

# Shubhang Bhatnagar

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## EDUCATION

### University of Illinois Urbana-Champaign

Aug '21- Present

Ph.D. student in Electrical and Computer Engineering, **Advisor-** Prof. Narendra Ahuja

### Indian Institute of Technology, Bombay

Jul '16- Jul '21

Dual Degree (B.Tech + M.Tech) Electrical Engineering, Specializing in Signal Processing, Minor in CS

**GPA 9.81/10**, **Institute Silver medal**, **Department Rank 1/72**, **Advisor-** Prof. Amit Sethi

### Nanyang Technological University, Singapore

Jul '19- Dec '19

**GPA 4.82/5**, TFLearn Fellowship Semester Exchange in Electrical Engineering

## PROFESSIONAL EXPERIENCE

### Bosch Research, CA | Computer Vision & Mixed Reality intern

('22)

- Designed, implemented and demonstrated a long distance **gesture recognition** system to interact with and control mobile robots, achieving state-of-the-art recognition accuracy on the LD-ConGR dataset while **reducing model** size by 40% using a novel **spatially dynamic** 3D neural network (presented at IROS'23). Patent under review .

### Qualcomm | Modem Firmware Intern

('19)

- Developed a tool to help optimize modem firmware for chipsets by **analyzing data** and automating multiple tasks, with the tool being eventually deployed on 50+ workstations for the team

### Decimal Point Analytics | Computer Vision intern

('18)

- Worked on designing a **CNN** based product to estimate household income from photos by recognizing objects of interest.

## SELECTED PUBLICATIONS

- Piecewise-Linear Manifolds for Deep Metric Learning** [paper], S. Bhatnagar, Narendra Ahuja, in **CPAL 2024 (Oral)**
- Long-Distance Gesture Recognition using Dynamic Neural Networks** [paper][arxiv], S. Bhatnagar, Sharath Gopal, Narendra Ahuja, Liu Ren, in **IROS 2023**
- PAL - Pretext Based Active Learning** [paper], S. Bhatnagar, S. Goyal\*, D. Tank\*, Amit Sethi, in **BMVC 2021**
- Analyzing Cross Validation in Compressed Sensing with Gaussian and Impulse Measurement Noise with L1 Errors** [paper], S. Bhatnagar\*, C. Gurjarpadhye\*, A. Rajwade, in **EUSIPCO 2021**
- QR Code Denoising Using Parallel Hopfield Networks** [preprint], S. Bhatnagar\*, I. Bhatnagar\*, Arxiv Pre print, 2018
- Memory Efficient Attention For Multi Domain Learning** [preprint], H.Aswani, A.Kanse, S.Bhatnagar, A.Sethi, 2021
- Insights on coding gain and its properties for principal component filter banks** [paper], P. Chaphekar, A. Bhatia, S. Bhatnagar, et al., Sādhanā, Journal of the Indian Academy of Sciences, 2023

*\*denotes that these authors contributed equally*

## KEY RESEARCH PROJECTS

### Potential Field based Metric Learning, Under Review

Prof. Narendra Ahuja, UIUC

- Proposed a continuous potential-field representation to model the influence of embeddings as opposed to discrete n-tuplet/contrastive models used in deep metric learning (DML). Proved that such a potential field forms a better model of the data distribution than previous methods, helping learn better **representations for visual search** while being more robust to label noise. Reduced error on zero-shot image retrieval benchmarks by **more than 10%** compared to **SOTA**.

### Piecewise-Linear manifolds for Deep Metric Learning [project page], CPAL '24, Oral

UIUC

- Proposed a **unsupervised framework** to learn semantically meaningful representations from images. Our framework models the data manifold using a piecewise linear model, identifying images with similar content with **50% better accuracy** than current SOTA methods. Representations learned established a new **SOTA** on unsupervised deep metric learning benchmarks.

### Long-Distance Gesture Recognition using Dynamic Neural Networks [project page], IROS '23

UIUC, Bosch

- Proposed a **novel dynamic neural network** to enable gesture recognition from long distances by identifying and processing only gesturing subject features. Outperformed **SOTA** in terms of recognition accuracy while using **40% lesser compute**.

