
CS482:
Interactive Computer Graphics

Sung-Eui Yoon
(윤성의)

Course URL:
<http://sglab.kaist.ac.kr/~sungeui/ICG>

KAIST

The KAIST logo consists of the letters "KAIST" in a bold, blue, sans-serif font. Below the text is a light blue, horizontal oval shape that tapers at both ends, serving as a shadow or base for the text.

About the Instructor

- **2019: 차세대 과학자상 수상 (IT 부문)**
- **2018~: ACM Senior member**
- **2012~: IEEE Senior member**
- **2011~2012: conf. and program co-chairs of ACM symp. on Interactive 3D Graphics and Games (I3D)**
- **Joined KAIST at 2007**

- **Main research focus**
 - **Rendering, robotics, and vision**

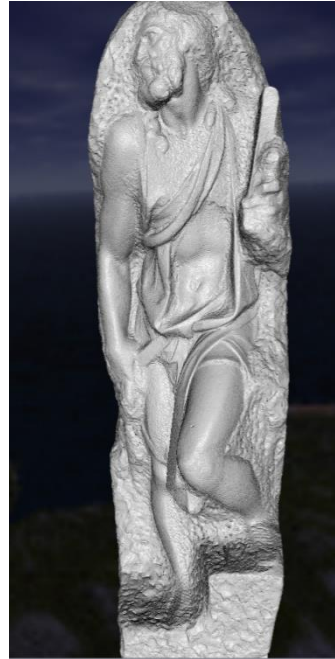
Past: Rendering Massive Geometric Data



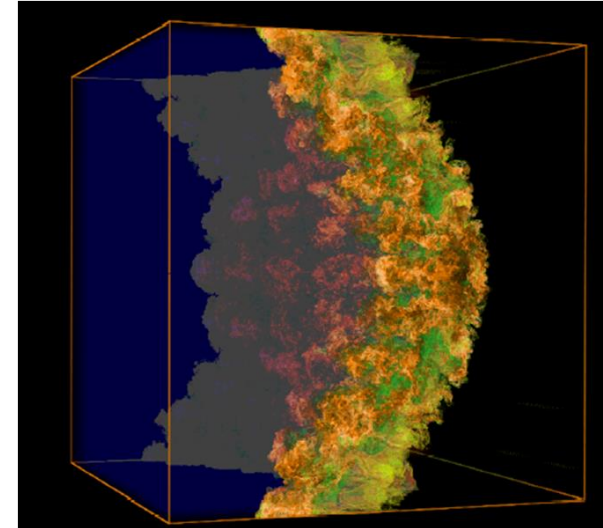
Boeing 777, 470 M tri.



Large-scale virtual world, 83 M tri.



**Scanned
model, 372 M
tri. (10 GB)**



**Over 3 Terabytes of
geometric data**

Present: Scalable Ray Tracing, Image Search, Motion Planning

- Designing *scalable graphics and geometric algorithms* to efficiently handle massive models on commodity hardware



Photo-realistic rendering

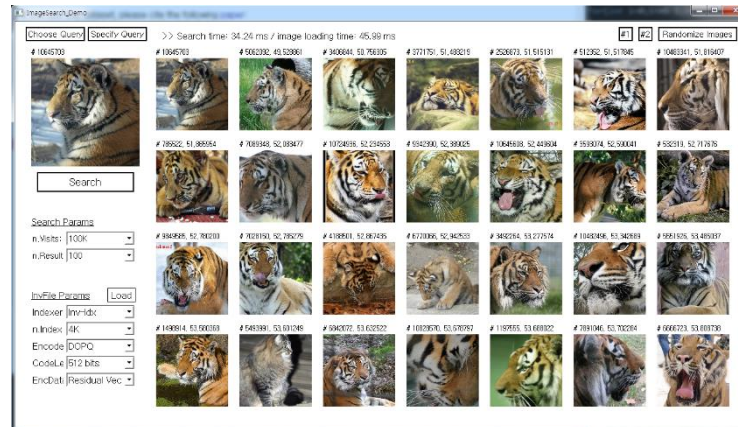


Image search



Motion planning

About the Instructor

- **Contact info**

- **Email: sungeui@kaist.edu**
- **Office: 3432 at CS building (E3-1)**
- **Homepage: <http://sglab.kaist.ac.kr/~sungeui>**

