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**CS580:**  
**Graduate-Level Computer Graphics**  
**- Focus on rendering**

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**Sung-Eui Yoon**  
(윤성의)

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

**KAIST**



# About the Instructor

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- 2012 ~ : IEEE Senior member
- 2011 ~ 2013: 이원부교수
- Joined KAIST at 2007
  
- B.S., M.S. at Seoul National Univ.
- Ph.D. at Univ. of North Carolina-Chapel Hill
- Post. doc at Lawrence Livermore Nat'l Lab
  
- Main research focus
  - Handling of massive geometric data for various computer graphics and geometric problems

# About the Instructor

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- Contact info
  - Email: [sungeui@gmail.com](mailto:sungeui@gmail.com)
  - Office: 3432 at CS building
  - Homepage: <http://sglab.kaist.ac.kr/~sungeui>

# Class Information

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- **Class time**
  - 4:00pm ~ 5:15pm on TTh
- **Office hours**
  - 2:30pm ~ 3:30pm on TTh
  - Or right after class
- **TA**
  - 김의태 <mutal09@kaist.ac.kr>
  - **Office hour: right after the class on TTh**
  - **Room: 2413**

# Overview

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- We will discuss various parts of computer graphics



**Computer vision** inverts the process  
**Image processing** deals with images

# Application of Computer Graphics

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- Games
- Movies and film special effects
- Product design and analysis
- Medical applications
- Scientific visualization

# Games

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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

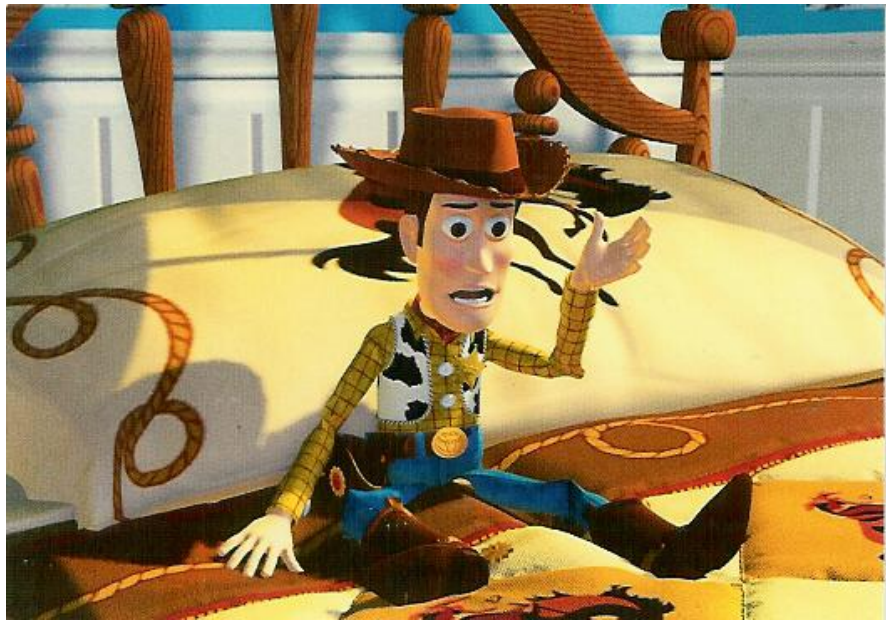
(서울=연합뉴스) 이상학 기자 =11일 오전 서울 강남구 도곡동 야구회관에서 열린 KBO 이사회에서 유영구 총재가 회의를 주재하고 있다. 8개 구단 사장단이 참석한 가운데 열린 이날 이사회에서는 9구단 승인 여부 등을 논의한다.2011.1.11 leesh@yna.co.kr



