Rajrup Ghosh

Doctoral Student in Computer Science
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Interests

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

Education

University of Southern California (USC)
Los Angeles, USA

Ph.D. in Computer Science — *Aug 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 — *Aug 2015 - July 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 — *July 2011 - Apr 2015*

- **GPA:** 9.3/10.0

Projects

Immersive Video Project [NSL]
USC, Los Angeles

Live Volumetric Video Streaming — *Aug 2021 - present*

- ***Point Cloud-based*:**
  - Volumetric videos capture 3D scenes in six degrees of freedom (**6DoF**), often represented as **point clouds**.
  - Developed an end-to-end pipeline to **live-stream** volumetric video over the internet at **30 fps** within **300 ms**.
  - Designed **bandwidth adaptation** for robust streaming in fluctuating network conditions.
  - The system leverages popular streaming technologies such as ***GStreamer***, ***Nvidia Codec SDK***, and ***WebRTC***.
  - **Challenges:** *Real-time encoding/decoding*, *Bandwidth adaptation*, *Low latency*, *Full frame rate*.
- ***GSplat-based*:**
  - Live capture and streaming of photo-realistic representation of participants/scenes for **3D video streaming** application.
  - Using **Gaussian Splatting (GSplat)** model to represent each frame of volumetric video.
  - Building the system using modern tools/frameworks such as ***NerfStudio*** and ***Unity***.
  - **Challenges:** *High bandwidth*, *Video-On-Demand*, *Inference on headset*, *Real-time rendering*.
- **Applications**: Telepresence, Virtual Classroom, Collaborative Workspace, Telemedicine, AR/VR Multiplayer Gaming.
- This project is a part of **NSF Grant – Multi-perspective Video**.

AR Localization Project [NSL]
USC, Los Angeles

AR Localization Using Gaussian Splatting, *ACM MM 2025* [Paper] — *May 2024 - April 2025*

- Proposed a method to perform **AR localization** by representing a map of an outdoor environment using **Gaussian Splatting (GSplat)**.
- **On-device** (iPhone, iPad, Vision Po) implementation of feature matching, GSplat rendering, and localization.
- Online **appearance adaptation** of the outdoor map in GSplat based on the time-of-day.
- The system is implemented in ***Swift*** using Apple's ***Metal*** library to replicate ***CUDA***-based rasterization.
- **Challenges:** *On-device GSplat rendering*, *Sparse linear optimization*, *Fast Gaussian sorting*

Drone Project [NSL]
USC, Los Angeles

LIDAR-based Fast 3D Reconstruction using Drone, *IMWUT/UbiComp 2023* [Paper] — *June 2021 - Dec 2021*

- Capture **3D structures** like buildings, airplanes using a drone-mounted **LIDAR** in the form of **point clouds**.
- Formulated **trajectory planning** as an optimization problem to minimize battery consumption, solved using ***Gurobi*** Library.
- Offload heavy computation such as localization using **SLAM** and point cloud registration using ICP to the Cloud.
- Implemented efficient point cloud compression using ***Draco***, adjusting compression ratios based on available bandwidth.

CONIX Project [NSL]

USC, Los Angeles

Accelerating Deep Neural Network Inference

Jan 2020 - May 2021

- ***Scrooge, ACM SoCC 2021*** **[Paper]:**
  - A framework for scheduling data-dependent **DNN** workloads on **Cloud Clusters** that satisfy application SLOs, while minimizing VM cost.
- ***RIM, IoTDI 2021*** **[Paper]:**
  - A framework for placing **DNN** applications on **Edge Clusters** that satisfy throughput and latency, while achieving high GPU utilization.
- 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).
- **Challenges:** *Compute latency*, *Network bandwidth*, *Battery capacity*
- This project was a part of **IISc Smart Campus Project**.

Selected Publications

LiVo: Toward Bandwidth-adaptive Fully-Immersive Volumetric Video Conferencing

CoNEXT

R. Ghosh, C. Shin, L. Zhang, M. Ye, T. Jin, H. V. Madhyastha, R. Netravali, A. Ortega, S. G. Rao, A. Rowe, R. Govindan

Dec 2025

- CoNEXT 2025 - 21st International Conference on emerging Networking EXperiments and Technologies, , **URL:** Paper

SplatPose: On-Device Outdoor AR Pose Estimation Using Gaussian Splatting

ACM MM

W. Pang, **R. Ghosh**, J. Yang, Z. Wei, B. Leong, Y. Wang, R. Govindan

Oct 2025

- ACM MM 2025 - 33rd ACM International Conference on Multimedia, **URL:** Paper

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 - Vol. 7 Issue 3
- UbiComp 2023 - 25th ACM international joint conference on Pervasive and Ubiquitous Computing, **URL:** Paper

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

- Developed a **VR Supermarket** application where users can have real-life purchase experiences.
- Supermarket provides personalized experience based on user's profile such as customized layouts, advertisements, and music.
- The system is built in ***Unity*** using ***Oculus XR*** and ***Triton Audio Spatialization*** plugin.

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, Swift, Android, Java, MATLAB, Golang

Frameworks/Platforms: GStreamer, WebRTC, Open3D, CUDA, Metal, Unity, PyTorch, Point Cloud Library (PCL), Draco, OpenMP, MPI

Development Tools: Visual Studio, Xcode, Android Studio, Eclipse

Databases: Oracle, MySQL, MongoDB

Services

Shadow TPC: CoNEXT 2025

Reviewer: IEEE Vehicular Technology Magazine, Elsevier Computer Communications, Elsevier Computer Networks

Artifact Evaluator: NSDI 2026, JSys 2025, EuroSys 2025, NDSS 2025, JSys 2024, SOSP 2024, NDSS 2024, MLSys 2023, SOSP 2023

Referred Reviewer: NSDI 2024, Mobicom 2023, NSDI 2023, NSDI 2022, Mobicom 2022, SOCC 2021

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

CSCI 353: Teaching Assistant for **CSCI 353 - Internetworking** in Fall 2025. *Instructor*: Prof. Ramesh Govindan

EE 689: Guest Lecture for **EE 689 - Computational Intelligence and Neural Learning** in Fall 2024. *Instructor*: Prof. Bart Kosko

EE 689: Guest Lecture for **EE 689 - Computational Intelligence and Neural Learning** in Fall 2023. *Instructor*: Prof. Bart Kosko

CSCI 551/651: Teaching Assistant for **CSCI 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** in Spring 2022. *Instructor*: Prof. Ravi Netravali

Courses

Systems: Operating Systems, Computer Networks, Distributed Systems, High-Performance Computing, Parallel Programming

ML: Advanced Computer Vision, Artificial Intelligence, Data Analytics, Data Analysis and Visualization

Basic: Design and Analysis of Algorithms, Probability & Statistics, Numerical Linear Algebra, Numerical Methods