Machine Vision

Introduction to computer vision
lecture 1

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materials: $ftp(public)://aszmigie/WMA$

Semester lecture schedule

1. Computer vision - introduction,
2. Image formation,
3. Image processing - filtering,
4. Image processing - detection of geometric features,
5. Detection of image features,
6. Algorithms detection and comparison of image features,
7. Convolutional networks,
8. Deep learning,
9. Architectures of convolutional neural networks,
10. Frequency methods in image processing,
11. Stereovision,
12. Vision and movement,
13. Visual SLAM - Simultaneous localization and mapping,
14. Image segmentation,
15. Semantical image segmentation.

Semester laboratory schedule

1. Introductory classes, familiarization with the laboratory,
2. OpenCV classes, color models, filters,
3. Identification of colored objects - project 1,
4. Track color objects,
5. Identification of coins and tray - project 2,
6. Object description using descriptors (e.g. SIFT algorithm),
7. Object tracking using descriptors description - project 3,
8. Convolutional networks using Keras,
9. Learning convolutional networks - creating your own patterns,
10. Object identification using neural networks,
11. Implementation of the Optical Flow algorithm (OF in openCV) - project 4
12. Implementation of the Optical Flow algorithm (OF in openCV),
13. Implementation of the segmentation algorithm - project 5,
14. Colloquium,
15. Final classes - submitting projects, giving grades,

How to pass WMA

- There are two grades in the MWR subject - exercises grade and exam grade,
- The subject ends with an exam. A colloquium will take place at the end of the semester. The grade from the test is the grade from the zero exam. There are no exemptions from the exam.
- 100 points to be obtained = 70 p. laboratory + 30 p. test
  - *Laboratory 70 p.* - During the classes, students will get several mini-projects to be carried out during the classes. The project will be able to be submitted for the next class without losing points.
  - *test 30 p.* - test on the 14th laboratory.
- In the case of justified absence from the test (week 14th) it is possible to write a test during 15 exercises.

- Laboratory grade table:

grade	points = lab. + test
2	0- 50
3	50,5 - 60
3,5	60,5 - 70
4	70,5 - 80
4,5	80,5 - 90
5	90,5 - 100

Test - zero exam

- Test is treated as a zero exam,
- The grade from the test can be treated as grade of zero exam, based on the following table:

grade	test points
2	0- 15
3	15,5 - 18
3,5	18,5 - 21
4	21,5 - 24
4,5	24,5 - 27
5	27,5 - 30

- The condition of passing the grade from the test to the zero exam is passing the laboratory.

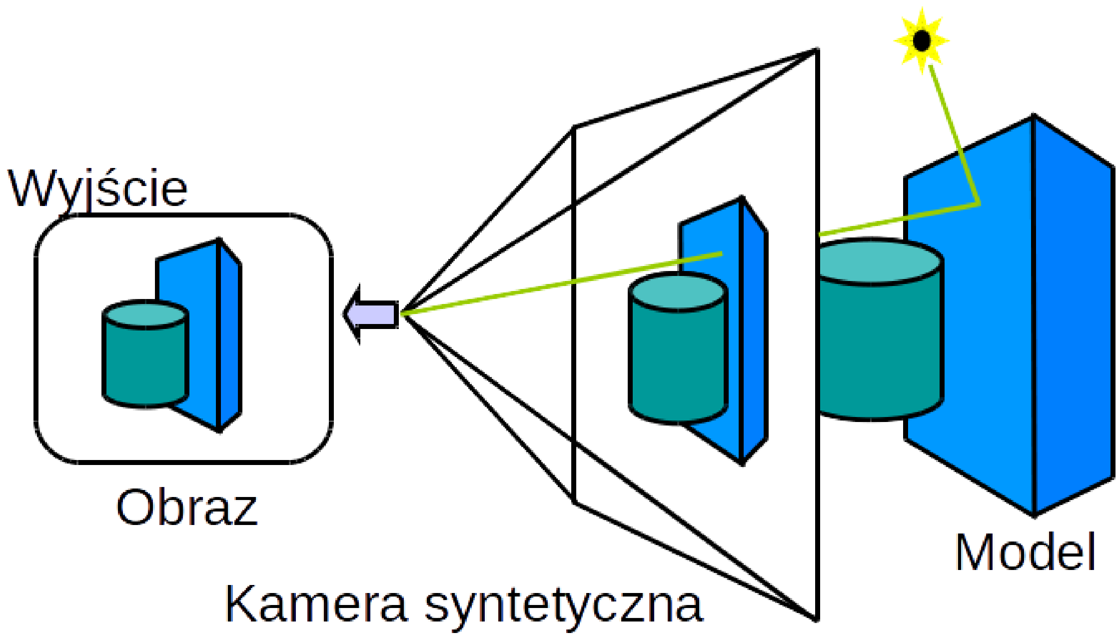
Software

Projects will be discussed using Python 3.