# Movies and Film Special Effects

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**Toy story**



**Matrix**

# 3D Movies

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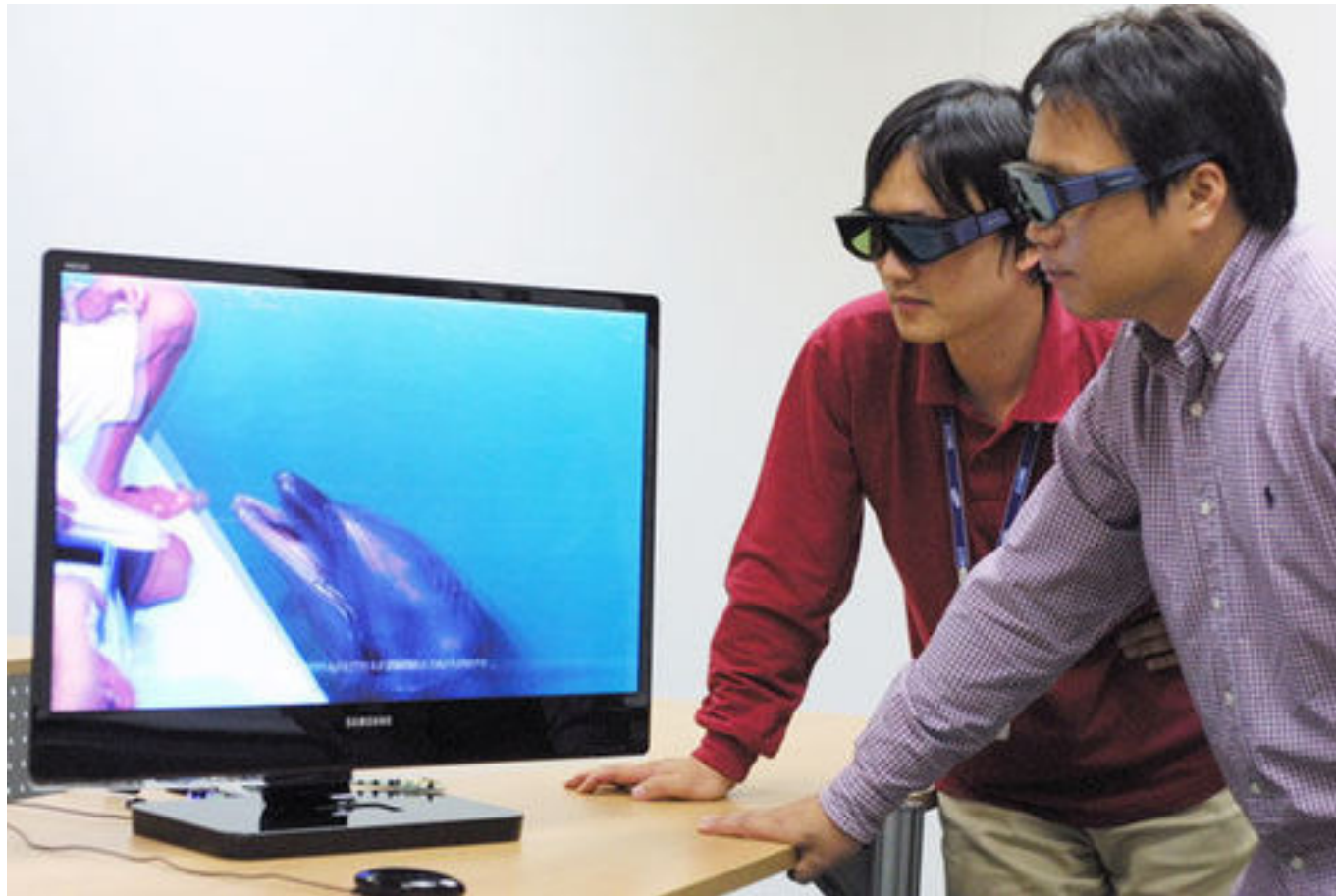


**Avatar**

# 3D TV

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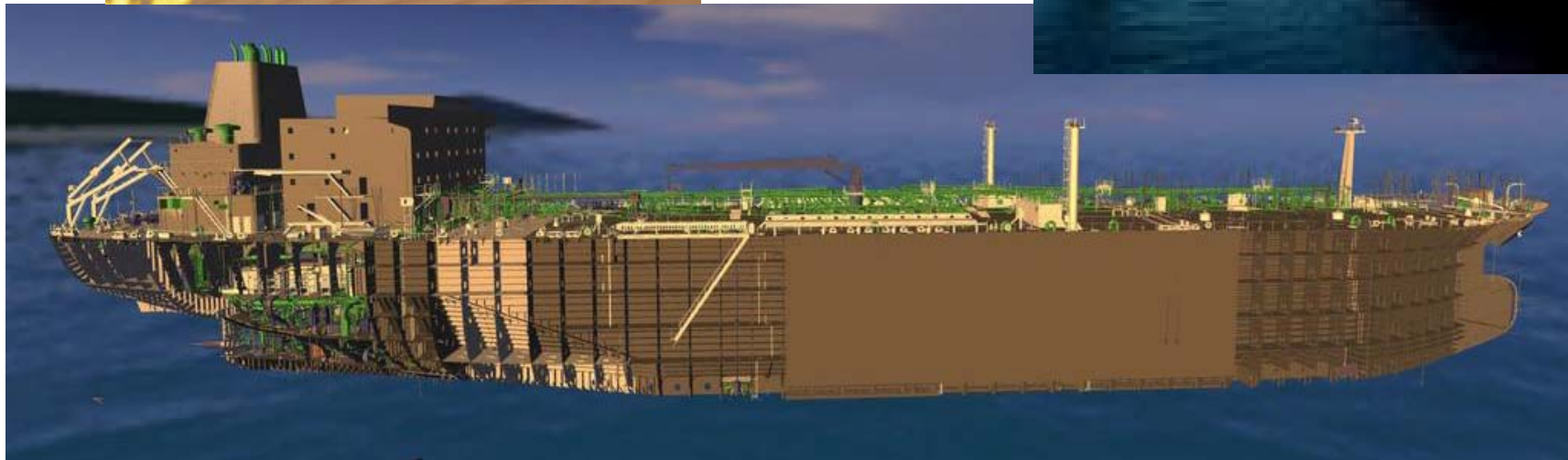
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**Samsung 3D TV**

