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

Publications

- **PAL - Pretext Based Active Learning** [paper]
  S. Bhatnagar, S. Goyal*, D. Tank*, A. Sethi, in **BMVC 2021**
- **CCNet : Why Have FC Layers When Clustering is All You Need**, N. Ahuja, N. Mahajan, **S. Bhatnagar**, submitted **CVPR 2022**
- **QR Code Denoising Using Parallel Hopfield Networks** [pre-print]
  S. Bhatnagar *, I. Bhatnagar *, Arxiv Pre print, 2018
- **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**
- **Memory Efficient Adaptive Attention For Multiple Domain Learning**
  H.Aswani, A.Kanse, **S.Bhatnagar**, A.Sethi, In submission

* denotes that these authors contributed equally

Research Experience

PAL - Pretext Based Active Learning [paper][slides]
BMVC '21 *(Mar '20 – Mar'21)*
Master's Thesis, Advisor - Prof. Amit Sethi, IIT Bombay

- Proposed a **novel technique** to predict informativeness of a sample combining supervision and self supervision for better **reliability** and **robustness**, using the difficulty of solving the pretext task as an input
- Outperformed current **State of the Art** techniques in experiments on CIFAR10, CityScapes, SVHN and Caltech-101

CCNet : Explainable CNN's through clustering
Advisor - Prof. Narendra Ahuja, UIUC (Jul'21- Present)

- Proposed CA(clustering algorithm) which can be trained in parallel to the convolutional layers in place of the fully connected layers, helping better **interpretability** and **lower network size** without loss in performance

Construction of Optimal Filter banks
Advisor - Prof. V.M. Gadre, IIT Bombay (Feb'21- Jul'21)

- Analyzed and **proved** properties of the coding gain of principal component filter bank under transforms of input and that it is monotonous with an increase in subbands for sinusoids, providing **insights for construction** of better filter banks

Real Time Wireless Video Transmission Through Obstacles [report]
Advisor- Prof. Shalabh Gupta, IIT Bombay (Jan'19-May'19)

- Designed, simulated, soldered and tested PAL video transmitter and receiver modules including upconverter, downconverter, noise rejection filters and amplifiers at 400 MHz for real time exchange of video achieving a range of more than **100 m out of line of sight**

Robust Cross Validation in Compressed Sensing
[paper] [supplement] *EUSIPCO '21 (Mar '20 – Oct '20)*
Advisor- Prof. Ajit Rajwade, IIT Bombay

- **Proposed a novel technique** for selecting parameters using the L1 cross-validation (CV) error and **theoretically proved** that it yields optimal reconstruction with high probability in presence of noise
- Demonstrated using simulations that using L1-CV results in an **order of magnitude gain** in PSNR over other techniques

Noise Tolerant QR Code Recognizer using Hopfield Network [pre-print] *(May'18-Jul'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

Few-Shot Interactive Segmentation
Advisor - Prof. Amit Sethi, IIT Bombay (Jan'21- Jul'21)

- Proposed a **novel architecture** for interactive segmentation to effectively use only a few images, outperforming suitably adapted segmentation methods on the **PASCAL-5i** dataset

Memory Efficient Adaptive Attention For Multiple Domain Learning
Advisor - Prof. Amit Sethi, IIT Bombay (Jan'21-Jul'21)

- Proposed attention based module to be attached in parallel to fixed convolutional layers for domain adaptation, helping reduce the number of trainable parameters by an **order of magnitude** over state of the art while demonstrating comparable performance on the visual decathlon challenge.

Professional Experience

Qualcomm | Modems Intern *(May'19-Jul'19)*

- Developed an automated **tool to optimise** the testing process for chipsets, **analysing** and automating multiple tasks, which was deployed on 50+ workstations for the modems team

Decimal Point Analytics|Image Pulse *(Jun'18 - Jul'18)*

- Worked on designing a **convolutional neural network** based method to estimate the income of a household from it's images

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 (S$6500) ('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**
- **Pipelined and Multicycle RISC processor design**
- **Noise cancelling headphones**
- **Bus tracking system**
- **Steganography using wavelet transform**

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 laboratory 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

Technical Skills

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

Key Courses Undertaken

Image Processing	Computer Vision, Digital Image Processing, Advanced Image Processing
Machine learning	Intro to Machine Learning, Stochastic Optimization, Advanced Signal Processing, Deep Learning theory, Pattern recognition
Math and statistics	Markov chains, Calculus, Probability and Random Processes, Linear Algebra
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 **Computational Aspects of Deep Learning(CADL), ICPR** ('20)
- 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)