Software

- Python 3
- OpenCV
- Biblioteki numpy, tensorflow, keras etc. - needed environment to manage modules, eg PIP

Computer Graphics



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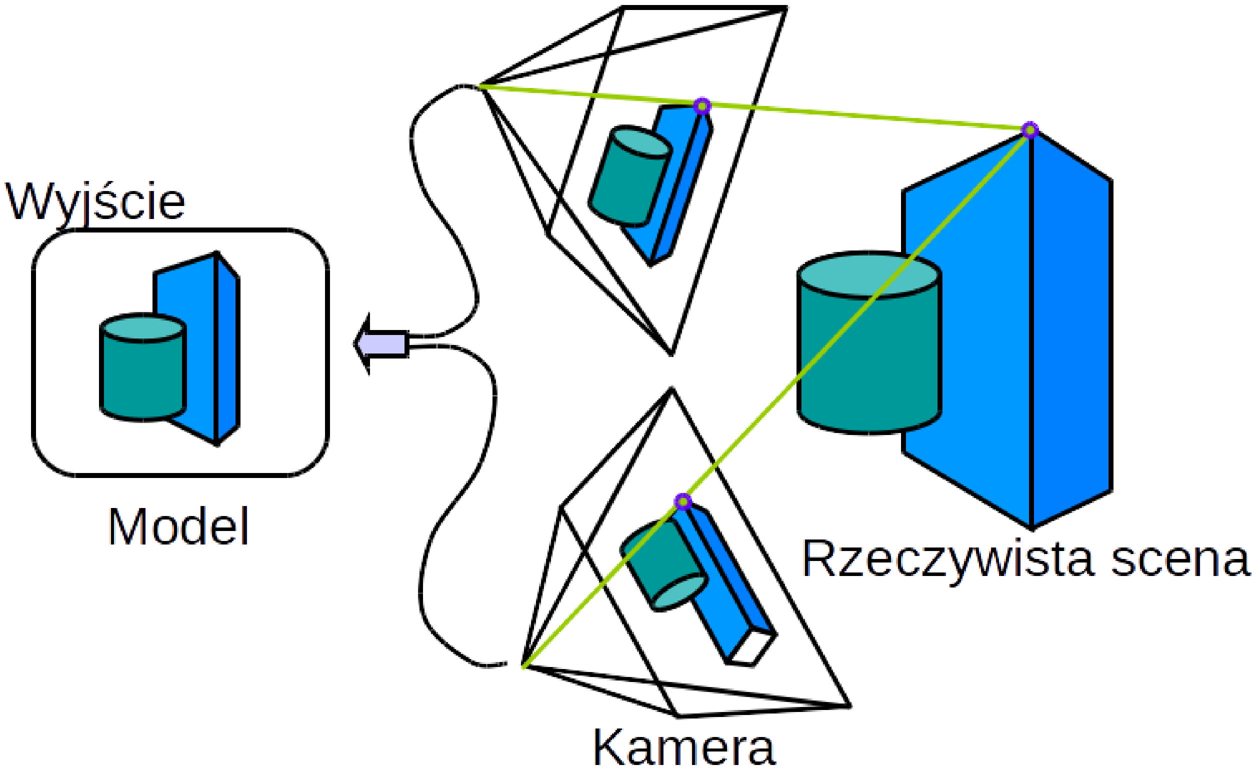
Computer Vision



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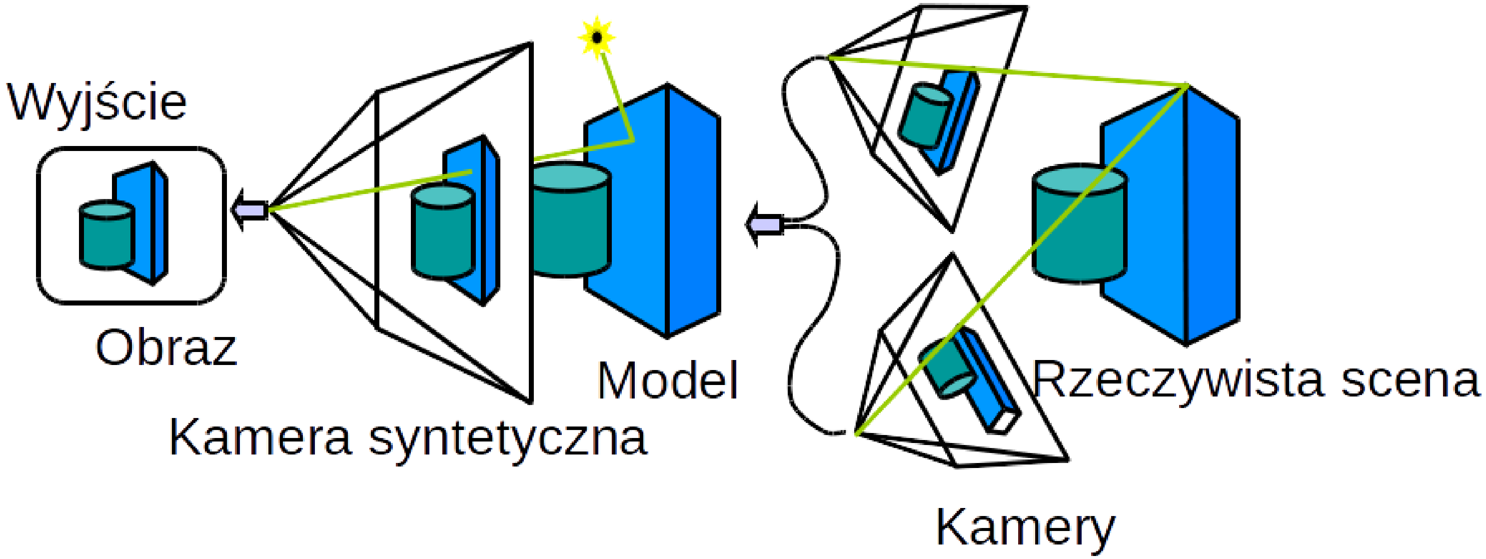
Combined systems



- Augmented reality,

Computer vision

- Basics
  - Image creation and camera calibration,
  - Image features
- 3D reconstruction:
  - stereovision,
  - Mosaic picture,
- Object detection and recognition:
  - Grouping,
  - Detection
  - Segmentaiton,
  - Classification,
  - Tracking.

