National Tsing Hua University
Department of Electrical Engineering
EE6941 Computational Photography (計算攝影學), Spring 2017

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Prerequisites: Linear algebra, probability, digital signal processing, C/C++

Course Description

Computational photography studies problems about image capture and processing that uses digital computation. For pictures captured by traditional photography, it can alleviate some common problems, e.g. image noise in low-light condition, blurred images for long exposure time, over-exposure under sunlight. In addition to quality improvement, it can also generate novel pictures for different applications, such as panorama stitching, free-viewpoint synthesis, digital refocusing, and video frame interpolation. Moreover, many computational cameras have been invented to address different issues for traditional photography. In particular, light-field cameras have been commercialized recently, which also started imaging revolution!
This course introduces computational photography in four different aspects:

Part I - Photometric processing: High dynamic range, denoise, deblur, matting;
Part II – Geometric processing: Image stitching, stereo matching, view synthesis, refocusing;
Part III – Temporal processing: Optical flow, frame interpolation, video magnification;
Part IV – Selected topics: Computational camera and display.

We will focus on how to model each real-world problem in mathematics (mostly linear algebra and probability) and then introduce classical and/or state-of-the-art solutions accordingly.

Teaching Method

Lectures are given every week at DELTA 210R. There will be **three** programming homework assignments and **one** term project for exercising how to convert interesting ideas to practical implementations.

Evaluation

Homework (60%) – each assignment 20% [local tone mapping, deblurring, matting]
Term Project (40%) – details will be declared later (will include a survey report)

Grading Rules:

1. One original work deserves only one credit. For example, if five students deliver the same (or very similar) programs for homework, the grades will be averaged by five. If the original work deserves 100 points, each one will get only 20 points. Rebuttal is allowed.
2. For homework, C/C++ is recommended. Otherwise, your grade will be multiplied by 85%.
3. For homework, the grading equation for late delivery is
   $$\text{New grade} = (\text{original grade}) \times 0.9^{(\text{delievery date} - \text{due date})}$$
4. For term project, no late delivery is allowed.

Syllabus

Item	Topic	Hour	Ref Chapter
	Introduction and course overview		1
Part I-1	Photometric image formation	3	2.2-3
Part I-2	High dynamic range	2	10.2.1
Part I-3	Denoise	7	
Part I-4	Deblur	4	
Part I-5	Matting	3	10.4
Part II-1	Geometric primitives and transformations	3	
Part II-2	Image stitching	2	9
Part II-3	Depth-based view synthesis and refocus	3	10, 13
Part II-4	Stereo matching	7	11
Part III-1	Dense motion estimation and optical flow	1	8
Part III-2	Video magnifcation	3	
Part IV-1	Computational camera and display	3	
Part IV-2	Selected topics	2	

Textbook

Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer 2010.

References

Selected papers [references will be given in lecture notes].

Course Link

(TBD)

Teaching Assistant

(TBD)