Multimedia Data Modelling

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About Me

- Prof. Luca Guarnera, Ph.D.
- Email: luca.guarnera@unict.it
- Web Page: https://www.dmi.unict.it/lguarnera/
- MDM: https://www.dmi.unict.it/lguarnera/teachings/2024-25/MDM/
- Department of Mathematics and Computer Science, Room 311 (second floor, first block)

Course Details

Details

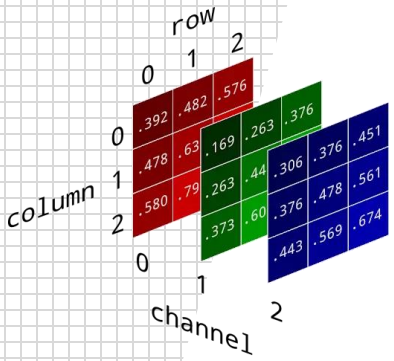
- Course: Multimedia Data Modelling
- 6 CFU (42h)
- Lectures: See Syllabus

  - The first part of the course is about digital images
  - The second part of the course is about digital video
  - The third part of the course covers Low-Level Vision
  - The fourth part of the course concerns modeling and processing of digital data

Course Details

Meetings with Students, Official Ms Teams Channel, Teaching Materials

- Tuesdays from 10 a.m. to 12 p.m., or email to schedule a day and time
- MS Teams, code **vexbjxu**. **join the team now ;)**
- **You will find the teaching materials on MS Teams or https://www.dmi.unict.it/lguarnera/teachings/2024-25/MDM/**

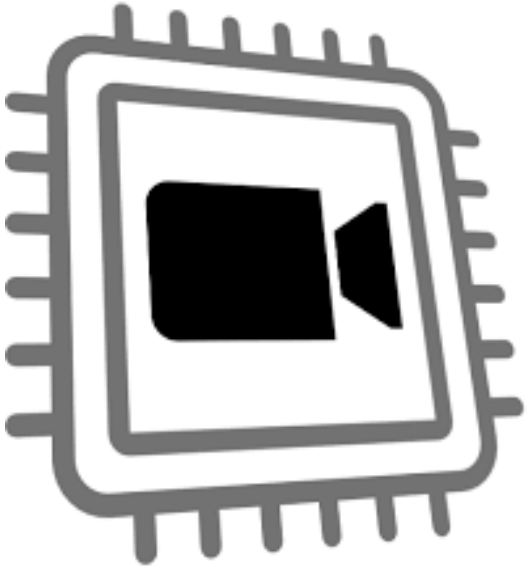


First part: **digital images**

- Introduction to digital images + Lab. Session
- Interpolation operations: replication, bilinear and bicubic + Lab. Session
- Space domain and Frequency domain + Lab. Session
- Fourier and DCT Transform + Lab. Session
- The convolution and convolution theorem
- Lossy and lossless compression
- The JPEG standard
- Mathematical morphology applied to digital images.
- Mathematical morphology applied to gray-scale images + Lab. Session
- Image restoration and Noise models + Lab. Session
- Filters: arithmetic, geometric, harmonic and counter-harmonic mean + Lab. Session
- Median, minimum, maximum, midpoint, + Lab. Session
- Adaptive filters + Lab. Session
- Periodic noise. Noise removal in the frequency domain + Lab. Session
- Filtering in the spatial domain. Edge detector. Canny's algorithm + Lab. Session

Second part: **digital video**

- Introduction to digital video and main definition: aspect ratio, resolution, video file format.
- Lab. Session: OpenCV and Digital Video
- Video formats (MPEG-1, MPEG-2, MPEG-4, H.264).



