CS-570 Computer Vision

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Concluding Remarks

Outline

1. What have we covered?
2. What were the general principles?
3. What mathematical ideas were important?
4. What have we not covered?
5. Which additional classes are offered?
6. Research opportunities
7. Acknowledgements

What have we covered?
Theory

1. **Introduction**
   - 1.1 CV is deceptively hard (Lec. 1)
2. **Background**
   - 2.1 Mathematical techniques (Lecs. 2,3)
   - 2.2 Image filtering (Lec. 4)
   - 2.3 Derivative approximations (Lec. 5)
3. **2D Computer Vision**
   - 3.1 Edge detection (Lec. 6)
   - 3.2 Structure tensor (Lec. 7)
   - 3.3 Corner detection (Lec. 8)
   - 3.4 Local image descriptors (Lecs. 9, 10)
   - 3.5 Line detection (Lec. 11)

What have we covered?
Theory

4. Deep Learning
- 4.1 Background (Lecs. 12, 13)
- 4.2 Convolutional Neural Networks (CNNs) (Lec. 14)
- 4.3 Mask R-CNN (Lecs. 15, 16)

4.1 Transformations
- 4.1.1 Homogenous coordinates and types of transformations (Lec. 17)
- 4.1.2 Estimation (Lec. 18)
- 4.1.3 Warping (Lec. 19)
- 4.1.4 RanSAC (Lec. 20)

5. 2D Computer Vision on Image Sequences
5.1 Optic flow
- 5.1.1 Background (Lec. 21)
- 5.1.2 Lucas & Kanade (Lec. 22)
- 5.1.3 Horn & Schunck (Lec. 23)

6. 3D Computer Vision

What have we covered?
Theory

6.1 Monocular

6.1.1 Camera Geometry (Lec. 24)

6.1.2 Camera Anatomy (Lec. 25)

What have we covered?
Recitations

1. Basics of Python and Numpy (Rec. 1)
2. Image handling (NumPy, PIL, OpenCV), Image Filtering, Histogram Equalization (Rec. 2)
3. Edge Detection, Video Processing, Applications (Rec. 3)
4. Corner Detection, Scale space, Gaussian Pyramid (Rec. 4)
5. Feature Extraction and Matching (SIFT, SURF, ORB), Object Matching (Rec. 5)
6. Hough Transform in OpenCV (Lines, Circles), Applications (Rec. 6)
7. Keras basics, Train/Val/Test sets, CNN Classification (Rec. 7)
8. Mask R-CNN (Training, Annotation, Custom datasets) (Rec. 8)
9. Transformations in OpenCV (Affine, Projective) (Rec. 9)
10. RanSAC, Object Tracking, Image Stitching (Rec. 10)

What have we covered?
Recitations

11. Optic Flow, Motion Estimation and Tracking (Rec. 11)
12. Camera Calibration in OpenCV (Rec. 12)

What were the general principles?

1. Always be ready for a decision.
2. But delay hard decisions as much as possible.
3. Analyse at multiple scales.
4. Filter out non-maxima to reduce computation and improve results.
5. Use geometry to simplify solutions.
6. DL is taking over.
7. Become experts of existing CV and DL frameworks.

What mathematical ideas were important?

1. Almost everything was solved in an *error minimization* framework.
   - 1.1 Corner detection via structure tensor
   - 1.2 Estimation of affine and projective transformations
   - 1.3 Estimation of both local and global optic flow
   - 1.4 Estimation of camera matrix
   - 1.5 Deep learning
2. **Calculus**: derivative operators, minimization, convolution
3. **Differential Equations**: calculus of variations, Euler-Lagrange equations
4. **Linear Algebra**: change of basis, quadratic forms, transformations, eigenvectors
5. **Geometry**: pinhole camera model, camera anatomy, infinity
6. **Numerical Methods**: finite difference approximations, Taylor series, interpolation, least squares approximation

What have we not covered?

1. Stereo Reconstruction
2. Optical Character and Handwritten Text Recognition (OCR and HTR)
3. Object Tracking
4. Traditional Object Detection
5. Traditional Segmentation

Which additional classes are offered?

- CS-568 Deep Learning
  - Comprehensive dive into the what, why and how of deep learning.
  - Applications of deep learning.
  - Sequential models for analyzing images and videos.

Research opportunities

- This course has introduced you to a variety of methods and problems in the area of CV.
- This course has *not prepared you fully* for research in CV.
  - That is a whole new ball game.
  - The course project might have nudged the earnest[1] student in the right direction.
  - To prepare yourself for research, the first step is to start devouring research papers.
- In case you are interested, contact us.

[1] showing sincere and intense conviction

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Good luck in your future endeavours.