# Product Design and Analysis

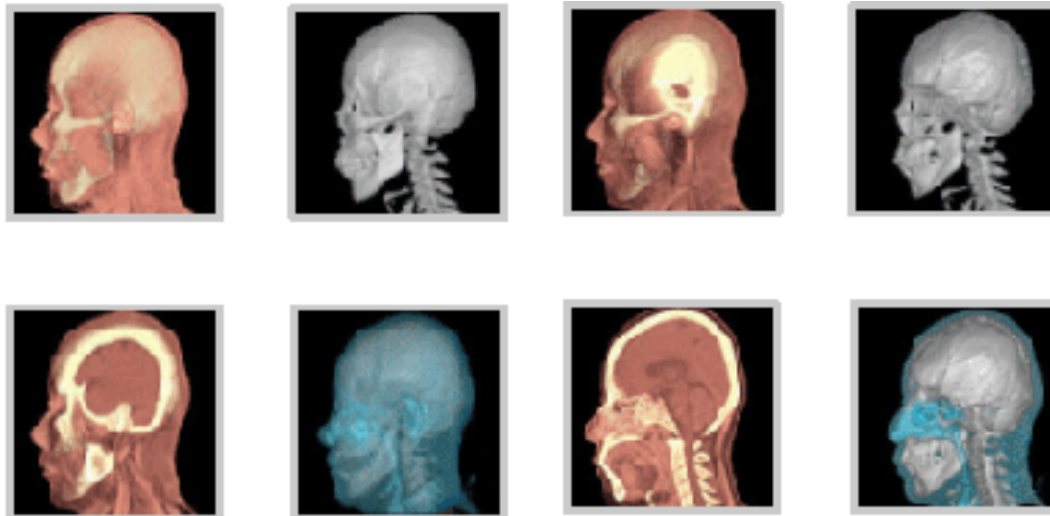
- Computer-aided design (CAD)



# Medical Applications

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- Visualizing data of CT, MRI, etc



Rapidia homepage

# Medical Applications

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- Visualizing data of CT, MRI, etc



