Research Statement

My research interest lies largely in computer graphics. Among the primary areas of computer graphics research, I am particularly focusing on rendering and its associated areas, which analyzes and computationally improves interactions between lights, 3D geometries, and views. Fundamental principles underlying the topics include physics, optics, GPU algorithms, and visual perception. Ongoing research subjects include: real-time Graphics-Processing-Unit (GPU) rendering, optical systems, deep learning and rendering, very-high-resolution GPU imaging, GPU algorithms, virtual reality (VR), global illumination, and information visualization.

Real-Time GPU Rendering and Physically-Based Optical Rendering

Despite the recent strides made in graphics algorithms and hardware, real-time rendering of natural phenomena remains challenging. In general, we sacrifice quality for real-time performance, which approximates physics. However, we believe there are always creative possibilities to improve images as similar in quality to reference solutions, while maintaining interactive real-time performance. GPUs considerably help us to realize our novel algorithms and data structures with high performance.

Our former studies on optical effects were successful attempts to prove our belief. Creative combinations of rasterization and ray tracing allowed us to achieve real-time performance and high image quality at the same time. We are still seeking for creative solutions to many open rendering problems, including optics and global illumination.

Deep Learning and Rendering

Deep learning (DL) allows us to explore many open-problem spaces, in which we usually cannot intuitively obtain a computational model. We are investigating its possibilities in the two aspects. Rendering for DL focuses on the generation of (labeled) images that can be fed into the network as input. This significantly helps to widen the application areas of DL, where we cannot easily attain the input data. To this end, we divert realistic rendering towards imperfect real imagery (CG images are too ideal and clean for this purpose). Another possibility is DL for rendering. Unlike what it sounds like, DL’s mechanism and rendering is contradicting, because many phenomena in the rendering are computationally predictable with explicit models. Instead, we now understand DL as a compact nonlinear modeler for many rendering problems, and explore many possibilities in how it can be effectively utilized in modeling-based areas.

Very-High-Resolution GPU Imaging

As 4K and 8K displays become popular, the traditional raster algorithm/pipelines may potentially encounter a bottleneck in the pixel processing. Processing in a native resolution may not be optimal in the near future. To this end, we are investigating how to design a novel pipeline with resolution-independent G-buffers, which encodes geometry and shading information in much lower data-space complexity and reconstructs at a higher resolution without precision loss.

GPU Algorithms

Rendering usually handles a gigantic amount of data. To facilitate rendering, graphics hardware has been rapidly evolving the recent decades. One of the important advances is a user-programmable rendering pipeline. Accordingly, the capability of GPU expands beyond the traditional usage to encompass general-purpose computing. We attempt to achieve improved performance in general computing up to order of two magnitudes. Such an approach is focused on creative algorithms rather than a simple use of GPU and CUDA/OpenCL.
**VR Illumination and Display Algorithms**  Real-time global illumination for VR and augmented reality (AR) requires to be computed with hard real-time constraints. We are trying to develop efficient techniques to achieve visually plausible and temporally coherent appearances. In particular, volume-based approximation of global illumination techniques are improved. Also, the global illumination techniques for pure VR are extended to AR with efficient acquisition of scene geometry, light sources, and materials from input video streams.

Stereoscopic (binocular) display needs to be employed to mediate interactive VR/AR experiences. Such display devices still incur visual fatigues in many optical and perceptual aspects. To cope with these problems, we are investigating how to improve optical accuracy of VR display in terms of motion blur and optical aberrations.

**Information Visualization**  Effective visualization of informative data involves in-depth understandings on human visual perception. Unlike common approaches based on image analysis, our research advances more to image synthesis solutions, leading to perceptually-effective visualization. Visual saliency is one of the important keys to such approaches.

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**Professional Positions**

*Professor* 2021–present  
Department of Software, Sungkyunkwan University, Suwon, Republic of Korea.

*Associate professor* 2015–2021  
Department of Software, Sungkyunkwan University, Suwon, Republic of Korea.

*Visiting professor* 2017–2018  
Computer Graphics and Visualization (CGV) Group, Delft University of Technology (TU Delft), Netherlands.  
- Host professor: Prof. Dr. Elmar Eisemann

*Assistant professor* 2011–2015  
Department of Software, Sungkyunkwan University, Suwon, Republic of Korea.

