Image Analysis and Computer Vision

Image Analysis and Computer Vision - staff

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Exercise classes plus some theory by:
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Image Analysis and Computer Vision – weekly schedule

Tuesday	h 12.15 - 14.15	room 9.1.2
Wednesday	h 12.15 – 14.15	room 3.1.3

NO streaming
SOME recording will be available

FRAMEWORK

Observation of a static or dynamic scene in the 3D world

through

one or several 2D images

IACV main object

IMAGE ANALYSIS:

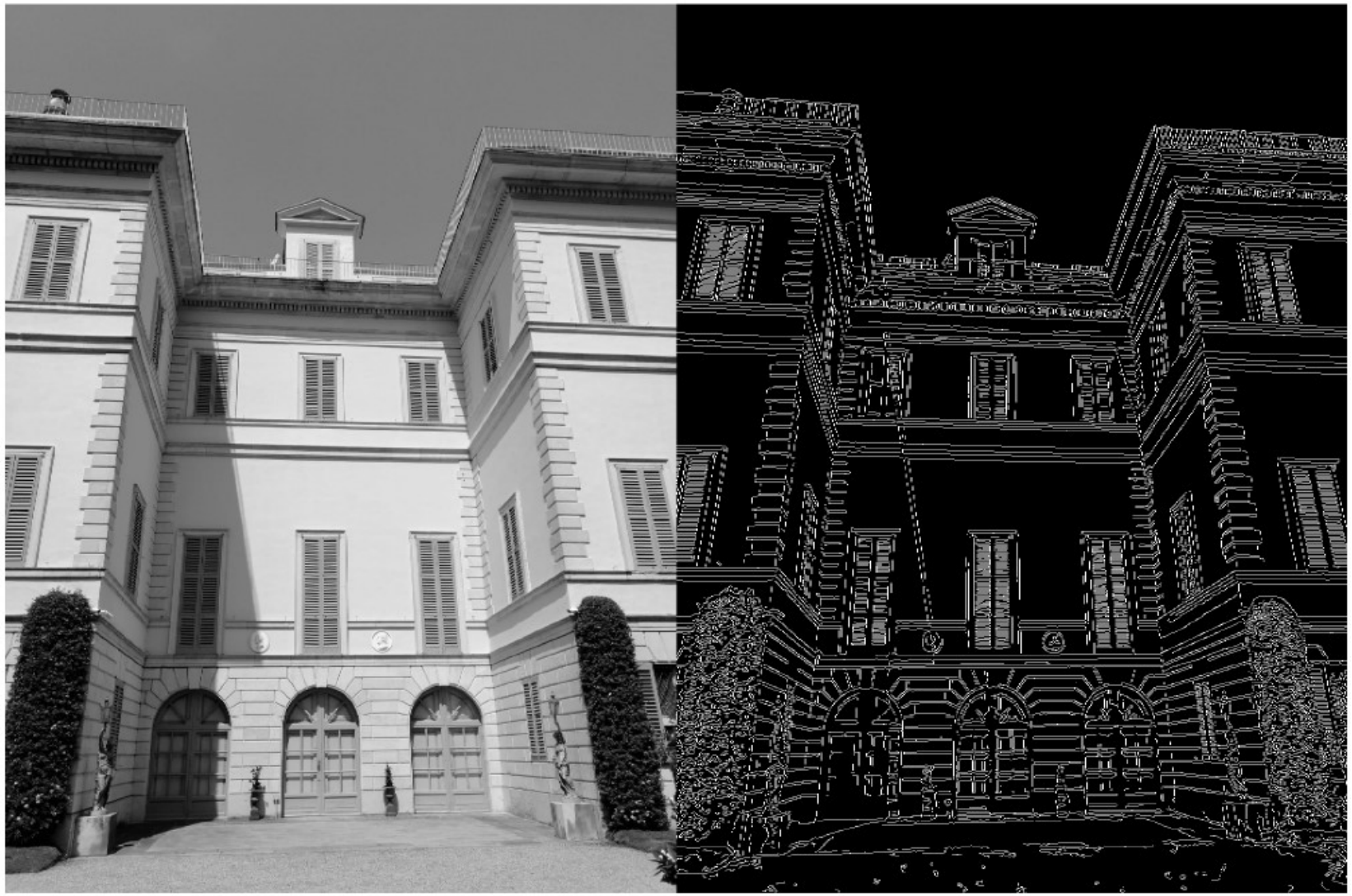
- extract image features (edges, corners, regions)
- match features among different images
- track features along an image sequence (video)

COMPUTER VISION:

compute a model of the observed scene

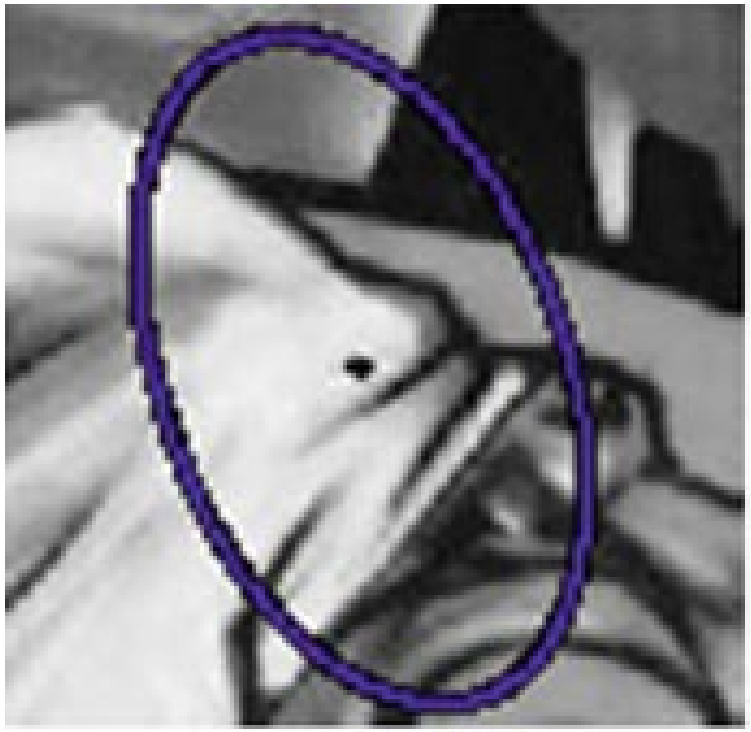
- 2D shape reconstruction
- 3D shape reconstruction
- Object recognition
- Object localization
- Action recognition