Wikipedia

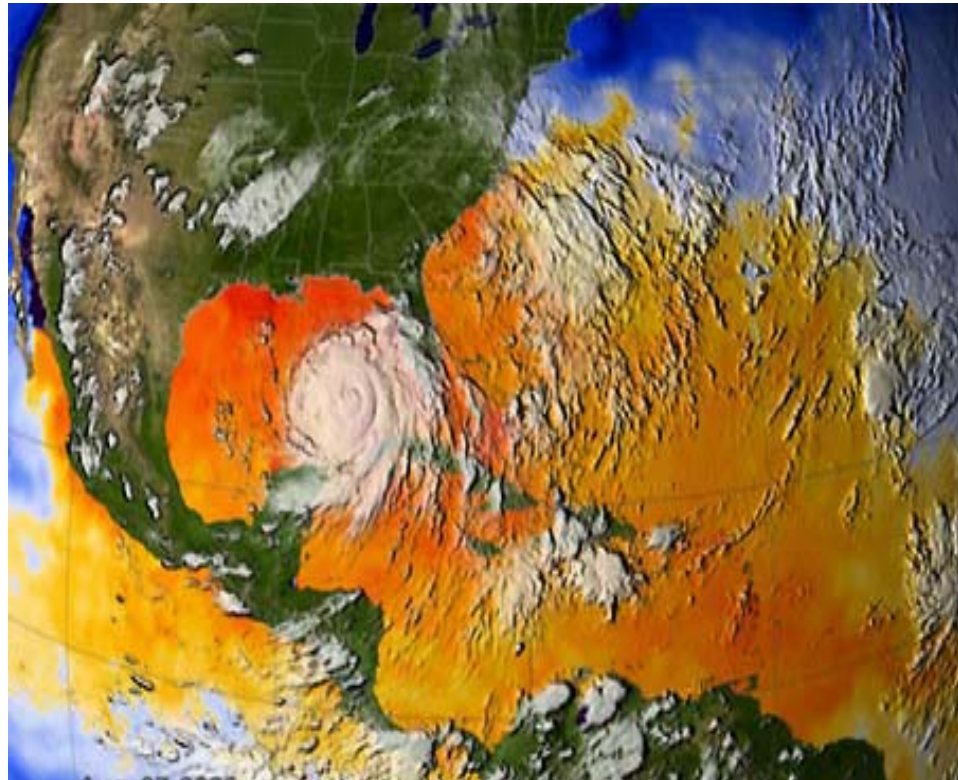
**Mouse skull (CT)**

# Scientific Applications

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- Weather visualization



LLNL

# About the Course

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- **We will focus on the following things:**
  - Study basic concepts of physically-based rendering
  - Discuss various basic concepts of computer graphics
  - Implement a recent technique, and discuss its pros and cons



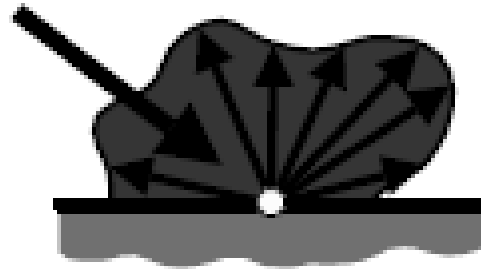


# Photo-Realistic Rendering

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- Achieved by simulating light and material interactions

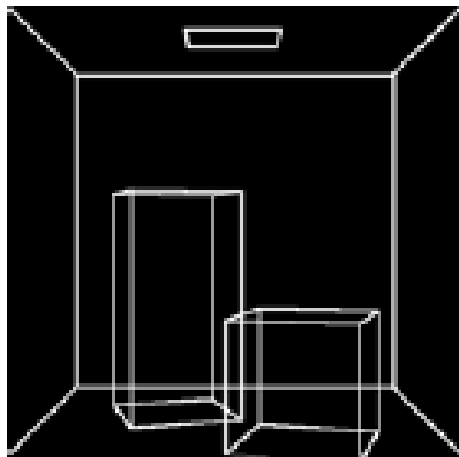


from Prof. Bala's slide

- Rendering equation
  - Mathematical formulation of light and material interactions

# Global Illumination (GI)

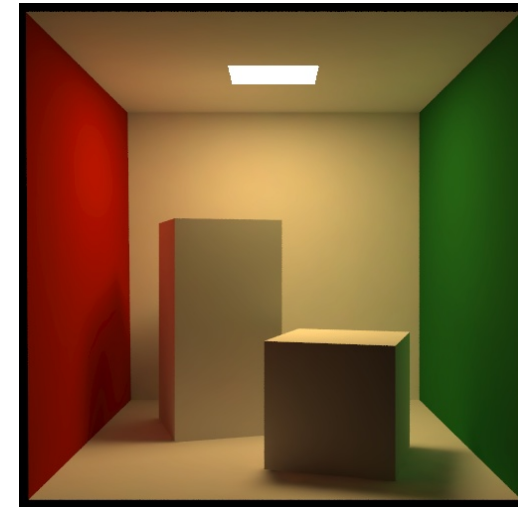
- GI algorithms solve the rendering equation
  - Generate 2D image from 3D scene