Class Information

- **Class time**
 - **1:00pm ~ 2:15pm on MW**
 - **Online class in this semester**
- **Office hours**
 - ~~Right after class~~ **KLMS board**

TA Information

- **Jaeyoon Kim (김재윤)**
 - kimjy2630@gmail.com
 - **Office: 3443 at CS building (E3-1)**

- **Kyubeom Han (한규범)**
 - qbhan@kaist.ac.kr
 - **Office: 3432 at CS building (E3-1)**

- **Share questions on KLMS first, before sending emails to TAs**

Overview

- We will discuss various parts of computer graphics, especially on interactive rendering



Modelling

Simulation & Rendering

Image

Computer vision inverts the process

Image processing deals with images

Robotics/AR combine real and virtual worlds

Applications of Computer Graphics

- **Games**
- **Augmented or virtual reality (AR/VR)**
- **Movies and film special effects**
- **Product design and analysis**
- **Medical applications**
- **Scientific visualization**

Games



2D game



3D shooting game

Game Industry at Korea

- One of biggest IT sectors in Korea

창원에 엔씨소프트 프로야구단 생긴다(종합)



새롭게 창단하는 구단은 모기업의 당기 순이익이 1천억원 이상이거나, ...

KBO 이사회 개최

(서울=연합뉴스) 이상학 기자 =11일 오전 서울 강남구 도곡동 야구회관에서 열린 KBO 이사회에서 유영구 총재가 회의를 주재하고 있다. 8개 구단 사장단이 참석한 가운데 열린 이날 이사회에서는 9구단 승인 여부 등을 논의한다. 2011.1.11 leesh@yna.co.kr

Movies and Film Special Effects



Toy story



Matrix

3D Movies



Avatar

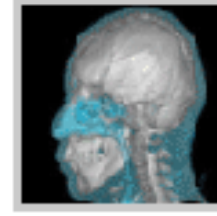
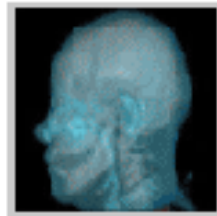
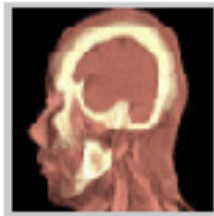
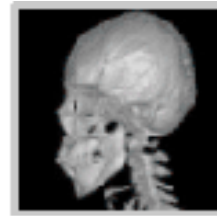
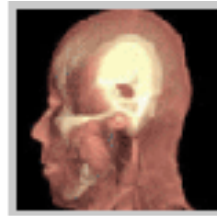
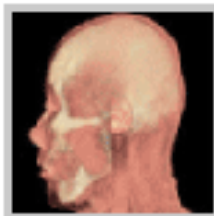
Product Design and Analysis

