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 are 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.

**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)

**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

**Academic Memberships**

<table>
<thead>
<tr>
<th>Type</th>
<th>Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular</td>
<td>ACM, ACM SIGGRAPH, Eurographics, Asia Graphics, IEEE, IEEE CS</td>
</tr>
<tr>
<td>Regular</td>
<td>KCGS (한국컴퓨터그래픽스학회), KHCI (한국HCI학회)</td>
</tr>
<tr>
<td>Lifetime</td>
<td>KIISE (한국정보과학학회), KIPS (한국정보처리학회)</td>
</tr>
</tbody>
</table>
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 문과 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 IT기술정보학과)

Steering Committee

2023.03–2023.10 BK21 Four 사업 제안서 작성위원
2018.03–2018.10 BK21+ 사업 운영위원
2018.04–2018.06 BK21+ 사업 중간점검보고서 작성위원
2015.06–2015.08 BK21+ 사업 중간평가보고서 작성위원
2013.09–2014.02 BK21+ 사업 실무간사
2015.12–2016.12 소프트웨어대학 교원인사규정 개편위원
2015.03–2017.02 소프트웨어플랫폼과(대학원) 운영위원
2014.03–2017.02 정보통신대학원(인문사회캠퍼스) 운영위원
2015.03–present IT융합학과(대학원 고용재학형학과) 운영위원
2016.01–2017.02 소프트웨어대학 연구진흥위원회위원
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

2013.06.17 Zaragoza Spain, EGSR 2013. Practical Real-Time Lens-Flare Rendering.
2004.10.13 Valencia Spain, Presence Workshop. Formation of Spatial Presence: By Form or Content?

Invited Seminar

2018.04.13 Kyunghee 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 Kyunghee 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.
2014.06.03  UNIST, Real-Time Optical Effect Rendering for Computer Graphics.
2012.09.27  KIST. GPU-Based Real-Time Lens Effects Rendering.
2012.09.19  Korea Univ., Getting started with GPGPU and CUDA.
2011.06.10  ETRI, Korea. GPU-Based Real-Time Lens Effects Rendering.
2011.06.10  KAIST, Korea. Real-Time Lens Effects.
2011.06.08  POSTECH, Korea. Real-Time Lens Blur Effects and Focus Control.

Research Grants

2022.3–2023.2  Deep Head-Motion Estimation for Latency Reduction in VR Rendering
(National Research Foundation of Korea)
2019.6–2021.5  Imperfect Rendering for Deep Learning
(ICT Program, Samsung Research Funding & Incubation Center for Future Technology)
2019.3–2022.2  Dynamic-Resolution Pipeline for Very-High-Resolution Rendering
(National Research Foundation of Korea)
2018.7–2019.6  Image Layer Extraction for Webtoon Conversion
(Naver Webtoon)
2018.3–2019.8  High-Performance Global Illumination Software
(Korea NRF Global Frontier Program)
2017.11–2020.9  Virtual reality system for personalized mental healthcare contents
(Korea NRF)
2016.7–2017.7  Image Improvement for VR Display
(Samsung Electronics)
2016.6–2019.12  Research on Mobile Platform-based Entertainment VR
(ICT Research Center (ITRC), Sejong University)

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2015.9–2018.2 Ultra-Speed Global Illumination for Co-Existential Space  
(실감교류확장공간을 위한 초고속 전역조명 기술 개발)  
Korea NRF Global Frontier Program (실감교류인체감응솔루션연구단)

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 (실감교류인체감응솔루션연구단)

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 논문경진대회 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
<table>
<thead>
<tr>
<th>Year</th>
<th>Name</th>
<th>Thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021</td>
<td>Jieun Ko</td>
<td>Thesis: Efficient and Effective Stratification-Based Technique for Stochastic Sampling</td>
</tr>
<tr>
<td>2021</td>
<td>Seung Youp Baek</td>
<td>Thesis: Road Scene Image Translation from Day to Night using Semantic Segmentation</td>
</tr>
<tr>
<td>2021</td>
<td>Gibeom Lee</td>
<td>Thesis: Efficient Object Visibility Culling with Screen-Space Ray Casting</td>
</tr>
<tr>
<td>2020</td>
<td>Yonggeol Jung</td>
<td>Thesis: 가변 크기 타일 기반 웹 엔진 렌더링</td>
</tr>
<tr>
<td>2020</td>
<td>Jaewon Choi</td>
<td>Thesis: Real-Time Indirect Illumination Rendering with Dual Paraboloid Map</td>
</tr>
<tr>
<td>2019</td>
<td>Hyojin Jung</td>
<td>Thesis: Primitive-based Crack Synthesis with Guidance Vector Field</td>
</tr>
<tr>
<td>2019</td>
<td>Soyoung Park</td>
<td>Thesis: Real-time light source estimation from geometry and texture of indoor scene</td>
</tr>
<tr>
<td>2019</td>
<td>Younji Choi</td>
<td>Thesis: Real-time Intrinsic Image Decomposition using Reconstructed Indoor Scene for Dynamic Relighting</td>
</tr>
<tr>
<td>2018</td>
<td>Sunghun Jo</td>
<td>Thesis: Scalable parser for massive OBJ models based on GPU</td>
</tr>
<tr>
<td>2017</td>
<td>Sangmin Lee</td>
<td>Thesis: Interactive expressive editing of lens flare effect</td>
</tr>
<tr>
<td>2017</td>
<td>Hyuntae Joo</td>
<td>Thesis: Efficient bokeh synthesis with ray tracing through aspheric lenses</td>
</tr>
<tr>
<td>2016</td>
<td>Younguk Kim</td>
<td>Thesis: Efficient occlusion culling using depth warping</td>
</tr>
<tr>
<td>2016</td>
<td>Kihyuk Kim</td>
<td>Thesis: Interactive free-form authoring of volume animation</td>
</tr>
<tr>
<td>2015</td>
<td>Kangtae Kim</td>
<td>Thesis: Perceptual color enhancement for OLED display</td>
</tr>
<tr>
<td>2015</td>
<td>Juhyun Jung</td>
<td>Thesis: High-level modular algorithm design for GPGPU computing</td>
</tr>
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</table>
Courses that I offered in Sungkyunkwan University

2011–present  Introduction to Computer Graphics
2021–present  Virtual Reality Theory
2019–2020  CSE Seminar (컴퓨터공학세미나)
2018–present  Engineering Computer Programming (공학컴퓨터프로그래밍; C++)
2011  Creative Engineering Design
2011  Programming Basics and Practice (C)

Courses for Industrial Participants

2021–2023  파이썬기초및데이터사각화, 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, 첨단기술연구소, Samsung Electronics

October 26, 2023