Ritika Malik

Prime Minister Research Fellow (PMRF)

Contact

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Dept. of Physics, IIT Delhi
New Delhi, India -110016

Skills

Computational

MATLAB, GNU Octave
LATEX, GNU plot
Jupyter Notebook
High Performance Computing (H.P.C.)

Instrumental

Microscopy - Brightfield, fluorescence, DHM
Spatial Light Modulators (SLM)
Scientific Camera Software

Education

Indian Institute of Technology, Delhi

Ph.D **Computational Imaging** 2019 - Present
Thesis : Information efficient computational imaging system.

Indian Institute of Technology, Delhi

M.Sc. **Physics** 2016 - 2018
Thesis : Electromagnetic analysis of diffraction and intereference.

D.A.V. College, Muzaffarnagar, U.P.

B.Sc. **Phy, Chem, Math** 2013 - 2016

Languages

English

Hindi

Profile

I am experienced in the field of computational imaging, with a specialization in developing information-efficient imaging systems. My expertise lies at the intersection of optics and mathematics, enabling the development of advanced imaging systems and the understanding of underlying theoretical principles and image reconstruction techniques. Additionally, I integrate computer vision applications to advance this domain further. By, leveraging my comprehensive knowledge and analytical skills, I aim to contribute to the progression of computational imaging technologies worldwide.

Work Experience

Indian Institute of Technology, Delhi

Prime Minister's Research Fellow — Feb 2021- present
[Supervisor: Prof. Kedar B. Khare & Prof. Ravikrishnan Elangovan]

- Objective: Increasing the information capacity of Imaging systems, especially digital microscopes and cameras.
- Space-Bandwidth product is taken as an information measure for the optical system. One way to increase the information capacity of the system is to improve its bandwidth, which leads to all the super-resolution microscopic techniques. Another way is to increase the spatial part, which leads to a large field of view system. We are working with the later class to increase the information capacity of the system. We increase the field of view of the system with a special design of the point spread function (PSF) of the system. We are also developing the algorithm to reconstruct the large field-of-view image from the collected data with the designed PSF.

Indian Institute of Technology, Delhi

Junior Research Fellow — July 2019 - Feb 2021
[Supervisor: Prof. Kedar B. Khare & Prof. Ravikrishnan Elangovan

- Objective: Determining a practical criterion for focusing on unstained cell samples using a digital holographic microscope
- Digital holographic microscopy (DHM) is an important technique that may be used for quantitative phase imaging of unstained biological cell samples. Since DHM technology is not commonly used in clinics or bioscience research labs, at present, there is no well-accepted focusing criterion for unstained samples that users can follow while recording image-plane digital holograms of cells.
- In this work, we have developed a practical method for estimating the best focus plane in the digital hologram domain. This method identifies the optimal focus by observing phase modulation in fringe patterns, ensuring minimal amplitude modulation.

Indian Institute of Technology, Delhi

Research Project
[Supervisor: Prof. Kedar Bhalchandra Khare

July 2018 - July 2019

- Objective: Unsupervised organization of cervical cells using digital holography microscopy.
- Digital Holographic Microscopy (DHM) is an interferometric imaging technology that provides quantitative phase information. The phase function contains information on the optical path length (product of refractive index and thickness) through the cell sample. By using unsupervised machine learning algorithms (PCA, Kernel PCA, Gaussian Mixture Model), it is possible to separate cancerous cells from normal cells in a 2D plot of the first two principal components.
- In this project, we collect data on different types of cells using the DHM system. We extract parametric information using the brightfield images as well as using quantitative phase values. We apply PCA to parameters to separate normal and cancerous cells.

Indian Institute of Technology, Delhi

July 2017 - May 2018

Master's Thesis (Research Project)
[Supervisor: Prof. Kedar Bhalchandra Khare & Prof. P.Senthilkumaran]

- Objective: Design a meta-surface structure for bending light in the desired direction.
- Metasurfaces are sub-wavelength sized structured elements arranged such that they impart the desired phase to the incident light, which then leads to the bending of light in the desired direction. Properly designed metasurface helps in various applications such as flat optical lenses, super-resolution, optical cloaking, etc.
- In this project, we did simulation studies using the Maxwell FDFD tool to design a gradient metasurface structure that has the ability to focus light and, therefore, shows the behavior of a flat lens. We were also able to calculate the approximate value of the angle at which light bends using effective medium theory

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NCRA -TIFR

May 2017 - July 2017

Internship [Research Project (as a VSRP student)]
[Supervisor: Dr. Sushan Konar]