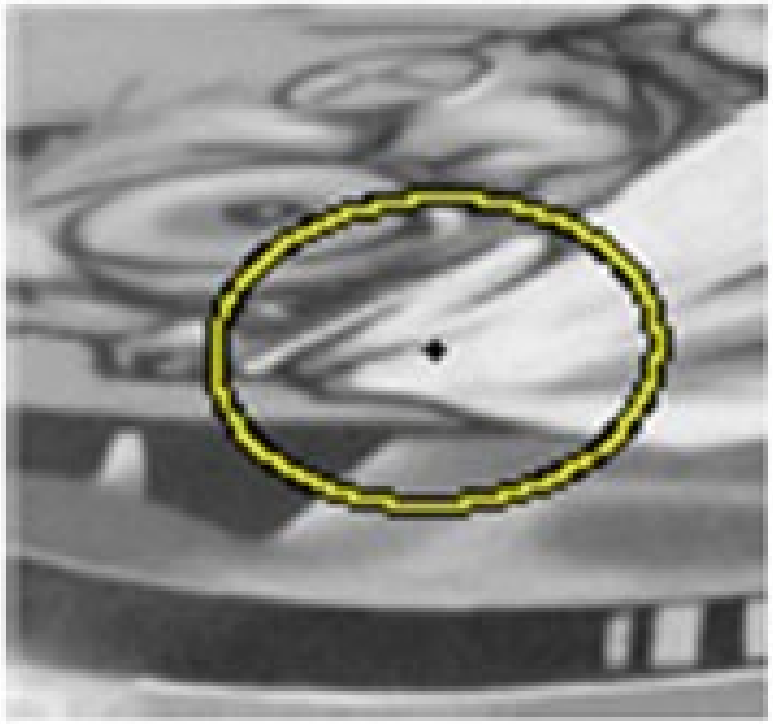
feature extraction: edges



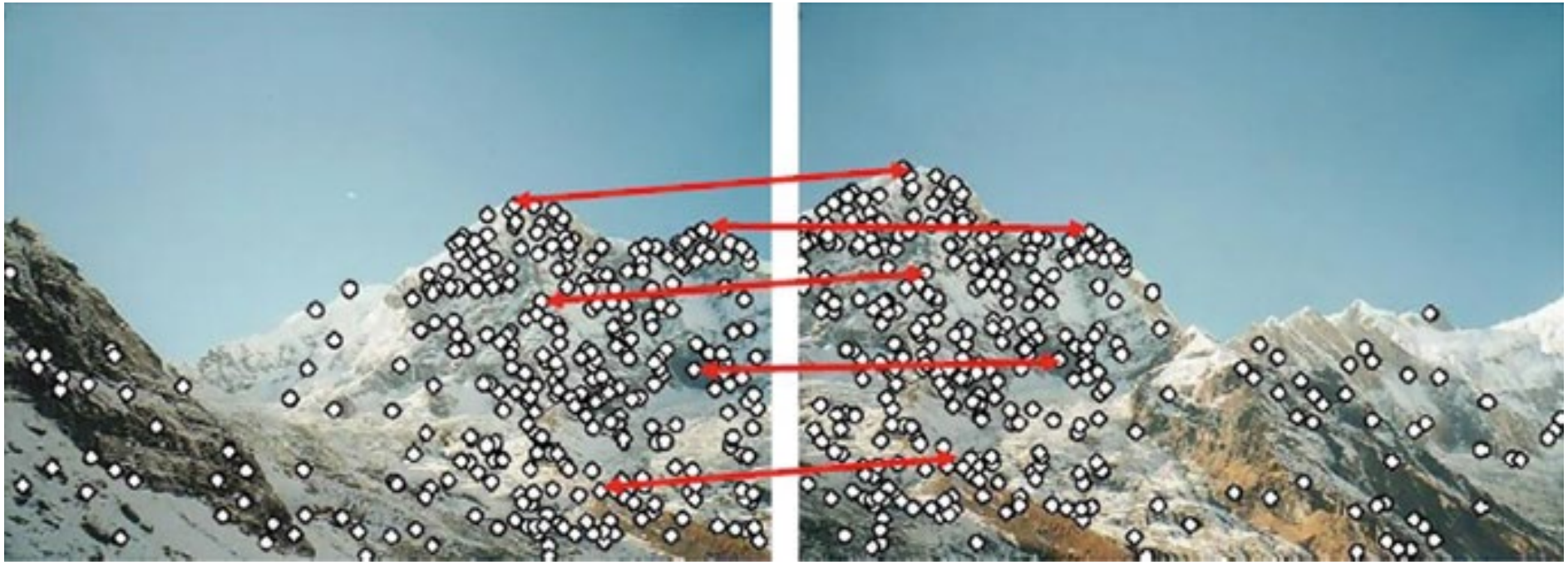
feature extraction: corners

feature extraction: regions

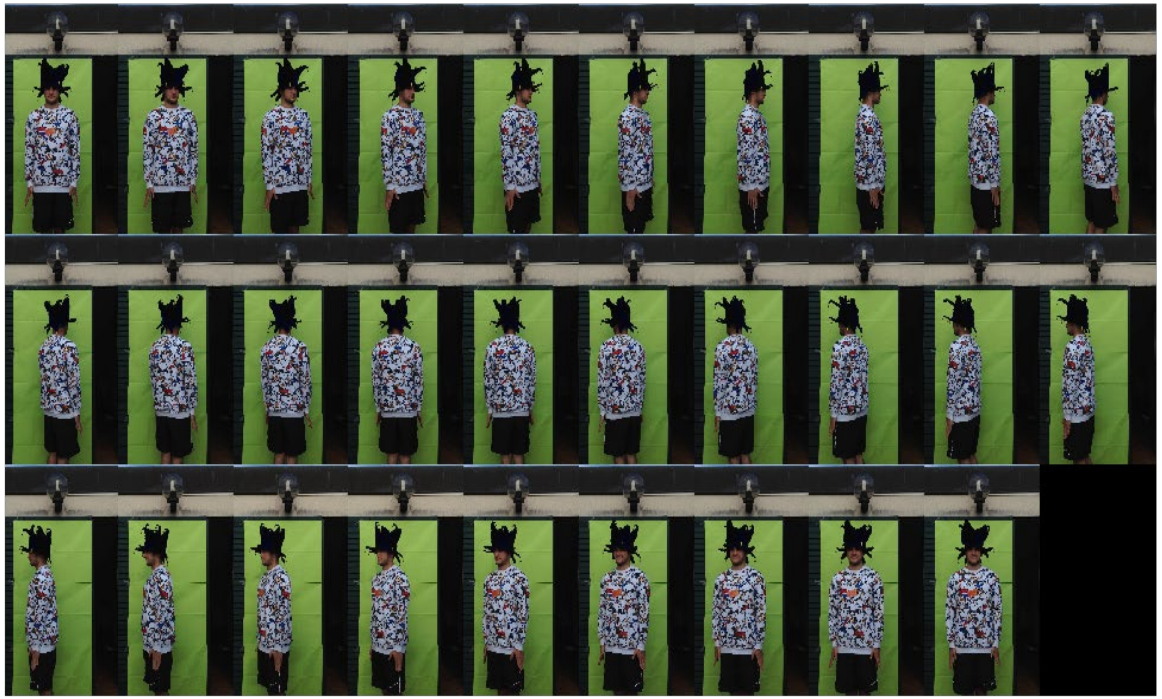


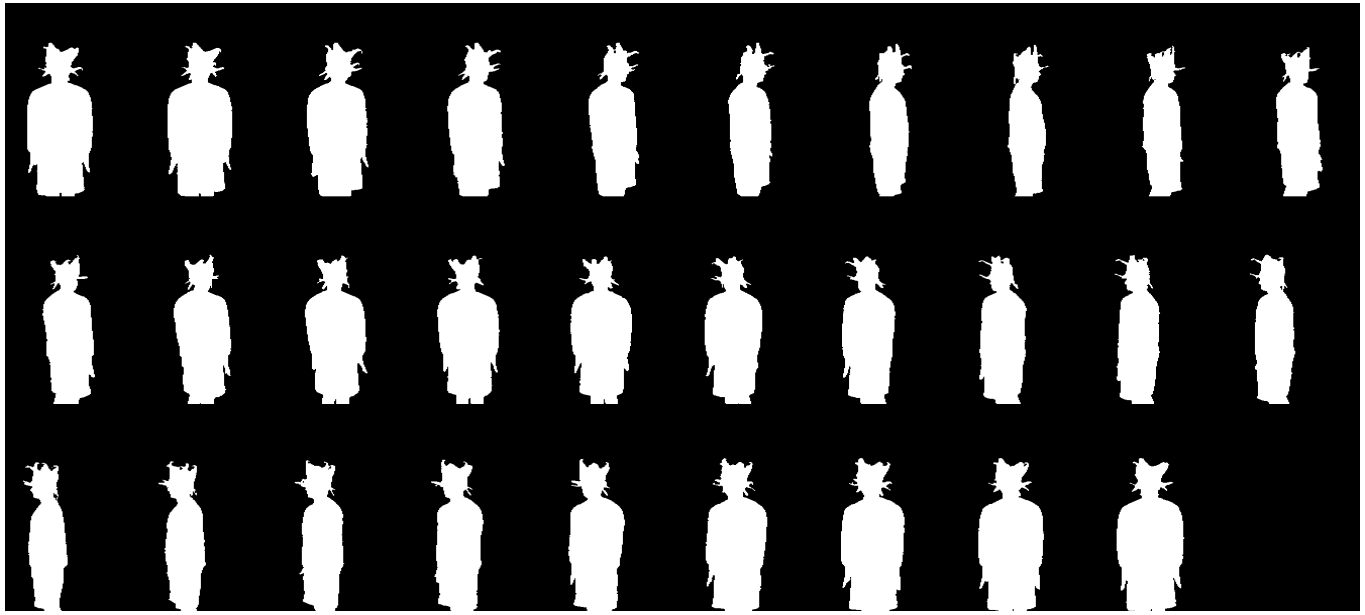


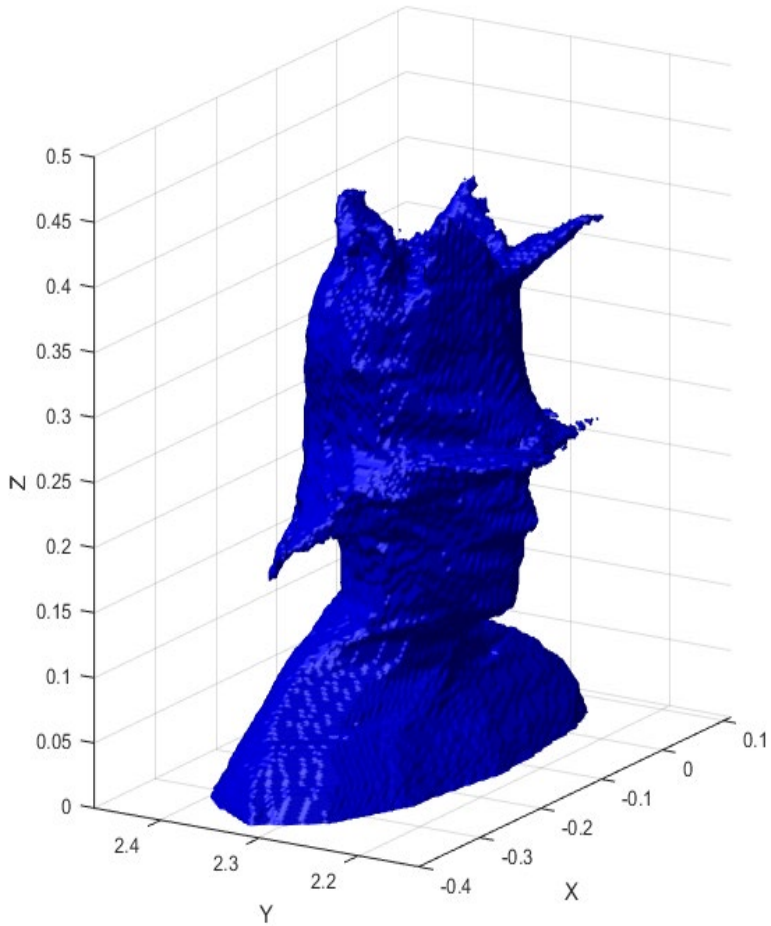
feature matching



3D shape reconstruction






Z
0.5
0.45
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0.2
