RAHUL VASANT GULVE

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OBJECTIVE

As a soon-to-graduate Ph.D. candidate, I am excited to bring my experience from mixed-signal IC and camera-system design to the industry. My training at the University of Toronto and experience with patenting and publishing at top conferences such as ISSCC and VLSI have prepared me for challenging and innovative product R&D projects.

In the past 5 years, I have also had the opportunity to lead large, cross-disciplinary projects and teams of graduate and undergraduate students, honing my leadership skills and ability to work collaboratively.

Now, I am eager to apply and expand upon my knowledge and experience in a dynamic and forward-thinking research group where I can continue to make a meaningful impact.

EDUCATION

Ph.D. Candidate in Electrical Engineering   *(Sep. 2017 - present)*
(Computational coded-exposure CMOS Image Sensors and Applications)   Advisors: Prof. Roman Genov (ECE),
University of Toronto, Toronto, Canada   Prof. Kyros Kutulakos(CS)

Dual Degree (M.Tech + B.Tech) in Electrical Engineering   *(Aug 2012 - Jul 2017)*
(Digitally Tunable Active Delay Elements for Broadband Beamforming)   Advisor: Prof. Nagendra Krishnapura (EE)
Indian Institute of Technology Madras, Chennai, India

RESEARCH EXPERIENCE

Coded-exposure pixel (CEP) image sensors and cameras   *(Sep. 2017 – present)*

○ The main goal is to study, design, and deploy a novel class of per-pixel coded-exposure computational cameras.

○ The light falling on each pixel in the CEP cameras can be sorted into multiple collection sites based on the 1000-bit arbitrary exposure-code sequence per-pixel per-frame.

○ **Devices:** Studied and optimized the performance of dual-tap global-shutter pixels and successfully fabricated high-speed high-contrast coded-exposure pixels. (VLSI22)

○ **Circuits:** Designed a novel scalable HDR regression-based flux-to-digital converter as an alternative to conventional ADCs in image sensors using robust, reliable, and simple circuits such as comparators (ISSCC23). Implemented RISCV processor on in 65nm technology (VLSI22).

○ **Systems:** Designed the first of its-kind always-ON global-shutter coded-exposure image sensor.
Participated in (3) and led (6) multiple tapeouts with fellow research student teams. (ISSC23, VLSI22)

○ **Testing and Firmware:** Designed robust PCBs and APIs that enabled close collaboration with researchers from computer science at home and international universities (KAUST, CMU). (ISSC23, VLSI22)

○ **Computer Vision:** Successfully implemented multiple new and existing computational imaging applications for HDR, 3D, machine-vision, vein, and multi-spectral imaging. (VLSI22, ICCP21, ICCP20)
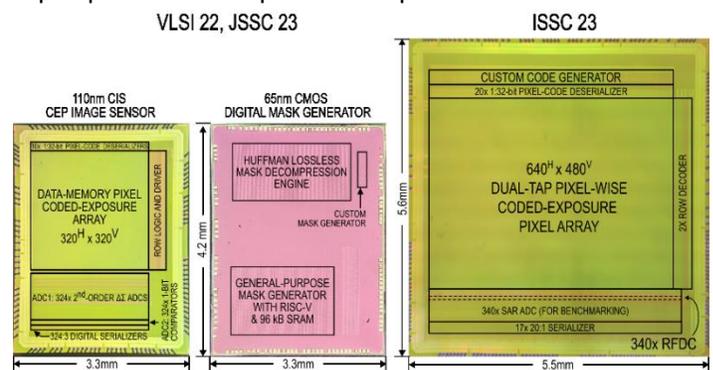
TECHNICAL SKILLS

IC Design: Analog, Digital and Mixed-Signal IC design, Pixel design, Top-level IC design & management
Programming languages: Verilog, Python (big-data, scripting, CV), C, C++
Software: Vivado, Virtuoso, Encounter, Innovus, Altium
Systems: PCB designing, Image sensors testing, Firmware, and API Development, 3D printing
Deployment: Active and passive computational imaging setups, Camera-projector alignment, and calibration, API docu.

AWARDS AND RECOGNITIONS

○ IWISS'22, Japan invited opening presentation based on the VLSI'22 paper   *Dec. 2022*
○ JSCC invited paper for a special issue as an extension of the VLSI'22 paper   *Aug. 2022*
○ CMC TEXPO 2021 Graduate Student Research Competition winner in micro-nanosystem design category   *Jan. 2021*
○ Best poster and demo award at International Conference on Computational Photography 2021, ICCP 2021   *May 2021*
○ University of Toronto Photonics Research Expansion Grant (REG)   *Jun. 2020*

PATENT
R. Genov, K. N. Kutulakos, N. Sarhangnejad, **R. Gulve**, H. Ke, "Method and System for Extending Image Dynamic Range Using Per-Pixel Coded Exposure," US Patent application 62/864,895, pending.