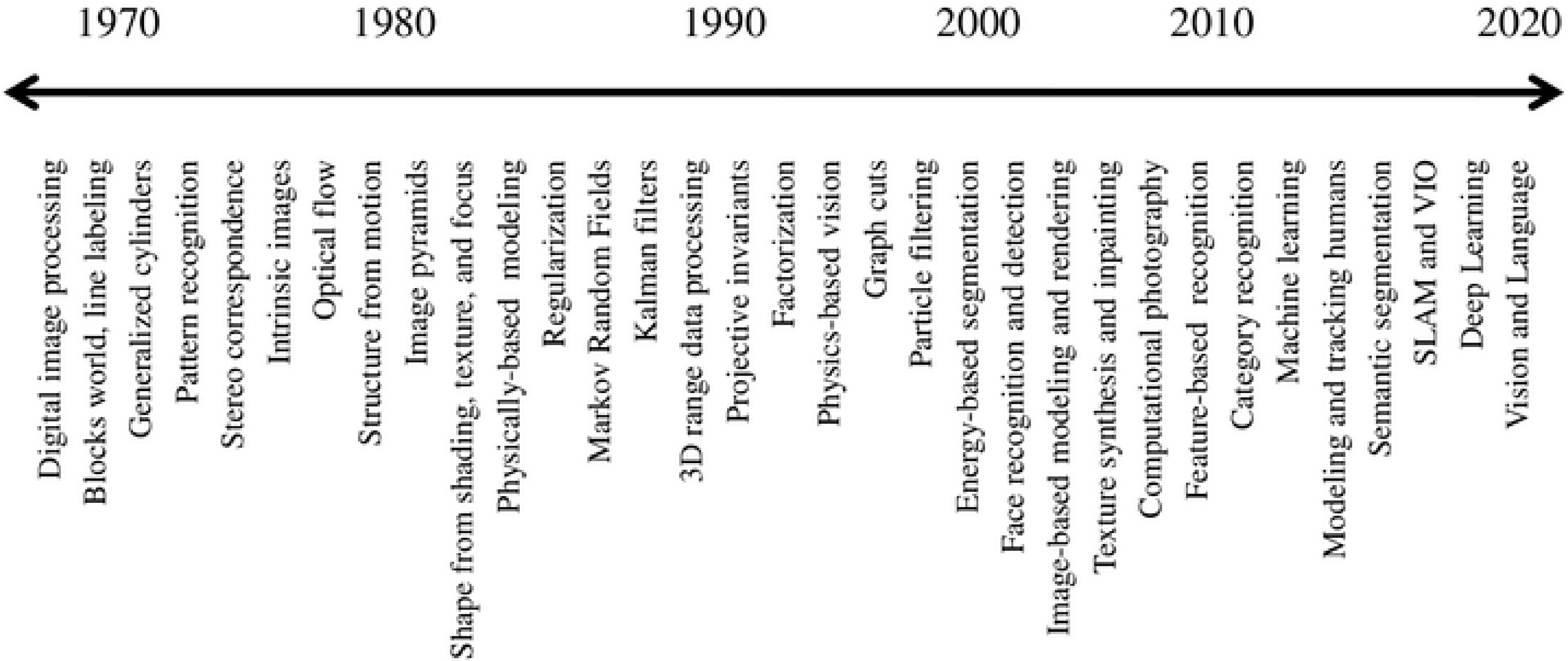
Application of Computer Vision

- Optical character recognition (OCR): reading handwritten letters,
- Machine inspection: rapid parts inspection for quality assurance using stereo vision,
- Retail: object recognition for automated checkout lanes and fully automated stores,
- Warehouse logistics: autonomous package delivery,
- Medical imaging: registering pre-operative and intra-operative imagery,
- Self-driving vehicles: capable of driving point-to-point between cities,
- 3D model building (photogrammetry): fully automated construction of 3D models from drone photographs
- Motion capture (mocap): using markers viewed from multiple cameras
- Surveillance: monitoring for intruders, analyzing highway traffic and

monitoring pools

- Fingerprint recognition and biometrics: for automatic access authentication as well as forensic applications,
- Face detection: for improved camera focusing as well as more relevant image searching,
- Visual authentication: automatically logging,

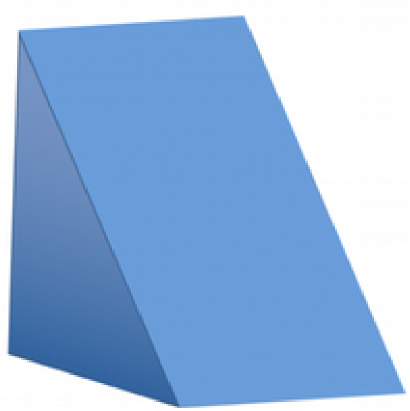
A brief history of Computer Vision



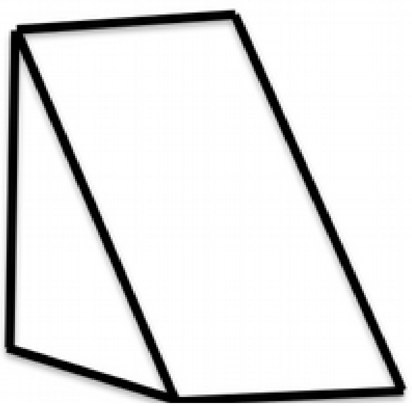
History of computer vision

- 1966: Minsky begins a summer bachelor's project in computer vision,
- 1960s (Larry Roberts, 1963) Interpretation of synthetic material,
- 1970s Attempts to interpret the image,
- 1980s trying to create a formal description - in the context of geometry,
- 90 years Face recognition - statistical analysis,
- years 2000 Large data sets with labels, video processing begins.