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Y
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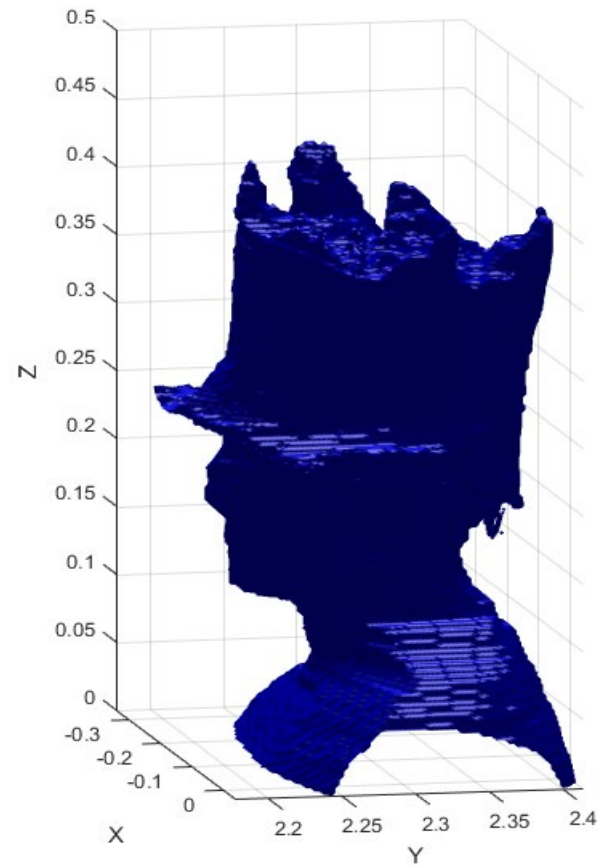
Z
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X
-0.3
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Y
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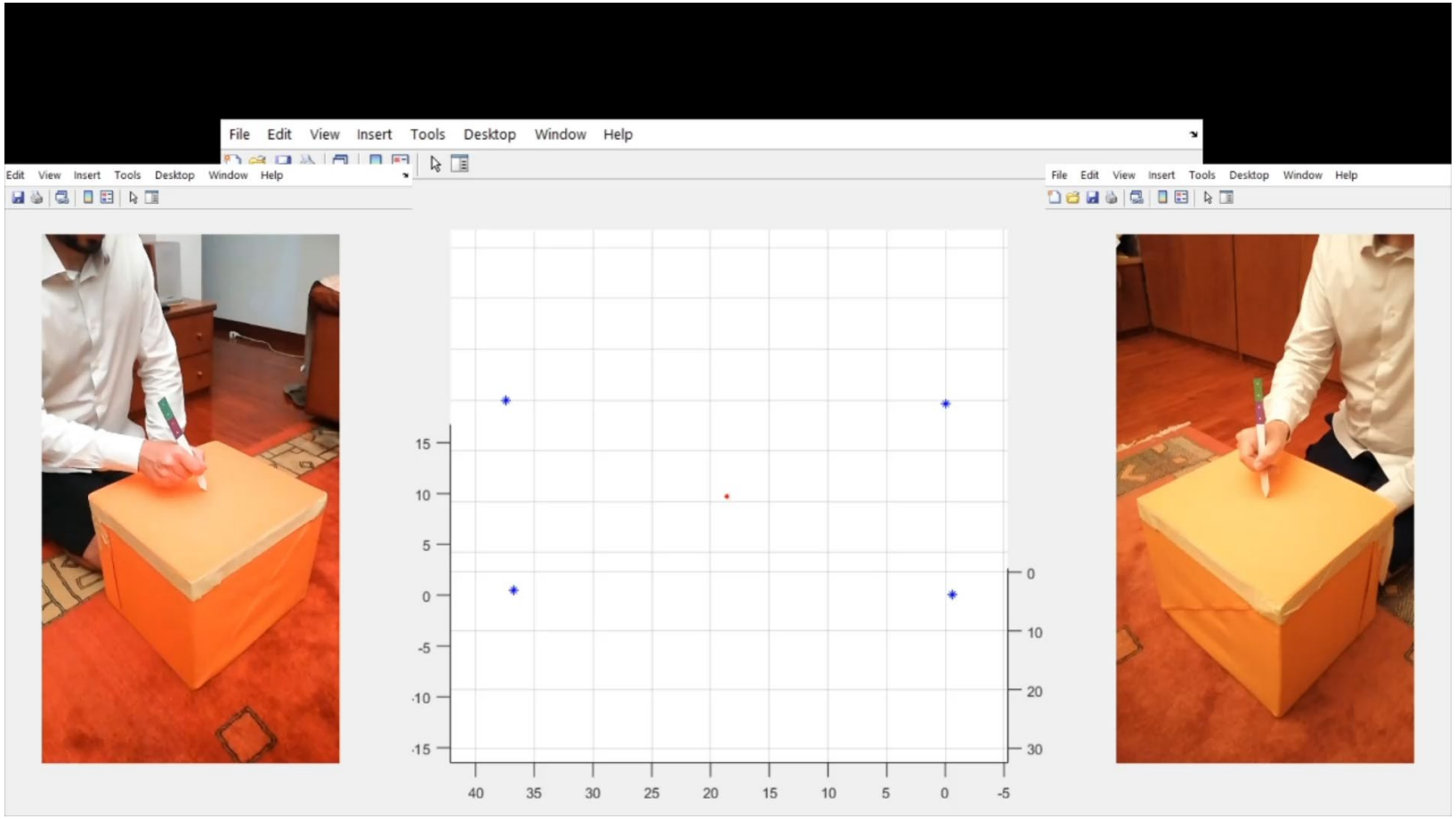
Microsoft

