Sanjeev Kumar

Date of birth: xx xxx 1992
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Profile: A researcher working at the intersection of **physical optics** and **image/signal processing**, with a focus of understanding the bottleneck problems in **biomedical sciences**, which can be solved with quickly evolving optical and computational techniques. Highly motivated for developing a long term academic research career in "unconventional optical systems" and "light transport and associated inverse problems".

Areas of Interest: Computational Microscopy, Computational Imaging, Optics, Mathematical and Computational Optics, Light Transport and Inversion, Optical Microscopy and Biomedical Optics.

Experience

California Institute of Technology, USA   July 2023-Present
Postdoctoral Research Associate (Image Reconstruction)

Singapore-MIT Alliance for Research and Technology   Jan 2022-June 2023
MIT's research enterprise in Singapore
Postdoctoral Research Associate (Computational Microscopy)

Massachusetts Institute of Technology, USA   Oct. 2022-Dec. 2022
Visiting Researcher (Computational Microscopy)

Defence Institute of Physiology and Allied Sciences
Defence Research and Development Organisation, India   June 2012-July 2012
Trainee (Biomedical Instrumentation)

Education

Indian Institute of Technology, Kharagpur, India   2016-2021
Doctor of Philosophy (Lensless Holography)
Thesis: Expectation-maximization based frameworks for holographic microscopy

Indian Institute of Technology, Kharagpur, India   2014-2016
Master of Technology (Medical Imaging and Informatics)

University School of Biotechnology
Guru Gobind Singh Indraprastha University, New Delhi, India   2010-2014
Bachelor of Technology (Biotechnology)

Relevant Courses Taken

Postdoc, MIT	Computational Imaging, Computational Photography.
Ph.D. ***IIT Kharagpur***	Advanced Digital Image Processing and Computer Vision, Machine Learning, Statistical Methods.
M.Tech. ***IIT Kharagpur***	Digital Image Processing, Pattern Recognition and Machine Intelligence in Medicine, Molecular Imaging, Physics and Instrumentation of Medical Imaging, Biomedical Instrumentation, Optoelectronic Material and Devices, Optoelectronics based Instrumentation, MEMS and Biosensors.

Awards and Scholarships

- Received **Gandhian Young Technological Innovation (GYTI) award 2021**, a national level award in India, given to promote entrepreneurial ventures to motivate solutions for unmet social needs.
  Project: A Low Cost Pocket-sized Digital Microscope.
- Received **Council of Scientific and Industrial Research (CSIR), India fellowship**. 2 years Junior Research Fellowship (JRF) and 3 years Senior Research Fellowship (SRF).
- Received Ministry of Human Resource Development (MHRD), India 2 year scholarship for Master of Technology.
- Secured **All India Rank 23** in Graduate Aptitude Test in Engineering (GATE) - 2014 in Biotechnology, a national level exam conducted for the eligibility and scholarship for postgraduate engineering studies in India.
  Score: 817/1000, Percentile: 99.8.
- Secured **All India Rank 23** in CSIR National Eligibility Test (NET) - 2014 in Life Sciences, a national level exam conducted for the eligibility and scholarship for research studies in India.
- Secured **All India Rank 36** in CSIR National Eligibility Test (NET) - 2013 in Life Sciences.

Technical Skills

IMAGE PROCESSING	Physics-informed Neural Networks, Untrained Neural Networks (Deep Image Prior), Digital Refocusing, Iterative Image Reconstruction, Compressed Sensing.
COMPUTATIONAL OPTICS	Digital Holography, Coherent Diffractive Microscopy, Phase-Retrieval Algorithms, Interference Fringe Pattern Processing.
HARDWARE	Assembling Optical Imaging Setups, Interferometric setups, Lasers, Optical Fibers, Illumination systems, Objective Lenses and other Optical Elements, Image sensors, Raspberry Pi.
PROGRAMMING LANGUAGES	Python, MATLAB, C, LaTeX.

Languages Known

- English (fluent), Hindi (first language).

