CS-565 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. Research opportunities
6. Acknowledgements

What have we covered?
Theory

1. **Introduction**
   - 1.1 CV is deceptively hard (Lec. 1)
2. **Background**
   - 2.1 Mathematical techniques (Lec. 2)
   - 2.2 Image filtering (Lec. 3)
   - 2.3 Derivative approximations (Lec. 4)
3. **2D Computer Vision**
   - 3.1 Edge detection (Lec. 5)
   - 3.2 Structure tensor (Lec. 6)
   - 3.3 Corner detection (Lec. 7)
   - 3.4 Local image descriptors (Lec. 8)
   - 3.5 Line detection (Lec. 9)
   - 3.6 Transformations
     - 3.6.1 Homogenous coordinates and types of transformations (Lec. 10)
     - 3.6.2 Estimation and Warping (Lec. 11)

What have we covered?
Theory

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Theory

6. Deep Learning

- **6.1** Background (Lecs. 21, 22)
- **6.2** Convolutional Neural Networks (CNNs) (Lec. 23)
- **6.3** Mask R-CNN (Lec. 24)

What have we covered?
Recitations

1. Basics of Python and Numpy (Rec. 1)
2. OpenCV, Filtering, Edge Detection, Video Processing (Rec. 2)
3. Contour Detection, Corner Detection
   Histogram Equalization, Image Thresholding (Rec. 3)
4. SIFT, SURF, Hough Lines and Circles in OpenCV (Rec. 4)
5. Transformations in OpenCV
   Object tracking and Image stitching (Rec. 5)
6. Optic Flow, Motion Estimation and Tracking (Rec. 6)
7. Camera Calibration in OpenCV (Rec. 7)
8. Video object replacement
   Pose estimation and augmented reality (Rec. 8)
9. Applications of Deep Learning in Computer Vision (Rec. 9)
10. Training Mask R-CNN on custom data (Rec. 10)

What were the general principles?

1. Always be ready for a decision.
2. But delay hard decisions as much as possible.
3. Filter out non-maxima to reduce computation and improve results.
4. Use geometry to simplify solutions.
5. DL is taking over.
6. 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 and fundamental 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, epipolar geometry
6. **Numerical Methods**: finite difference approximations, Taylor series, interpolation, least squares approximation

What have we not covered?

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

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

Acknowledgements

- Thank you for your interest in this class.
- The TA: Adeela Islam. You probably learned more in the recitations.
- Members of the CVML group.
- Joachim Weickert and Sohaib Khan.

Good luck in your future endeavours.