Object recognition

Object localization



Action recognition

Human pose detection

Keypoints detection

DIFFICULTIES

- Noise, degradation, blur, and ILL-POSEDness

→feature extraction and feature matching difficult

- Projection -> information loss (dimensionality reduction from 3D to 2D)

→3D reconstruction is difficult

→

we need to study:

- IMAGE SIGNAL ANALYSIS
- PROJECTION GEOMETRY

TOPICS

- Introduction
- Optical Sensors (camera)
- 2D Projective Geometry (image plane, planar scenes)
- 3D Projective Geometry (3D scenes)
- Camera Geometry (3D → 2D projection) and Calibration
- Digital image Filters and Image Morphology
- Edge and Corner Detection
- Image Feature Detection and Description and Matching
- Model Fitting to Noisy Data
- Multi-view Geometry and 3D Shape Reconstruction

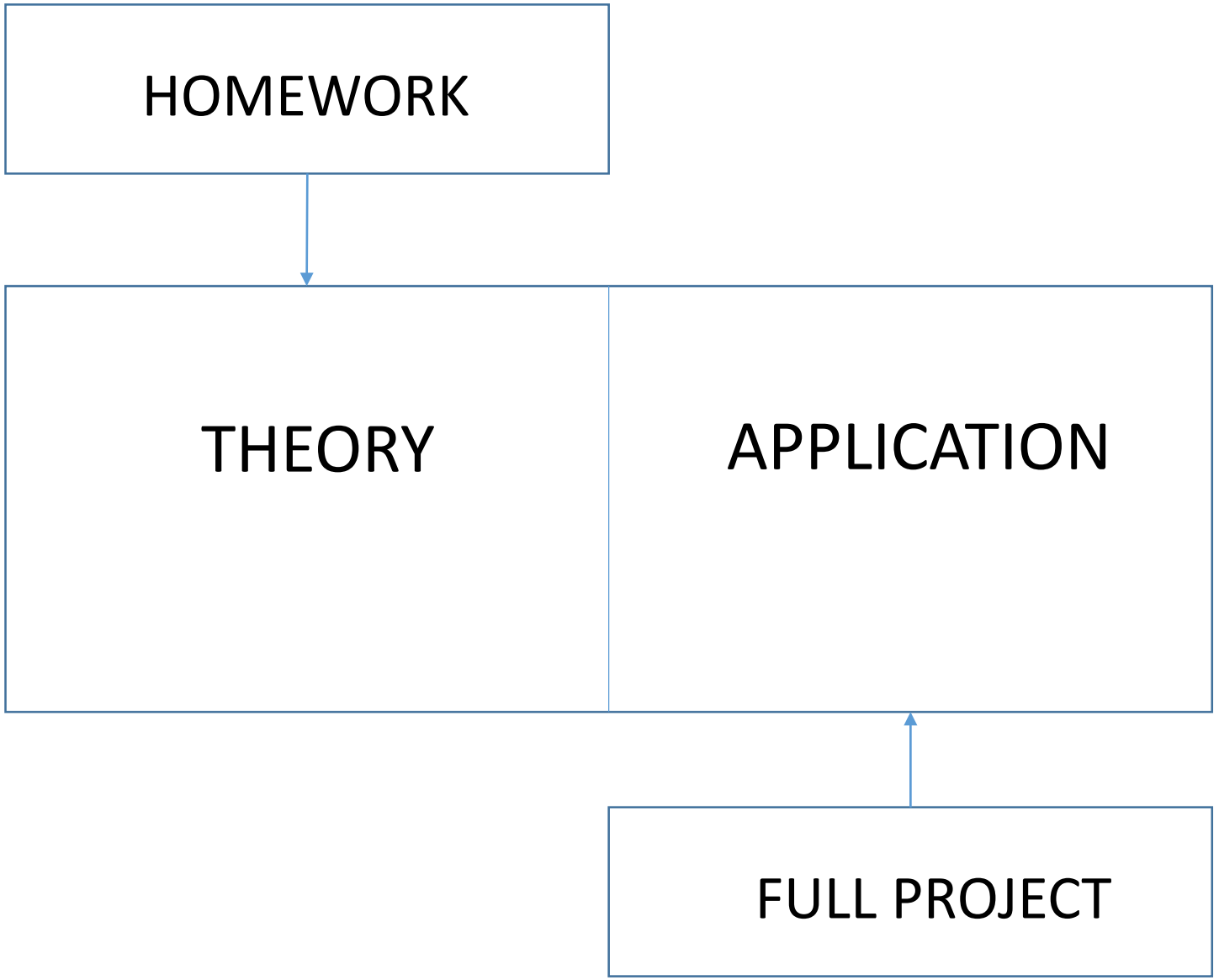
textbooks

- Hartley & Zisserman «Multi-view Geometry in Computer Vision»
- Forsyth and Ponce «Computer Vision: A Modern Approach»
- Course Slides on the WeBeep Platform