- **Computer-aided design (CAD)**



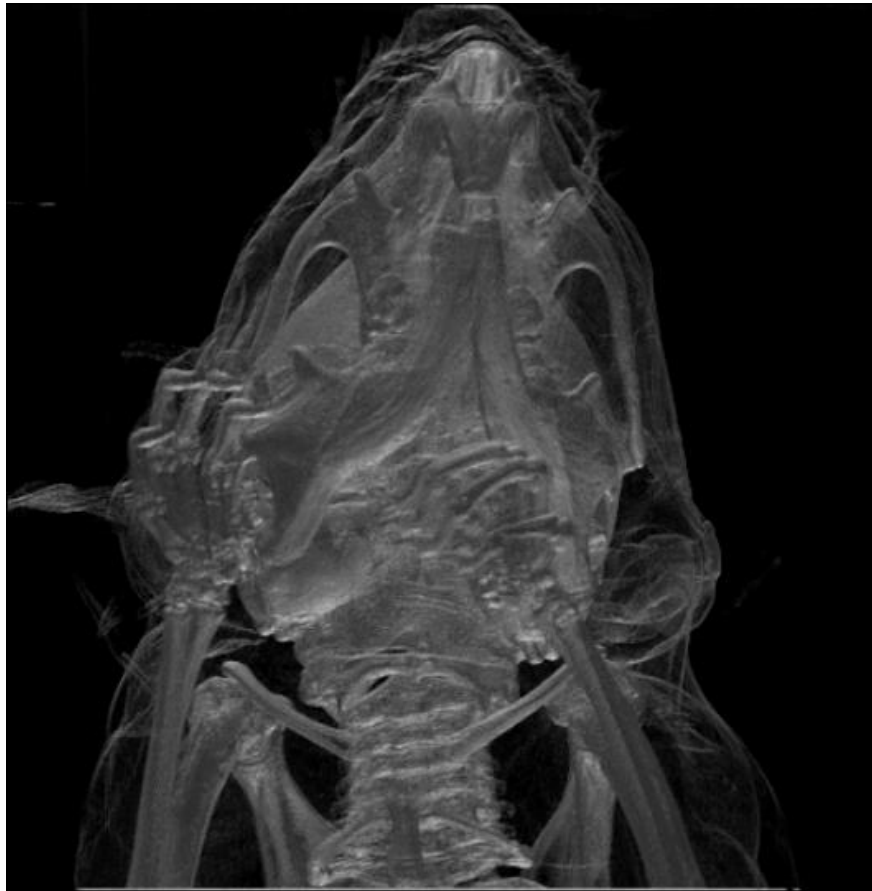
Medical Applications

- Visualizing data of CT, MRI, etc



Medical Applications

- Visualizing data of CT, MRI, etc



Wikipedia

Mouse skull (CT)

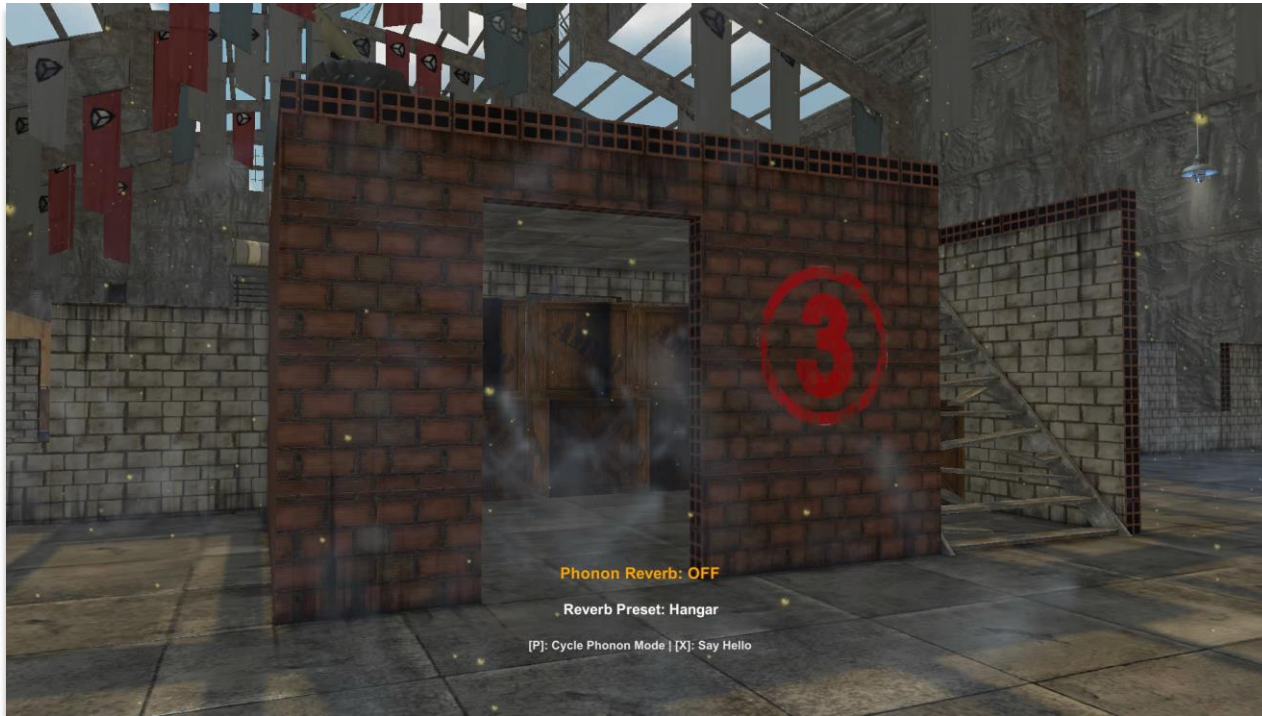
Head-Mounted Display (HMD) for VR



HoloLens for Augmented Reality (AR)