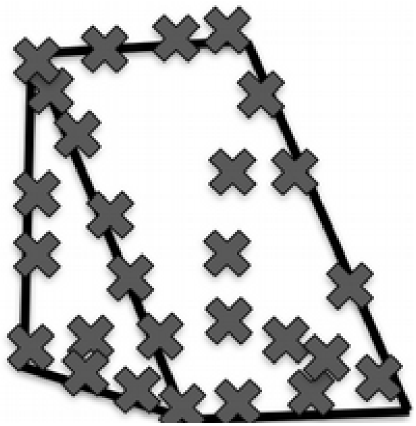
Block world Larry Roberts, 1963



original picture

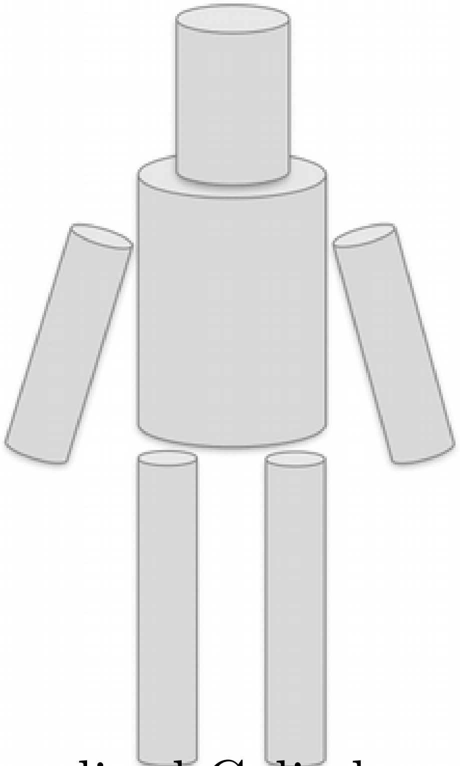


differential description



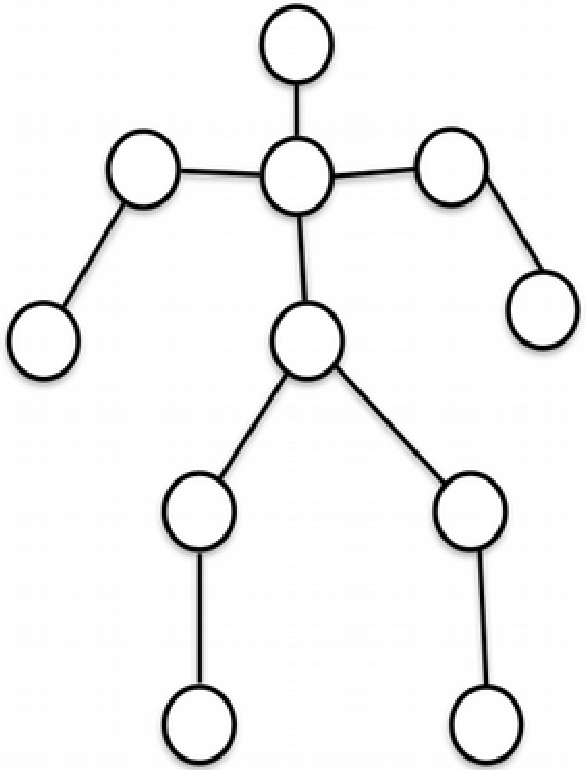
selected points

Image models - interpretation



Generalized Cylinder

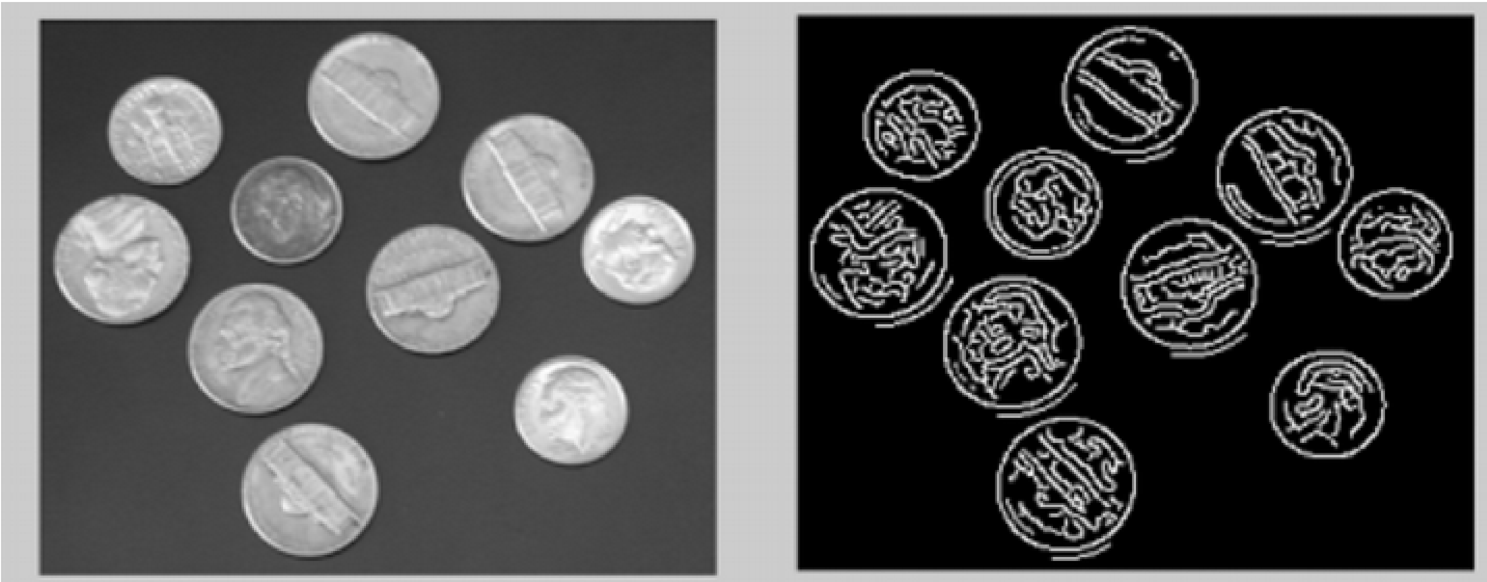
Brooks Binford, 1979