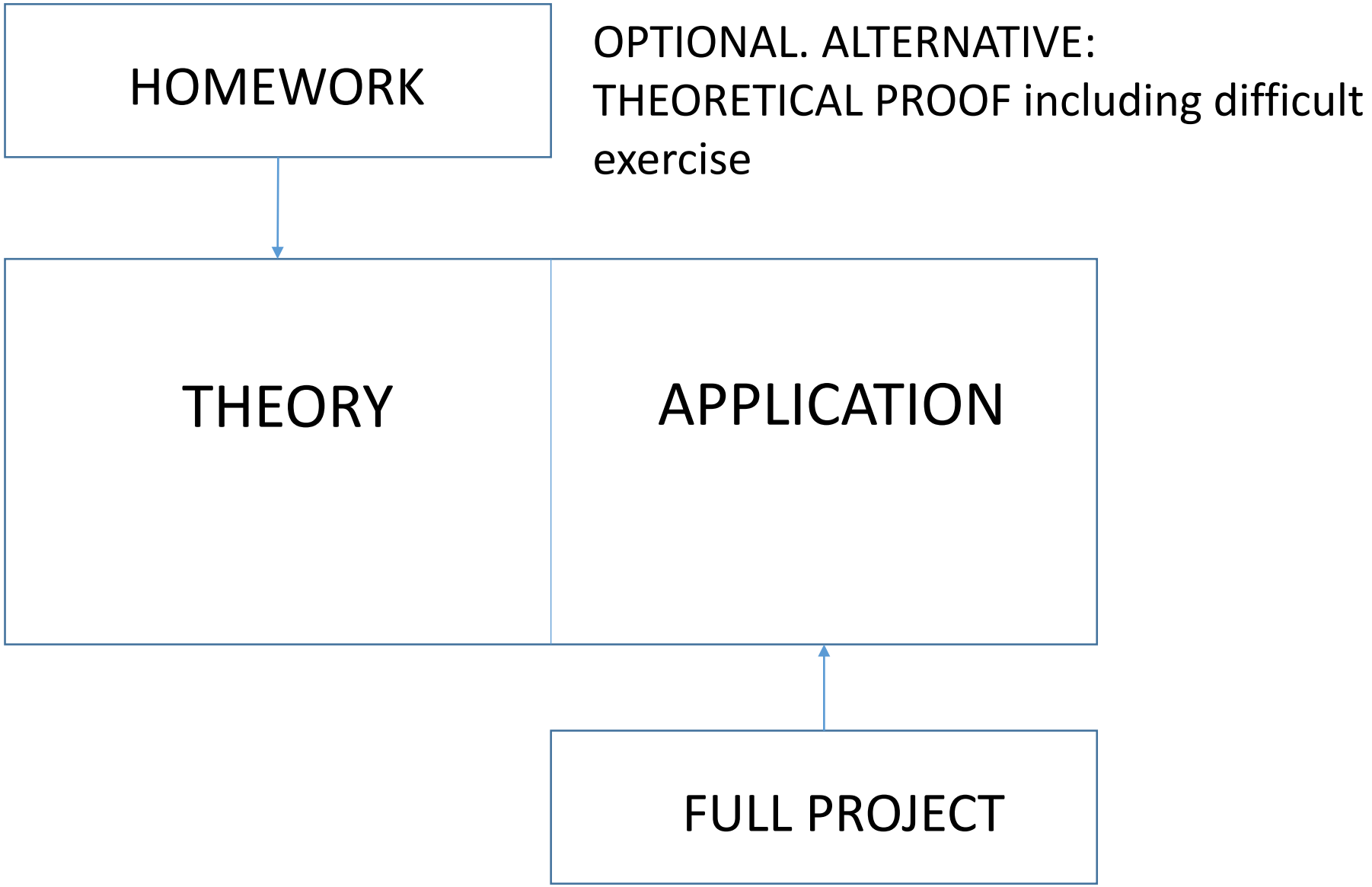
STANDARD EXAM: 2 parts → up to 30 cum laude

THEORY	APPLICATION

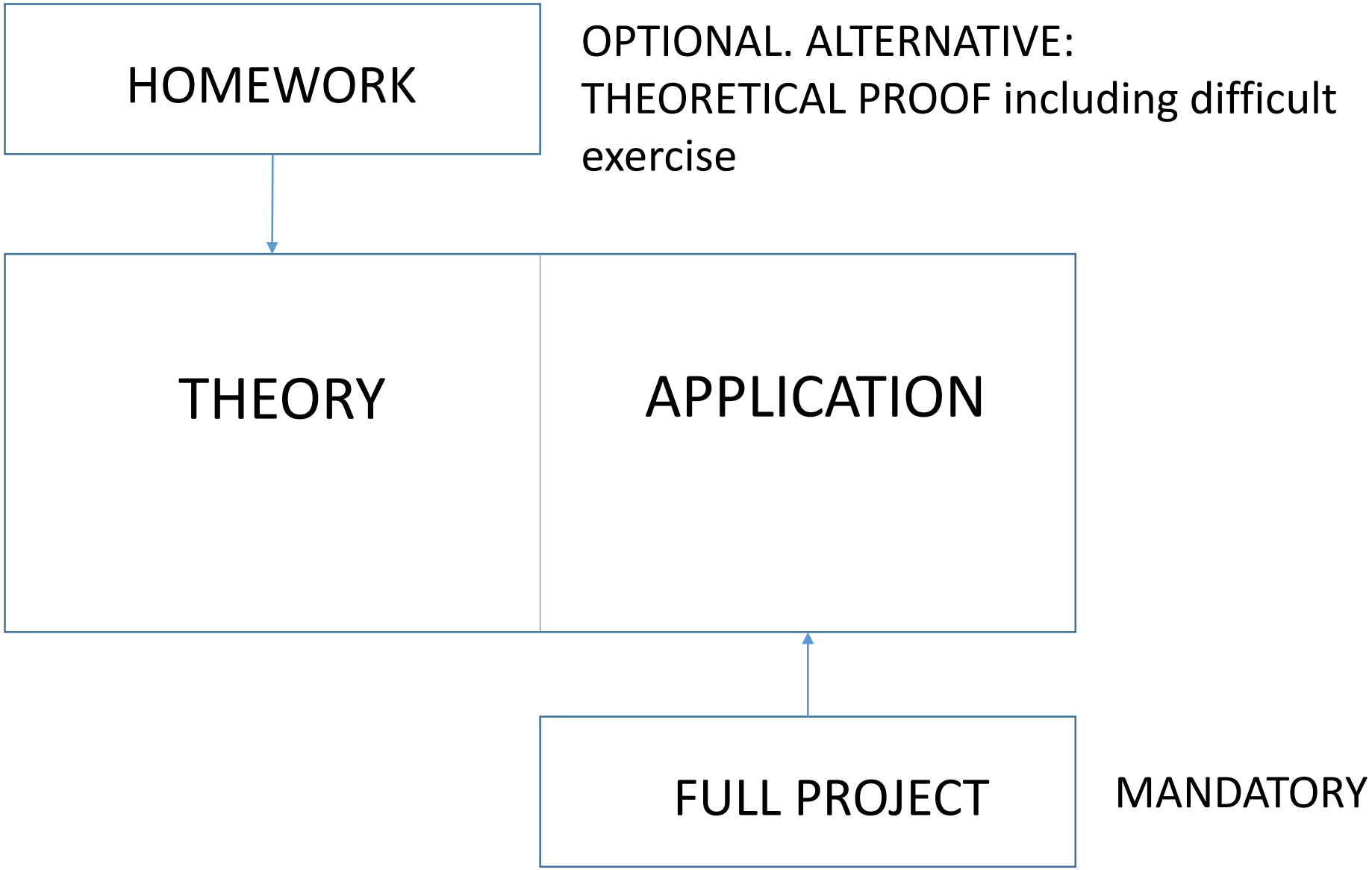
STANDARD EXAM: 2 parts → up to 30 cum laude



STANDARD EXAM: 2 parts → up to 30 cum laude



STANDARD EXAM: 2 parts → up to 30 cum laude



STANDARD EXAM → up to 30 cum laude

- individual HOMEWORK on Theory:

  a long, **difficult** exercise about (usually) 2D reconstruction, camera calibration and localization + a little bit of image feature extraction