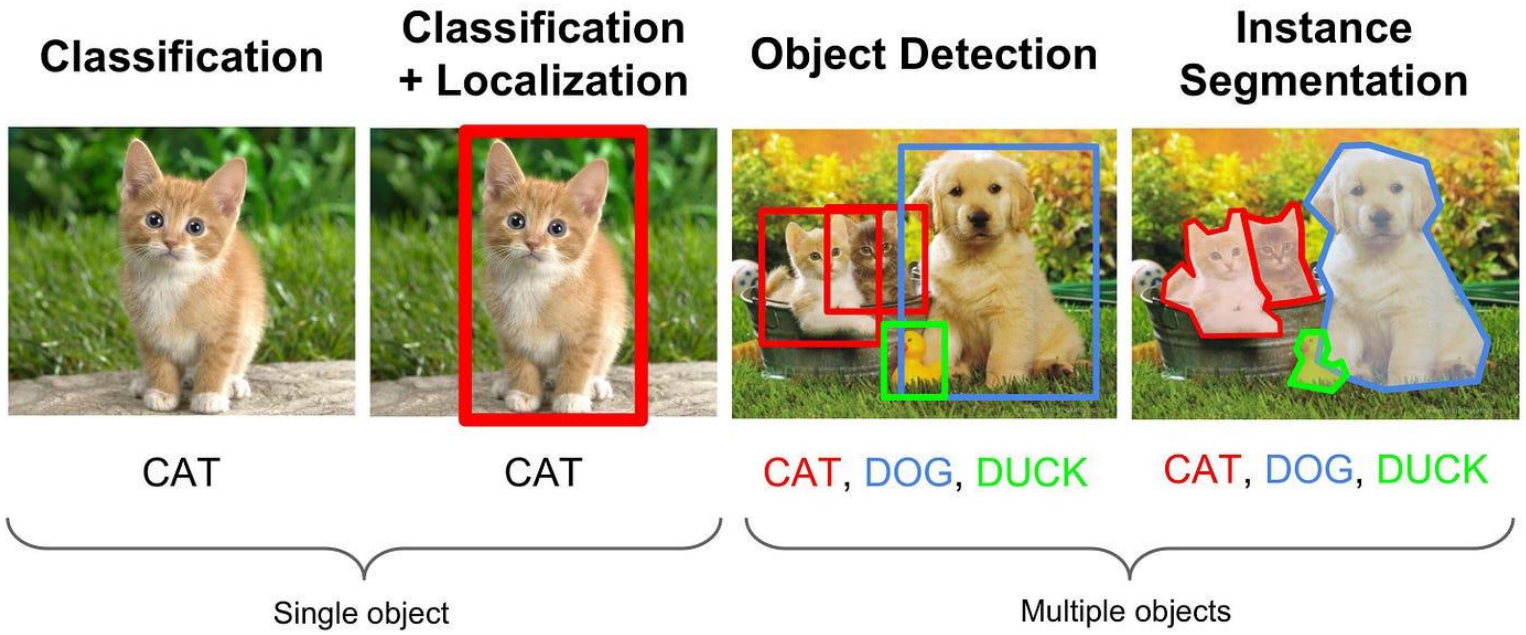
Third part: **Low-Level Vision**

- Low-Level Vision: Filters and Features: Edges, Textures, Laplacian Pyramid, Corner Detection (Harris, ...), SIFT.

- Computer Vision applications: face detection and recognition, etc..

Fourth part: **modeling and processing of digital data**

- Data modeling (features extracted from multimedia contents) and classification tasks

