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 fatigue 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**

**Associate professor**  2015–
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 Joungyun 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**

<table>
<thead>
<tr>
<th>Type</th>
<th>Organization</th>
</tr>
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<tr>
<td>Regular</td>
<td>ACM</td>
</tr>
<tr>
<td>Pioneer</td>
<td>ACM SIGGRAPH</td>
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<tr>
<td>Regular</td>
<td>Eurographics, Asia Graphics</td>
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<tr>
<td>Regular</td>
<td>KCGS (한국컴퓨터그래픽스학회), KHCI (한국HCI학회)</td>
</tr>
<tr>
<td>Lifetime</td>
<td>KIISE (한국정보과학회), KIPS (한국정보처리학회)</td>
</tr>
</tbody>
</table>
Professional Academic Services

International Program Committee

ACM Web3D: 2020
Eurographics: 2015, 2014
IEEE Virtual Reality: 2014
IEEE/ACM ISMAR: 2009

Conference Referee

ACM SIGCHI: 2015
IEEE Visualization (VIS): 2010, 2020
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

ACM Transactions on Graphics (TOG): 2011
Computers and Graphics (CnG): 2013
The Visual Computer (VisCom): 2014, 2017
Graphical Models (GMod): 2014
Journal of Supercomputing: 2014

Award Committee/Referee
Domestic Academic Services

- Program Chair of KCGS 2020 (한국컴퓨터그래픽스학술대회 2020 프로그램위원장)
- Vice President of Korea CG Society (한국컴퓨터그래픽스학회 이사)
- KCGS Editor (한국컴퓨터그래픽스학회 논문편집위원장): 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 IT컨설팅학과)

Steering Committee

- 2018.03–2018.10 BK21+ 사업 운영위원장
- 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 개편위원장
- 2015.03–2017.02 소프트웨어플랫폼학과(대학원) 운영위원장
- 2014.03–2017.02 정보통신대학원(인문사회캠퍼스) 운영위원장
- 2015.03–present IT융합학과(대학원 고향계통학과) 운영위원장
- 2016.01–2017.02 소프트웨어대학 연구진흥위원회 위원
- 2015.12, 2016.12 소프트웨어중심대학 사업 보고서 작성위원
Selected Publications (대표연구실적)


Other Publications: Journal Articles

[1] Young Im Kim, Seo-Yeon Jung, Seulki Min, Eunbi Seol, Sungho Seo, Ji-Won Hur, Dooyoung Jung, Heon-Jeong Lee, 
**Sungkil Lee**, Gerard J. Kim, Chung-Yean Cho, Seungmoon Choi, Seung-Moo Lee, and Chul-Hyun Cho, 
“Visuo-Haptic-Based Multimodal Feedback Virtual Reality Solution to Improve Anxiety Symptoms: A 


[4] Sungeol Baek, Dong Yun Chang, Sungkil Lee, and Young Ik Eom, “Efficient Graph Pattern Matching Framework 


[7] Soonhyeon Kwon, Younguk Kim, Kihyuk Kim, and Sungkil Lee, “Heterogeneous Volume Deformation and 
Animation Authoring with Density-Aware Moving Least Squares,” 


[10] Kihong Lee, DongWoo Lee, Sungkil Lee, and Young Ik Eom, “Power-efficient and High-performance Block I/O 

Authoring and Visualization of Indoor Internet of Things,” 


Other Publications: Conference Papers and Posters


[5] Myongchan Kim, Sungkil Lee, and Seungmoon Choi, 
pp. 258–269.