  EVALUATION BASED on (i) SUBMISSION and (ii) REPORT

  OR, as an **alternative**,

  THEORETICAL PROOF including **difficult** exercises

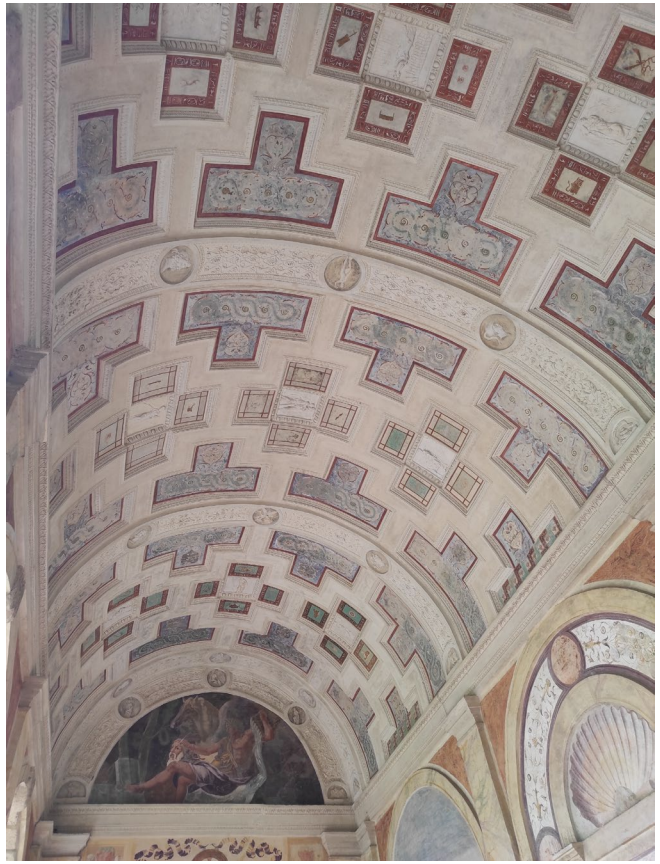
- either individual or team FULL PROJECT:

  an individual or team work involving design, implementation and experimental activity

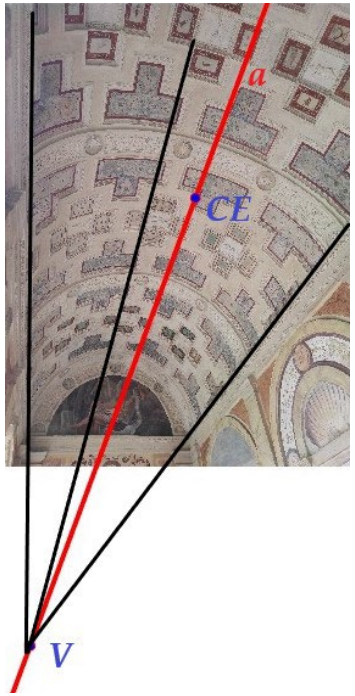
  EVALUATION BASED on

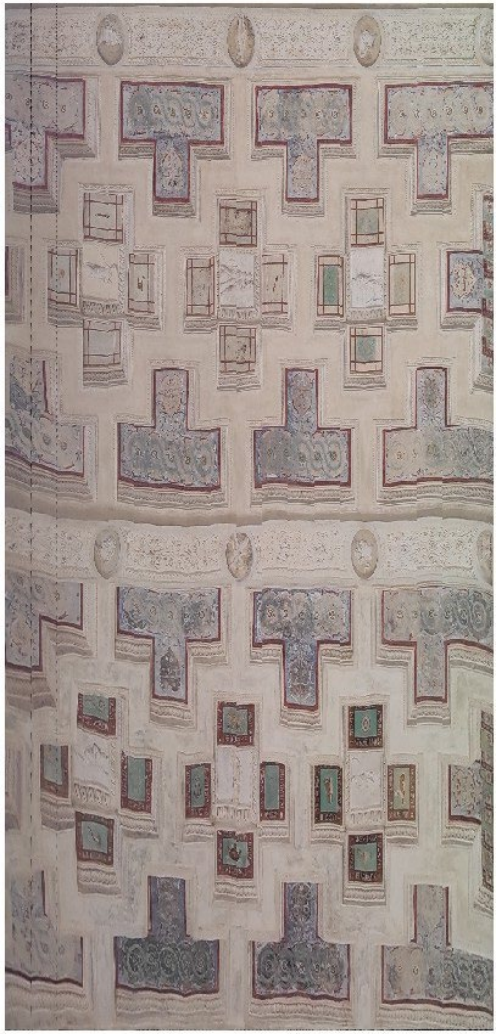
  (i) SUBMISSION, (ii) REPORT and (iii) ORAL DISCUSSION

