CENG 587 COMPUTER GRAPHICS
METU, Department of Computer Engineering
Fall 2021 Syllabus

Instructor: Prof. Dr. Ahmet Oğuz Akyüz - akyuz@ceng.metu.edu.tr - Office: B210

Lecture Hours: Thursdays, 12:40 - 15:30 at G-102 and online (times subject to change)

Course Objectives: This course aims to familiarize graduate level students with the emergent and exciting field of high dynamic range (HDR) imaging. Students will learn about what is dynamic range and why it is important, what are the differences between low and high-dynamic range images, how to create, tone map, and display HDR images and video, and how to use HDR data in various applications in computer graphics.

Prerequisite: Some knowledge of image processing and computer graphics is expected. Ask for instructor approval.

Course Outline:

Week	Topic	Notes
1	Introduction a) What is HDR imaging? b) HDR vs LDR c) A walk through the HDR imaging pipeline d) Syllabus and course conduct	
2	Fundamentals a) Radiometry, photometry, colorimetry b) Capture/display devices and gamma c) Human visual system d) Basics of color spaces e) A hands-on measurement experiment	
3	Camera response recovery a) Research papers [1, 2, 30]	**PA1 assigned**
4	HDR image reconstruction a) Research papers [3, 4]	
5	Introduction to deghosting a) Presentation of [5, 6] **b) Student presentation 1**	
6	Advanced deghosting algorithms a) Presentation of [7, 8, 9, 10] **b) Student presentation 2**	**PA2 assigned**

7	HDR formats and encodings a) Presentation of [11, 12] **b) Student presentation 3**	
8	Introduction to tone mapping a) Presentation of [13, 14] **b) Student presentation 4**	
9	Advanced tone mapping algorithms a) Presentation of [15, 16, 17, 18] **b) Student presentation 5**	**PA3 assigned**
10	Color issues and exposure fusion a) Presentation of [19, 20, 21] **b) Student presentation 6**	
11	HDR display devices a) Presentation of [22, 23, 31]	
12	Inverse tone mapping a) Presentation of [24, 25] **b) Student presentation 7**	
13	HDR metrics and applications a) Presentation of [26, 27, 28, 29]	
14	**Project presentations**	**Projects due in 3 weeks**

Grading:

Paper reflections:	36% (divided evenly across reflections)
Programming assignments:	30% (10% each)
Student presentations:	14% (7% each)
Project:	20% (10% initial presentation + 10% final presentation)

- **Reflections** are 1.5-2 page analysis of selected research papers from the literature. Using latex is strongly recommended.
- **Student presentations** involve presenting a selected (and instructor approved) paper in the class. The presentations should target about 30 minutes including Q&A.
- **Implementation assignments** require implementing a selected (and instructor approved) research paper. You can use any programming language (no reuse of code from the Internet).
- **Project** involves proposing and implementing a simple extension to an existing paper or presenting and implementing a recent method in the literature. The topic must be approved by the instructor.
- **Attendance** is required. Missing more than 3 classes without approval from the instructor may lead to an NA grade.
- **Late submission** of reflections and the project is not allowed. For programming assignments late submission up to three days is possible with 10% penalty for each late day.

Reference Books:

- Reinhard, E., Ward, G., Pattanaik, S., & Debevec, P. ***High Dynamic Range Imaging: Acquisition, Display and Image-based Lighting***, Morgan Kaufmann, 2005 (the second edition published in 2010 is even better).
- Banterle, F., Artusi, A., Debattista, K., & Chalmers A. ***Advanced High Dynamic Range Imaging: Theory and Practice***, AK Peters/CRC Press, 2011.
- Reinhard, E., Khan, E. A., Akyüz, A. O., & Johnson, G. M. ***Color Imaging: Fundamentals and Applications***, AK Peters, 2008.
- Myszkowski, K., Mantiuk, R., & Krawczyk, G. ***High Dynamic Range Video,*** Morgan & Claypool Publishers, 2008.
- Hoefflinger, B. ***High-Dynamic-Range (HDR) Vision: Microelectronics, Image Processing, Computer Graphics,*** Springer, 2007.

References:

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[2] Mitsunaga, T., & Nayar, S. K. (1999). Radiometric self-calibration. In IEEE Computer Vision and Pattern Recognition, 1999.

[3] Akyüz, A. O., & Reinhard, E. (2007). Noise reduction in high dynamic range imaging. *Journal of Visual Communication and Image Representation*, *18*(5), 366-376.

[4] Granados, M., Ajdin, B., Wand, M., Theobalt, C., Seidel, H. P., & Lensch, H. P. (2010, June). Optimal HDR reconstruction with linear digital cameras. In *Computer Vision and Pattern Recognition (CVPR), 2010 IEEE Conference on* (pp. 215-222). IEEE.

[5] Ward, G. (2003). Fast, robust image registration for compositing high dynamic range photographs from hand-held exposures. Journal of graph. tools, 8(2), 17-30.

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[7] Hu, J., Gallo, O., & Pulli, K. (2012). Exposure stacks of live scenes with hand-held cameras. *Computer Vision–ECCV 2012*, 499-512.

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[9] Kang, S. B., Uyttendaele, M., Winder, S., & Szeliski, R. (2003, July). High dynamic range video. In *ACM Transactions on Graphics (TOG)* (Vol. 22, No. 3, pp. 319-325). ACM.

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[11] Ward, G., Simmons, M. 2005. JPEG-HDR: A Backwards-Compatible, High Dynamic Range Extension to JPEG. *Proceedings of 13th Color Imaging Conference.* (JPEG-HDR)

[12] Mantiuk, R., Efremov, A., Myszkowski, K., & Seidel, H. P. (2006, July). Backward compatible high dynamic range MPEG video compression. *In ACM Transactions on Graphics (TOG)* (Vol. 25, No. 3, pp. 713-723).

[13] Reinhard, E., Stark, M., Shirley, P., & Ferwerda, J. (2002). Photographic tone reproduction for digital images. In *ACM Transactions on Graphics (TOG)* (Vol. 21, No. 3, pp. 267-276).

[14] Drago, F., Myszkowski, K., Annen, T., & Chiba, N. (2003, September). Adaptive logarithmic mapping for displaying high contrast scenes. In Computer Graphics Forum (Vol. 22, No. 3, pp. 419-426). Blackwell Publishing, Inc.

[15] Durand, F., & Dorsey, J. (2002). Fast bilateral filtering for the display of high-dynamic-range images. In *ACM Transactions on Graphics (TOG)* (Vol. 21, No. 3, pp. 257-266).

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[17] G. Eilertsen, R. K. Mantiuk, and J. Unger. 2015. Real-time noise-aware tone mapping. *ACM Trans. Graph*. 34, 6, Article 198*.*

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