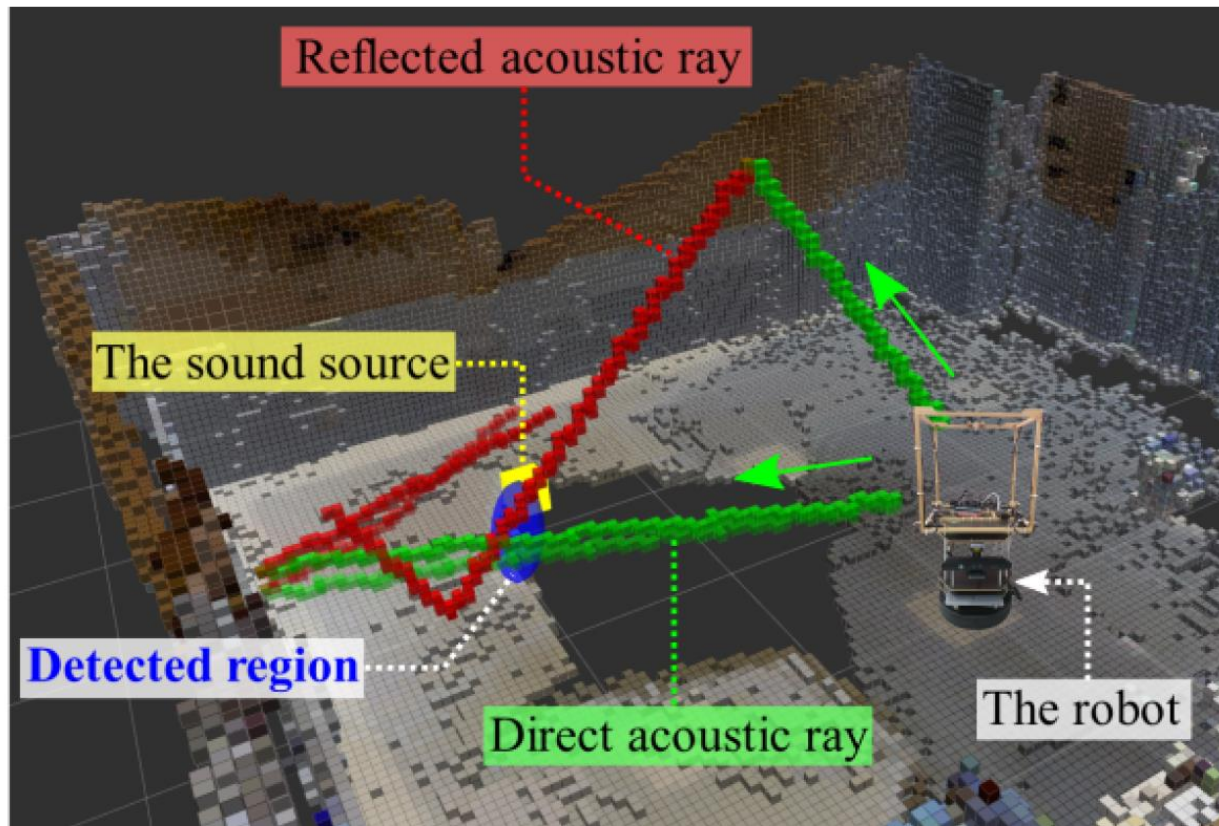


Sound Rendering



Sound Localization

- React to sound in AR applications
 - Tightly couple real and simulated environments



About the Course

- **We will focus on the following things:**
 - **Study basic concepts of physically-based rendering**
 - **Study recent techniques, and discuss their pros and cons**