Research Experience

- Developed a computational microscopy method of encoding the fluorescent neuronal cells located in a 3D volume (3D scaffold and 3D organ) in a single snapshot, followed by the volume reconstruction algorithm. (Postdoc).

- Developed an untrained deep neural network based method of defocus fringe suppression in coherent imaging. (Postdoc).

- Developed physics-informed neural network based method for single-shot phase retrieval, useful for diffractive imaging. Also demonstrated it's effectiveness in extremely high quantization noise conditions. (Ph.D.).

- Developed compressed sensing principle based iterative frameworks for single-shot holographic tomography and single-shot phase retrieval, in lensless diffractive imaging setups. (Ph.D.).

- Showed that high resolution holographic microscopy is not limited to high coherence light sources, as believed conventionally. (Ph.D.).

- Showed that photonic crystal fiber is a good illumination source for holographic microscopy, for improvements in resolution and magnification. (Ph.D.).

Other Minor Projects

- Deep prior based computational super-resolution applied on fourier ptychographic microscopy datasets (worked with online datasets).
- Coded aperture lensless imaging in passive illumination.
- Influence of exposure time and image fusion on lensless microscopy.

Publications

Manuscript to be submitted

1. **Sanjeev Kumar**, Chongquan Huang, Zheng Li, Vincent Lin, Sing Yian Chew, Rajeev J Ram "Caustic wavefront encoded imaging for snapshot 3D fluorescence microscopy" (draft ready for Nature Communications).

Journals/Conference Proceedings

1. **Sanjeev Kumar**, Zheng Li, Chongquan Huang, Vincent Lin, Sing Yian Chew, Rajeev J Ram, "Exploiting caustics for snapshot 3D fluorescence imaging in wide-field microscopy", Computational Optical Sensing and Imaging (COSI), Optica Imaging Congress, 2023.

2. **Sanjeev Kumar**, Manjunatha Mahadevappa and Pranab K. Dutta "Compressive holography from poisson noise plagued holograms using expectation-maximization", IEEE Transactions on Computational Imaging, Volume 6, 2020. (click here)

3. **Sanjeev Kumar**, Manjunatha Mahadevappa and Pranab K. Dutta "Lensless in-line holographic microscopy with light source of low spatio-temporal coherence", IEEE Journal of Selected Topics in Quantum Electronics, Volume 27(4), 2021. (click here)

4. **Sanjeev Kumar** "Phase retrieval with physics informed zero-shot network", Optics Letters, Optica Publishing Group (formerly OSA), Volume 46(23), 2021. (click here).

5. **Sanjeev Kumar**, Manjunatha Mahadevappa and Pranab K. Dutta "Extended light-source-based lensless microscopy using constrained and regularized reconstruction", Applied Optics, Optica Publishing Group (formerly OSA), Volume 58(3), 2019. (click here)

6. **Sanjeev Kumar**, Manjunatha Mahadevappa and Pranab K. Dutta "Photonic crystal fiber for high resolution lensless in-line holographic microscopy", Optical Fiber Technology, Elsevier, Volume 58, 2020. (click here)

7. **Sanjeev Kumar**, Ravi Prakash, Satish Chouhan, AK Salhan, "CMOS sensors for microscopy, spectrophotometry and as a transducer in biosensors", IEEE Point-of-Care Healthcare Technologies (PHT)-2013, Pages 196-199, 2013. (click here)

Archives

1. **Sanjeev Kumar**, Manjunatha Mahadevappa and Pranab K. Dutta "Geometric solution of image degradation by diffraction in lensless sensing and microscopy", arxiv.org, 2020. (click here)

Reviewer

- Optics Letters, Optics Express, Journal of Biomedical Optics.

Invited Talks

1. Invited talk at MIT on the topic "Snapshot 3D Fluorescence Microscopy with Caustics". September 2023 (online).
2. Invited talk at Singapore-MIT Alliance for Research and Technology (SMART) on the topic "Holographic Microscopy". January 2021 (online).

Teaching Assistant

1. Digital image processing lab at IIT Kharagpur (July-Dec. 2018 and July-Dec. 2019).

References: Available upon request.