from Prof. Bala's slide



**GI  
Algorithm**



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

# Classic Methods of GI

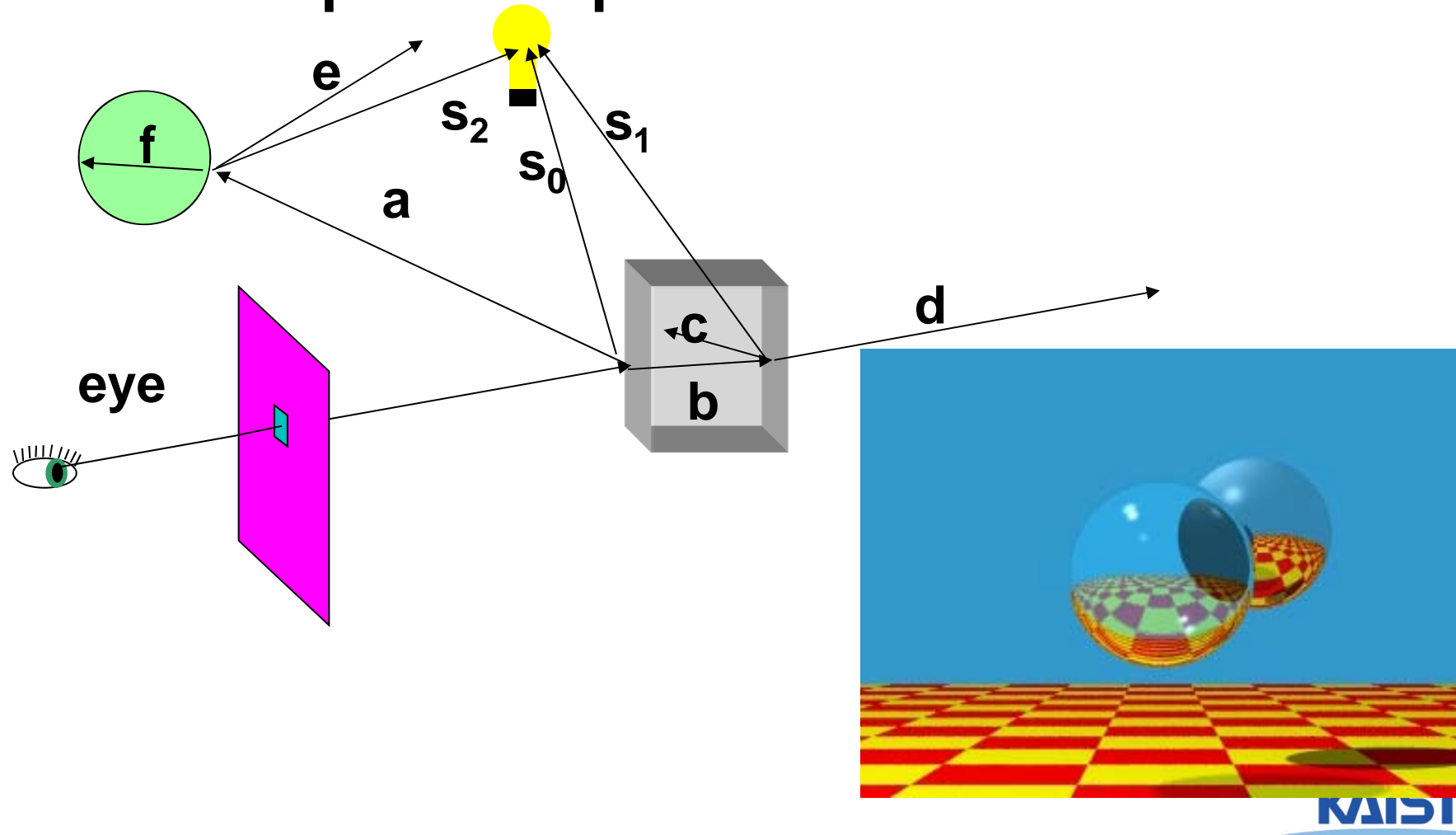
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- **Ray tracing**
  - Introduced by Whitted in 1980
- **Radiosity**
  - Introduced in 1984
- **Monte Carlo rendering**

# Ray Tracing

- Assume perfect specular or diffuse material



# Radiosity

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- Assume diffuse inter-reflections



# Advanced Global Illumination

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- **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

# Scalable GI

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- **How can we handle complexity?**
  - Many objects
  - Many triangles
  - Many lights
  - Complex BRDFs
  - Dynamic scenes, etc.
- **Can we achieve interactive GI on commodity hardware?**

# Some of Topic Lists

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- Ray tracing
- Rendering pipeline
- Path tracing
- BRDF
- Rendering equations
- Monte Carlo method
- Shading
- Textures
- Shadow
- Lighting and shading
- Radiosity
- GPU acceleration
- Reyes architecture
- Tessellation and subdivision
- Sampling and reconstruction
- Realistic rendering