CONFERENCES
[ISSCC23] R. Gulve, R. Rangel, A. Berman, D. Nguyen, M. Wei, M. A Sakr, X. Sun, D. B. Lindell, K. N. Kutulakos and R. Genov, "Dual-Port CMOS Image Sensor with Regression-Based HDR Flux-to-Digital Conversion and 80ns Rapid-Update Pixel-Wise Exposure Coding," *In IEEE International Solid-State Circuits Conference-(ISSCC 23)*, 2023
I presented this work at the conference, as well as it was demonstrated live.

[VLSI22] R. Gulve*, N. Sarhangnejad*, G. Dutta, M. Sakr, D. Nguyen, R. Rangel, W. Chen, Z. Xia, M. Wei, N. Gusev, E. Y. H. Lin, X. Sun, L. Hanxu, N. Katic, A. Abdelhadi, A. Moshovos, K. N. Kutulakos and R. Genov, "A 39,000 Subexposures/s CMOS Image Sensor with Dual-tap Coded-exposure Data-memory Pixel for Adaptive Single-shot Computational Imaging," In *2022 IEEE Symposium on VLSI Technology and Circuits (VLSI22)*, pp. 78-79. IEEE, 2022.
I presented this work at the conference.

[IISW23] R. Rangel, N. Sarhangnejad, M. Wei, **R. Gulve**, A. Barman, G. Dutta, Z. Xia, N. Gusev, N. Katic, H. Haim, K. N. Kutulakos, and R. Genov, "Flexible Spectrally-Scanning Snapshot Multispectral Imaging On Dual-Tap Coded-Exposure-Pixel CMOS Image Sensors," in *International Image Sensor Workshop*, 2023.

[ICCP20] Y. Li, M. Qi, **R. Gulve**, M. Wei, R. Genov, K. Kutulakos and W. Heidrich, "End-to-End Video Compressive Sensing using Anderson-accelerated Unrolled Networks,"in *IEEE International Conference on Computational Photography*, 2020.

[IISW19] H. Ke, N. Sarhangnejad, **R. Gulve**, Z. Xia, N. Gusev, N. Katic, K. Kutulakos and R. Genov, "Extending Image Sensor Dynamic Range by Scene-aware Pixelwise-adaptive Coded Exposure," in *International Image Sensor Workshop, 2019*.
I presented this work at the workshop.

[ISSCC19] N. Sarhangnejad, N. Katic, Z. Xia, N. Gusev, G. Dutta, **R. Gulve**, M. Monero, M. Wei, H. Haim, D. Stoppa, K. Kutulakos and R. Genov, "Dual-Tap Pipelined-Code-Memory Coded-Exposure-Pixel CMOS Image Sensor for Multi-Exposure Single-Frame Computational Imaging," in *IEEE International Solid-State Circuits Conference (ISSCC 19), 2019*.
I presented this work at the conference, as well as it was demonstrated live.

JOURNAL
[JSSC__] R. Gulve, R. Rangel, A. Berman, D. Nguyen, M. Wei, M. A Sakr, X. Sun, D. B. Lindell, K. N. Kutulakos and R. Genov, "Dual-Port CMOS Image Sensor with Regression-Based HDR Flux-to-Digital Conversion and 80ns Rapid-Update Pixel-Wise Exposure Coding." *Writing as an extension to ISSCC23 and will be submitted to JSSC.*

[JSSC23] R. Gulve, N. Sarhangnejad, G. Dutta, M. Sakr, D. Nguyen, R. Rangel, W. Chen, Z. Xia, M. Wei, N. Gusev, E. Y. H. Lin, X. Sun, L. Hanxu, N. Katic, A. Abdelhadi, A. Moshovos, K. N. Kutulakos and R. Genov. "39 000-Subexposures/s Dual-ADC CMOS Image Sensor With Dual-Tap Coded-Exposure Pixels for Single-Shot HDR and 3-D Computational Imaging," *IEEE Journal of Solid-State Circuits (2023)*.

[JSSC19] N. Sarhangnejad, N. Katic, Z. Xia, M. Wei, N. Gusev, G. Dutta, **R. Gulve**, P. Li, H. Ke, H. Haim, M. Monero-Garcia, D. Stoppa, K. Kutulakos and R. Genov, "Dual-tap Computational Photography Image Sensor with Per-pixel Pipelined Digital Memory for Intra-frame Coded Multi-exposure," *IEEE Journal of Solid-State Circuits (2019)*.

