Rajrup Ghosh

Doctoral Student in Computer Science
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Interests

Research: AR/VR Streaming, 3D Capture and Rendering, Immersive Video Delivery, Systems for ML
Related: 3D Computer Vision, Edge Computing, Cloud Computing

Education

University of Southern California (USC)
Los Angeles, USA

Ph.D. in Computer Science — *2019 - present*

- **GPA:** 4.0/4.0
- **Position:** Research Assistant in **Networked Systems Laboratory (NSL)**
- **Advisor:** **Prof. Ramesh Govindan**

Indian Institute of Science (IISc)
Bangalore, India

M.TECH. in Computational Science — *2015 - 2017*

- **GPA:** 6.8/8.0, Gold Medalist

Indian Institute of Engineering Science and Technology (IIEST)
Shibpur, India

B.E. in Computer Science and Technology — *2011 - 2015*

- **GPA:** 9.3/10.0

Projects

Immersive Video Project [NSL]
USC, Los Angeles

Volumetric Video Streaming — *Aug 2021 - present*

- ***6DoF Video*:**
  - Volumetric videos capture 3D scenes in six degrees of freedom (6DoF), given by position and color information of the scene.
  - Developing an end-to-end pipeline consisting of live **stereo capture**, **registration**, **compression**, and **live streaming** to user devices.
  - Multiple Azure **Kinect cameras** deployed in an indoor environment capturing **point clouds** at 30 fps.
  - **Challenges:** Fast compression, Bit-rate Adaptation, Low Latency, Real-time Decompression, Realistic Rendering.
- ***6DoF Audio*:**
  - Capture audio from multiple **Ambisonic** or **Lavalier** microphones.
  - Track audio sources in the volumetric capture for accurate localization.
  - Generate spatial audio using **Head-related Transfer Functions (HRTFs)** from the localized sources relative to the user.
- **Applications**: Telepresence, Virtual Classroom, Collaborative Workspace, Telemedicine, AR/VR Multiplayer Gaming.
- This project is a part of **NSF Grant – Multi-perspective Video**.

Drone Project [NSL]
USC, Los Angeles

LIDAR-based Fast 3D Reconstruction using Drone — *June 2021 - Dec 2021*

- Capture **3D structures** like buildings, airplanes using a drone mounted **LIDAR** in the form of **point clouds**.
- Efficient trajectory planning for the drone to maximize the quality of reconstruction while minimizing battery usage.
- Offload heavy computation such as localization using SLAM and point cloud registration using ICP to the **Cloud**.
- Requires fast **point cloud compression** at different compression ratios depending on bandwidth.
- Will appear in *UbiComp 2023*.

CONIX Project [NSL]
USC, Los Angeles

Accelerating Deep Neural Network Inference — *Jan 2020 - May 2021*

- ***Scrooge*:**
  - A framework for scheduling data-dependent **DNN** workloads on **Cloud Clusters** that satisfy application SLOs, while minimizing VM cost.
  - Published in *ACM SoCC 2021* [Paper].
- ***RIM*:**
  - A framework for placing **DNN** applications on **Edge Clusters** that satisfy throughput and latency, while achieving high GPU utilization.
  - Published in *IoTDI 2021* [Paper].
- These projects are part of **CONIX Research Center**.

Masters Thesis [DREAM:Lab] *IISc, Bangalore*

Distributed Scheduling of Event Analytics across Edge and Cloud *Jan 2016 - June 2017*

- The thesis focused on efficient static and dynamic **scheduling** of distributed run-time query plans for complex event processing.
- Designed **algorithms** to map user queries on heterogeneous resources such as **Edge devices** (Raspberry Pi) and **Cloud VMs** (Azure) to meet constraints like compute latency, network bandwidth, and energy capacity of the resources.
- Published in *ACM TCPS 2018* [Journal] and *CCGRID 2018* [Conference Paper].
- This project was a part of **IISc Smart Campus Project**.

Selected Publications

Democratizing Telepresence *Submitted*

R. Ghosh, W. Pang, C. Shin, H. V. Madhyastha, R. Govindan *June 2023*

- Under review

AeroTraj: Trajectory Planning for Fast, and Accurate 3D Reconstruction using a Drone-based LiDAR *IMWUT/UbiComp*

F. Ahmad, C. Shin, **R. Ghosh**, J. D'Ambrosio, E. Chai, K. Sundaresan, R. Govindan *Sep 2023*

- IMWUT - Issue 3 Vol. 7
- UbiComp 2023 - 25th ACM international joint conference on Pervasive and Ubiquitous Computing