# Prerequisites

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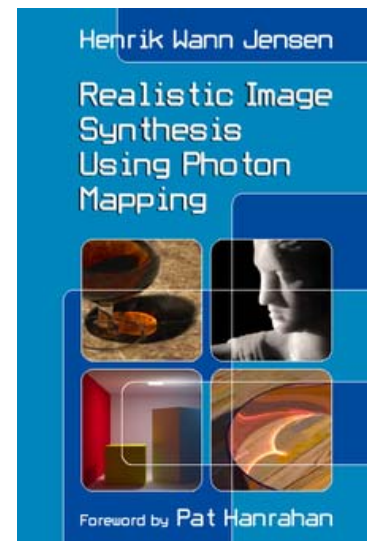
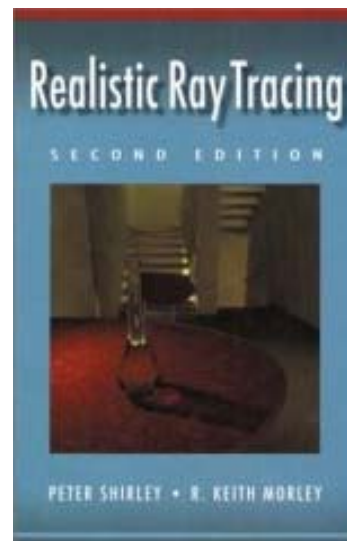
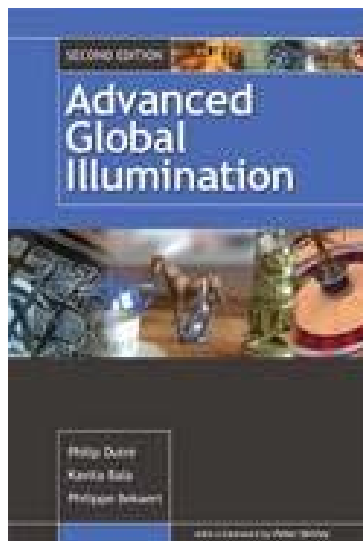
- **Basic programming skill**
- **Basic understanding on data structures (e.g., stack) and linear algebra (e.g., matrix multiplication)**
- **If you are not sure, please consult the instructor at the end of the course**

# Resource

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- No textbook
- Reference
  - Physically based rendering, Matt Pharr et al.
  - Advanced Global Illumination, Philip Dutre et al. 2<sup>nd</sup> edition
  - Realistic Image Synthesis Using Photon Mapping, Henrik Jensen
  - Realistic Ray Tracing, 2<sup>nd</sup> edition, Peter Shirley et al.



# Other Reference

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- Technical papers
  - Graphics-related conference (SIGGRAPH, etc)
  - <http://kesen.huang.googlepages.com/>
- SIGGRAPH course notes and video encore
- Course homepages
- Google or Google scholar

The Google logo is displayed in its characteristic multi-colored font (blue, red, yellow, blue, green, red) with a trademark symbol (TM) to the right.

# Course Overview

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- **3/4 of lectures and 1/4 of student presentations**
  - **Mid-term & final-term exams with a few quiz**
  - **Two programming assignments**
  - **A paper presentation**
  - **Team project**

# What you will do

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- **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
    - Role of each team member should be clear
  - Present what the team did for the team project

# Course Awards

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- **Best speaker and best project**
  - Provide small gifts

# Grading

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- Quiz, assignments, and exams: 60%
- Class presentations: 20%
- Final project: 20%
  
- Late policy
  - No score for late submissions
  - Submit your work before the deadline!
- Instructor and students will evaluate presentations and projects
  - Instructor: 50% weights
  - Students: 50% weights

# Class Attendance Rule

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- 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

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- Collaboration encouraged, but *assignments must be your own work*
- Cite any other's work if you use their code

# Official Language in Class

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- **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

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

# Homework for Each Class

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- **Go over the next lecture slides before the class**
  - **Just 10 min ~ 20 min for this should be okay**

# Homework

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- **Watch 2 SIGGRAPH Videos**
  - Write their abstracts and submit at the beginning of every Tue. class
- **Example of an abstract**
  - Just one paragraph for each abstract

**Title: XXX XXXX XXXX**

**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.**

# About You

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- Name
- Your (non hanmail.net) email address
- What is your major?
- Previous graphics experience
- Any questions

# Next Time

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- **Rasterization based classic rendering pipeline**