*Postdoctoral researcher* 2009–2011  
Computer Graphics Department (D4), Max-Planck-Institut (MPI) Informatik, Germany.  
- Advisers: Prof. Dr. Hans-Peter Seidel (MPI Informatik) and Prof. Dr. Elmar Eisemann (TU Delft)

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**Educational Qualifications**

*Ph.D. in Computer Science and Engineering, POSTECH* 2002–2009  
Dissertation: *Real-Time Perceptual Rendering with Computational Visual Attention Tracking in Virtual Environments*  
- Advisers: Profs. Seungmoon Choi (POSTECH) and Gerard Jounghyun Kim (Korea University)

*B.S. in Materials Science and Engineering, POSTECH* 1994–2002  
Minor in Computer Science and Engineering

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**Academic Memberships**

Regular  
- ACM, ACM SIGGRAPH, Eurographics, Asia Graphics, IEEE, IEEE CS
- KCGS (한국컴퓨터그래픽스학회), KHCI (한국HCI학회)

Lifetime  
- KIISE (한국정보과학학회), KIPS (한국정보처리학회)
Professional Academic Services

International Program Committee

- Eurographics Symp. Rendering: 2023
- 3D Systems and Applications (3DSA): 2023
- ACM Web3D: 2020
- Eurographics: 2015, 2014
- IEEE Virtual Reality: 2014
- IEEE/ACM ISMAR: 2009

Conference Referee

- ACM SIGCHI: 2015
- IEEE Visualization (VIS): 2020, 2010
- Eurographics Symp. on Rendering (EGSR): 2014, 2011
- EG/VGTC Conf. on Visualization (EuroVis): 2019
- Graphics Interface (GI): 2014
- Motion in Graphics (MIG): 2010
- IEEE 3DUI: 2009
- WorldHaptics: 2015
- IEEE Int. Conf. on Consumer Electronics (ICCE): 2012
- Int. Conf. on Database Systems for Advanced Applications (DASFAA): 2018

Journal Referee

- IEEE Transactions on Computational Imaging (TCI): 2022, 2021
- The Visual Computer (VisCom): 2017, 2014
Graphical Models (GMod): 2014  
Journal of Supercomputing: 2014

Award Committee/Referee

Pacific Graphics (PG) Best Papers: 2019  

Domestic Academic Services

Program Chair of KCGS 2021 (한국컴퓨터그래픽스학술대회 2021 프로그램위원장)  
Program Chair of KCGS 2020 (한국컴퓨터그래픽스학술대회 2020 프로그램위원장)  
Vice President of Korea CG Society (한국컴퓨터그래픽스학회 이사)  
KCGS Editor (한국컴퓨터그래픽스학회 논문편집위원): 2016–2018  
PC member of Korea Software Congress (조직위원회 부위원장): 2018  
한국정보과학회 우수학술대회목록 3차 개편위원회 분과 전문위원: 2018

University Services

Positions

2019.01.01–2020.12.31 Department Chair, Department of Software  
2019.01.01–2020.12.31 Department Chair, Department of Computer Science and Engineering  
2018.03.01–2019.02.28 ABEEK PD (공학교육혁신센터 프로그램 주관 교수)  
2014.03.01–2015.12.31 Department Chair, GSIT (정보통신대학원 정보통신공학과)  
2014.03.01–2015.12.31 Department Chair, GSIT (정보통신대학원 IT기술정책학과)

Steering Committee

2023.03–2023.10 BK21 Four 사업 제안서 작성위원  
2018.03–2018.10 BK21+ 사업 운영위원  
2018.04–2018.06 BK21+ 사업 중간점검 보고서 작성위원  
2015.06–2015.08 BK21+ 사업 중간평가 보고서 작성위원  
2013.09–2014.02 BK21+ 사업 실무간사  
2015.12–2016.12 소프트웨어대학 교원인사규정 개편 위원  
2015.03–2017.02 소프트웨어융합학과(대학원) 운영위원  
2014.03–2017.02 정보통신대학원(인문사회캠퍼스) 운영위원  
2015.03–present IT융합학과(대학원 고용계약학생과) 운영위원  
2016.01–2017.02 소프트웨어대학 연구진흥위원회 위원  
2015.12, 2016.12 소프트웨어중심대학 사업 보고서 작성위원
Selected Publications (대표연구실적)


