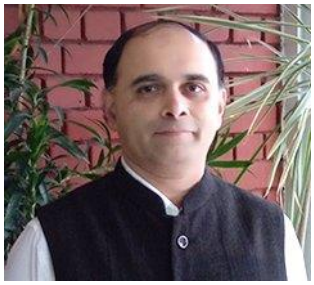
Executive Summary



Kedar Khare
Professor, Optics and Photonics Centre, IIT Delhi
(joint appointment with Department of Physics, IIT Delhi)

1. Title of the Project:

   Lens-less Computational Microscopy: Concepts, Devices and Bio-Medical Applications

2. Date of Start of the Project:

   1-October-2023

3. Aims and Objectives:

   Year 1: Algorithm design for lens-less imaging and simulation tests.

   Year 2: First system setup with associated algorithm, comparison with standard microscopes.

   Year 3: Demonstration of cell imaging with developed system, specify system parameters.

   Years 4, 5: Point-of-care device prototype and application development in collaboration with Bio-Medical science researchers. Investigate important newer possibilities for achieving super-resolution imaging in the lens-less microscopy platform.

4. Significant achievements (not more than 500 words to include List of patents, publications, prototype, deployment etc)

During the first year of the Fellowship, the following significant contributions have been made:

(1) Novel conceptual idea for stagnation-free phase retrieval algorithms has been established through simulations tests and initial experiments. This result is of critical importance to

realization of the lens-less imaging device. The work is at patent filing stage and will be published in due course.

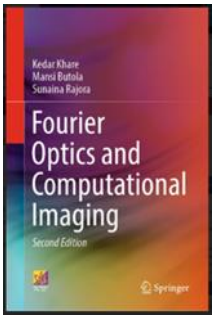
(2) Application of quantitative phase imaging/holography to problems in plant sciences and biomedical flow-cytometry applications has been demonstrated through collaborative work.

(3) A novel concept of extended FOV camera (camera that can "see" beyond sensor boundary) has been demonstrated experimentally. Ongoing work will aim to make this system compact and realizable as a viable device targeted for specific microscopy and photography applications.

(4) A joint project work on lens-less imaging of blood cells has been initiated with a diagnostics company. The ideas developed through this Fellowship support can potentially be converted into a product through this collaboration.

Publications during 1 October 2022 – 30 September 2023

Book publication:



K. Khare, M. Butola and S. Rajora, Fourier Optics and Computational Imaging (2nd Edition) [January 2023]

Publisher: Springer

ISBN: 978-3-031-18352-2

Journal publications

(1) N Goyal, D Mahor, K Khare, "Recognition of masked faces", J. Optics 52, 1327-1335 (2023).

(2) N Sharma, K Khare, S Gupta, "Determining the transfer function of a reconstructive spectrometer using measurements at two wavelengths", Opt. Lett. 48, 3753-3756 (2023).

(3) V Kumar, N Goyal, A Prasad, S Babu, K Khare, G Yadav, "Quantification of pollen viability in Lantana camara by digital holographic microscopy", Quantitative Plant Biology 4, E7, doi:10.1017/qpb.2023.5 (2023).

(4) R Malik, K Khare, "Single-shot extended field of view imaging using point spread function engineering", JOSA A 40, 1066-1075 (2023).

(5) S Rajora, M Butola, K Khare, "3D reconstruction of unstained weakly scattering cells from a single defocused hologram", Appl. Opt. 62, D146-D156 (2023).

(6) A V Malagi, D Kandasamy, D Pushpam, K Khare, R Sharma, R Kumar, SBakhshi, A Mehndiratta, "IVIM-DKI with parametric reconstruction method for lymph node evaluation and characterization in lymphoma: A preliminary study comparison with FDG-PET/CT", Results in Engineering 17, 100928 (2023).

(7) YM Patel, R Malik, K Khare, SS Bahga, "Accurate holographic cytometry using three-dimensional hydrodynamic focusing", Journal of Micromechanics and Microengineering 33, 024003 (2023).

(8) R Sapra, M Gupta, K Khare, P K Chowdhury, V Haridas, "Fluorescence by self-assembly: autofluorescent peptide vesicles and fibers", Analyst 148, 973-984 (2023).

(9) E B Kayal, S Bakhshi, D Kandasamy, M C Sharma, S A Khan, V Sampath Kumar, K Khare, R Sharma, A Mehndiratta, "Non-invasive intravoxel incoherent motion MRI in prediction of histopathological response to neoadjuvant chemotherapy and survival outcome in osteosarcoma at the time of diagnosis", Journal of Translational Medicine 20 (12), 1-7 (2022).

(10) M Butola, S Rajora, K Khare, "Robust Phase Retrieval with Complexity-Guidance for Coherent X-Ray Imaging", Intelligent Computing doi: 10.34133/2022/9819716 (2022).

Patents (granted during the past year):

1. K. Khare, P. Lochab, P. Senthilkumaran, System and Method for Engineering Robust Laser Beams Capable of Propagating through Random Media with Minimal Distortion, Patent Number 415992, 29 Dec 2022.
2. K. Khare, S. Bhattacharya, System and Method for Full Resolution Fourier Domain OCT Imaging, Patent Number 446657, 23 Aug 2023.

5. Concluding remarks

The proposed work through Abdul Kalam National Innovation Fellowship has progressed as per the proposed timeline. New conceptual ideas have emerged that have been demonstrated with initial simulation results and/or experimental results. Partnership work on lens-less imaging of blood cells with a commercial entity has also been initiated. Overall, the Fellowship support has proved to be fruitful for taking the PI's research and development work in the proposed topical areas forward in a significant manner.