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.
**Grants (as PI) and Awards**

**Research Grants** (KRW 1,000 is roughly equivalent to 1 USD)

2018.7–2019.6  
Image Layer Extraction for Webtoon Conversion  
(웹툰 변환을 위한 이미지 레이어 추출 연구)  
Naver Webtoon  
KRW 100,000,000

2018.3–2019.8  
High-Performance Global Illumination Software  
(초고속 전역조명 소프트웨어 개발)  
Korea NRF Global Frontier Program (실감교류인체감응솔루션연구단)  
KRW 216,000,000

2016.7–2017.7  
Image Improvement for VR Display  
(VR 디스플레이 이미지 보상 기술 개발)  
Samsung Electronics  
KRW 90,000,000

2015.9–2018.2  
Ultra-Speed Global Illumination for Co-Existential Space  
(실감교류확장공간을 위한 초고속 전역조명 기술 개발)  
Korea NRF Global Frontier Program (실감교류인체감응솔루션연구단)  
KRW 660,000,000

2015.5–2018.4  
Software Analysis/Improvement for Seamless GPU Computing  
(간극없는 GPU 컴퓨팅을 위한 소프트웨어 분석/향상 기법)  
Korea NRF Mid-Career Program (중전연구자지원사업)  
KRW 300,000,000

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)  
KRW 550,000,000

2012.9–2015.8  
High-Level GPU Software Modeling and Design Interface  
(하이레벨 GPU 소프트웨어 모델링 및 디자인 인터페이스)  
Korea NRF Mid-Career Program (중전연구자지원사업)  
KRW 300,000,000

2012.1–2015.7  
Core Software Technology Research for Cloud Platform  
(클라우드 플랫폼 핵심 SW 기술 연구)  
Samsung Electronics  
KRW 150,000,000

2011.5–2014.4  
Perception-Based Optimization of Visualization  
(시각화의 지각 기반 최적화)  
Korea NRF New-Researcher Program (한국연구재단 신진연구자지원사업)  
KRW 135,000,000

**Honors and Awards**

2020  
Best-paper award, KCC (한국정보과학회 하계학술대회)

2020  
2020년도 한국정보과학회 우수논문상

2019  
학부상/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

2020  Yonggeol Jung (정용걸), Samsung Electronics (삼성전자)
Thesis: 가변 크기 타일 기반 웹 엔진 렌더링
2020  Jaewon Choi (최재원)
Thesis: Real-Time Indirect Illumination Rendering with Dual Paraboloid Map
2020  Soonhyeon Kwon (권순현)
2020  Jaemyung Kim (김재명), Teneneven
Thesis: Single-pass stereo rendering with bidirectional image warping
2020  Je Seon Lee (이세선)
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), Teneneven
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
2015 Hyunjin Lee (이현진), LG전자 CTO
Thesis: Highly adaptive terrain rendering using recursive tessellation

Current Ph.D Students

Zhu Jie, Ph.D. Student
Moonsoo Jung (정문수), Int. Ph.D. Student
Liu Yingying, Int. Ph.D. Student
Jun Sup Shin (신준섭), Int. Ph.D. Student

Current Master Students

Jieun Ko (고지은), Master Student
Gibeom Lee (이기범), Master Student
Yechan Seok (석예찬), Master Student
Seung Youp Baek (백승엽), Master Student
Junwon Kang (강준원), Master Student
Hoonmin Cho (조훈민), Master Student
Hyeonjang An (안현장), Master Student
Seungyoon Lee (이승윤), Master Student
Gunhee Cho (조건희), Master Student

Courses that I offered in Sungkyunkwan University

2019 CSE Seminar (컴퓨터공학세미나)
2019–present Computer Graphics Project
2018–present Engineering Computer Programming (공학컴퓨터프로그래밍, C++)
2012-2014 Algorithms, Algorithms Analysis (알고리즘해석)
2012–present Advanced Topics in Computer Graphics
2011–present Introduction to Computer Graphics
2011 Creative Engineering Design
2011 Programming Basics and Practice (C)
### Courses for Industrial Participants

<table>
<thead>
<tr>
<th>Year</th>
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<tr>
<td>2014</td>
<td>OpenGL ES, 첨단기술연수소, Samsung Electronics</td>
</tr>
<tr>
<td>2016</td>
<td>Real-Time Rendering for VR, 대한전자공학회 투토리얼</td>
</tr>
<tr>
<td>2017</td>
<td>Computer Graphics and OpenGL ES 3, System LSI 사업부, Samsung Electronics</td>
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July 8, 2020