Photo-Realistic Rendering

- **Achieved by simulating light and material interactions**

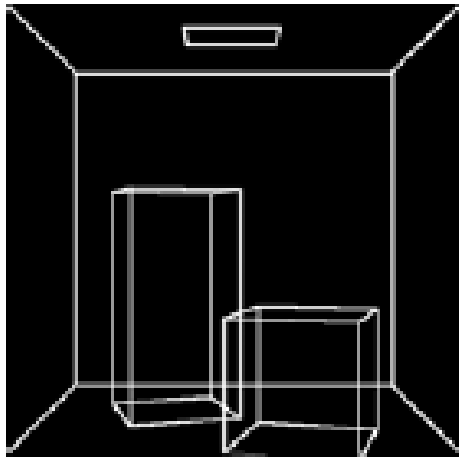


from Prof. Bala's slide

- **Rendering equation**
 - **Mathematical formulation of light and material interactions**

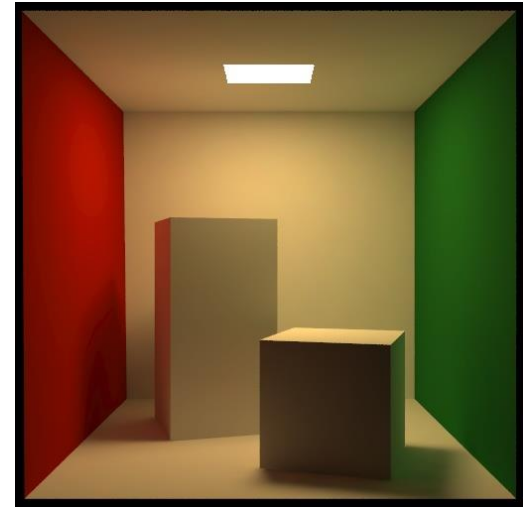
Global Illumination (GI)

- **GI algorithms solve the rendering equation**
 - **Generate 2D image from 3D scene**



from Prof. Bala's slide

⇒ **GI
Algorithm** ⇒



+

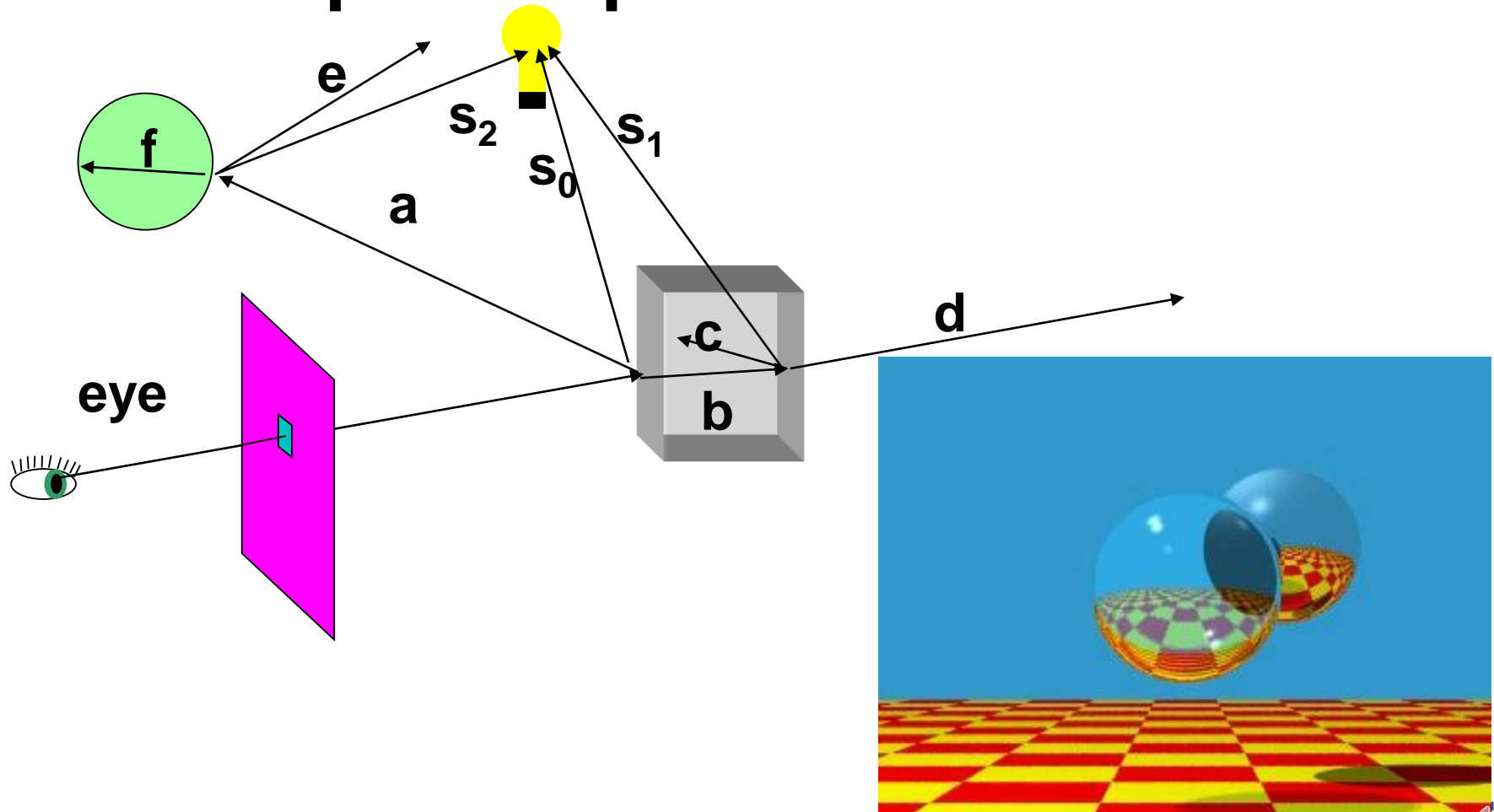
Emission (light sources)
Geometry (objects)
BRDF (materials)