Last year homework

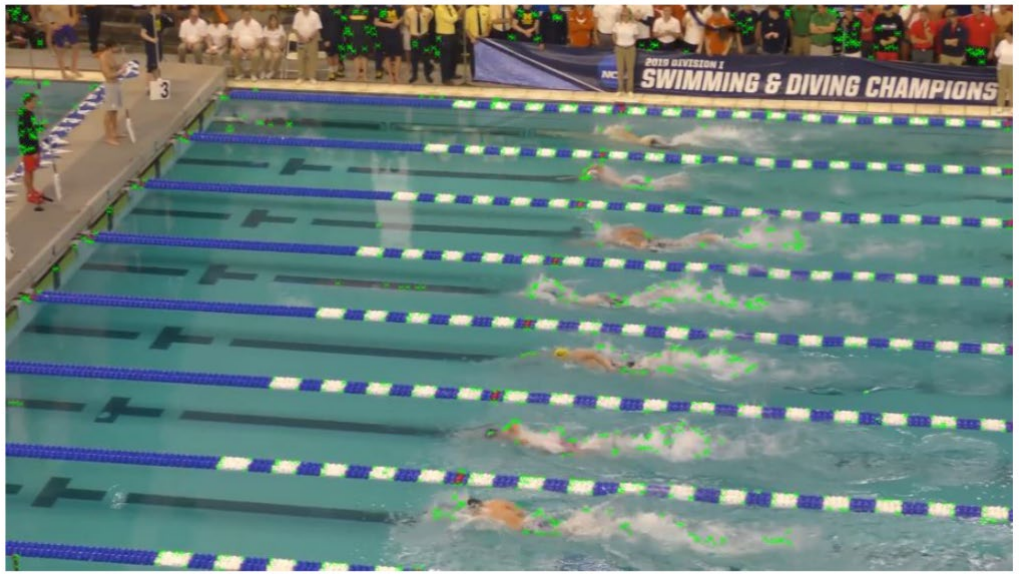


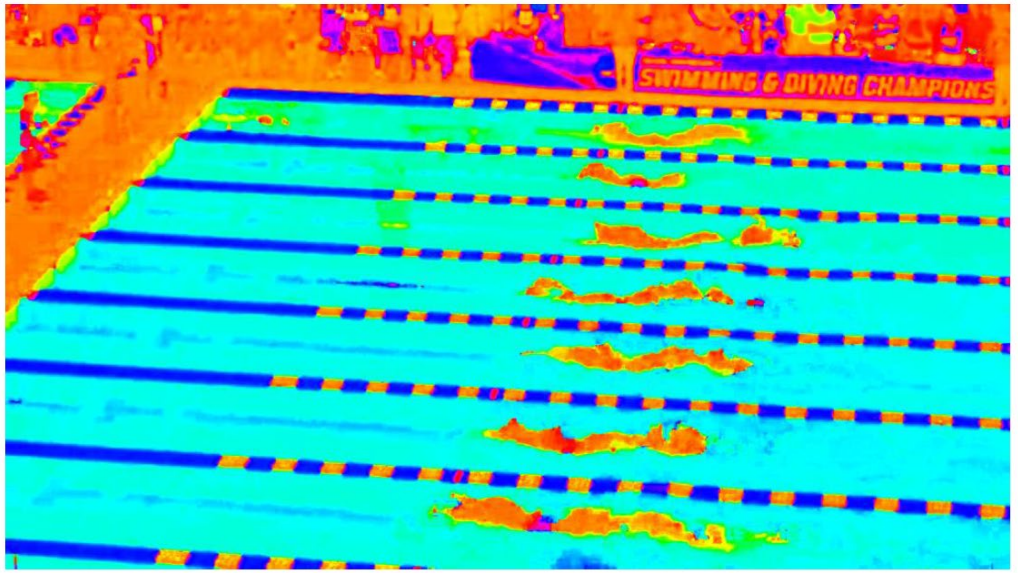
Palazzo Te - Mantova
cylindric vault

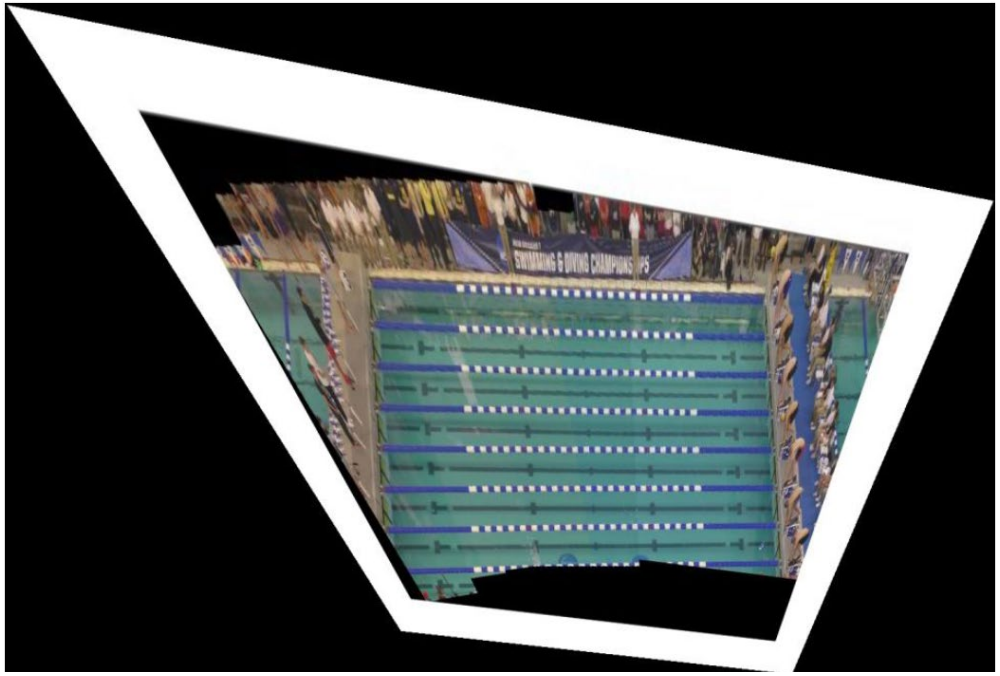


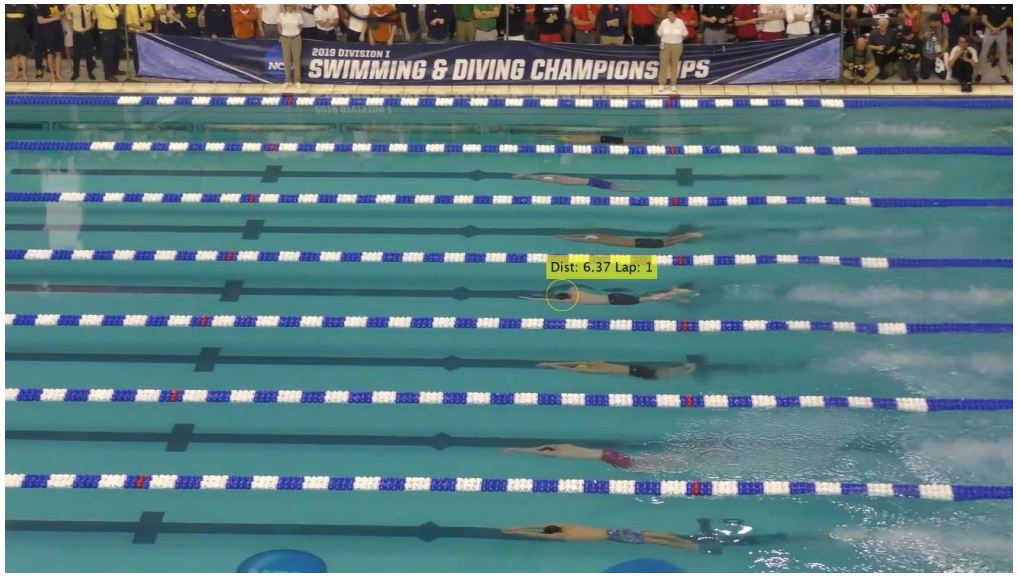


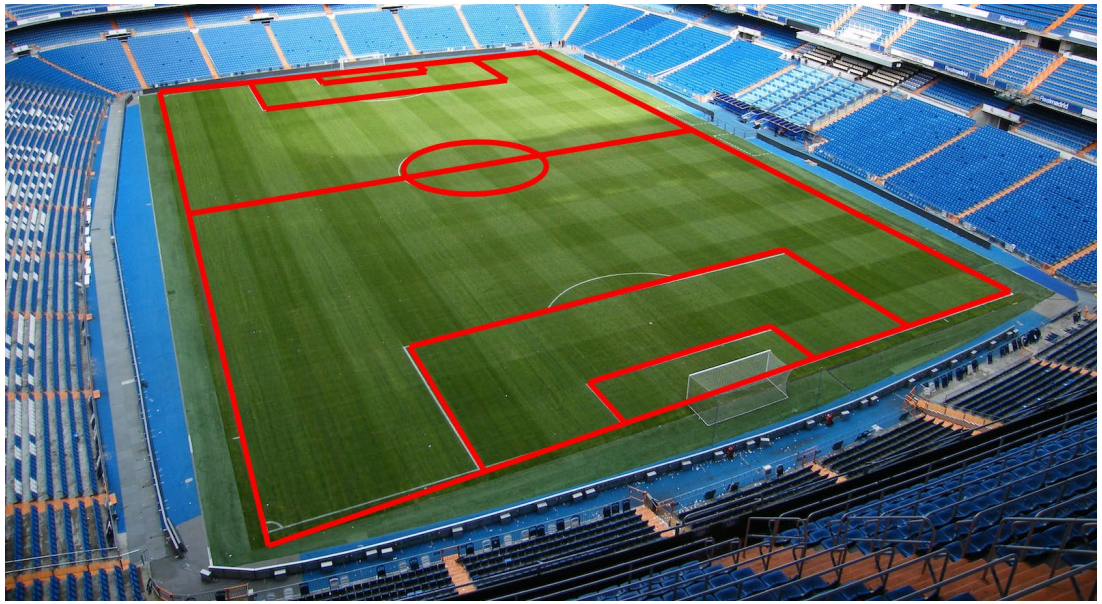
some past projects by your colleagues


2019 DIVISION I
SWIMMING & DIVING CHAMPIONS

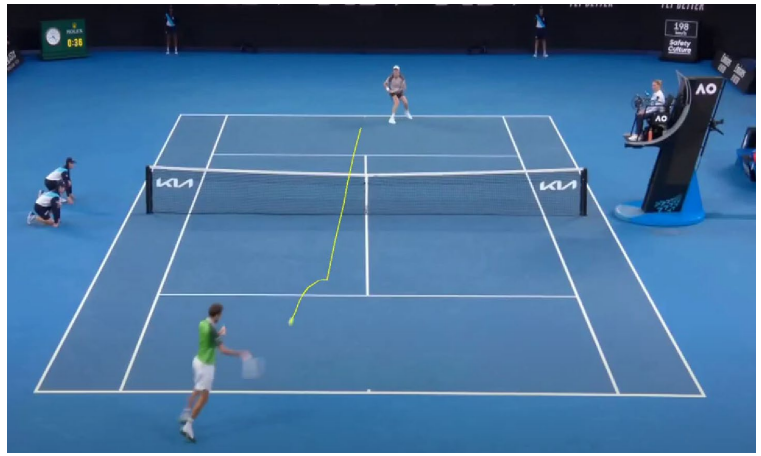

SWIMMING & DIVING CHAMPIONS

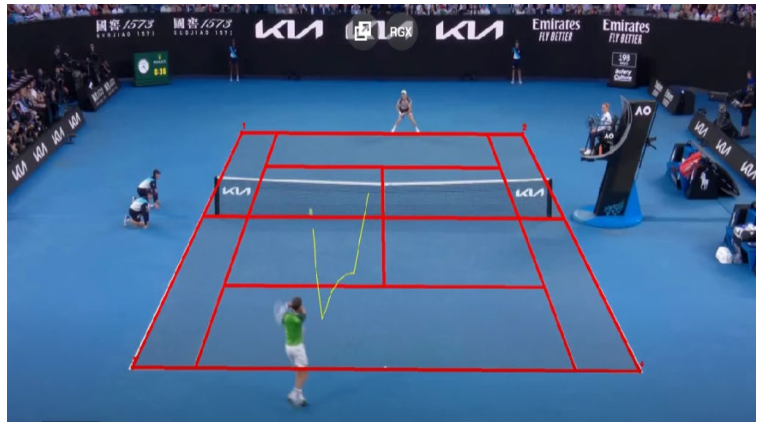


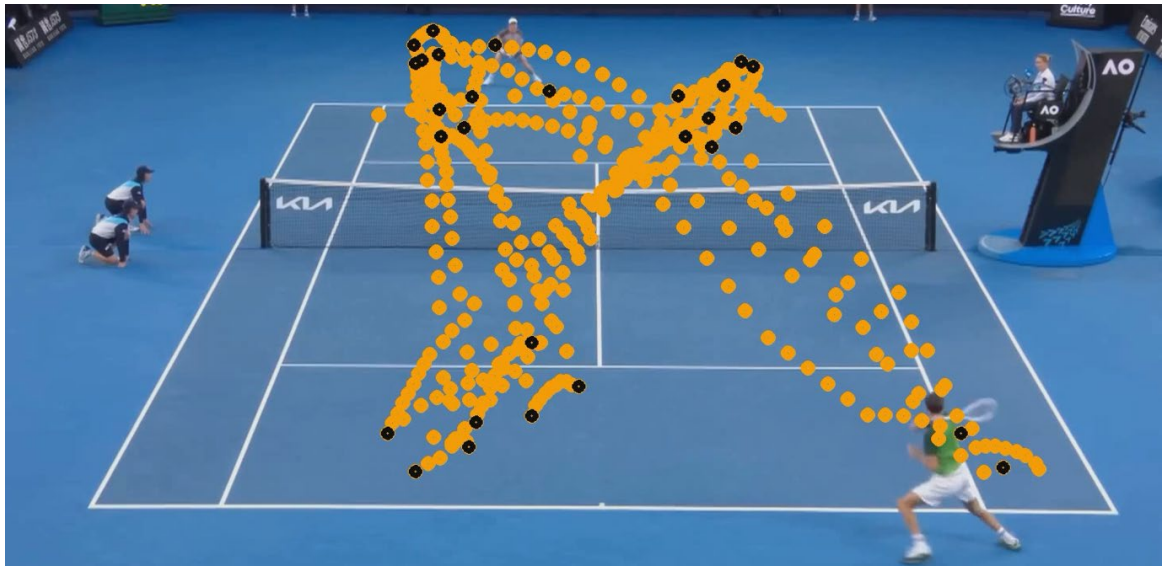

2019 DIVISION I
SWIMMING & DIVING CHAMPIONSHIPS
Dist: 6.37 Lap: 1

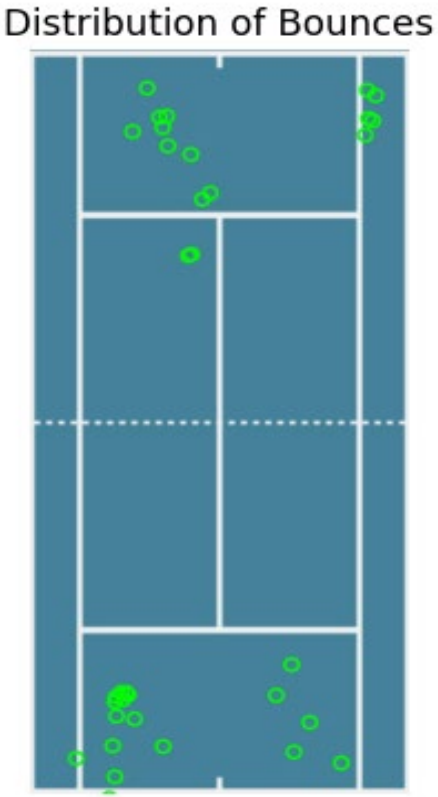


3D trajectory of tennis ball









Object tracking

Robust tracking

VII. Object tracking

Robust tracking

HOMEWORK

- **HOMEWORK** on Theory:

- A LONG AND DIFFICULT EXERCISE
- INDIVIDUAL (no collaboration)
- NOT MANDATORY (alternative: THEORETICAL PROOF with EXERCISES)
- PUBLISHED END NOVEMBER
- UNIQUE DEADLINE: within the 1° EXAM CALL (about end of January)
- but still VALID IN FUTURE CALLS AND YEARS
- DEVELOPED IN MATLAB
- EVALUATION based on (i) SUBMISSION and (ii) REPORT

EXAM

- **PROJECT**:

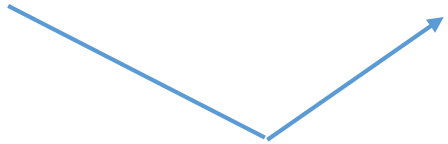
- TEAMS of 1, 2, or 3 STUDENTS (collaboration is welcome)
- MANDATORY IN STANDARD EXAM MODE
- PUBLISHED MID DECEMBER,
- DEVELOPED IN (ALMOST) ANY PROGRAMMING LANGUAGE
- MANY DEADLINES = TWO DAYS BEFORE EACH EXAM CALL
- EVALUATION based on
- (i) SUBMITTED MATERIAL
- (ii) pdf REPORT and ppt PRESENTATION