Pictorial Structure

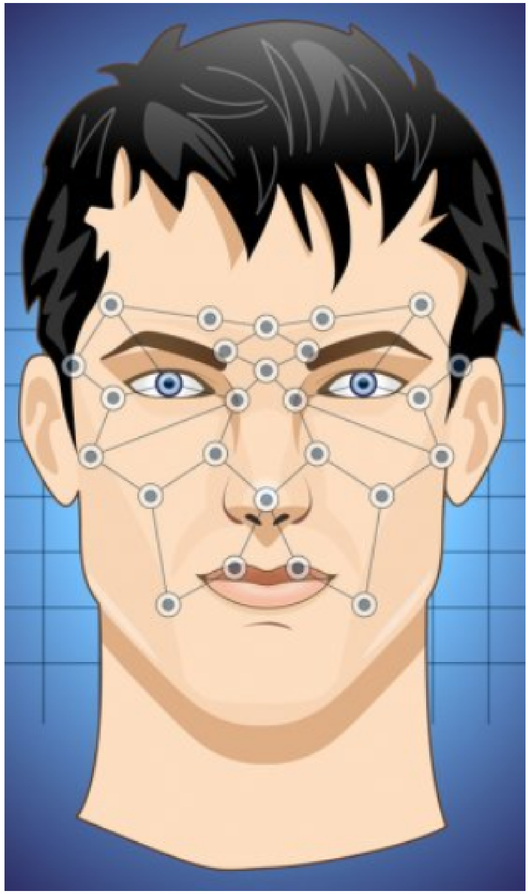
Fischler and Elschlager, 1973

David Lowe, 1987 - Filtration



original image after filtration

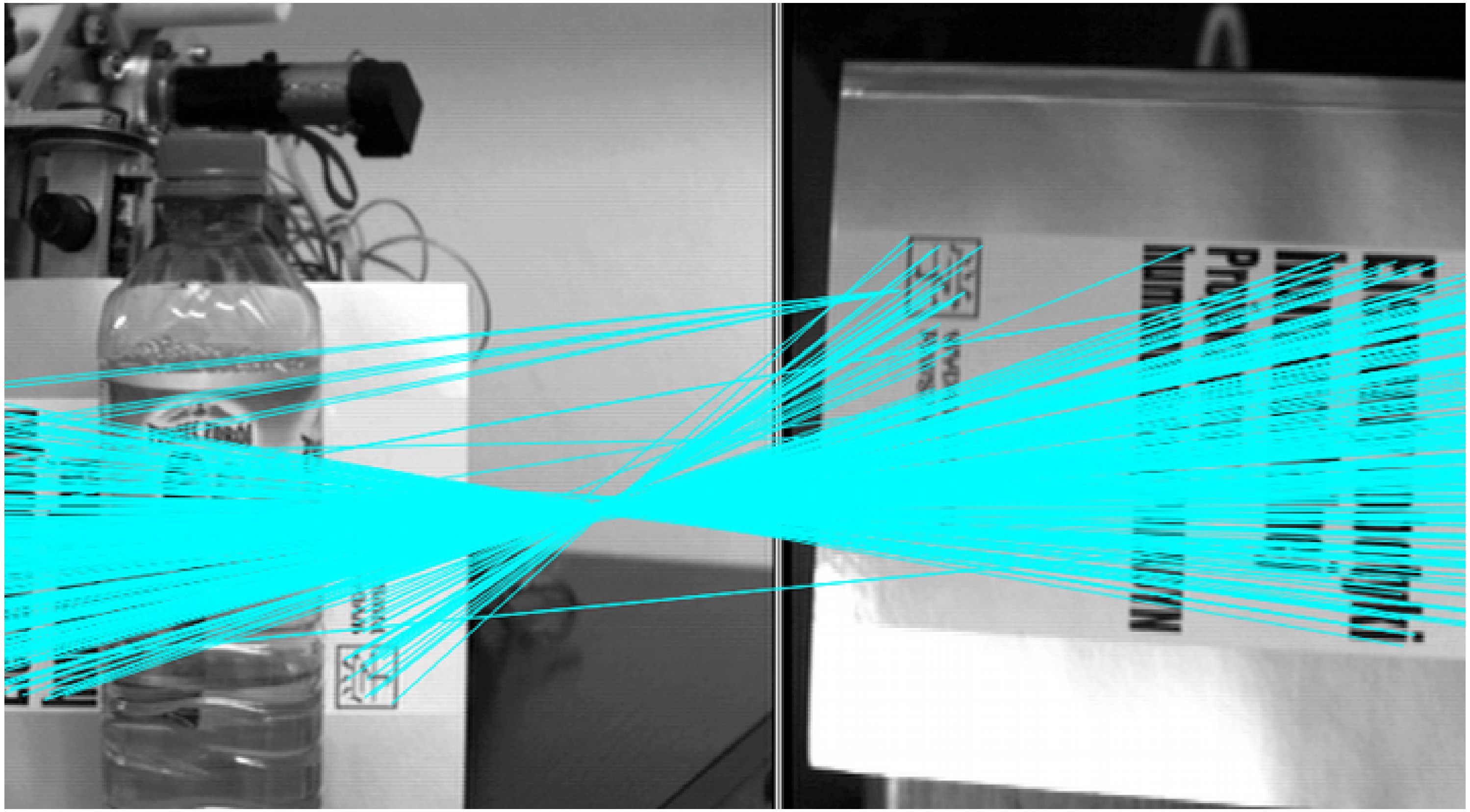
Face recognition - 90's



Decade 2000s

- Embraced data-driven and learning approachs as core components of vision,