Classic Methods of GI

- **Ray tracing**
 - **Introduced by Whitted in 1980**
- **Radiosity**
 - **Introduced in 1984**
- **Monte Carlo rendering**

Classic Ray Tracing

- Assume perfect specular or diffuse material



Classic Radiosity

- **Assume diffuse inter-reflections**



Advanced Global Illumination

- **Extend to handle more realistic materials than just perfect specular/diffuse**
 - **Classic ray tracing and classic radiosity are basic building blocks**



from photon map paper



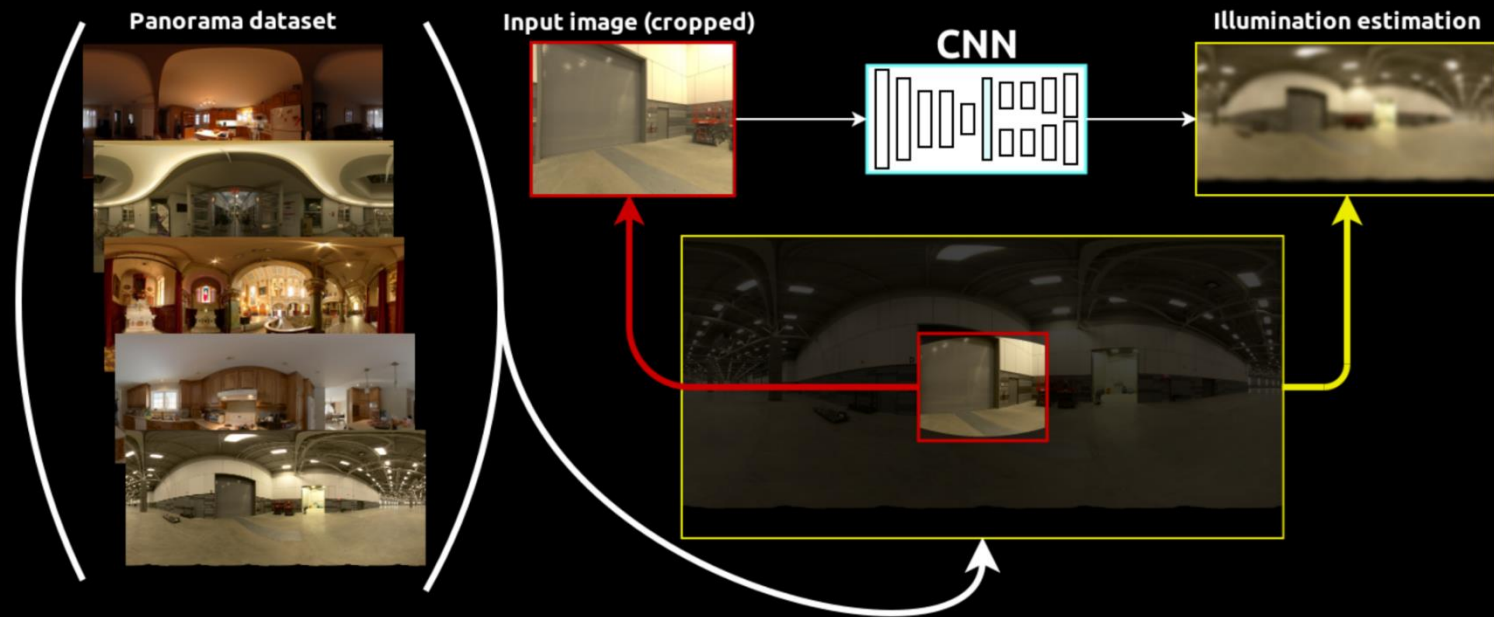
from Pixar movie

Sound and AR/VR Applications

- **How can we interactively generate sounds?**
- **How can we effectively locate sound sources?**
- **How can we integrate them with AR/VR applications?**

Indoor Light Estimation

End-to-end learning approach



Gardner et al.

Some of Topic Lists

- Ray tracing
- **Path tracing**
- BRDF