- (iii) DISCUSSION

STANDARD EXAM: EVALUATION → 30L

CHOOSE BETWEEN TWO POSSIBILITIES :

1° THEORY (Homework* or Theoretical Proof including difficult exercise) 10L/30 + FULL PROJECT 20L/30

2° HOMEWORK* good evaluation (> 7/10) Pass /Fail + FULL PROJECT 30L/30



* the evaluation of the homework is saved for future calls: you don't have to deliver it twice

NON-STANDARD EXAM: EVALUATION → ≤30
NO LAUDE

THREE POSSIBILE «ESCAPE STRATEGIES»:

1° THEORY (Homework* or Theoretical Proof including difficult exercise) **10**/30 + **SHORT** PROJECT **20**/30

NO PROJECT

2° HOMEWORK* **9**/30 + EXTENDED PROOF (including difficult exercises) **18**/30

NO HOMEWORK & NO PROJECT

3° EXTENDED PROOF (including difficult exercise) → max total: **25**/30

* the evaluation of the homework is saved for future calls: you don't have to deliver it twice

Project evaluation:
maximum score (20/20) is NOT the DEFAULT outcome.
Here are some minimal requirements:

- Avoid unnecessary assumption or restrictions
- Awereness of the theory thought in the course: avoid to re-invent (often worst) solutions
- Awereness of the theory thought in the course: capability to autonomously apply theory to derive solutions
- Autonomy in the retrieval and/or construction of the needed data sets
- Experimental results based on real images, not only simulated ones
- Develop a solution with a certain degree of generality, without tailoring it to just a single case (e.g., single video or image)