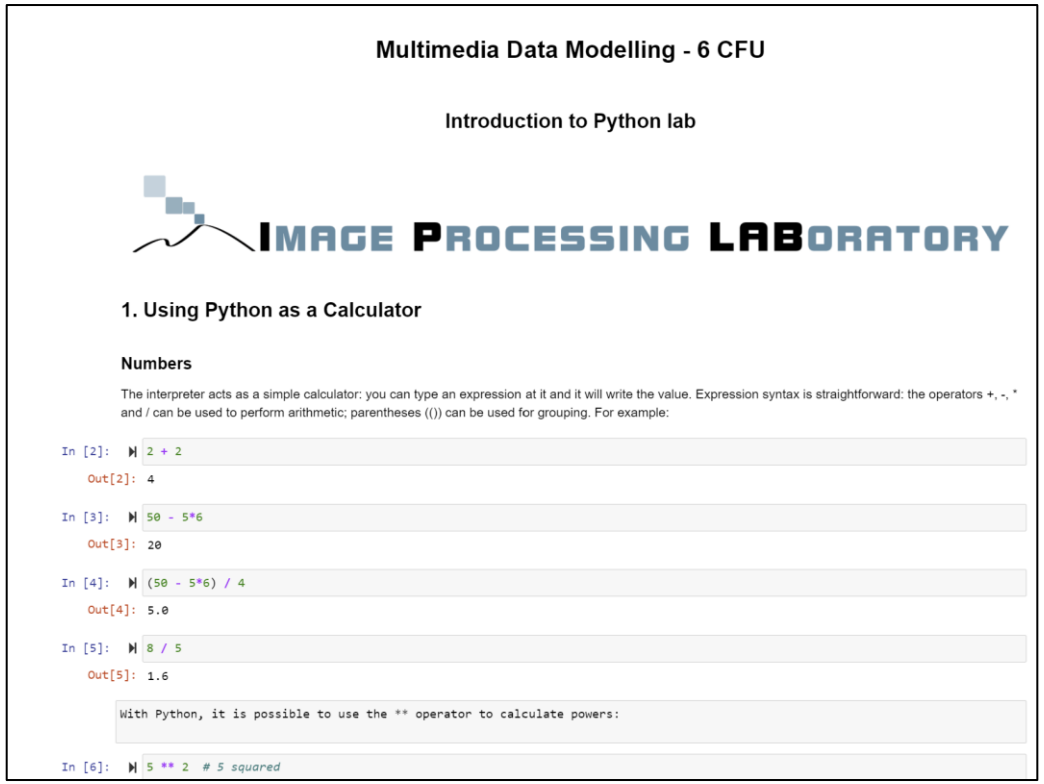


Laboratory Session

- The python language applied to digital image and video processing
- Introduction to OpenCV and other image/video processing libraries
- Implementation of Computer Vision algorithms (studied in the theoretical part)

Homework

- You will be shared a jupyter (paper) notebook that you will need to replicate (during the lab lesson)



Multimedia Data Modelling - 6 CFU

Introduction to Python lab

IMAGE PROCESSING LABORATORY

1. Using Python as a Calculator

Numbers

The interpreter acts as a simple calculator: you can type an expression at it and it will write the value. Expression syntax is straightforward: the operators +, -, * and / can be used to perform arithmetic; parentheses (()) can be used for grouping. For example:

```
In [2]: 2 + 2
Out[2]: 4

In [3]: 50 - 5*6
Out[3]: 20

In [4]: (50 - 5*6) / 4
Out[4]: 5.0

In [5]: 8 / 5
Out[5]: 1.6
```

With Python, it is possible to use the ** operator to calculate powers:

```
In [6]: 5 ** 2  # 5 squared
```

Laboratory Session

Lecture Schedule

theory

- WEDNESDAY 15:00-17:00 - DMI - Aula MI6
- THURSDAY 15:00-17:00 - DMI - Aula MI6

Lab Session

OCTOBER 2024

SUN	MON	TUE	WED	THU	FRI	SAT
29	30	1	2 Lesson (2h)	3 Lesson (2h)	4	5
6	7	8	9 Lesson (2h)	10 Lesson (2h)	11	12
13	14	15	16 Lesson (2h)	17 Lesson (2h)	18	19
20	21	22	23 Lesson cancelled	24 Lesson cancelled	25	26
27	28	29	30 Lesson (2h)	31 Lesson (2h)	1	2

NOVEMBER 2024

SUN	MON	TUE	WED	THU	FRI	SAT
27	28	29	30	31	1	2
3	4	5	6 Lesson (2h)	7 Lesson (2h)	8	9
10	11	12	13 Lesson (2h)	14 Lesson (2h)	15	16
17	18	19	20 Lesson (2h)	21 Lesson (2h)	22	23
24	25	26	27 Lesson (2h)	28 Lesson (2h)	29	30

The mid-term test will be held in November.