- During this decade was the emergence of feature-based techniques (combined with learning) for object recognition,
- Most aspects of computer vision, was the application of sophisticated machine learning techniques to computer vision problems .

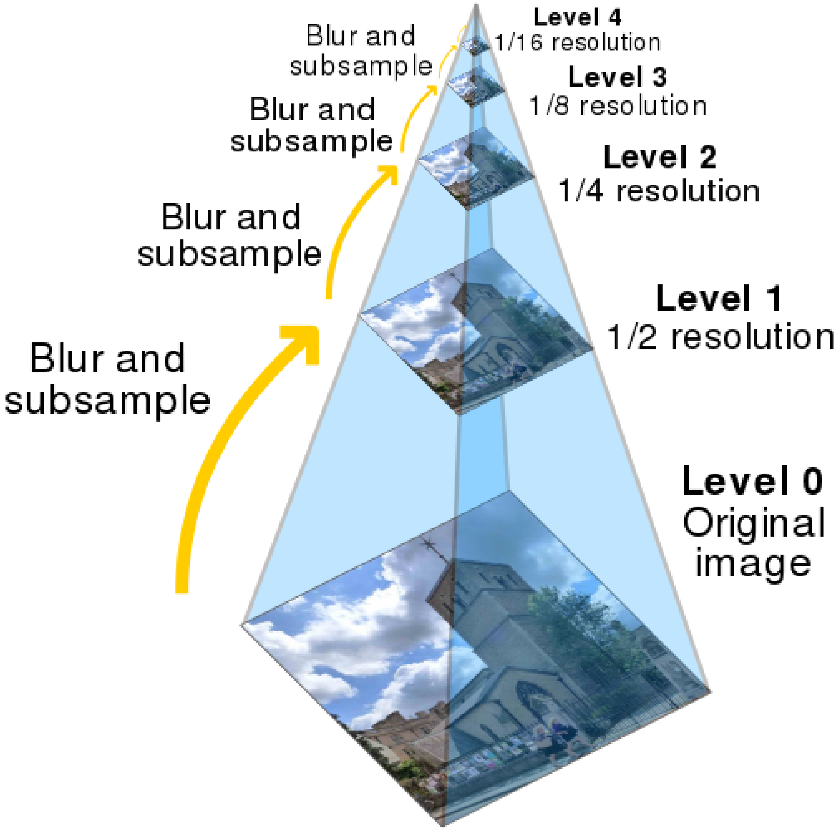
SIFT and pattern recognition, David Lowe, 1999