- **Rendering equations**
- **Monte Carlo method**
- Textures
- Lighting and shading
- Radiosity
- Instant radiosity
- GPU acceleration
- Sampling and reconstruction
- Sound rendering and localization
- **Rendering for AR/VR**
- **Deep learning for light/material estimation**

Prerequisites

- **More or less CS380**
- **Basic programming skill**
- **Basic understanding on data structures (e.g., stack) and linear algebra (e.g., matrix multiplication)**
- **Basic deep learning knowledge & programming**
- **If you are not sure, ~~please consult the instructor at the end of the course~~ discuss it at KLMS w/ TAs**

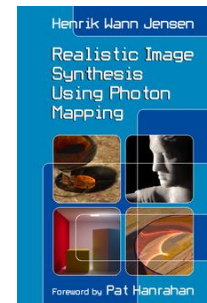
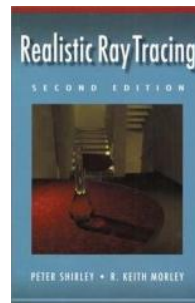
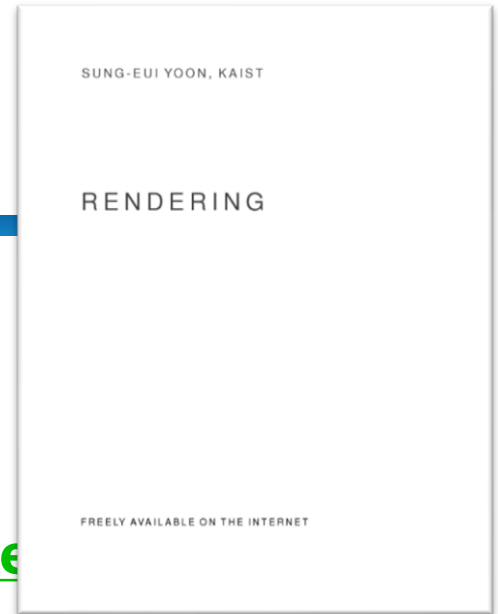
Resource

- **Rendering**

- **1st edition, July 2018, 148 pages**
- **Sung-eui Yoon, Copyright 2018**
- <https://sgvr.kaist.ac.kr/~sungeui/rendering>