- We will start at 15.00 pm.
- The test lasts one hour
- Wait for the results

DECEMBER 2024

SUN	MON	TUE	WED	THU	FRI	SAT
1	2	3	4 Lesson (2h)	5 Lesson (2h)	6	7
8	9	10	11 Lesson (2h)	12 Lesson (2h)	13	14
15	16	17	18 Lesson (2h)	19 Lesson (2h)	20	21
22	23	24	25	26	27	28
29	30	31	1	2	3	4

Total lesson hour

- October: 16 h
- November: 16 h
- December: 10 h

Total: **42**/**42h**

Final examination & mid-term test

Mid-term Tests

1 There will be an mid-term test (t_1) in **November** and **one at the end of the course** (t_2).

+ Project P (optional)

$$vote = \frac{t_1 + t_2}{2} + P + \sum k\,, \qquad P \in [0,3]$$

t_1 = will consist of a 30-question multiple-choice test

t_2 = Lab examination - You can use the material provided at the Lab

$k = 0,5$ *for each correct program (for a maximum of 2 points per student)*

30-question multiple-choice test

1. What is a digital image?
   a) A photograph taken with an analogue camera
   b) A matrix of light intensity values
   c) A compressed video
   d) A hand-drawn image

2. What are the types of images?
   a) Black and White, Gray and Blue
   b) Gray and Green, Color, Pink and Blue
   c) Black and White, Greyscale, Color
   d) Yellow and Red, Green and Blue, Color

3. What does the RGB color space represent?
   a) A series of abstract coordinates
   b) A color representation based on red, yellow and blue
   c) The gray line
   d) A color representation based on red, green and blue

Python Project:
- Share the Python Code
- Technical Documentation

BONUS k

Write a python program that reads a sequence of digital images. Using the command line, the user chooses the interpolation operation to apply to the digital data. Save the results in a dedicated folder chosen by the user.

- If **BONUS k** will be shared during some lesson:
  - Solve the exercise using only the handouts made available in class. You are not allowed to use additional documentation (except in exceptional cases) and search the Internet! Otherwise the student will not benefit from the bonus k
  - The exercise must be complete and working by 15 minutes before the end of the lesson.
  - All students may participate, and all may acquire the bonus k

For those taking mid-term tests

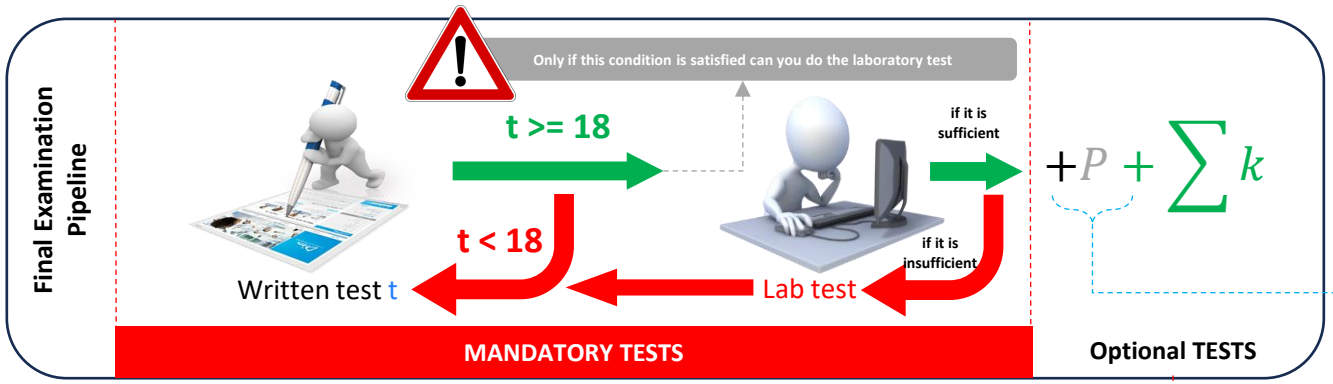
It is important that you book in an official exam date to register your final grade

Final Examination

2 Written test t (10 Multiple-choice and 2 open-answer tests) and Lab test. Project P (optional)

$$vote = t + Lab + P + \sum k, \qquad P \in [0,3]$$

$$k = 0,5 \text{ for each correct Homework (for a maximum of 2 points per student)} \qquad Lab \in [0,5]$$



The optional project and/or bonuses will only be added to the final grade if previous tests have been taken and passed!