Scrooge: A Cost-Effective Deep Learning Inference System *SoCC*

Y. Hu, **R. Ghosh**, R. Govindan *1-3 Nov 2021*

- SoCC 2021 - 12th ACM Symposium on Cloud Computing, **URL:** Paper

Rim: Offloading Inference to the Edge *IoTDI*

Y. Hu, W. Pang, X. Liu, **R. Ghosh**, B. Ko, W. Lee, R. Govindan *18-21 May 2021*

- IoTDI 2021 - 6th ACM/IEEE Conference on Internet of Things Design and Implementation, **URL:** Paper

Adaptive Energy-Aware Scheduling of Dynamic Event Analytics across Edge and Cloud Resources *CCGRID*

R. Ghosh, S. P. R. Komma, Y. Simmhan *1-4 May 2018*

- CCGRID 2018 - 18th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing, **URL:** Paper

Distributed Scheduling of Event Analytics across Edge and Cloud *ACM TCPS*

R. Ghosh, Y. Simmhan *Sep 2018*

- ACM Transactions on Cyber-Physical Systems (TCPS), **URL:** Article

Experiences

Networking Research Group, Microsoft Research *Microsoft Research, Redmond*

Research Internship - Krishna Chintalapudi, Nikunj Raghuvanshi, Ranveer Chandra *May 2022 - Aug 2022*

- Real-time and batch Analytics in **Virtual Reality** (Ongoing).
- Developed a **supermarket application** in Virtual Reality where users can have real-life purchase experience.
- Supermarket provides personalized experience based on user's profile such as customized layouts, advertisements and music.

DMX Group, Microsoft Research *Microsoft Research, Redmond*

Research Internship - Krishna Chintalapudi *June 2020 - Aug 2020*

- Greedy layer-by-layer neural network training for tasks such as image classification, detection, and segmentation.
- Developed segmentation-based **person tracking** using body parts-based re-identification.
- Conceptualized **automated model training** for machine learning systems deployed in production pipelines.

Advanced Technology Lab, Samsung R&D Institute India *Samsung R&D Institute India*

Lead Engineer (Research Position) *July 2017 - July 2019*

- Built **on-device Neural Network**-based solutions for smartphone keyboard applications like Swipe, Auto-correct and Emoji Prediction.
- Developed applications over **Blockchain** - User Authentication System for smart building and peer-to-peer payment system.
- Developed an **IoT Query Engine** to perform data fusion on home appliance data stored across different SQL and NoSQL datastores.

Crypto Research Lab, IIT Kharagpur *IIT Kharagpur*

Summer Internship - Prof. Dipanwita Roy Chowdhury *Sum. 2013, Sum. 2014*

- Cryptanalysis of a light-weight hash function PHOTON using **fault-based attack** technique similar to Diagonal Faults for AES. A similar technique was applied for a SHA-3 Finalist hash function GROSTL.
- Studied the design and cryptanalysis of SHA-3 standard Keccak Hash Function for reduced round attacks.

Skills

Programming: C, C++, Python, Java, Golang
Frameworks/Platforms: Open3D, Point Cloud Library (PCL), Unity, CARLA, PyTorch, Tensorflow, CUDA, OpenMP, MPI, OpenCV
Development Tools: Visual Studio, Android Studio, Eclipse
Databases: Oracle, MySQL, MongoDB

Services

Reviewer: IEEE Vehicular Technology Magazine, Elsevier Computer Communications, Elsevier Computer Networks
Artifact Evaluator: MLSys 2023, NDSS 2023, SOSP 2023
Referred Reviewer: SOCC 2021, Mobicom 2022, NSDI 2022, NSDI 2023, Mobicom 2023, NSDI 2024

Achievements

Apr 2022 Nominated for **Outstanding Mentor Award** in the Spring 2022 Viterbi Graduate Mentorship Program.
2019 - Pres. Received **Annenberg Fellowship** for outstanding Ph.D. student joining in Fall 2019.
June 2018 Received **Motorola Gold Medal** for best performance in Master's degree in both academic courses and thesis.
June 2016 **Second** in Microsoft Research IoT Summer School hackathon on innovative IoT applications/projects.
2015 - Pres. Participated in Google APAC 2017 (Best Rank - 412), ACM ICPC 2015.
Jan 2015 Received **INAE (Indian National Academy of Engineering) Fellowship** for performance in internship under an INAE Fellow.

Teaching

CS 551/651: Teaching Assistant for **CS 551/651 - Advanced Computer Networks** in Spring 2022. *Instructor*: Prof. Ramesh Govindan
COS 598a: Guest Lecture at Princeton University for **COS 598a - Machine Learning-Driven Video Systems**. *Instructor*: Prof. Ravi Netravali

Courses

Systems: Operating Systems, Computer Networks, Distributed Systems, High Performance Computing, Parallel Programming
ML: Artificial Intelligence, Data Analytics, Data Analysis and Visualization
Basic: Design and Analysis of Algorithms, Probability & Statistics, Numerical Linear Algebra, Numerical Methods