OTHER RESEARCH & PROFESSIONAL EXPERIENCE

Digitally programmable active delay elements for broadband beamforming *(June 2016 - June 2017)*
Advisor: Prof. Nagendra Krishnapura, Dept. of Electrical Engineering, IIT Madras
- Designed the programmable delay filter with the GmC filter.
- Designed and implemented the circuit in TSMC 65nm technology.

Guided Ultrasonic Monitoring of Pipeline Systems (GUMPS) - Electronic lead *(Aug. 2015 – Dec. 2016)*
Starting member of the startup: Detect Technologies, Ltd.
- GUMPS is a real-time monitoring system for oil and gas pipelines for locating cracks and corrosion.
- Developed a system from scratch which can be mass-produced in a cost-efficient way.

Motion artifact cancellation in wrist-based PPG sensor *(May 2015 – July 2015)*
Research & Development Trainee Engineer @ Sony Corporation, Japan
- Worked with the R&D division of Sony Corporation, which develops future products for the company.
- Successfully designed the experiments and analyzed the data for Motion Artifact Cancellation.

LEADERSHIP ROLES & TEAMWORK

Coded-Exposure-Pixel Camera Project Lead *(Sep. 2017 – present)*
- Leading a team of graduate and undergraduate students working on the CEP camera sensors in the VLSI domain.
- Conducted initial interviews and screening of graduate and undergraduate applicants interested in joining the research project.
- Helped new graduate students with navigating different research directions. Delegated research tasks for a deep understanding of the subject.
- Recruited M.Eng. students, defined the semester-long course projects, and guided them in those projects.
- Defined research projects for the undergraduate summer research program and supervised students over summer to achieve those research goals.

Lab Manager for Intelligent Sensory Microsystems Laboratory (Prof. Genov Lab) *(Sep. 2018 – Dec. 2022)*
- Managing the lab logistics with >12 graduate and >10 undergraduate student lab members.
- Overseeing and planning the long-term (5+ years) lab funding (>$ 1M).
- Upgraded the ISML lab test bench hardware setups with state-of-the-art test & measurement equipment (>$200 K).
- Instituted different policies based on the requirement for efficient lab collaboration between different projects in labs.

Teaching Assistant *(Sep. 2018 – Sep. 2022)*
- Assisted in teaching three courses, ECE1388: VLSI design methodology, ECE334: Digital electronics, ECE295: Hardware Design and Communication, at the University of Toronto.
- Upgraded course material for a graduate course, ECE1388, with newest information.
- As a head TA, redesigned manuals, a tutorial for a better understanding of the students.
- Engaged students during tutorial sessions for efficient understanding and better learning experience.
- Helped students define and explore final projects, ECE1388, ECE295.

ECE Graduate Student Society (ECEGSS) Executive Member *(Sep. 2018 – Sep. 2021)*
- I was elected as one of the executive members three times for different roles.
- Hosted multiple professional development events for graduate students to engage with tech. companies.
- Arranged monthly events for graduate students to socialize with each other outside the lab environment.
- Planned department-wide research expo (canceled due to the pandemic) and conference for educating other students about the ongoing research works in other labs at the university.

CODED-EXPOSURE-PIXEL CAMERA TEAM

Graduate Fellows			Undergraduate Research Mentees		
Nikita Gusev	M.A.Sc.	(9/2017 – 9/2019)	**2018**	**2020**	**2022**
Motasem Sakr	M.A.Sc.	(9/2019 – 9/2021)	Tobias Rozario	Alex Buck	Karthikeyan Rajan
Don Nguyen	M.A.Sc.	(9/2019 – current)	Yangfan Wang	Sean Wu	David Shemesh
Roberto Rangel	Ph.D.	(9/2019 – current)	Alexander Buck	Kathy Zhuang	Bora Bayazit
Ayandev Berman	Ph.D.	(9/2021 – current)	Yuanli(Danny) Ding	Abhay Gopinathan	
Xiaonong(Frank) Sun	M.A.Sc	(9/2022 – current)	Xinyi(Cindy) Hou	Drini Kerciku	
			Tianyi(Ronan) Zhang	Selina Wan	
			2019	**2021**	
			Sharon Lin	Leo Hanxu	
			EnXu Li	Xiaonong(Frank) Sun	
			Dylan Hai-Hien Dao	Nicholas Popowich	
			Xin Chen		
			Yifan Cui		
			Rain Wu		