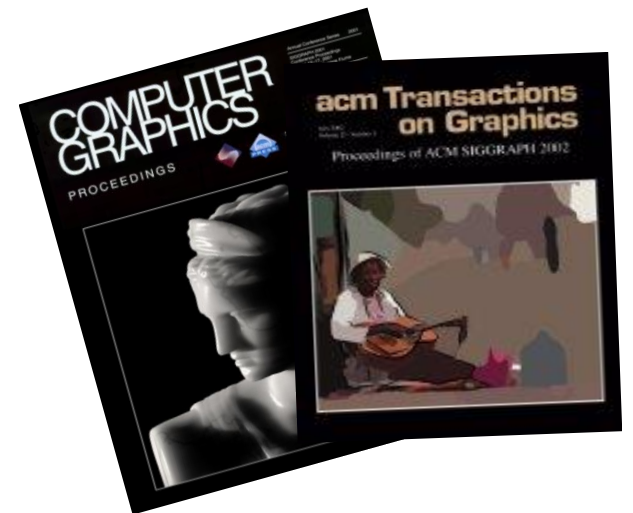
- **Reference**

- **Physically based rendering, Matt Pharr et al.**
- **Advanced Global Illumination, Philip Dutre et al. 2nd edition**
- **Realistic Ray Tracing, 2nd edition, Peter Shirley et al.**



Other Reference

- **Technical papers**
 - Graphics-related conference (SIGGRAPH, etc)
 - <http://kesen.huang.googlepages.com/>
- **SIGGRAPH (Asia), ISMAR, CVPR/ICCV, ICRA/IROS papers and tutorials**
- **Course homepages**
- **Google or Google scholar**



Course Overview

- **1/2 of lectures and 1/2 of student presentations**
 - **Mid-term & final-term exams with a few quiz**
 - **A few programming assignments**
 - **A few paper presentations**
 - **Team project**

What you will do

- **Paper presentation and final team project**
 - **Make a team of two or three members**
 - **Choose a topic for the team, and each team member presents a paper related to it**
 - **All the team members implement techniques of a paper and improve them**
 - **Role of each team member should be clear**
 - **Present what the team did for the team project**

Course Awards

- **Best speaker and best project**
 - **Lunch or dinner for awardees with me and TAs**
- **A high grade will be given to members of the best project**

Grading

- **Quiz, assignments, and exams: 40%**
- **Class presentations: 30%**
- **Final project: 30%**

- **Late policy**
 - **No score for late submissions**
 - **Submit your work before the deadline!**
- **Instructor/TA and students will evaluate presentations and projects**
 - **Instructor/TA: 50% weights**
 - **Students: 50% weights**

Class Attendance Rule

- **Most class will be online, while there are some Zoom meetings**
- **Late two times → count as one absence**
- **Every two absences → lower your grade (e.g., A- → B+)**
- **To check attendance, I'll call your names or take pictures**
- **If you are in situations where you should be late, notify earlier**

Honor Code

- **Collaboration encouraged, but *assignments must be your own work***
- **Cite any other's work if you use their code**
- **Classroom etiquette: help you and your peer to focus on the class**
 - Turn off cell phones
 - Arrive to the class on time
 - Avoid private conversations
 - Be attentive in class

Official Language in Class

- **English**
 - **I'll give lectures in English**
 - **I may explain again in Korean if materials are unclear to you**
 - **You are also recommended to use English, but not required**

Schedule

- Please refer the course homepage:
 - <http://sglab.kaist.ac.kr/~sungeui/ICG/>

Homework

- **Watch 2 SIGGRAPH or CVPR Videos**
 - **EGSR, HPG and I3D are also possible**
 - **ISMAR, ICRA, ECCV/ICCV are also possible**
 - **Write their summary and submit it online before Mon. class**

- **Example of summary**

- **Just one paragraph for each summary**

Title: XXX XXXX XXXX, Year: 2017

Abstract: this video is about accelerating the performance of ray tracing. To achieve its goal, they design a new technique for reordering rays, since by doing so, they can improve the ray coherence and thus improve the overall performance.

Next Time

- **Ray tracing and radiosity**