To pass the exam, you must necessarily take both the written test and the laboratory test

2 - open-answer tests

- Morphological filters (max 10 pt)
- JPEG encoding (max 10 pt)

10 - question multiple-choice test

1. What is a digital image?
   a) A photograph taken with an analogue camera
   b) A matrix of light intensity values
   c) A compressed video
   d) A hand-drawn image

2. What are the types of images?
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Python Project:
- Share the Python Code
- Technical Documentation

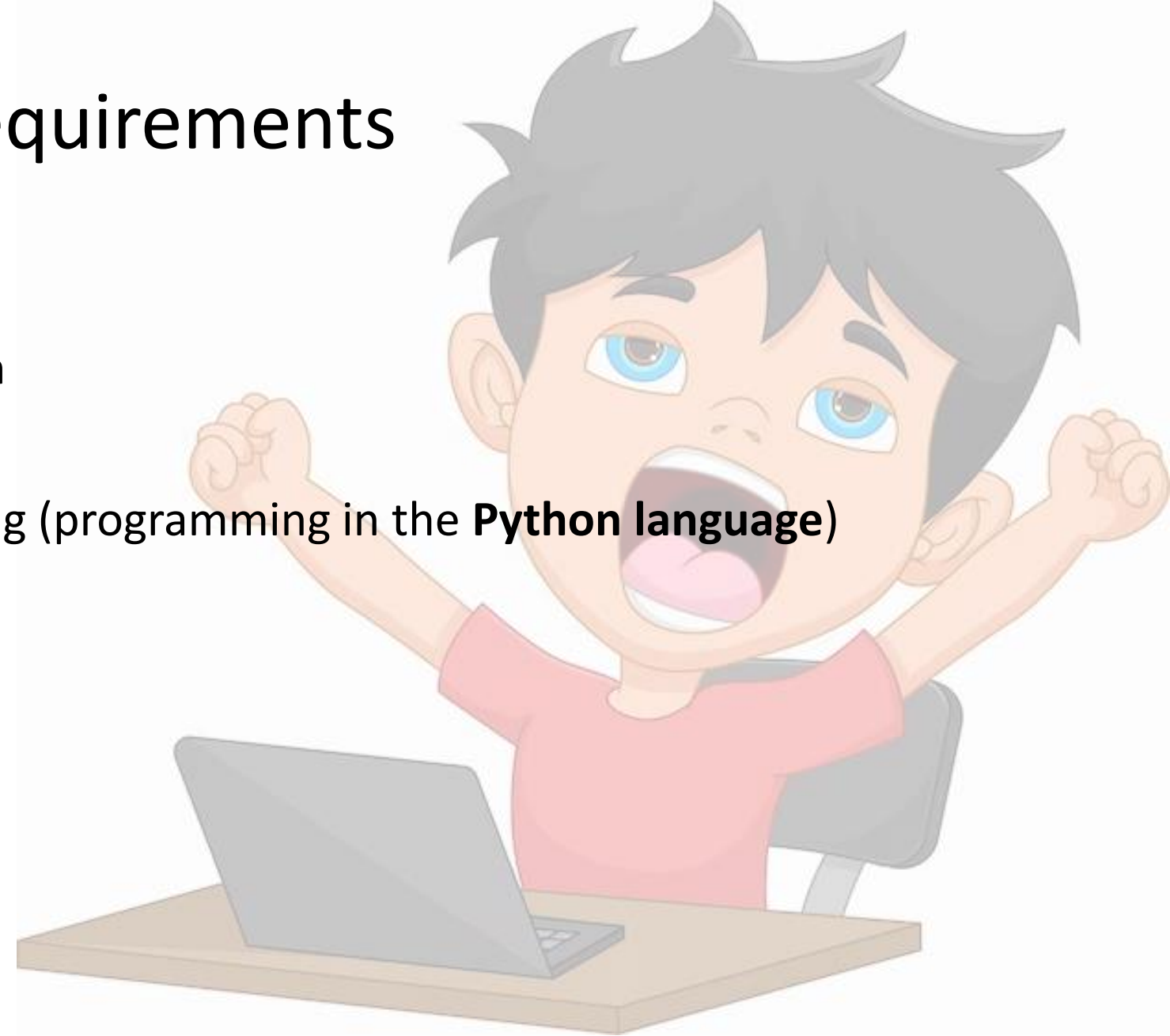
For those taking the full examination

It is important that you book on an official examination date (in time, i.e. before the reservation deadline).