Decade 2010s

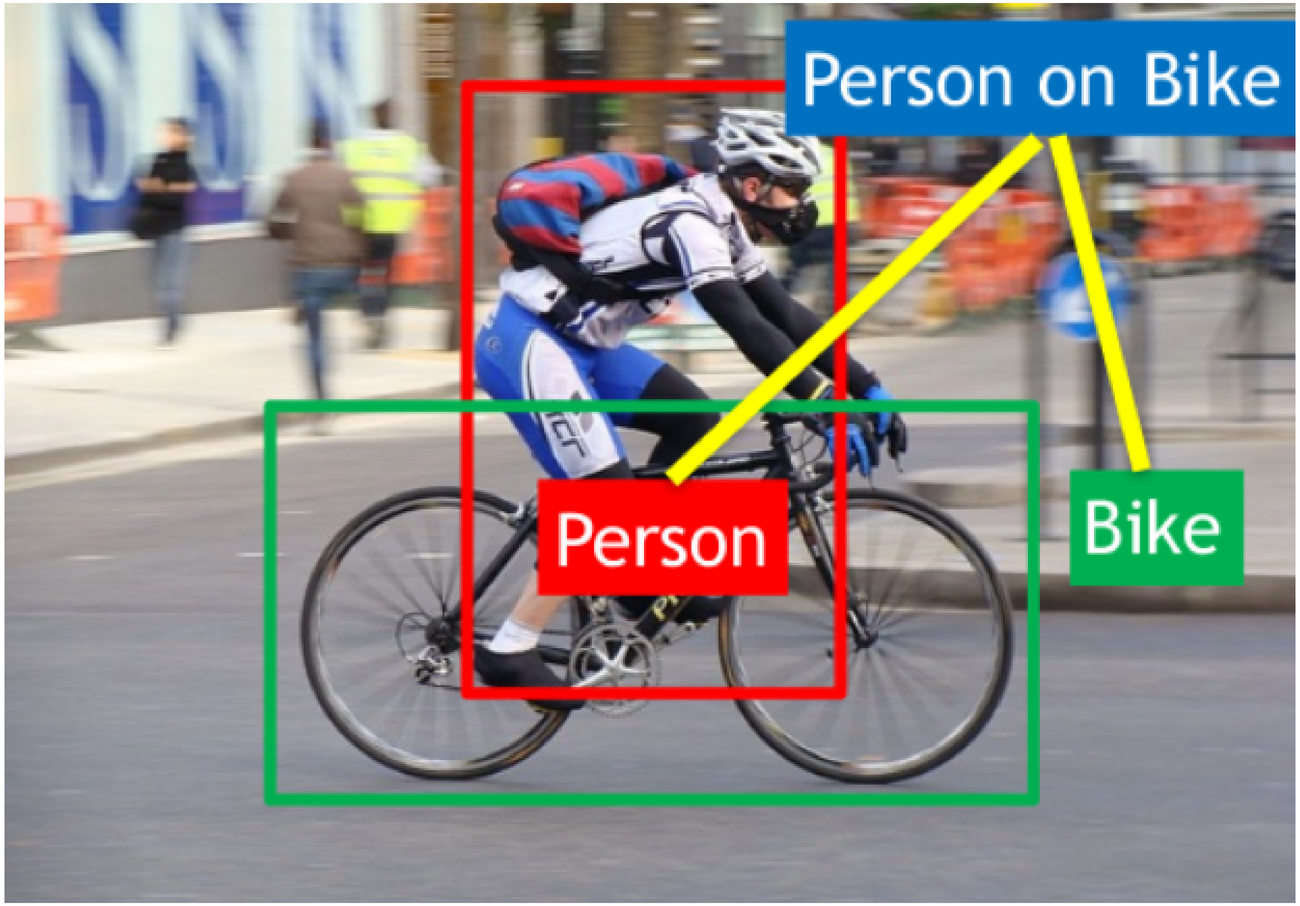
- The trend towards using large labeled datasets to develop machine learning algorithms,
- These datasets provided not only reliable metrics for tracking the progress of recognition and semantic segmentation algorithms,
- Specialized sensors and hardware for computer vision tasks also continued to advance - Kinect depth camera, released in 2010, quickly became an essential component of many 3D modeling,
- Real-time SLAM (simultaneous localization and mapping) and VIO (visual inertial odometry).