### Other Publications: Journal Articles


Conference Papers and Posters


Selected Cover Images


Patents


Invited Talks

Conference Presentation

2019.10.04

2019.7.30

2013.10.17

2013.06.17
Zaragoza Spain, EGSR 2013. Practical Real-Time Lens-Flare Rendering.

2010.07.25

2009.12.09

2008.10.10

2007.11.03

2004.10.13
Valencia Spain, Presence Workshop. Formation of Spatial Presence: By Form or Content?

Invited Seminar

2018.04.13
Kyunghhee University, Effective Rendering of Optical Effects.

2017.10.18
GFZ Potsdam, Germany. Perceptually Driven Visibility Optimization for Categorical Data Visualization.

2017.05.23
CGV Group Seminar, Delft University of Technology, Netherlands. Effective Rendering of optical Effects.

2016.10.27
K-Global Connect Pangyo Festival, Realistic High-Performance Lens-Flare Rendering for Virtual Reality.

2016.09.30
Kyunghhee University, Introduction to Modern Real-Time Rendering.

2016.05.31
Modern AR/VR Tutorials, The Institute of Electronic and Information Engineers. Real-Time Global Illumination for VR.

2015.04.22
Nexon, Inc. Practical Real-Time Lens-Flare Rendering.

2014.07.11
Samsung Advanced Institute of Technology. Real-Time Postfiltering Effects.
KIST. GPU-Based Real-Time Lens Effects Rendering.
Korea Univ., Getting started with GPGPU and CUDA.
Korea Univ., Korea. GPU-Based Real-Time Lens Effects Rendering.
ETRI, Korea. GPU-Based Real-Time Lens Effects Rendering.
KAIST, Korea. Real-Time Lens Effects.
POSTECH, Korea. Real-Time Lens Blur Effects and Focus Control.

Research Grants

Deep Head-Motion Estimation for Latency Reduction in VR Rendering (VR 렌더링 문익 감소를 위한 딥 헤드 모션 예측 기법) 
National Research Foundation of Korea

Imperfect Rendering for Deep Learning (딥러닝을 위한 불완전 렌더링) 
ICT Program, Samsung Research Funding & Incubation Center for Future Technology (삼성 미래기술융성재단 ICT창의 사업)

Dynamic-Resolution Pipeline for Very-High-Resolution Rendering (초고해상도 렌더링을 위한 동적해상도 파이프라인) 
National Research Foundation of Korea (중앙연구자지원사업)

Image Layer Extraction for Webtoon Conversion (웹툰 변환을 위한 이미지 레이어 추출 연구) 
Naver Webtoon

High-Performance Global Illumination Software (초고속 전역조명 소프트웨어 개발) 
Korea NRF Global Frontier Program (실감교류인체감응솔루션연구단)

Virtual reality system for personalized mental healthcare contents (맞춤형 정신건강 증진 콘텐츠를 위한 가상현실 시스템) 
Korea NRF

Image Improvement for VR Display (VR 디스플레이 이미지 보상 기술 개발) 
Samsung Electronics

Research on Mobile Platform-based Entertainment VR (모바일 플랫폼 기반 엔터테인먼트 VR 기술 연구) 
ICT Research Center (ITRC), Sejong University 
Institute for Information and communication Technology Promotion (IITP)
2015.9–2018.2  Ultra-Speed Global Illumination for Co-Existent Space  
(심각교류확장공간을 위한 초고속 전역조명 기술 개발)  
Korea NRF Global Frontier Program (심각교류연계기술융합연구단)

2015.5–2018.4  Software Analysis/Improvement for Seamless GPU Computing  
(간극없는 GPU 컴퓨팅을 위한 소프트웨어 분석/향상 기법)  
Korea NRF Mid-Career Program (중견연구자지원사업)

2012.9–2015.8  Parallel Software Library for Real-Time 3D Graphics Implementation  
(실시간 3D 그래픽스 구현을 위한 병렬처리형 소프트웨어 라이브러리 개발)  
Korea NRF Global Frontier Program (실감교류연계기술융합연구단)

2012.9–2015.8  High-Level GPU Software Modeling and Design Interface  
(하이레벨 GPU 소프트웨어 모델링 및 디자인 인터페이스)  
Korea NRF Mid-Career Program (중견연구자지원사업)

2012.1–2015.7  Core Software Technology Research for Cloud Platform  
(클라우드 플랫폼 핵심 SW 기술 연구)  
Samsung Electronics

2011.5–2014.4  Perception-Based Optimization of Visualization  
(시각화의 지각 기반 최적화)  
Korea NRF New-Researcher Program (한국연구재단 신진연구자지원사업)

