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 Funded Semester Exchange Program in Electrical Engineering

Professional Experience

Bosch Research, CA | Computer Vision & Mixed Reality intern *(May'22 - Sep'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 *(May'19 -Jul'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 *(Jun'18- Aug'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**, S. Gopal, N. Ahuja, L. Ren, in **IROS 2023**
- **PAL - Pretext Based Active Learning** [paper], **S. Bhatnagar**, S. Goyal*, D. Tank*, A. 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

* denotes that these authors contributed equally

Key Research Projects

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

- Proposed a **unsupervised framework** to learn semantically meaningful representations from data. Our framework models the data using a piecewise linear model, identifying semantically similar points 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 focusing on processing only gesturing subject features. Outperformed **SOTA** in terms of recognition accuracy while using 40% lesser compute.

Potential Field based Metric Learning, *Under Review* *Prof. Narendra Ahuja, UIUC*

- Proposed a potential-field minimization approach to help CNNs learn effective **representations for semantic visual search**. Potential fields model point influence enabling learning of rich intra and inter-class features with inter-batch influence modeled using proxies. The proposed method achieved **SOTA** on zero-shot image retrieval benchmarks on the Cars, CUB200 and SOP datasets.

PAL - Pretext Based Active Learning [paper][slides], *BMVC '21* *Masters Thesis, IITB*

- Proposed a **novel technique** to predict informativeness of a sample combining supervision and self-supervision for better **reliability** and **robustness**. Outperformed **state-of-the-art** techniques in experiments on classification and segmentation

Efficient Music Conditioned Dance Motion generation *Prof. Liangyan Gui*, UIUC *(Jan'22 -Jul'22)*

- Proposed a multi-modal spatio-temporally **separable GCN** to generate human dance poses conditioned on music using the AIST ++ dataset. The proposed model used **10x fewer parameters** than SOTA.

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* **[code]** (Oct'18-Dec'18)

- Designed and implemented **datapath and control unit** of a multicycle and a pipelined processor on an FPGA
- Implemented Turing complete **IITB-RISC** instruction set with instructions like conditional jump and store multiple
- Designed and included logic for hazard detection, data forwarding, stalling etc in the **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)
- **Bhavesh Gandhi memorial award** given to most outstanding student in EE IITB ('21)
- **Institute Award** for **academic excellence**, IIT B (twice) ('18,'20)
- **Temasek Foundation TFLearn** fellowship ('19)
- **INSPIRE** scholarship, Govt of India for being in top 1% of class 12 ('15)
- **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**
- **Designing of pipelined RISC processors**

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, Probability and 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)