Chaitanya Kapoor

chaitanya.7.kapoor@gmail.com github.com/ckapoor7 ckapoor7.github.io

Research Interests

My research interests lie at the intersection of 3D vision and computational imaging. I seek to apply these principles to design better imaging systems and algorithms to perceive the 3D world around us.

Education

Birla Institute of Technology and Science (BITS), Pilani **Nov. 2020 – Present**
B.E. (Hons.) in Electrical and Electronics engineering *Pilani, India*

Publications

Large-Scale 3D ExM Registration: A Comparison of Methods
A. Casamitjana, G. Fleishman, E. Besier, R. Zhang, M. Alawi, ***C. Kapoor****, H. Pfister, E. S. Boyden, D. Wei*
[manuscript in preparation]

Multiplexed Expansion Revealing for Imaging Multiprotein Nanostructures in Healthy and Diseased Brain
J. Kang, M. Schroeder, Y. Lee, ***C. Kapoor****, E. Yu, T. B. Tarr, K. Titterton, M. Zeng, D. Park, E. Niederst, D. Wei, G. Feng, E. S. Boyden*
[Under review - Nature Methods]

RnR-ExM: Robust Non-Rigid Registration Challenge for Expansion Microscopy Volumes
E. Besier, R. Zhang, Y. Bando, Y. Quéméner, ***C. Kapoor****, M. Alawi, M. Hoffman, A. Dalca, A. Casamitjana, I. Arganda-Carreras, E. S. Boyden, H. Pfister, D. Wei*
IEEE International Symposium on Biomedical Imaging (IEEE ISBI), 2023 - **website**

Attention-enabled Deep Neural Network for Enhancing UAV-Captured Pavement Imagery in Poor Visibility
C. Kapoor*, A. Warrier, M. Singh, P. Narang, H. Puppala, R. Srinivas, A. P. Singh*
IEEE Multimedia Information Processing and Retrieval (IEEE MIPR), 2023 - **paper**

Fast and Lightweight UAV-based Road Image Enhancement Under Multiple Low-Visibility Conditions
C. Kapoor*, A. Warrier, M. Singh, P. Narang, H. Puppala, R. Srinivas, A. P. Singh*
PerCom Workshops (PerSASN 2023) - **paper**

Dense Residual Networks for Gaze Mapping on Indian Roads
C. Kapoor*, K. Kumar, S. Vishnoi, S. Ramanathan*
preprint

Research Experience

Talmo Lab **May 2023 – Present**
Supervisor: Dr. Talmo Pereira *Salk Institute, La Jolla, CA*

- Working on the development of methods for pose estimation and tracking to quantify animal behavior through robust tracking of anatomical landmarks in 3D.
- Designing algorithms utilizing projective geometry to create inputs for a CNN that leverages geometric reasoning.

Camera Culture Group **August 2022 – Present**
Supervisor: Dr. Ramesh Raskar *Massachusetts Institute of Technology, Boston*

- Working on extracting environments from surfaces of glossy objects from sparse, and unstructured views.
- Exploring methods that incorporate shape priors, which enable us to turn everyday objects having unknown geometry into radiance-field camera to image the world from an objects perspective.

McGovern Institute of Brain Research **Feb. 2022 – Present**
Supervisor: Dr. Donglai Wei *Massachusetts Institute of Technology, Boston*

- Working on the development of a *generalist* 3D segmentation model for Expansion Microscopy (ExM) volumes for various animal species.
- Proposing a human-in-the-loop feedback learning mechanism, built on top of an existing deep learning framework, NucMM.
- Worked on developing a new joint-intensity and point-based, high throughput image registration algorithms having nanoscale precision ($\mathbf{10-40}$ nm) for Multiplexed Expansion Revealing **(multiExR)**. This work is currently under review at Nature Methods.

Multimodal Cognition Research Group **Jan. 2022 – Feb. 2023**
Supervisor: Dr. Pratik Narang *BITS Pilani, India*

- Worked on image-to-image translation from RGB to hyperspectral color space by making use of an ACL-GAN.
- Worked on enhancing drone Based Surveillance in Low-Visibility Conditions by using YOLOv8 and canonical image processing techniques to build a toolbox for civil engineers to conduct pavement health monitoring.

Sally Robotics **August 2021 – June 2023**
Supervisor: Prof. Bijay Kumar Rout *BITS Pilani, India*

- Lead of the Computer Vision subsystem.
- Worked on designing lightweight Real time Semantic Segmentation algorithms for deployment on autonomous vehicles
- Proposed using a dense residual network architecture for monitoring a car driver's *gaze* to assess attentiveness.
- Using the proposed method, we surpassed SOTA accuracies by **1.5**% without prior conditioning.

Invited Talks

06/23 **SIS Symposium, Harvard SEAS,** *Seeing Beyond the Camera*

Teaching Experience

Department of Mathematics, BITS Pilani **August 2023 – Present**
Teaching Assistant *Pilani, India*

- **Undergraduate TA**: assisting with the course Combinatorial Mathematics (MATH F421)

Other Projects

Expression Recognition using Deep CNNs | *Python* **August 2021**

- Facial expression recognition seeks to classify facial expressions into various categories such as **anger, fear, surprise** etc. Using the network model from DeXpression, and enhancing it with **5-fold** cross validation on the canonical Extended Cohn-Kanade (CKP+48) dataset, I was able to achieve a mean training set accuracy of **99.47%** and a mean testing accuracy of **98.98%**.

Generative Adversarial Network (GAN) | *Python* **April 2021**

- This introductory project uses a GAN to generate numeric digits from its corresponding Devanagari equivalent. I used `scikit-learn` to implement the digit classifier, and wrote the GAN implementation (from scratch using `numpy`), which using output from the digit classifier, generates digits in the MNIST dataset.

Technical Skills

Languages: Python, C, MATLAB, Unix Shell Scripting , LaTeX
Technologies/Frameworks: Keras, Tensorflow, Numpy, PyTorch, Git, OpenCV