Pyramid algorithm

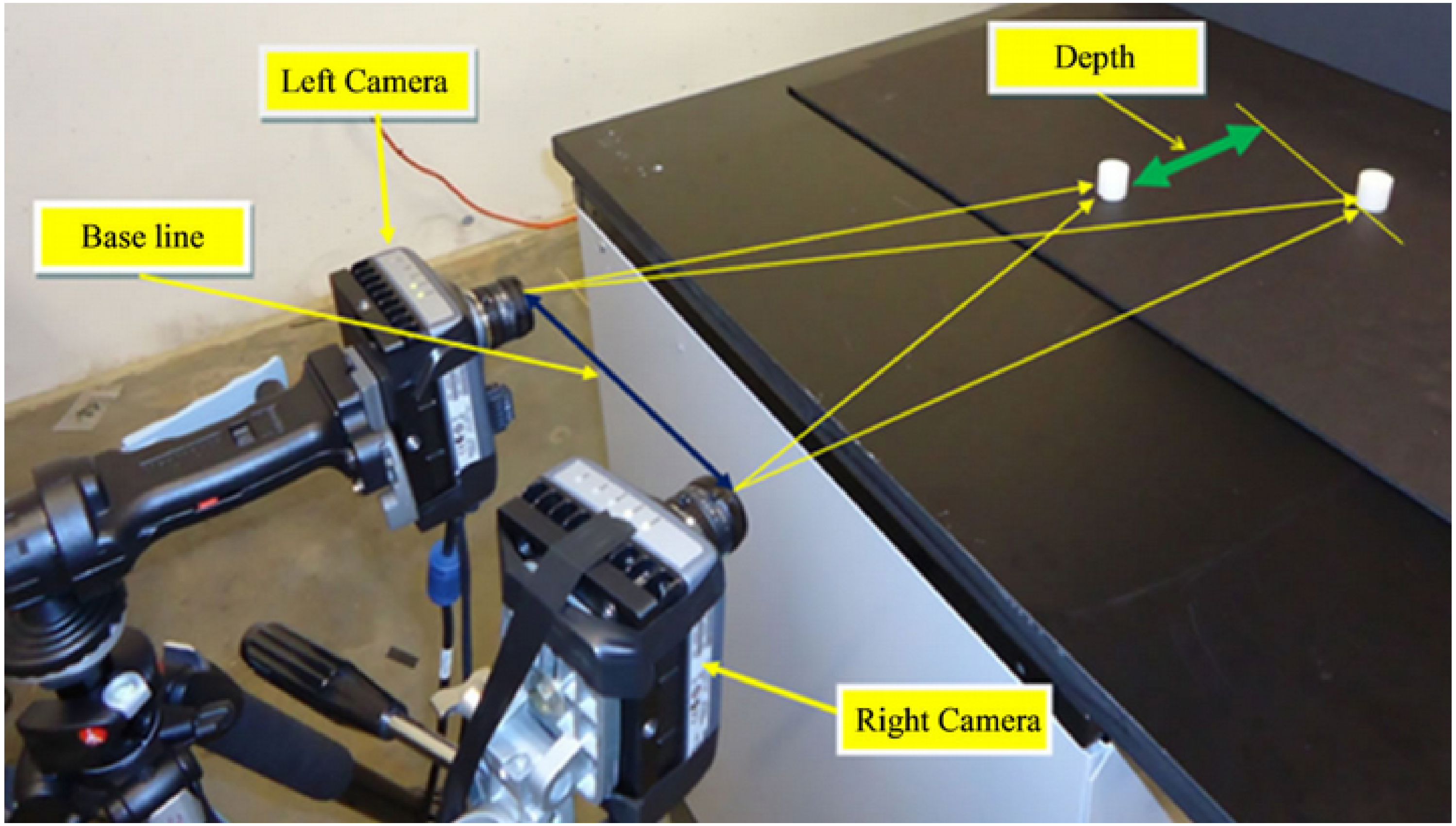


- This algorithm has the property of preserving invariants of linear transformations - translations, rotation, scaling.
- This property gives the opportunity to describe the pattern as a set of transformation invariants and is the reason for the emergence of a new type of network - CNN convolution networks

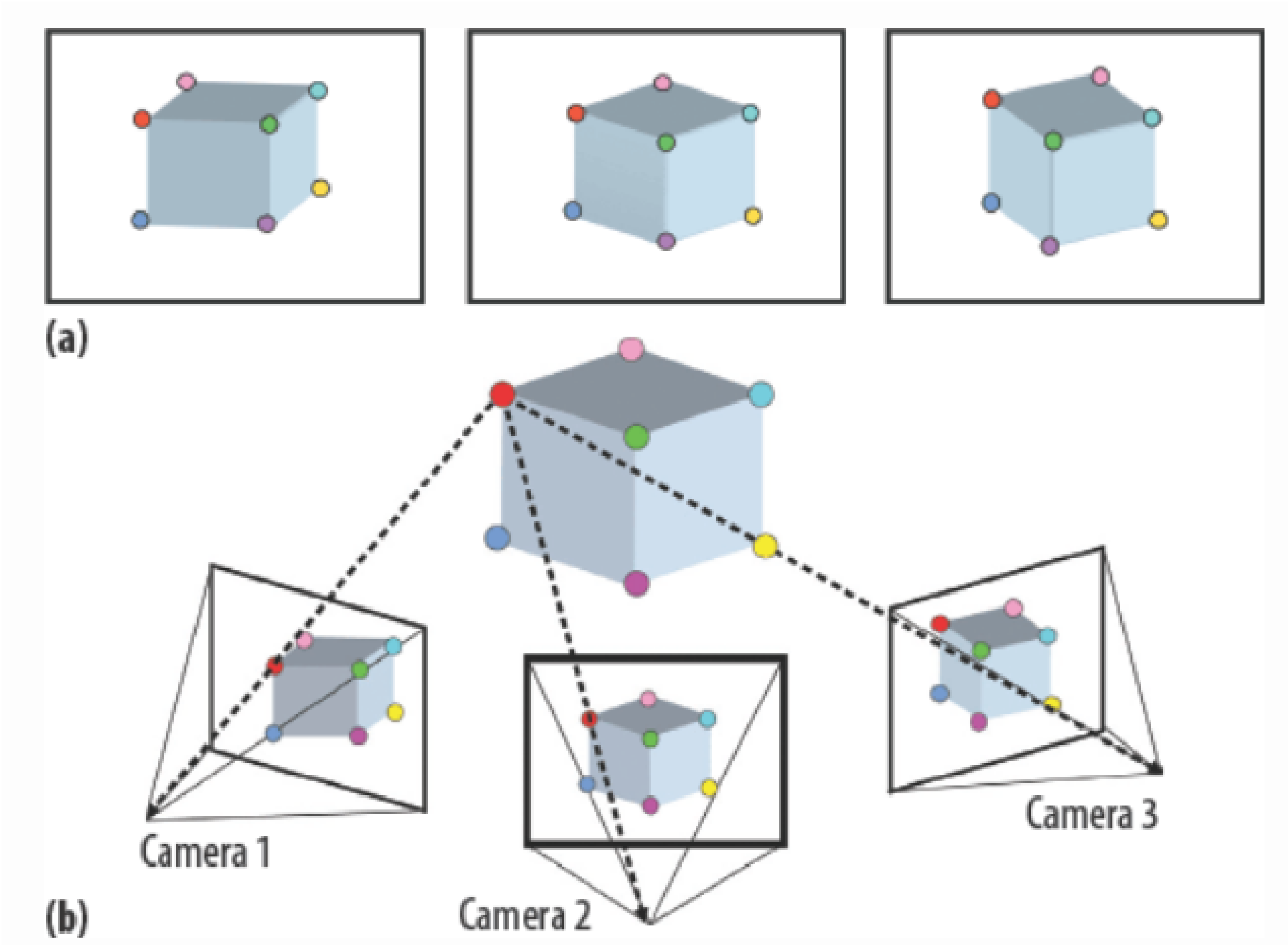
Visual Object Challenge - up to nowadays



Stereovision - determination of image depth



Structuring



Literature

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