- Objective: Statistical studies of the radio pulsar's glitches.
- Neutron stars are one of the most extreme and exciting nuclear physics laboratories in the universe, with a mass slightly above that of the sun, compressed into a radius of 10 km. Radio pulsars are the rotating magnetized neutron star. Their huge moment of inertia, 10^45gcm^2, leads to exceptionally stable rotation rates and provides us with the most stable clock in the universe. Radio pulsars exhibit several timing irregularities, the most striking of which are so-called glitches. Pulsars are observed to slow down due to the continuous emission of electromagnetic radiation, but this continuous slow down breaks at the time of glitches. Glitches are sudden spin-ups in the normal slowdown rate of pulsars, and their observation in pulsars helps in probing the interior of Neutron stars.
- In this project, we tried to find a systematic(if any) relationship between glitch size and pre/post glitch size using glitch data from Jodrell Bank Telescope. We had not seen any standard repetitive trends in plots of glitch size versus pre/post-glitch time. Also, no trends were seen for the consecutive glitches.

Academic Achievements

2024 • **Recommended with Commendation Research**
Recognized and appreciated by the National Review Committee, PMRF, 2023.

2023 • **Best Oral Presentation Award**
International Conference on Advanced Biomedical Imaging 2023, IIT Madras.

2021 • **Prime Minister Research Fellowship (PMRF),** February 2021.

2019 • Joint Entrance Screening Test (JEST), 2019
All India Rank: 18.

2019 • Gratitude Aptitude Test in Engineering (GATE), 2019
All India Rank: 46, score: 755.

2018 • Council of Scientific and Industrial Research-National Eligibility Test, Junior Research Fellow (CSIR-NET JRF), 2018
All India Rank: 108

2017 • Visiting Student Research Program (VSRP), 2017
Selected for an internship at NCRA-TIFR. Pre-selected as a **research scholar** in PhD for the session beginning in 2018.

2016 • Joint Admission Test for Masters (IIT-JAM), 2016
All India Rank: 171

2016 • Joint Entrance Screening Test (JEST), 2016
All India Rank: 121

2016 • National Graduate Physics Examination (NGPE), 2016
Among the top 10% of the students enrolled at the center.

Publications

2023 • **Malik, R.,** and Khare, K., "Single-shot extended FOV imaging using point spread function engineering," *J. Opt. Soc. Am. A,* 40, pp. 1066–1075 (2023).

2023 • Patel, Y.M., **Malik, R.,** Khare, K., and Bahga, S.S., "Accurate holographic cytometry using three-dimensional hydrodynamic focusing," *J. Micromech. Microeng.,* 33, 024003 (2023).

2021 • **Malik, R.,** Elangovan, R., and Khare, K., "Computational imaging with an extended field of view," *Journal of Optics,* 23, pp. 085703, (2021).

2021 • Ahlawat, S., Sharma, P., Pandey, A., Bisht, D., Jan, A., Pant, A., **Malik, R.**, Mathur, S., Agarwal, K., Singh, S., Singh, M., and Khare, K., "Cytopathology Using High-Resolution Digital Holographic Microscopy," *IntechOpen,* book chapter, 2021.

2020 • **Malik, R.**, Sharma, P., Poulose, S., Ahlawat, S., and Khare, K., "A practical criterion for focusing unstained cell samples using a digital holographic microscope," *Journal of Microscopy,* 279, 2020, 114–122.

Conferences & Workshops

Symposium • Point Spread function Engineering for Extended FOV Imaging, *PMRF Annual Symposium* (2024), IIT Indore.

Conference • Exploring PSF engineering for enhanced FOV in computational imaging systems while overcoming practical constraints, Unconventional Optical Imaging IV, *SPIE Photonics Europe,* 1299606 (2024).

Conference • Computational imaging with extended FOV, (Best oral presentation award), *International Conference on Advanced Biomedical Imaging,* (2023), IIT Madras.

• A computational imaging system that can see outside the sensor boundary, *Workshop on Recent Advances in Photonics (WRAP)*, (2022), IIT Bombay.

Conference

- A Practical Criterion for Focusing on Unstained Cell Samples Using a Digital Holographic Microscope, *International OSA Network of Students (IONS 2020).*, IIT Delhi.

Patent

- Priority date: April 9, 2021 (Field Provisionally)
  COMPUTATIONAL CAMERA WITH EXTENDED FIELD OF VIEW
  The patent discloses a method for imaging systems that can image accurately beyond the physical sensor size

Education and Technical Proficiencies

- Computational Optical Imaging
- Statistical Optics
- Fourier Optics & Holography
- Biomedical Optics & Bio-photonics
- Numerical & Computational Methods in Research
- Numerical Optimization
- Electromagnetism
- Classical Mechanics
- Mathematical Physics

Volunteering

2022 - 2024 • Teaching Assistance: NPTEL Gate Physics Course
2024 • **Reviewer:** Journal of Physics D: Applied Physics
2021 • **Reviewer:** Journal of Modern Optics (JMO)
2020 • **Volunteer:** IONS India Conference 2020, IIT Delhi