### PAL - Pretext Based Active Learning [paper][slides], BMVC '21

Masters Thesis, IITB

- Proposed a **technique** to estimate the novelty of a sample for a given model by using self-supervision to augment task-specific uncertainty leading to a better and more diverse selection of samples for active learning. Required 15% less labeled data than **state-of-the-art** techniques to achieve the same performance on classification and semantic segmentation.

## Efficient Music Conditioned Dance Motion generation

Prof. Liangyan Gui, UIUC ('22)

- Proposed a multi-modal spatiotemporally **separable GCN** to generate human dance poses conditioned on music using the AIST++ dataset. The proposed model used **10x fewer parameters** than SOTA while still being competitive in generation quality.

## Robust CV in Compressed Sensing [paper] [slides] [arxiv], EUSIPCO '21

Prof. Ajit Rajwade, IITB

- Proposed a novel technique** for selecting parameters using the L1 **cross-validation (CV)** error and **theoretically proved** it yields optimal reconstruction in presence of noise demonstrating **order of magnitude gain** over other techniques empirically

## Designing of pipelined RISC processors | Prof. Virendra Singh, IITB [code]

('18)

- Designed and implemented **datapath and control unit** of a multicycle and a pipelined processor on an FPGA. Implemented the Turing complete **IITB-RISC** instruction set with logic for hazard detection, forwarding and stalling in a **6-stage** pipeline design.

## Noise Tolerant QR Code Recognizer using Hopfield Network [pre-print]

(IITB, '18)

- Proposed a **novel technique** to use Hopfield networks in **parallel** using the **energy gradient difference** around trained and false energy minima, providing a method to deal with applications requiring large storage capacity, like QR code denoising.

## HONORS AND AWARDS

- Institute Silver Medal**, IIT B for graduating at the top of my batch ('21)
- Institute Award for academic excellence**, IIT B (twice) ('18,'20)
- INSPIRE** scholarship, Govt of India for being in top 1% of class 12 ('15)
- Bhavesh Gandhi memorial award** given to most outstanding student in EE IITB ('21)
- Temasek Foundation TFLearn** fellowship ('19)
- KVPY fellowship** awarded by Govt of India with All India Rank 93 ('13)

## TECHNICAL PROJECTS

- End to End licence plate recognition
- Music genre recognition using CNN's
- Low cost class D amplifier design
- General equalizer design using DSP
- Face Image de-specularization
- Iris Recognition
- Bus tracking system
- Steganography using wavelet transform
- Few-Shot Interactive Segmentation
- Wireless Video Transmission Through Obstacles

## SKILLS

- Programming Languages:** Python, Pytorch, TensorFlow, Java, MATLAB, C, C++, ROS, VHDL
- Software Packages:** NGSPICE, Quartus, AutoCad, Git, GNURadio, Selenium, Pandas, Gazebo

## POSITIONS OF RESPONSIBILITY

### Graduate Teaching Assistant

('18,'20,'21)

- Responsible for tutorials, guiding and evaluating the performance of students in MA 207 Complex analysis, EE214 Digital circuits lab and EE 308 Communication systems.

### Institute Student Mentor| SMP, IIT B

('20)

- Responsible for **mentoring** and **guiding** incoming batch of freshmen in academic and co-curricular endeavors

## KEY COURSES UNDERTAKEN

Computer Vision	Computer Vision, Efficient and predictive vision, Digital Image Processing, Advanced Image Processing
ML and Optimization	Intro to Machine Learning, Stochastic Optimization, Deep learning theory, Advanced Signal Processing, Pattern recognition
Math and statistics	Markov chains, Calculus, Random Processes, Linear Algebra, Vector space signal processing
Electrical Engineering	Microprocessors, Audio signal processing, Information security, Digital Signal Processing, Digital Communication
Computer Science	Computer Networks, Operating Systems, Data Structures and Algorithms

## MISCELLANEOUS

- Served as a **Reviewer** for ICPR '20, CVPR '22, '23, '24
- Presented a poster on Steganography at the **MHRD-TEQIP-KITE** workshop for knowledge incubation ('19)
- Represented India** in the **Young Asian Leaders** Forum for development held at NUS, Singapore ('19)