- an artifact that has a similar appearance to some subject—usually a physical object or a person. [Wikipedia];
- a reproduction or imitation of the form of a person or thing [Merriam-Webster].

Usually, an image is intended to be a representation of objects or scenes on a bidimensional support

- painting,
- picture,
- ▶ graph.

The concept can be extended to a volumetric representation (e.g., a statue, but also the inside).

Definition of digital image

- In Mathematics, an image is defined as a function, f : ℝ^m → ℝⁿ.
- Usually, m = 2 and, in the simplest case, n = 1.
- When the spatial coordinates and the function value are finite and discrete, the image is called *digital*.

$$f:\mathbb{Z}^m\to\mathbb{Z}^n$$

The elements composing a digital image are called "pixels" (contraction of *picture element*) or "pels" (or even "image elements").

What is image processing?

- Roughly speaking, it can be considered as *image* what is perceived through the sight.
- However, "seeing" is a complex task, and it results from a very variegated processing chain realized by the brain.
- In the same way, the image processing is a discipline with a fuzzy contour.
- Besides, it makes use of and provides techniques to other disciplines.

What is image processing? (2) At least three disciplines are overlapping: image processing image understanding computer vision Generally, three processing categories, which are characterized by their abstraction level, are acknowledged: low level (image enhancement); medium level (feature extraction); high level (object recognition). Example: OCR (optical character recognition) low level: noise suppression, binarization; medium level: character segmentation; high level: character and text structure recognition.



Which application for image processing? (2)

► For example, in astronomical observation.



Harvard College Observatory Computers, 1890s.

Stars cataloging were realized with manual methods and were based on photographic plates.

https://en.wikipedia.org/wiki/Harvard_Computers

A lot of tasks are not easily automated:



Galaxy Zoo Project. Volunteers (with no special astronomy knowledge) are required for galaxy classification.

http://www.galaxyzoo.org/





Gamma-ray imaging



a b c d

(a) gamma-ray imagingby radioactive isotopeinjection;(b) positron emission

tomography (PET);
(c) Gamma radiation
emitted by a nuclear
reactor valve;
(d) Cygnus Loop.

NB: (c) and (d) capture the natural radiation of the observed object.



Ultraviolet imagingImaging











The weather satellite images taken from are bands. several This LANDSAT image pictures the Katrina hurricane (2005)the in visible and infrared bands.





Radio wave imaging



Radio waves are used in medicine, for instance, for magnetic resonance imaging (MRI).

<image><image><image><image><image>













Homeworks and suggested readings DIP, Sections 1.1, 1.2, 1.3 pp. 1–24 Image: This is your brain on fMRI http://spectrum.ieee.org/geek-life/tools-toys/this-is-your-brain-on-fmri http://dx.doi.org/10.1109/MSPEC.2012.6189569