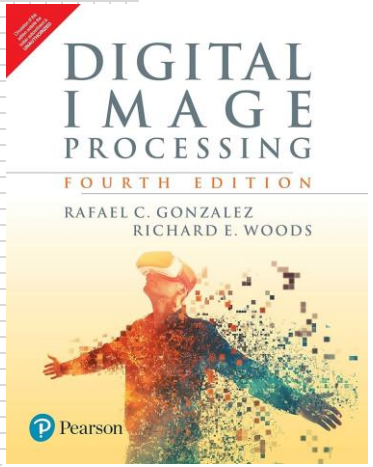
Those who do not book will not be able to take the exam

Requirements

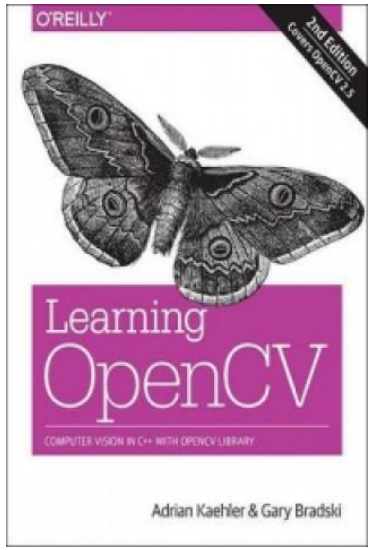
- Bring your own laptop to each lesson
- Knowledge of the basics of computing (programming in the **Python language**)



Books and Resources

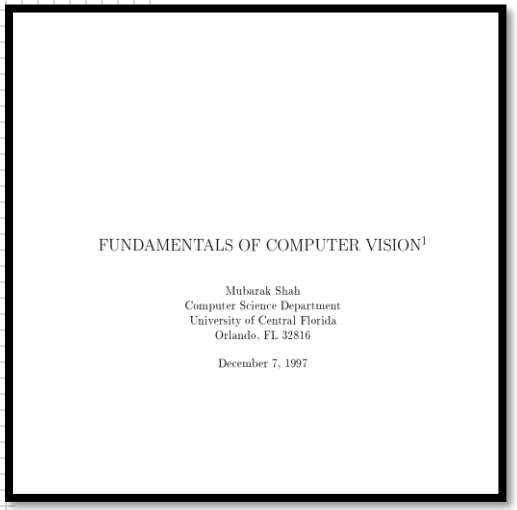


Digital Image Processing, (3rd Edition) Rafael C. Gonzalez, Richard E. Woods, Ediz. Pearson, Prentice Hall



G. Bradski, A. Kaehler, "Learning OpenCV Computer Vision with the OpenCV Library" O'Reilly Media, 2008;

Books and Resources

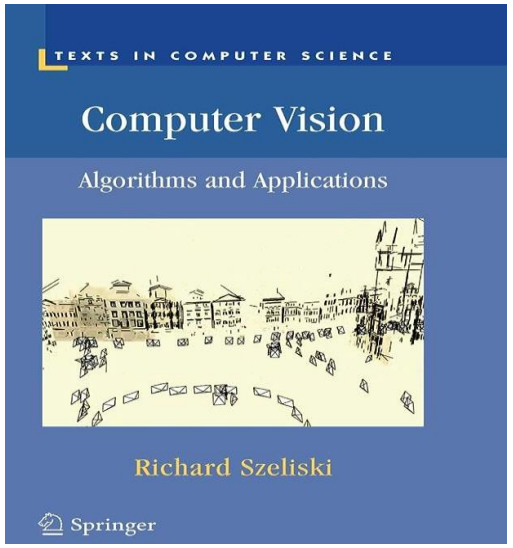

FUNDAMENTALS OF COMPUTER VISION[1]

Mubarak Shah
Computer Science Department
University of Central Florida
Orlando, FL 32816

December 7, 1997

Mubarak Shah, "Fundamentals of Computer Vision"

https://www.cse.unr.edu/~bebis/CS485/Handouts/ShahBook.pdf



Richard Szeliski, Computer Vision: Algorithms and Application, Springer 2010

Resources

Slides, assignments and other teaching materials will be shared with students.

- https://www.dmi.unict.it/lguarnera/teachings/2023-24/MDM/
- MS Teams: **vexbjxu**

Questions?

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Dipartimento di Economia e Impresa

Break… See you in 10 minutes

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