Honors and Awards

2022  공로상, 한국컴퓨터그래픽스학회 (2020–2021 학술대회 프로그램위원장), 7월 14일
2020  Society best-paper award, 한국정보과학회
2020  Best-paper award, KCC (한국정보과학회 하계학술대회)
2020  2020년도 한국정보과학회 우수논문상
2019  학부생/주니어 논문집대회 장려상, KSC (한국정보과학회 동계학술대회) 2018
2015  Best-paper award, KCC (한국정보과학회 하계학술대회)
2014  Best-paper award, KCC (한국정보과학회 하계학술대회)
2013  Best-paper award, KIPS (한국정보처리학회 하계학술대회)
2008  Best-paper award, KHCI (한국HCI학회)

Educational Experiences

Ph.D. students I supervised

2019  Yuna Jeong (정유나), KISTI (한국과학기술정보연구원)  
Thesis: Efficient and Expressive Rendering for Real-Time Defocus Blur and Bokeh

Masters students I supervised

2021  Junwon Kang (강준원)  
Thesis: Scalable Dynamic Rasterization for Postprocessing  
2021  Yechan Seok (석예찬)  
Thesis: Hybrid Voxel Tracing for Real-Time Global Illumination
2021 Jieun Ko (고지은)  
Thesis: Efficient and Effective Stratification-Based Technique for Stochastic Sampling

2021 Seung Youp Baek (백승엽)  
Thesis: Road Scene Image Translation from Day to Night using Semantic Segmentation

2021 Gibeom Lee (이기범)  
Thesis: Efficient Object Visibility Culling with Screen-Space Ray Casting

2020 Yonggeol Jung (정용秸), Samsung Electronics (삼성전자)  
Thesis: 가변 크기 타일 기반 웹 엔진 렌더링

2020 Jae-won Choi (최재원), Osstem  
Thesis: Real-Time Indirect Illumination Rendering with Dual Paraboloid Map

2020 Soonhyeon Kwon (권순현)  

2020 Jaemyung Kim (김재명), Teneleven  
Thesis: Single-pass stereo rendering with bidirectional image warping

2020 Je Seon Lee (이제선)  
Thesis: Depth Range Shift and Compression for Real-Time Depth-of-Field Rendering

2019 Hyojin Jung (정효진), TeeLabs  
Thesis: Primitive-based Crack Synthesis with Guidance Vector Field

2019 Yuri Roh (노유리), Hotel Shilla  
Thesis: Experimental Quality Assessment of Ultra-High-Definition Resolution Image Upscaling of Postprocessing Effects

2019 Soyoung Park (박소영), Naver Labs  
Thesis: Real-time light source estimation from geometry and texture of indoor scene

2019 Younji Choi (최윤지), Shinhan Bank (신한은행)  
Thesis: Real-time Intrinsic Image Decomposition using Reconstructed Indoor Scene for Dynamic Relighting

2019 Taemoon Kim (김태문), Teneleven  
Thesis: Fast User-Weighted Viewpoint/Lighting Control for Multi-Object Scene

2018 Sunghun Jo (조성훈), IDIS  
Thesis: Scalable parser for massive OBJ models based on GPU

2017 Sangmin Lee (이상민), Samsung Electronics  
Thesis: Interactive expressive editing of lens flare effect

2017 Hyuntae Joo (주현태), TmaxSoft  
Thesis: Efficient bokeh synthesis with ray tracing through aspheric lenses

2016 Younguk Kim (김영욱), 인체감응솔루션연구단  
Thesis: Efficient occlusion culling using depth warping

2016 Kihyuk Kim (김기혁), Korea Telecom (KT)  
Thesis: Interactive free-form authoring of volume animation

2015 Kangtae Kim (김강태), Korea Telecom (KT)  
Thesis: Perceptual color enhancement for OLED display

2015 Juhyun Jung (정주현), SAP  
Thesis: High-level modular algorithm design for GPGPU computing
Hyunjin Lee (이현진), LG전자 CTO
Thesis: Highly adaptive terrain rendering using recursive tessellation

Courses that I offered in Sungkyunkwan University

2011–present  Introduction to Computer Graphics
2021–present  Virtual Reality Theory
2012-2014  Algorithms, Algorithms Analysis (알고리즘해석)
2019–2020  CSE Seminar (컴퓨터공학세미나)
2018–present  Engineering Computer Programming (공학컴퓨터프로그램밍; C++)
2011  Creative Engineering Design
2011  Programming Basics and Practice (C)

Courses for Industrial Participants

2021–2023  파이썬기초및데이터시각화, 삼성전자공과대학교 (SSIT)
2017  Computer Graphics and OpenGL ES 3, System LSI 사업부, Samsung Electronics
2016  Real-Time Rendering for VR, 대한전자공학회 튜토리얼
2014  OpenGL ES, 첨단기술연수소, Samsung Electronics

September 1, 2023